Christian Walloth

Emergent Nested Systems

A Theory of Understanding and Influencing Complex Systems as well as Case Studies in Urban Systems

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Brussels
Belgium

*All science is cosmology. It is an attempt
to understand to learn more about the world.
About atoms, about molecules.
About living organisms and about the riddles
of the origins of life on earth. About the
origin of thinking, of the human mind;
and about the ways in which our
minds work.*

<div align="right">Popper 1990, p. 7</div>

To Arwin

Preface

This work is about understanding and influencing emergence. Ideas presented are relevant to a variety of fields, including matter, the emergence of consciousness, and the emergence of human cultures. Following the tradition introduced by the great systems scientist Ludwig von Bertalanffy, this work is intended to make a contribution to a "General Systems Theory," which will be valid for complex systems in general.

Since such a general system theory potentially targets readers from a variety of different disciplines, the theory is presented in a way that requires no particular, prior knowledge about systems, complexity, or even emergence. The theory builds up piece by piece, building on a common understanding of complex systems that I review in the Introduction. Thus, the chapters of this work should probably be read sequentially and in their entirety, not selectively.

This work aims to trigger change in the established ways of thinking about how novelty comes into existence and about longstanding convictions of how the physical world is closed. These convictions are denying the influence of conscious thought or cultural rules on humanity's shaping of the material world.

A further aim of this work is to bring the concept of so-called strong emergence into the applied sciences, such as urban planning. According to strong emergence, non-material qualities, such as consciousness and cultural rules, exert influence on the material world. If what emerges always comes with something new, i.e., it cannot be predicted, forecasting and planning become challenges. My aim is to articulate how the purposive activity of conscious man may nevertheless effectively influence the course of events.

The focus of this work is on the following:

1. Sketching a theory of emergence as a property of complex systems.
2. Demonstrating how the application of such a theory may yield potentially helpful insights in the exemplary case of urban development.

The theory brings together a variety of concepts of systems and emergence theories. Ways to influence emergence of novelty are deduced, as is a case-study

approach that is at least suited to urban systems. An urban system is chosen to demonstrate how the theory can be applied. Thus, this work seeks to explore new ways to interpret how the world works, and it strives to present ways to understand and influence the course of events.

Brussels   Christian Walloth
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Acknowledgment

Abstract

This work presents a theory, as well as methods, to understand and to purposively influence complex systems. Complex systems are understood as nested systems, where each system is enclosed by, and is enclosing, other systems. In particular, enclosing systems are understood as being emergent of the generating activities of enclosed systems. This occurs at first diachronically, then synchronously, i.e., autopoietically. Whenever a system emerges, in principle unpredictable, ontological novelty comes into existence. This novelty further implies new rules that will be required to guide self-reproduction of the whole (autopoiesis).

A first implication of this theory is that enclosing systems show a slower frequency of change than enclosed systems. Thus, by the very measurement of activity, it becomes possible to delimit ontologically real systems and to conceive ways to influence them.

Two directions of influence can be distinguished in Emergent Nested Systems (ENS). The first direction is generative influence from enclosed systems outwards on enclosing ones, and the second is guiding influence of enclosing systems inwards on enclosed ones.

A second implication of the theory of ENS is that, since every emergent system comes with real novelty, no two complex systems are ever the same. Therefore, studies of complex systems have to focus on a single case, rather than comparing different systems. A single-case-study approach is developed and applied to demonstrate three ways of influencing ENS. For the purposes of this work, that single case is an urban system, the city of Lviv in Ukraine.

Findings from the theory and the case studies lead to the conclusion that purposive influence in complex systems can be achieved by devising fast, triggering activities, as well as guiding rules. However, concerning the latter, decision-makers should more often consider enabling activities, rather than restricting them. Timing

interventions during phases of change, applying a method of effectuation, and working with and generating new local resources can make purposive influence in ENS highly effective.

Summary

In the present work, I suggest a theory of complex systems as nested systems, i.e., systems that enclose other systems and that are simultaneously enclosed by even other systems. According to the theory presented, each enclosing system emerges through time—i.e., diachronically—from the generative activities of the systems they enclose. The emergent, enclosing system is not another form of anything that exists yet, and there is no way to predict the quality of the emergent system before it is there.

This new quality implies new rules for the activities of the then-enclosed systems, and the enclosing quality guides the activities of the enclosed systems. Therefore, the enclosed systems synchronously reproduce the emergent, enclosing qualities in a way that is aimed at autopoiesis—i.e., self-maintenance—of the nested systems. In other words, activities in enclosed systems continuously reproduce the emergent qualities of enclosing systems.

My finding is that enclosed systems' activities—or frequencies of change—are always faster than those of enclosing systems. This finding is relevant to analyzing, understanding, and influencing complex systems. Discerning complex systems by the frequencies of their activities allows two developments. First, boundaries can be objectively drawn around systems that exist independently from an observer—i.e., ontologically real systems. Second, one can see how the frequencies of systems relate to the systems' positions in the nested systems' whole.

Thus, it becomes possible to understand which systems are emergent, i.e., enclosing and rule-setting, and which systems are generative, i.e., enclosed and guided by the rules of relatively slower systems. Furthermore, knowing this relation allows one to discern guiding rules and generative activities. One can influence by acting inwards from enclosing to enclosed systems and by acting outwards from enclosed to enclosing systems, respectively.

Where guiding rules and generative activities can be discerned—based on the frequencies of enclosing and enclosed systems—it becomes possible to purposively influence complex systems. In a nested system, there are three possible ways of influence:

1. Outward influence—changing the generative activities of enclosed systems in such a way that they are no longer in compliance with existing rules of inward influence, aiming at the emergent change of enclosing, guiding quality.
2. Inward influence—changing guiding rules, aiming at change in the activities of enclosed systems.
3. Carrying out, in enclosed systems, activities that are in compliance with existing rules of inward influence, i.e., disturbing the established, autopoietic, and stable whole as little as possible.

I demonstrate these three generic ways of influencing complex systems, i.e., of influencing the course of events in our world, by using examples of urban systems. The city I studied is a post-communist city of 800,000 inhabitants in western Ukraine. There, I could discern four superordinate systems. These systems included cultural systems that were changing very slowly, economic systems that were changing less slowly, and political systems that were changing somewhat faster. The last of these systems were technical systems that were changing relatively quickly, i.e., the systems of citizens in interaction with technical artifacts.

Besides these four superordinate systems, I studied three enclosed systems with distinct frequencies of change. The first of these systems was discerned by the interaction of dwellers with their dwellings, the second by activities of entrepreneurship, and the third by activities of using local public transport.

These three systems provided examples for inward influence that largely failed because activities of individuals did not submit to the changed, guiding rules. They also provided examples of outward influence of citizens starting up Information Technology (IT) businesses, from which a new, local, guiding 'culture' of entrepreneurship may emerge. Furthermore, the studied systems suggested that successive activities—each small enough to not disturb the emerged whole—could lead to aimed-at change.

The case studies also exemplify the need for focusing the analysis of ENS on the particular case, i.e., the actual situation in space and time. It is the possibility of emergence of new quality that is highly contingent on particular situations, which makes each complex system unique.

In order to properly conduct a case study, it is thus inevitable to apply a case-study method that focuses on a single case. I suggest such a case-study method, departing from methods of ethnography and being further influenced by a selection of recent complexity research. In conducting a single-case study, a researcher must be able to discern relative frequencies of activities, in order to understand existing nested systems and to conceive possible, new, purposive ways to influence these systems, both inward and outward.

Influence should ideally be aligned to the relatively fast and slow frequencies of change in the nested systems. The present research suggests that whenever several of the nested systems are in a phase of change, i.e., when the emergence of new quality is possible, they can be more easily influenced. Furthermore, where triggering influence is required and change may easily be enacted from enclosed systems (such as individuals or, in urban systems, citizen initiatives), slower

changing systems (such as political ones) are required to enable individuals to carry out a fast succession of activities.

Finally, I suggest that the ideas of the theory of effectuation may be adapted to effectively influence ENS:

1. Working with given local resources.
2. Continuously creating new situations, out of which new qualities may emerge.
3. Adapting a previously conceived guiding vision upon change of emergent qualities, in order to purposively influence the development of a complex system.

Contents

About the Author

Christian Walloth was born in 1979. In 2011, he joined the Advanced Research in Urban Systems (ARUS) program at the University of Duisburg-Essen, Germany. One of his research interests is complex systems, in particular the emergence of real novelty (new qualities) in complex systems. Another interest is pursuing the possibilities of influencing emergent systems, specifically possibilities of applying methods of effectuation to urban development.

Christian is the chair of the biannual symposium of Urban Systems Research at the European Meetings on Cybernetics and Systems Research (EMCSR). He is also the editor of the book series on Understanding Complex Urban Systems. Before joining the ARUS program, he worked as a strategy and management consultant for five years, primarily advising clients in the hightechnology, energy, and financial industries. He holds a degree in electrical engineering.

Acronyms

BPO	Business Process Outsourcing
CEE	Central and Eastern European
CEPT	Cultural, Economic, Political, Technical
E-CEPT	Ecological, Cultural, Economic, Political, Technical
EBRD	European Bank of Reconstruction and Development
ENS	Emergent Nested Systems
GIZ	Gesellschaft für internationale Zusammenarbeit
IT	Information Technology
PESTE	Political, Economic, Social, Technical, Ecologic
SME	Small and Medium Enterprise
UNESCO	United Nations Educational, Scientific and Cultural Organization
WWII	World War II

Introduction

We may, however, conceive of a scientific understanding of human society and its laws in a somewhat different and more modest way. Such knowledge can teach us not only what human behavior and society have in common with other organizations, but also what is their uniqueness. Here the main tenet will be: Man is not only a political animal; he is, before and above all, an individual. The real values of humanity are not those which it shares with biological entities, the function of an organism or a community of animals, but those which stem from the individual mind. Human society is not a community of ants or termites, governed by inherited instinct and controlled by the laws of the superordinate whole; it is based upon the achievements of the individual and is doomed if the individual is made a cog in the social machine. This, I believe, is the ultimate precept a theory of organization can give: not a manual for dictators of any denomination more efficiently to subjugate human beings by the scientific application of Iron Laws, but a warning that the Leviathan of organization must not swallow the individual without sealing its own inevitable doom.

von Bertalanffy (1968/2006, pp. 52–53)

Difficulties of Planning and Forecasting

In major cities that continue to attract greater numbers of people, we see the success and failure of man-made and seemingly self-organized developments. A plethora of books has been published on how cities ought to be organized and what successful developments look like: healthy, green, sustainable, for people, renewable, compact, self-reliant, and resilient. In particular, the aforementioned kind of literature comes with the promise to learn from a positive development that has happened elsewhere and in many other time periods. Examples are studies about Vancouver (e.g., Punter 2003), about waterfront developments such as the London Docklands (e.g., Desfor et al. 2011), and about the development of the thriving region around Palo Alto in California known as Silicon Valley (e.g., Castells and Hall 1994, p. 12ff. and Leslie 2001).

Successful developments planned after these types of success stories, or any other development plans, are difficult to find. There have been a large number of attempts to create something similar to California's Silicon Valley elsewhere, such as Silicon Saxony (Germany), the Dubai Silicon Oasis (United Arab Emirates), Silicon Alps (Switzerland), and Silicon Glen (Great Britain). However, no place modeled after these largely successful communities comes close to the originals. Rather, Castells and Hall (1994, p. 238) have "recorded many partial failures and many still-open verdicts" of planned "technological-industrial futures" carried out "by deliberate action and with foresight."

In another example of a planned development drawn from case studies that are presented in this work, policymakers tried to change the habits of citizens without breakthrough success. This case study was conducted in a Central European city with many buildings that were built before 1900. With the aid of a Western European development agency, these policymakers tried to get citizens to remodel their houses in a prescribed way, e.g., renewing windows in the 'right' way and painting facades in the 'right' colors. Workshops were organized, educational material was provided, and regulations were devised. But citizens still cut doors in the façades of the built heritage and installed the 'wrong' windows. How could changes have been implemented more effectively?

There are, on the other hand, urban systems that are thriving and are seemingly self-organized, e.g., around central places. Larger cities attract and then provide services and other functions to their own citizens, as well as to citizens of smaller towns in the vicinity (cf. Christaller 1933). Interactions among these central places and the surrounding towns keep the organization of the system alive. What seems to be self-organized may, however, just follow some implicitly understood cultural habits, economic rules, and ways of political decision-making. I think it may be interesting to know how these rules come into existence, rather than how structures of readily developed places can be copied from successful developments, such as Silicon Valley or the London Docklands.

In the same Central European city mentioned above, a culture of entrepreneurship is just about to come into existence—without this being the result of a plan or subsidies for start-up companies. How many cities are trying to create or plan a thriving start-up culture, which is often seen as the precursor to an economy based on local knowledge? Isn't the core of such attempts of planning and policymaking today an unbroken belief in the power of forecasting, fed by facts and figures from past developments, often in other places? What accounts for planning also holds true for the evaluation of plans, in particular ex-ante evaluations. How would it be possible to assess a plan if the future environment—the conditions found when the plan would be implemented—is unknown?

When such attempts at planning, policymaking, and forecasting are made, why have they proven to be disappointing far too often in the past? Whether it is urban planning, policymaking, economic market forecasting, or even the prediction of new inventions, why do predicted scenarios of planning rarely match reality? What can be done?

Two questions are of interest in this work. First: What renders forecasting and planning so difficult, if not impossible, in our world? This is the question guiding the theoretical study. Second: What can be done to purposively shape our future, even if forecasts and plans fail? The latter is the question that leads to ways of influencing the course of events, based on an understanding of what is actually going on.

What Makes Planning Difficult?

There are further questions guiding the theoretical study: Is everything determined, and as such, in principle, predictable (even if the sheer amount of possible futures would exceed all practical possibilities)? If everything is not determined, does this uncertainty about the future have something to do with the complexity of our world? But what is complexity? What is it that makes systems become, or become perceived as, complex? Is there a general system principle behind complex systems and related (immaterial) qualities, such as consciousness in men and urbanity in a city?

Can immaterial, cultural norms influence the activities of individuals, i.e., their material bodies moving around material things? An urban place, in this sense, is more than the material structure, but it comes with cultural connotations. For example, if you have a good 'feeling' about a place in a city you visit, will you act differently than when you are in a place that doesn't make you feel good? What is the significance of new developments, of new ideas, of real novelty? How does novelty come into existence?

When something comes into existence that is qualitatively new and, in principle, unpredictable from what it was before, I call it emergent. This type of emergence is different from the emergence referred to in (popular) scientific literature, describing the development of patterns such as fractal shapes. This latter type of development clearly is an arrangement of given and known elements following certain rules.

With the present work, however, I aim *not to see qualities and rules as given* preconditions. Rather, I aim to develop a theory of how novelty comes into existence—i.e., how new qualities and new rules emerge, how such *novelty changes the course of* events, and which tools can be used to influence the emergence of novelty. This will lead me to the hypothesis of Emergent Nested Systems (ENS), i.e., of systems that become enclosed by a new emergent system—the enclosure being realized through new rules that come with the emerging quality. A theory of ENS applies to both emergence from unconscious nature, and to emergence from purposive activity.

Purposive activity requires emergent consciousness and conscious minds that are able to interact with the physical world. No emergence means no consciousness, which leads to no inward influence and no free will (that has an impact). Purposive decision-making—and how it is possible when everything is complex and when the future bears surprises—is the main underlying theme of this thesis. That decisions

taken by conscious minds may create tangible impacts is, on one hand, an example for interactionism between the material world (body) and mind. On the other hand, (and more important in the context of this work), it is an example of the outward influence of relatively faster activities, e.g., human activities, able to trigger changes in relatively slower systems, e.g., cultural and technical systems.

Even technical artifacts become complex systems in interaction with other systems, and with users of these artifacts. Seen from a technical perspective, technical artifacts are not, per se, complex systems. E.g., in cities, a network of roads or a network of tramways is, when considered as a closed system, a mechanical system. Only upon their interaction with other urban systems and with users such as drivers and passengers—when these technical systems cannot be considered closed any more—do they become a part of the complex (urban) system. (This will become clear in Chap. 6, in which I will discuss an intervention aimed at improving the public transport system in the city of Lviv in Ukraine.)

The existence of consciousness and the social realm is explained in old and new theories of emergence—accounts that "diverge into a bewildering variety" (Wilson 2012, p. 2). I will add to this variety, since it is not my intention to start from older theories of emergence. This is because the knowledge gained through the systems and complexity sciences over roughly the past 70 years cannot be neglected. This knowledge will serve as a basis for a new development, or a redevelopment, of a theory of emergence.

In this research, I could draw a connection between systems of relatively high and relatively low frequency of internal activity: the faster system is always enclosed by a slower one. This finding may have great explanatory power. It also points to the direction of ontological systems, i.e., systems that are not constructed as such—or seen as systems—by a subjective observer.

Thus, the present work is an attempt to conceptualize a theory of emergence, in which relative frequencies of change in systems are related to other notions that come along with ENS. Almost all aspects of the theory I originally assumed were unique, I later discovered in writings of other scientists. This is even true of the hypothesis that slow systems enclose faster systems. However, I did not come across any theory of the emergence of nested systems which includes the concept of fast systems being enclosed by slower ones.

Purposively Influencing the Course of Events

During my studies, I have often been confronted with questions like: "What is this good for?" Or: "Do you have a method to be applied?" Upon thinking about how the knowledge brought forward in this work can be applied to urban development, I had these questions in mind myself. However, I felt that some basic research was necessary.

I've begun research to contribute to a real, although broad, problem: Why doesn't urban planning work out more often? This question could be formulated

similarly for any other planning—in business, private life, and public life. This, consequently, leads to the question of knowledge: What can we know and not know? Furthermore, it leads to the causally unexplainable qualities of life, such as consciousness and urbanity.

Planners like to talk about making policies, changing mindsets, educating people, and telling citizens what to do. However, it doesn't seem to cross their minds that a cultural system has emerged; the location-specific, citizen-specific habits, the things one does and things one doesn't do, the points of view and the valuations of this and that are much stronger than policies aimed at reeducation.

This work will hopefully contribute to the understanding of why we cannot acquire full knowledge, how this relates to real novelty (rather than cognitive limitations of the human mind), and how, nevertheless, we can influence the course of events, effectively shaping our environment. By acknowledging man's creativity, inventiveness, intelligence, foresight, and goals, we also acknowledge principle limits; i.e., we can't plan urbanity, and we are surprised by emergent qualities. Emergence limits our a priori knowledge in principle. Furthermore, effectuation— when based on a thorough understanding of given nested system relations and applying outwards, inwards, or within-the-system influence—enables us to provide appropriate environments to cultivate growth.

The result is a piece of theory that might turn out to be useful in purposive planning, in shaping the future, and in the creative act of influencing our future, such as in urban research and/or development practice. The theory suggests that, if we look at nested systems, we see that they can be seen as emerging from the enclosed systems. They are extremely full of, and influenced by (through the processes of emergence) other systems, some of which may not even be known yet.

Structure of This Work

The theory of ENS started with an abduction, an idea somehow based on basic ideas of complex systems that were already around (Introduction, Chap. 1). In Chap. 2, I discuss the abductive leap, a thought that developed around unknown unknowns—things that we cannot know and in principle cannot predict, because they will be absolutely new once they come into being. The theory of emergence, i.e., the coming into existence of the unknown unknowns in complex systems, is also a theory of nested systems, i.e., of systems that are enclosed in one another. It is also a theory of relatively fast and relatively slow systems.

This theory of emergence of real novelty, of nestedness, and of relatively fast and slow systems has major implications on all our forecasting and planning. It is a good starting point for a theory that aims to explain why our plans often don't work out. Everything that follows in theory is deduced: deduced implications about the way complex systems and emergence work (Chap. 3), deduced ways to influence ENS (Chap. 4), and a deduced case-study method (Chap. 5). I , thus, explain how we may still shape our future with foresight and intention.

I back up and demonstrate the application of the theory with the examples of three case studies from an urban system (Chap. 6). I hold, with Manson and O'Sullivan (2006), that urban systems are particularly well-suited to test hypotheses about complex systems: "Place and space research presents ample opportunity to … free research from being trapped at a given level of analysis. This is particularly useful when addressing emergence, which tends to act at multiple spatial, temporal, and societal scales" (Ibid., p. 684).

Over the course of each of the case studies, the nested relations of various systems, as well as outward and inward influence between nested systems, will become clear. With the background of the theory of emergent systems, the single case-study approach becomes more than an ethnographic, thick description. It also becomes more valuable, since the theory points out ways of influencing complex systems.

I use examples and findings from three case studies to show how purposeful interventions in urban space can be understood through the theoretical contribution of ENS, and how the suggested approaches to influence ENS could make these interventions more effective. Or, at least, I show how to be more realistic about the limits within which possible outcomes of urban interventions can be achieved (Chaps. 7 and 8).

Chapter 1
Complex Systems and Man's Desire to Understand and Influence Them

> *How can we have any security or plan anything if everything changes all the time?*
>
> Rand 1957, p. 10

Why does some purposive planning fail, while some unplanned developments prosper? Why is one city lucky to develop a culture of cozy coffee shops, while another city becomes a tourist attraction, and yet another city doesn't seem to develop new, decisive qualities? Why do neighborhoods or entire regions also fail to develop the latter? What gives rise to urbanity in a city, and how is it possible to introduce urbanity into an assembly of buildings and streets?

All these exemplary questions concern the city as a whole—the city as urban *system*. System and complexity theories have been developed and applied to explain urban systems. But what can researchers and practitioners learn from these existing theories about the success or failure of planning in systems like cities? What could they learn about the development of *qualities*, such as urbanity, that may have a significant impact on the course of events?

It is, thus, no surprise that system and complexity theories have long been applied in urban and regional studies. Before system studies had become popular, Christaller (1933) had already described how smaller and larger towns form an interdependent network in his theory of central places (Fig. 1.1a). Jane Jacobs concluded her famous analysis of the *The Death and Life of Great American Cities* by recognizing that cities are what Weaver (1948) called systems of organized complexities. "The Kind of Problem a City Is," Jacobs states, is one of "organized complexity, 'in which a half-dozen or even several dozen quantities are all varying simultaneously and in subtly interconnected ways' " (Jacobs 1961, p. 433). Such interconnectedness may be visualized by Kauffmann's button model (Fig. 1.1b).

More recently, system approaches applied to understanding and influencing complex urban systems are flourishing with the research of Juval Portugali (e.g., Portugali 2008, 2011), publications edited by De Roo et al. (2012) and Walloth et al. (2014), and the dedication of research groups, such as Advanced Research in Urban Systems (UDE 2015), urban systems symposia (e.g., EMCSR 2014) and researcher's work

groups (e.g., AESOP 2015). And this is mentioning only a few of the latest activities. A brief overview of branches of system sciences and their application in urban studies is provided in Gurr and Walloth (2014, pp. 4–5).

The aim of applying complex-system concepts to cities is often related to the support of decision-making in the context of urban development. For example, system-dynamics models may reveal hidden interrelations and allow for the simulation of various scenarios—assuming the structure of the system and the dependencies remain the same over time. The system-dynamics method was pioneered for cities by Forrester (1969).

Later, system theories were likewise demonstrated to help with decision-making, such as theories of self-organization. Both Nicolis and Prigogine (1977) and Haken (1977) have developed theories of self-organizing systems, i.e., of dissipative systems and of synergetics, respectively. In the context of urban systems, the first theory was applied by Allen and Sanglier (1981), the second by Weidlich (1987). Today, agent-based models that simulate individuals' activities have gained considerable ground in supporting decision-making processes (e.g., Batty 2003 and Gebetsroither-Geringer 2014).

It isn't often asked why plans don't work out—despite all our theories and models of complex systems. Why could all the chains of causes and effects—or the activities of individuals—considered in our system-dynamics—or agent-based models—not come up with a scenario of a new coffee shop culture or the attraction of love locks?[1]

(a) Levels of central places (Christaller 1933, Fig. 2)

(b) Kauffmann's button model (after Kauffman 1996, Fig. 3.3)
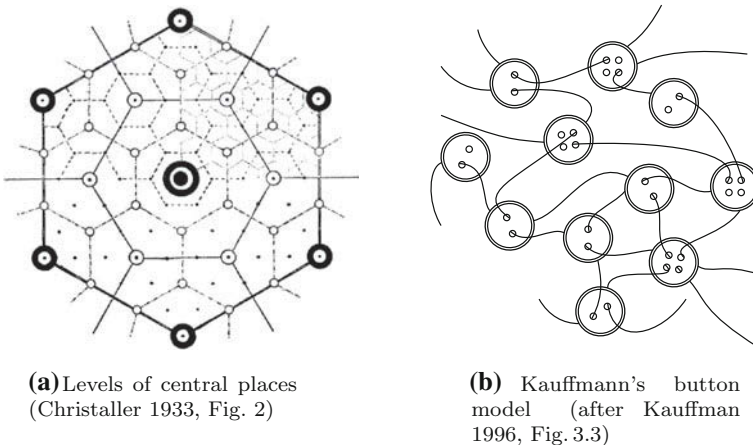
Fig. 1.1 Systems as networks of interdependent elements: **a** Christaller's model of central places and **b** Kauffman's button model (own illustration). Kauffman's model illustrates the interconnectedness in complex systems, as well as the interdependence in case of local variation: If one button is pulled into one direction (or even removed), the change propagates through the entire network (see also Atun 2014, p. 53)

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[1]Love locks are padlocks, which are usually engraved with the names of lovers. The lovers then fasten the locks onto the balustrade of a bridge and throw the key into the water. The love-lock

What are our theories and models good for if forecasting the real game changers lies outside their capabilities? By investigating the reasons why some plans do not work out, I will offer an alternative route to understanding complex systems, as well as understanding how purposive planning could become more effective.

In this work about complex systems, I will often draw on examples from cities, i.e., complex *urban* systems. Urban systems are complex in the way complexity is understood in this work (see below, Sect. 1.1). Urban systems are complex, in that interactions in urban systems can be very many and of various kinds. These interactions may be among many parts of the system, and both parts and interactions may be changing over time. For example, Christaller (1933, p. 26) suggests that central places gain their significance from the intensity of (economic) interactions of individuals.

These interactions may change with time and by the activities of individuals:

> Every birth and every death, every change of profession by an individual, every change in fashion, every change in individual wants for certain goods, every invention, every price fluctuation, every new tax, etc., influences the size of the range of the central goods, even if only to a small degree (Christaller 1933, p. 113).

This, in turn, "might well lead to changes in the overall system of central places" (Ibid., p. 113).[2]

With this work, my aim is to contribute to a branch of science that Ludwig von Bertalanffy (1968/2006) termed "General System Theory." General system theory seeks to identify principles common to a variety of, if not all, complex systems. General principles, so-called isomorphisms, are valid for, e.g., both the physical and the social realms. In choosing urban systems to exemplify my theory of studying complex systems, as well as my corresponding case-study methods, I will be able to apply this theory and these methods in a way that transcends disciplinary approaches. Other than urban systems, not many systems could be studied from a variety of disciplinary perspectives. These varied perspectives include politics, the physics of the present materials, the biology and ecology of the living beings, the psychology and social habits of citizens, and so on. In urban systems, very different things come together; e.g., technical artifacts meet cultural codes. This will allow me to demonstrate general system principles on a study object that is one and the same.

Structure of This Chapter

In this first chapter, I will introduce basic ideas, concepts, assumptions, and conjectures related to complex systems. I will take up the idea behind complex systems, as opposed to mechanical (analytical) and random (stochastic) systems (Sect. 1.1). Then I will come back to the problem of prone-to-failure planning, from which I will

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(Footnote 1 continued)

trend has changed urban places, including their attraction to locals and tourists, in an unforeseen way. For example, it had a major impact on the image and tourist attraction of the Hungarian city of Pécs (cf. Hammond 2010).

[2]My translations.

deduce my working hypotheses, as well as questions to be answered in the course of this work (Sect. 1.2).

In this context, it is important to understand that, despite the risk of failures of any purposive activities such as urban planning, there is a point in searching to influence the course of events. This understanding requires a concept of development that is different from both the concepts of deterministic planning and random evolution (Sect. 1.3). The empirical focus of this work is on urban systems. From these systems, many examples could be provided from failed planning and unplanned developments, and they also make good case studies to exemplify theories of complex systems (Sect. 1.4). This introduction concludes with an overview of the structure of the subsequent parts of this book (Sect. 1.5).

1.1   Complex Systems

Any attempt to understand a system faces the first challenge of its description—creating a model, i.e., a representation of the system. Three types of models of a system can be distinguished since the work of Weaver (1948):

1. Models of systems in which all (relevant) cause-and-effect relations can be analyzed and in which said systems can be understood from the understanding of all of these cause-and-effect relations.
2. Models of systems that can be built on the likelihoods of effects the systems produce with and/or without external stimuli.
3. Models of systems that seem to be 'more complex' and that cannot be achieved by either of the first two methods.

For some systems, analyses of their parts and activities, i.e., the systems' cause-and-effect relations, may lead to their descriptions. This is possible in cases where the parts to be modeled are few, and the activities, e.g., the interactions to be modeled, are either few, or structured enough as to be easily understood (Fig. 1.2, region A). In urban systems, one could, e.g., select a good or service an individual regularly purchases. Knowing the distance that individuals would go to purchase the good or service, the population distribution, and the minimum purchases of a good or service justifying a sales location, one could then model the development of a system of central places (central with respect to having a sales location for that good or service). The difficulty of such explicit cause-and-effect models arises from mutual influences among central places: a demand satisfied in one center will leave profit there, increasing the center's relative significance. Over time, the system's development—growth or decline of central and peripheral places—follows profit shifts among centers (White 1974, p. 220).

For other systems, the analysis of average effects may lead to a system's description. This is possible in cases where the parts are very many and/or the activities are randomly distributed (Fig. 1.2, region B). In urban systems, one could, e.g., consider the median household income. Knowing the number of households in each town and

the average annual household expenditures on goods and services, one could then determine the centrality of a place by the expenditures it additionally attracts from outside sources (Preston 1971, pp. 139–140). Such a statistical model could help to predict how central places develop if incomes and/or expenditures grow or decline, if products and/or services are replaced by new ones offered in different centers, or if a central place from just outside the considered region grows stronger. However, such a statistical model cannot predict the impact of a single activity on the growth or decline of a center's relative significance, as it develops under the mutual influences among all central places.

In many additional systems, parts and their activities are too manifold and/or unstructured to be modeled analytically. At the same time, single activities can have too significant an impact for the systems to be modeled statistically (Fig. 1.2, region C). In those cases, when a system cannot be adequately modeled analytically or statistically, the system may be called complex.[3] It is both too complex to be reduced to an analytical model and too complex to be modeled in terms of statistical averages (cf. von Bertalanffy 1968/2006, pp. 35, 93 and Weaver 1948, p. 583).[4]

A complex system, according to this classification, is made of many different parts that act in a nontrivial way. In order to be a complex system, these parts and their activities must be dynamically changing over time (after Simon 1962, p. 468).
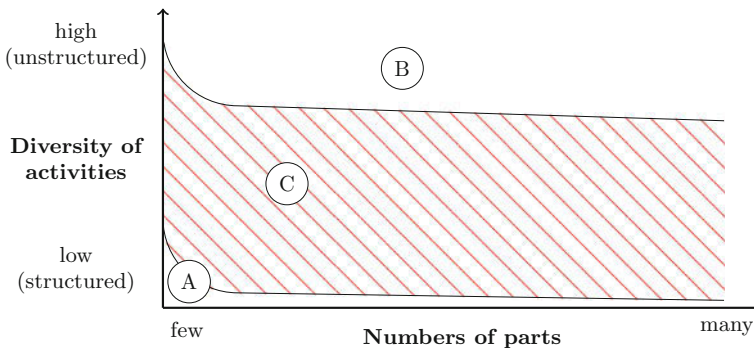
Fig. 1.2 Analytical (A), statistical (B), and complex (C) systems can be defined by the number of parts and diversity of these parts' activities each (after Weinberg 1975, p. 18)

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[3]Weaver (1948) originally called this 'organized complexity', as opposed to what he called 'disorganized complexity' and to what would later be referred to as statistically describable systems. However, in this work, complex systems are those which cannot be adequately modeled analytically or statistically.

[4]Weaver's distinction between three types of systems may not point to ontologically different systems, but only *epistemologically* different systems. If so, then all systems are in fact complex systems. However, at some aggregate levels, we can observe them as mechanical artifacts, such as a tramway, or as statistical "systems," such as a population.

1.2   The Limits of Planning Complex Systems

Where systems are complex—where interactions and parts are changing all the time—how then is it possible to devise effective plans? Where systems are too complex to be reduced to an analytical model and too complex to be modeled in terms of statistical averages, how can results of purposive activities be foreseen?

Indeed, plans often don't work out as intended. Examples of this are provided in the case studies discussed in Chap. 6. Thus, I would like to state the following …

> **problem definition**: Planning in complex systems is prone to failure.

But why might plans not work out in complex systems? My conjecture is that some plans don't work out due to the types of system properties that are able to stabilize or break up systems without men's purposive activities. These properties must be influencing the complex system in such a way that purposive development plans might not succeed. Referring again to Christaller's central place theory, how could urban planning change the order of economic significance in an established central place system, or even change it in a case where a central place system is just developing on its own? Which kinds of properties in a system establish and maintain such a central place system, in which each smaller or larger town has its particular significance?

I suggest that it is worth looking at how complex systems come into existence, in order to possibly find ways to influence their development, i.e., methods which are less prone to failure—and thus more effective—than planning methods that consider cities as either mechanical or statistical systems. This leads to my …

> **working hypotheses**: Properties of complex systems may void purposive development plans. However, purposive development might become more effective if these properties could be understood.

In brief, I claim that the (deduced) fact that complex systems develop on the basis of their own, inherent properties is at the core of (at least some) planning failures and, thus, that this requires investigation. Henceforth, I set out to discover these properties, to understand how purposive activities are influenced by these forces, and to find out how this influence of the complex system can itself be influenced effectively by man's purposive activities. Thus, these are my …

> **research questions**: Of which type are the inherent properties of complex systems? How do they influence purposively planned developments? How can purposive planning, in turn, influence these system-inherent properties?

1.3   Purposive Planning and Untargeted Evolution

Even though, or perhaps because, planning, as it is understood and performed today, is prone to failure, there is a point in searching for ways to better influence the development of the complex system. This might require a different approach to

understanding complex systems. Besides the understanding that rests on analytical cause-effect relations or statistical correlations, a complex system could be understood as an evolutionary system that shows results of mutations and various types of 'natural' selection. In addition to or instead of this understanding, it could be seen as a system in which purposive and creative human activity complements the evolutionary development.

Much planning rests on the idea that (at least partly) deterministic cause-effect relations can be discerned—either by analytical (discrete cause-effect relations) or statistical (overall cause-effect relations) methods and reproduced. E.g., urban planning assumes that "design and regulation of the uses of space … involving goal setting, data collection and analysis, forecasting, design, strategic thinking, and public consultation" (Encyclopaedia Britannica 2012) is effective.

However, as explained above, there are limits to the analytical understanding of complex systems (cf. Sect. 1.1), as well as limits of planning in complex systems in general (cf. Sect. 1.2). Above all, our daily experience tells us that the future cannot be determined.

The theory of evolution introduces mutation and selection into concepts of development. Evolution follows no strategy; it "has no foresight or memory: it can't aim at future targets, and can't learn from models of past successes" (Marshall 2009, p. 268). But understanding complex systems purely in analogy to biological systems would mean giving no consideration to man's ability to make foresighted decisions and/or regarding man's decision-making as either just a series of noises leading to mutations or a selection of developments which have already appeared.

In fact, planning involves purposive decision-making, though that does not stand alone in a complex system. On one hand, there is untargeted evolutionary development that can be understood as "unthinking trial and unforgiving error," with selection determined "by the environment, which itself has no purpose" (Ibid., p. 269). On the other hand, in contrast to biological evolution, man is able to "evaluate the end state of the imagined behavior" (Popper 1978, p. 354). Man's ability to anticipate, his (imperfect) "foresight and memory" (Marshall 2009, p. 269) "may lead to useful actions in the physical world" (Popper 1978, p. 350), as well as to creative, targeted "macro-mutations" (Marshall 2009, p. 269). However, purposive decision-making by one person may interfere with the (unrelated) decisions of other individuals. Development is, at first, evolutionary, and, in cases of purposive decisions and activities of men, it is influenced—but not determined—by these decisions and activities.

Whether by mutation or design, development happens in a complex system. There are, in complex systems, mutation and purposive introduction of change, as well as purposive and purposeless selection. This "implies that … we can do better than having no planning at all [and] that we can somehow have an … outcome that is better than … evolution left on its own" (Ibid., p. 254).

In order to make purposive activities more effective in influencing complex systems, I suggest looking into how the interplay of complex systems and purposive activities works. From this endeavor, an understanding of complex systems shall arise that enables man to consider and employ a system's inherent properties, which is a

significant contrast to what traditional (urban) planning does. The subsequent chapters aim to make a contribution to understanding and influencing complex systems in this sense.

1.4 Evidence Supporting the Theory

Evidence is required to test a theory that is being developed. More generally, case studies are required to illustrate a theoretical understanding of complex systems. Case studies may show the system-inherent properties, as well as the game-changing influence of particular activities or developments. In addition, such studies show how particular activities and developments can be traced back to man's purposive decisions—implemented as, e.g., urban interventions.

The following questions, raised implicitly and explicitly throughout this introduction, were helpful in choosing insightful case studies: How does urbanity come back into a city which had been deprived of it? Under which circumstances may a culture of cozy coffee shops develop? Why don't some places thrive? Does planning fail because there are systems-inherent properties in place that will not let the plan prosper? How do complex systems develop in a city over time? How can knowledge about a complex system be used to make development targets more effective? How can a deadlock situation in a stable system be broken up to allow for innovation?

Hence, studies of urban systems should deliver two types of evidence. The first evidence should support the hypothesis of the existence and influence of system-inherent properties. The second evidence should show that case studies—that do not assume that the city is understandable as either an analytical or statistical entity—can provide an insight into approaches to urban development. Thus, case studies should reveal how complex systems develop from the interplay between system-inherent properties and man's purposive activities.

1.5 The Structure of This Work: Theory, Evidence, Conclusion

Some fundamental ideas have been introduced in this chapter. It should be clear by now that complex systems develop through an interplay of purposeless evolution and of purposive activities, and that I assume that men's purposive activities might become more effective if complex systems' inherent properties are understood.

Subsequently, an initial question to be answered is exactly how complex systems come into existence. This question will be dealt with in Part I of this book, in which I am going to make a contribution to the general theory of complex systems. In Part II, I will develop an approach to understanding complex systems, and I will present three case studies from an urban system, the city of Lviv, that support this

theoretical contribution. Finally, in Part III of this work, I will draw a number of conclusions concerning the understanding and influencing of complex systems.

> But people who are interested only in how a city "ought" to look, and are uninterested in how it works, will be disappointed by this book. It is futile to plan a city without knowing what sort of innate, functioning order it has
>
> Jacobs 1961, p. 14

Part I
A Theory of Emergent Nested Systems

Chapter 2
Emergent Systems: Nested, Fast, and Slow

> *What matters is that the movement and fate of the parts from*
> *that time onward, once a new whole is formed, are thereafter*
> *governed by entirely new macro-properties and laws that*
> *previously did not exist, because they are properties of the new*
> *configuration ...*
>
> Sperry 1986, p. 267

Where do these game-changing qualities, such as a new coffee shop culture or the attraction of engraved padlocks, come from? As indicated above, I suspect that such qualities are due to properties that can only be found in complex systems, but not in analytical or statistical ones. These properties are not (yet) usually considered when decisions are made in complex systems. I claim that the available approaches cannot predict *new* qualities, which, I argue, are the true game changers in complex systems. It is the core concern of this chapter to uncover this property of complex systems.

Is it, in principle, possible to know what the future may bring for complex systems, i.e., what may interfere with our plans? Or do we simply have to deal with novelty that is, in principle, unpredictable? Would such novelty arrive out of the blue, or could it at least be anticipated as the result of contemplation—or even of a subtle feeling? Considering the often seemingly stable order of urban or other complex systems, how may novelty exert any significant influence at all?

In this chapter, I aim to provide a first understanding of complex systems as *Emergent Nested Systems*. In brief, I will claim that complex systems are emergent and that a relatively faster system is always enclosed by a relatively slower one. This chapter and the following two chapters will present a largely theoretical contribution; however, here and there, I will exemplify some points by referencing urban systems, or systems that can be found in cities. I will exemplify the applicability of my theoretical contribution in Chap. 6.

Developing this contribution would not have been possible for me without the ground prepared by prior works of many remarkable scholars. Among the works cited throughout this chapter, I would like to highlight the first chapter in *The Self And Its Brain* by Popper (1977), and "The Architecture of Complexity," an article by Simon (1962); these are very fruitful resources concerning "the admittedly vague idea of emergent evolution" (Popper 1977, p. 16).

In the former mentioned work, Karl Popper introduced his propensity theory (first published in Popper 1959) on the probabilities of *single cases* into the wider context of emergence, e.g., the emergence of life, consciousness, and "creativity…which…we find in man" (Popper 1977, pp. 15ff.). In the same chapter, he also introduces levels of emergence in nature, and furthermore, he suggests that there is both outward and inward influence acting between the levels. "Each level is open to causal influences coming from lower and from higher levels" (Ibid., p. 35). The blend of propensity theory with notions of emergence is what makes Popper's ideas the point of departure for my work. Also, his merely-sketched theory presents the possibility to re-conceptualize—in light of the recent developments in system and complexity sciences—a theory of emergence.

In the latter mentioned work, Herbert Simon attributed high-frequency dynamics to enclosed systems and low-frequency dynamics to enclosing systems. However, Simon did not, at least to my knowledge, suggest any relation between emergence, nestedness, and fast and slow systems.

Many other scientists, who have influenced the development of my theoretical contribution, have been working along the same, or complementary, lines. These scientists notably—but certainly not exclusively—include Herman Haken (e. g.1977, 1981, and 2012), Christopher Alexander (2002a, 2002b, 2004, and 2005), and Christian Fuchs and Wolfgang Hofkirchner (e.g., 2005).[1] It should not go unmentioned that many other scholars have worked on theories of emergence over the past 100 years—from the British emergentists (e.g., Samuel Alexander, Charles Dunbar Broad, and Conway Lloyd Morgan, cf. Stephan 1999) to more modern proponents, such as Roger Walcott Sperry and Donald Thomas Campbell (cited in, e.g., Popper 1977) and the contemporary American emergentists, such as Sawyer (2005) and Deacon (2011).

However, none of the scientists mentioned in the last paragraph seem to have been aware of the high- versus low-frequency dynamics mentioned by Simon—an idea which plays a key role in my work.

Structure of This Chapter

The structure of this chapter can be understood along three key themes: unknown unknowns, propensities and emergent qualities, and properties of nested systems, especially the relation between relatively fast and relatively slow systems.

At first, I will suggest that *nested* systems emerge out of propensities, i.e., inherent dispositions of *unique situations*. This means that the emergence of a system is not under the control of anyone, and that it cannot be predicted before it starts to exist (Sects. 2.1 and 2.2). This, of course, has consequences for the value of *comparative* case studies; more about this in Chap. 5.

The notion of *emergence* is certainly the most intriguing one here. I will argue that emergence always involves a *qualitative leap*, i.e., a new quality beyond what could have been imagined, based on known qualities and the knowledge of the situation

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[1]Although Alexander is approaching complex systems from a slightly different point of view, I'm convinced that he is working on elucidating the very same quality. What he calls life, the quality that creates and is bound by centers, is what I describe here as emergent quality—being enclosed as a center and enclosing other centers.

it appeared from. There are qualities which we have no ability to know, predict, or imagine until they start existing in this world. I.e., how could life have been imagined in a world without life, and how could a city have been imagined in a world with only scattered farmhouses?

In Sect. 2.2, I will argue that the ever-new emergence of systems actually leads to a *nested* arrangement (Sect. 2.3.1). In nested arrangements, the emerged systems are guiding the systems that previously existed by means of *new rules* (Sect. 2.3). I will explain in Sect. 2.4 how the nested systems always exhibit faster *dynamics* than the nesting ones. In a nested arrangement, the emerged slower systems guide the fast systems' activities, while the fast systems might, in turn, indirectly change the guiding rules—a relation that I consider to be most crucial for the understanding of complex systems.

The bottom line with regard to decision-making in complex systems might appear as trivial as this: Plans don't work because situations change. The entire story, however, is not as simple as this sounds.

2.1 What Do We Not Know that We Don't Know?

Man is continuously making decisions based on limited, imperfect knowledge. On one hand, this is due to individual limitations of knowledge, since "knowledge…[is] not given to anyone in its totality" (Hayek 1945, p. 520).[2] On the other hand, there is,
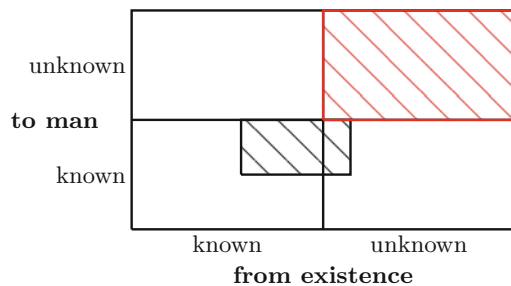
Fig. 2.1 The four realms of (un)knowledge. The knowledge of the individual (*dark hatched area*) excludes unknown knowns. It is furthermore limited to the individual's subset of known knowns, i.e., the knowledge about what exists in the world, and known unknowns, i.e., the knowledge that some situations in the future cannot be known, e.g., the time and strength of the next earthquake. Like known unknowns, which may not be known by anything in the universe except man, unknown unknowns do not yet exist in the universe. Unknown unknowns involve objective novelty and, hence, they cannot be known by man (*red hatched area*)

_____

[2]Hayek draws on the problem of complex situations. To Hayek, complex situations depend on such a large amount of mutually dependent variables that it is practically impossible for man to find out how a situation came into existence (see, e.g., Hayek 1964, pp. 343ff. and pp. 348ff.).

at any given time, knowledge which cannot be possessed by anybody—knowledge of the future.

Everything outside of what is known to the individual can be considered as the individual's "unknowledge" (Shackle 1974, p. 4). This individual unknowledge can be reduced by gathering other individuals with complementary knowledge (known knowns) and by acquiring knowledge through research (making known knowns from unknown knowns). For example, bacteria were unknown knowns—known to the universe (they existed in), but unknown to men—before they were *discovered* by van Leeuwenhoek in 1676 and, hence, became known knowns. The areas of individual knowledge, unknowledge, and knowns and unknowns are depicted in Fig. 2.1.

Yet man may still know that some future situations may, in principle, come into existence, e.g., the decline or renewal of an urban neighborhood. Other future situations, however, will be fundamentally different, compared to anything that existed before.

Known Unknowns

Possible future situations include those that are mere reconfigurations of known situations, e.g., the renewal of an urban neighborhood in (almost) the same manner as had been observed somewhere else. Man knows that something like this may

Fig. 2.2 Models, forecasts, and scenarios are built on known unknowns, i.e., future situations that man can imagine (*red strokes*)
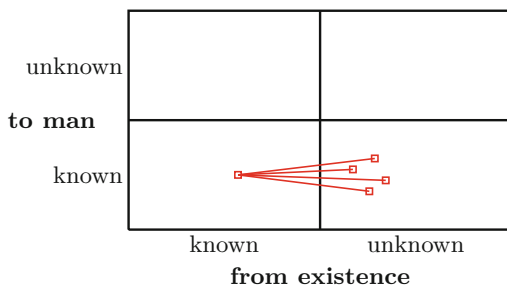
Fig. 2.3 Whenever an unknown unknown comes into existence, it may or may not become known to man

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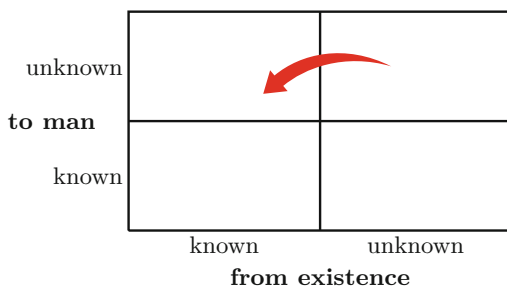
(Footnote 2 continued)
He does not see the limitation in ontological novelty that is, in principle, unpredictable (an argument which is independent of human ignorance). Rather, he sees our capabilities as being too limited to disentangle the continuous succession of situations, and internal and environmental factors, that may lead to ever-new situations.

happen and may even try to influence the development (cf. Chap. 4). However, until it actually comes into existence, the particularities of the situation remain unknown.

The imagination or simulation of possible, future situations produces known unknowns (Fig. 2.2). Models are built, based on known knowns; by any means of imagination or simulation, situations that are not yet existent, i.e., unknown to the universe, are forecast. The known knowns in models include, e.g., a time series of past demographic developments, activities of real estate developers, or correlations among car traffic, citizens' healthiness, and economic productivity.

The consideration of known unknowns cannot afford the existence of novelty. Simulations or imaginations of future situations, based on known knowns and their variations, yield possible configurations of known situations—known unknowns. If there were something new, it could not be predicted, based on known situations.

Unknown Unknowns

No knowledge of novelty can be possessed by man, or by the universe, until it comes into existence somewhere first—whether it be by man's creative invention or not. Until it comes into existence, such novelty remains an unknown. Unknown unknowns cannot simply be imagined or simulated as configurations of known situations. As mentioned earlier, man could not have known what a city would be like before it first came into existence.

Yet novelty—the coming into existence of unknown unknowns (Fig. 2.3)—plays an eminent role in the course of events. And while it can only be in vain to seek to foresee when, and which, unknown unknowns could come into existence, it might be useful to understand *how* they come into existence. What—if anything—gives rise to unknown unknowns, to something new emerging out of existing situations?

The expectation is that through understanding more about unknown unknowns coming into existence, novelty can be identified, and the ground may be prepared on which (desired) novelty grows. In other words, what are the catalysts required for novelty to come into existence, and how can those catalysts be influenced?

A further conjecture is that there is a connection between the coming into existence of unknown unknowns and of nested systems. If, as hypothesized in Sect. 1.2, a better understanding of the forces underlying nested systems could make, e.g., urban development more effective, it is worth studying how novelty comes into existence.

2.2 The Emergence of New Qualities

From logical concepts, such as the one shown in Fig. 2.1 and described above, it can be expected that the future bears unknown unknowns that must involve novelty, i.e., something not yet existent that cannot be known by any means before it first comes into existence. Thus, situations out of which unknown unknowns, i.e., novelty, can come into existence, are required. Furthermore, such novelty must be more than a mere reconfiguration of existing parts.

Propensities in Complex Systems

The concept of propensities—possibilities of developments, i.e., dispositions inherent in each particular situation—offers an explanation for the manifold possibilities for unknown unknowns to come into existence in complex systems (Popper 1959, p. 34 and Ulanowicz 1996, p. 219). It allows man to understand that the continuous change of situations may generate propensities, out of which novelty may come into existence.

In complex systems, as defined in Sect. 1.1, every small change in a situation might lead to great overall changes. Out of the number of parts, and the diversity of their interrelations, there arises, at every point in time, a number of potential futures. These futures immediately change themselves upon the realization of any purposive decision, mutation, or 'natural' selection (cf. Sect. 1.3). In complex systems, individual choices might thus have a significant impact on the development of the complex system. This is what Christaller (1933, p. 113) pointed out regarding urban systems, as quoted at the beginning of Chap. 1.

Every situation comes with its own propensities, and choices are made instantaneously from within unique situations. Every single one of a succession of choices, or other changes in a complex system, generates *its own* set of propensities (Fig. 2.4), i.e., a new range of possible futures. The probability of a particular choice or change is then a disposition or property of the particular situation itself (Popper 1959, p. 34). Thus, in every situation, i.e., configuration of a complex system's parts and relations, lies "propensities, [which,] when realized, can change those situations so that new propensities appear, then new situations, and so on" (Simkin 1993, pp. 74–75).

This sequel of propensities—realized by choices of nature, i.e., without foresight, or of men, i.e., with purpose and foresight—opens the door to an ever-changing universe and, hence, to the possibility for novelty to come into existence. Although
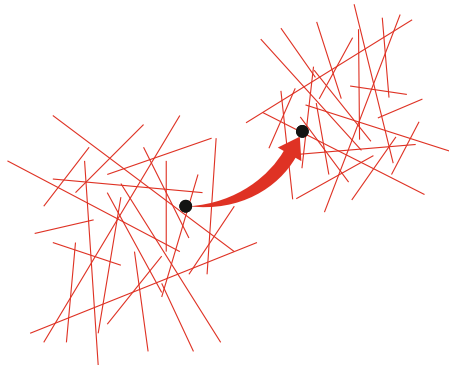
Fig. 2.4 Every situation (indicated by *black dots*) comes with its own propensities—possibilities for future situations. The propensities are visualized as *red lines* in space, and a situation at a given time in a given place meets these lines of propensities. If a propensity is realized, the space of propensities is changed. Thus, in a sense, a first situation (*black dot on left*) *generates* the very next propensities (*red lines on right*)

not a necessity of the concept of propensities, novelty may come into existence out of changing situations and ever-new propensities.

Emergent, Not Resultant

Complementary to such logical constructions as depicted in Fig. 2.1, there is evidence for novelty at several stages of the coming into existence of both natural and artificial systems (Fig. 2.5). This evidence ranges from the development of life out of inanimate matter to the development of consciousness in living beings and the coming into existence of economies or urban cultures. These, and many more novelties, are more than the sum of their (material) parts, i.e., more than what existed before they came into existence.

The coming into existence of an unknown unknown cannot be foreseen by what is known to man and/or the universe. Novelty is not explainable by reduction to its

Fig. 2.5 Some selected stages of the emergence (indicated by *red arrows*) of ever-new novelty since the beginning of the world

cultures

consciousness

life

inanimate matter
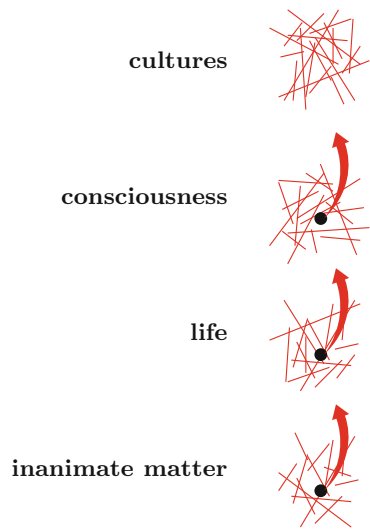
Fig. 2.6 Real novelty cannot be reduced to previously existing qualities: Novelty comes into existence from the realm of unknown unknowns (indicated by *red hatched areas*)

unknown

to man

known

known   unknown

from existence
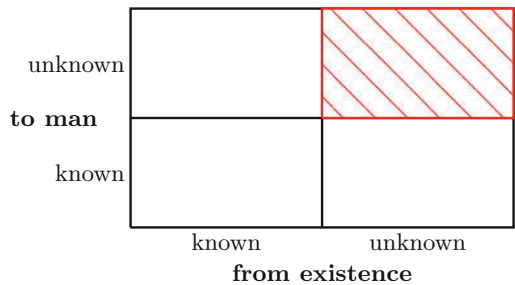
parts, e.g., to atoms, molecules, or pre-urban cultures. Novelty cannot be *resultant*; it must be *emergent* (Hofkirchner 2011, p. 191).[3,4]

More than the Sum of Its Parts

Whatever kind of leap leads to something beginning so that more exists than it had prior to the moment that it began, i.e., more than could be chosen from knowns, it must involve the coming into existence of something emergent, not resultant. This concept of novelty requires the bold conjecture that *emergent qualities* cannot be reduced to previously existing qualities; otherwise, they could have been imagined as known unknowns. Likewise, they cannot be explained by cause-and-effect situations operating within these existing qualities.

> The meaning of the somewhat mystical expression, 'the whole is more than the sum of [its] parts' is simply that the constitutive characteristics are not explainable from the character-istics of isolated parts. The characteristics of the complex, therefore, compared to those of the elements, appear as 'new' or 'emergent.' (von Bertalanffy 1968/2006, p. 55)

Emergence requires new quality to come into existence (Fig. 2.6). The new quality, which is emergent, can be distinguished by its being more than the sum of its parts. The new quality cannot be explained by the qualities of its parts because there are no precursors of the emergent quality in its parts:

> Once there was no poetry in the universe; once there was no music. But then, later, it was there. Obviously, it would be no sort of explanation to attribute to atoms, or to molecules, or even to lower animals, the ability to create (or perhaps to pro-create) a forerunner of poetry, called proto-poetry. (Popper 1978, p. 352)

2.3 General Properties of Emergent Systems

Just postulating that emergent novelty cannot be explained by the parts alone—such as life or consciousness—explains, in fact, nothing. However, a further-developed theory of emergence, embedding the notion of emergence into a more comprehensive concept built around this notion, might add some explanatory value.

Subsequently, I will largely follow and extend the argument of Popper (1977), who conjectures that ever-new emergence leads to a *nested* arrangement of systems (Sect. 2.3.1), and that there is both *outward and inward influence* among the

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[3]Hofkirchner refers to Blitz (1992).

[4]The genesis of this line of argument about emergence is generally attributed to J.S. Mill and G.H. Lewes. John Stuart Mill, in the sixth chapter (titled *On the Composition of Causes*) of the third volume of his 1843 *A System of Logic*, distinguishes 'mechanical' (homopathic) and 'chemical' (heteropathic) effects. For homopathic effects, "the composition of causes correspondent[s] to addi-tive properties, while heteropathic laws give rise to constitutive properties" (excerpt from a lecture by Lloyd Morgan on *Scientific Thought*, 1912, quoted in Stephan 1999, pp. 75–76). The effects of heteropathic laws were termed 'emergent' in G.H. Lewes's 1875 *Problems of Life and Mind* (cf. Sawyer 2005, p. 32).

nested systems (Sects. 2.3.2 and 2.3.3).[5] On one hand, outward influence generates the propensities, out of which a new quality may emerge. On the other hand, rules of, and selection by, an emergent quality influences inward. I suggest that together, the enclosed and the enclosing systems in a nested arrangement form a *whole* (Sect. 2.3.4).

2.3.1 Nestedness

With every emergent quality, new situations become possible. With every one of these new situations, further new propensities are generated, out of which even further novelty may come into existence. Hence, out of new, formerly impossible situations, it may become possible for new qualities to emerge.

What follows is a succession of *ever-new emergent qualities*, made possible by *ever-new propensities* (cf. Popper 1977, pp. 30–31). These nested systems exist without being designed as such by purposive human activities. And yet, nesting and nested systems potentially interfere with purposive human activities, e.g., in the field of urban planning. Urban systems are also nested, in that they are enclosed by other systems, e.g., regional systems, and in that they enclose other systems, e.g., urban districts.

Furthermore, the emergence of urbanity only becomes possible where a city exists already.[6] After the emergence of consciousness, cultural and social qualities emerged, among them economies and cultural codes, which, in turn and in combination with other qualities, made it possible for cities to generate further new propensities, out of which, e.g., urbanity could emerge.

In such a succession of emergent qualities, previously existing qualities become parts of newly emerged qualities; qualities become *enclosed* or "encapsulated" (Fuchs and Hofkirchner 2005, p. 29) by one another. This "leads…to a…theory of the universe, in which the world is composed of stacked layers of emergence" (Miller and Page 2007, p. 45).

From the succession of emergent qualities, one of the most universal features of natural and artificial systems follows: their arrangement into nested systems (e.g., von Bertalanffy 1968/2006, p. 27). Nested systems are like onions: one system inside another system, the outer system enclosing the inner one. For example, metropolitan

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[5]Popper, as other authors, writes of upward and downward causation. I refrain from following this terminology for two reasons. First, given the potential of emergence of novelty, there may be no such thing as repeatable causation—but repeatability is key to the idea and usefulness of (rather mechanistic) cause and effect; I prefer to use 'influence' instead (which does not exclude causation). Second, upward and downward may imply a hierarchical relation, just as bottom-up and top-down do; I prefer to express the idea in line with the image of nested systems, where one system is nested *inside*, and not below, another.

[6]The material shape of a city is a result of the emerged qualities, e.g., in the form of immaterial ideas and (cultural) images that are guiding the activities of citizens in shaping the city. See also Footnote 7.

regions enclose cities and towns, which enclose districts, which enclose neighborhoods, which enclose micro-neighborhoods. The latter enclose even further systems, e.g., buildings in the physical realm and families in the social domain.

In his theory of central places, Christaller (1933, p. 26) explains spatially nested systems, in which a central place of relatively higher economic significance covers a region, which includes central (and remote) places of relatively lower economic significance (cf. Fig. 1.1a). With emergent quality being at the core of every system, it becomes plausible why an arrangement of nested systems (Fig. 2.7) is "fundamental in the general theory of systems…from elementary particles to…atoms, molecules,…cells…organisms and beyond to supra-individual organizations" (von Bertalanffy 1968/2006, p. 27).

2.3.2 Inward Influence

Every system in the arrangement of nested systems is defined by an emergent quality, reflected by rules that guide and select activities in the enclosed systems. E.g., after the emergence of a new quality such as urbanity—itself emerging out of situations in cultural and material systems—the (unwritten) rules of an urban place guide the activities of individuals in the city. In that way, the emergent system has inward influence (Fig. 2.8) on the (cultural and material) systems from which it emerged.[7]

New rules start to guide activities in enclosed systems, upon the emergence of a new enclosing system. An enclosing system's inward influence toward the enclosed
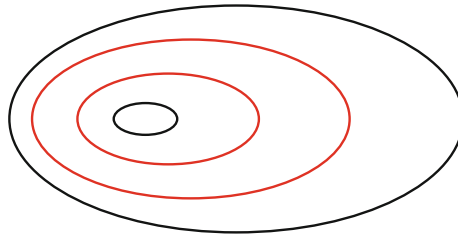
Fig. 2.7 When through the emergence of a new quality the first system becomes enclosed by another system, a nested arrangement of systems comes into existence. Highlighted is a single nested relation, as it will be used in subsequent illustrations

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[7]In the case of cities developing a (partly) fractal spatial shape, new rules guide the fractal development after the emergence of, e.g., cultural, esthetic, and social qualities. As a consequence, the fractal shape is not emergent, but the quality of the rules, which guide the fractal shape, is; the fractal shape itself is a resultant. As a further consequence, the concept of self-organization subsides. I.e., despite spontaneous activity—e.g., mutation or creative thought, both subject to selecting rules—which is not organized, there is no such thing as 'bottom-up' self-organization of parts. I hold that patterns that seem to be self-organized are, in fact, resultants guided by the rules of emerged, enclosing systems.

system is restrictive and prescriptive (cf. Fuchs and Hofkirchner 2005, pp. 29 and 31). It is restrictive in that situations that were possible before may not be possible any more, and prescriptive in that situations may become possible that were not possible without the emergent system. By virtue of its guiding rules, every emergent system may act back or even "exert a dominant influence" (Popper 1977, p. 35) upon the enclosed systems.

By restricting the enclosed systems, the enclosing system's inward influence is a selective one that includes choice-making. Whatever (purposive) activity is attempted in the enclosed systems, the enclosing system may or may not let it pass (Popper 1978, p. 348).[8] Either a purposive "choice process may be a selection process" (Ibid., p. 349), or the rules of the enclosing system's emerged quality may accept or reject the activity of the enclosed system. For example, a certain personal activity might not fit within the ethical or moral rules of the actual cultural system, and the activity subsequently might be suppressed.

New rules might as well guide and select such activities in the enclosed systems that support and maintain the emergent quality. The emergent qualities "prescribe the activities of the subsystems", i.e., of the enclosed systems (Haken 1981, p. 17). Thus, there is circular and continuous, autopoietic regeneration of a whole at work (cf., e.g., Maturana and Varela 1980, pp. 78–79 and Luhmann 2004, pp. 78, 108 ff.). For example, a central place system comes along with (unwritten) rules, through which the central place's relatively surplus importance and, hence, the central place quality, can be maintained. The roles of both the enclosed central and less central places are guided by the rules of the emergent system.

2.3.3 Outward Influence

Besides inward influence, there is outward influence in complex systems (Popper 1977, p. 35). Outward influence (Fig. 2.9) is *generative*, in that it enables and maintains the emergent quality. However, outward influence may also lead to the breaking up of the emergent quality. Thus, on one hand, emergent systems may only come into existence if changing situations in existing systems generate ever-new propensities,

Fig. 2.8 There is inward influence via guiding and selecting rules from the enclosing system

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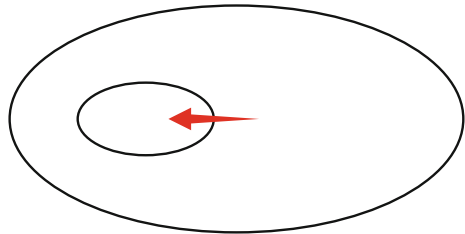
[8]The cited author refers to Cambell (1974), Sperry (1969), and Sperry (1973).

out of which emergence may occur. On the other hand, the continued existence of the emergent system is based on the continued existence of the enclosed systems (Fuchs and Hofkirchner 2005, p. 30).

Activities of outward influence can be either purposive, i.e., with foresight, or untargeted; they can either fit, or be rejected by, the enclosing system's rules of inward influence. The activities of the enclosed systems can also generate propensities, out of which the emerging quality changes. This can be exemplified in social systems where emergent cultural and political systems continuously change. In the most extreme cases, such as a revolution, citizens may break up the political system that encloses them. Similarly, decay of enclosed systems could destroy the enclosing system, i.e., the emergent quality and its rules.

Out of ever-changing propensities in existing systems, eventually an enclosing system will emerge. This could explain why cultural, economic, political, and other systems eventually emerge from the activities of man. Similarly, in natural systems, free elementary particles may form and then get enclosed in atoms; these particles form and get enclosed again, and so on. This leads to an endless realization of ever-new *Emergent Nested Systems.*

2.3.4 Wholes

Together, the enclosing and enclosed systems form a whole. The whole is discernible by the quality of the enclosing system and by its rules that apply to the enclosed system. The enclosed system becomes "sublated" into the whole (cf. Fuchs and

Fig. 2.9 There is outward influence through activities in enclosed systems that generate propensities, out of which the enclosing quality might be changed, or new enclosing quality might emerge
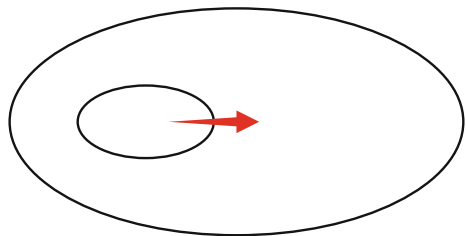
Fig. 2.10 Together, the emerged enclosing system and the generative enclosed system form a whole
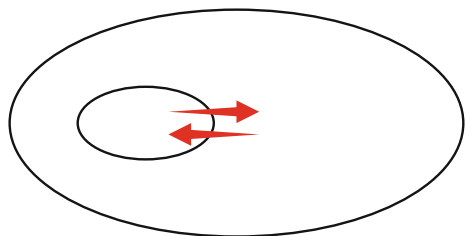
Hofkirchner 2005, p. 29). Without an emergent quality, there will be no whole, but only an assembly of parts.

Generative outward influence, and guiding and selecting inward influence, makes the enclosed and enclosing systems an interdependent whole (Fig. 2.10). On one hand, the emergent quality and the enclosed systems are linked by inward influence. On the other hand, the new quality could not even arise without outward influence.

In a whole, neither the enclosed systems nor the enclosing system stand alone. For example, in a system of central places, the whole, i.e., the central place system, and its parts, i.e., the region and the central places, cannot exist independently. There is mutual influence between the enclosing system and the enclosed ones, i.e., between the whole and its parts.

2.4   Fast and Slow Systems

I suggest, building on arguments brought forward by, e.g., Simon (1962), that a further property of ENS is the relatively slower speed of the enclosing systems, as compared to the enclosed ones. Relatively fast outward influence of enclosed systems may generate, change, or even break up the enclosing system. Thus, the enclosing system may be destroyed if it cannot adopt the changes of the enclosed systems.

If this hypothesis holds true, (the relation between) enclosing and enclosed systems could be discerned by measuring the speed of their internal activities, e.g., of their turnover and exchange rates, and/or their rate of change. Also, the slow/fast relation holds explanatory power for outward and inward influence in emergent systems. Generative activities must be able to adapt quickly to changes of rules, just as rules would not be effective if what they governed could not keep up with the changes. In the same way, revolutions breaking up enclosing systems can only work because the enclosing systems cannot adapt quickly enough to the activities of the revolutionists.

The understanding of fast and slow systems provides a means to understand complex systems beyond the hardly useful 'everything is connected with everything else' paradigm. In particular, tools and methods developed to effectively influence emergent and nested, i.e., complex, systems, might aim at influencing the relations between relatively faster and slower systems.
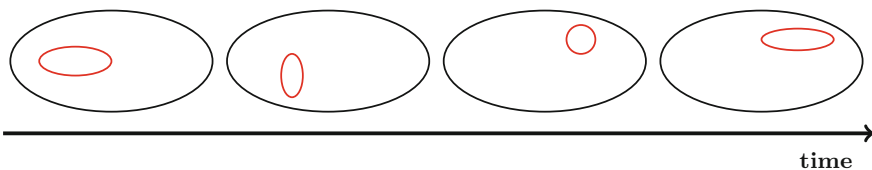
Fig. 2.11   The enclosing system changes slower than the enclosed one

Systems Change Over Time

There is evidence for a link between a system's speed of operation and its position in the arrangement of nested systems. For example, while the individual's habits change relatively fast—every couple of years—the cultural system of a society that guides the individual's habits changes much slower—every couple of decades (cf. Fig. 2.11). Man gives rise to social systems, e.g., political, cultural, or economic systems that constrain a group or society; the social systems have a slower pace of change than the individuals within them. This supports the conjecture that a relatively slower system is enclosing a relatively faster one.

This observation for social systems is in perfect analogy with von Bertalanffy's description of biological systems:

> The living organism is a hierarchical order of open systems. What imposes as an enduring structure at a certain level, in fact, is maintained by continuous exchange of components of the next lower level .... As a general rule, turnover rates are the faster the smaller the components envisaged. (Ibid. 1968/2006, p. 160)

Simon (1962) introduces the concept of "nearly decomposable" systems, i.e., of systems, in which faster subsystems are encapsulated by slower ones[9]:

> It is well known that high-energy, high-frequency vibrations are associated with the smaller physical subsystems and low-frequency vibrations with the larger systems into which the subsystems are assembled. (pp. 475–476)

Similarly, Haken (1977, pp. 191 ff.) and Weidlich (1999, p. 139) observe faster dynamics in subsystems than in the "global conditions" of the environment. In settlement systems, e.g., "fast processes take place on the *local microlevel*" (buildings, traffic infrastructure, etc.), but "slow processes take place on the *regional macrolevel*" (whole settlements) (Ibid., p. 138).

Enclosing Systems Are Slower

The examples above further support the conjecture that enclosing systems are characterized by a slower speed of change than the systems they enclose. E.g., slowly changing social systems guide the relatively fast activity of man, whose overall, relatively slow body guides the relatively fast, biological activities of its organism.

Such relations between slow, enclosing and fast, enclosed systems appear throughout the animate and inanimate world. These relations apply to natural and man-made systems alike, and they interrelate all types of systems through guiding and selecting rules, as well as through generative activities. Simon (1962) notes that:

> "[i]t is probably true that in social and in physical systems, the higher frequency dynamics are associated with the subsystems, the lower frequency dynamics with the larger system. It is generally believed, for example, that the relevant planning horizon of executives is longer the higher their location in the organizational hierarchy" (Ibid., p. 477).

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[9]The term "nearly decomposable" refers to Simon's claim that, when analyzing complex systems, the relatively faster activities within systems may be neglected, and only the slower activities of the enclosing system have to be analyzed together with the few relevant interactions between the faster and the slower systems. Hence, according to Simon, systems can nearly be decomposed—nearly only—because some of these activities in between systems are relevant (see also Sect. 3.3.1).

From the existence of enclosing systems, Simon, like Haken and Weidlich, derives the ability to understand nested systems from the enclosing conditions of the relatively slower system alone (cf. Sect. 3.3.2). Such a conclusion, however, neglects the impact which (individual) activities in the faster system may exert on the slower one.

Enclosed Systems Are Faster

Finally, the relation between slow, enclosing and fast, enclosed systems can explain the important properties of outward influence. It is not only that the slower system emerges from the faster ones, but also that the faster, more dynamic system has the power to change or even break up the slower, enclosing system.

For example, Holling (2001a), following up on Simon (1973)s work, ascribes the role of "triggering a crises," starting a "revolt," and invigorating faster systems. To slower systems, he ascribes the role of "constraining, " setting "the conditions," guiding, and protecting (Holling 2001a, pp. 397 ff.).[10]

For a "revolt" of a faster system, he provides the example of "local activists succeed[ing] in their efforts to transform regional organizations and institutions, because the latter have become broadly vulnerable" (Ibid., p. 398). If not through revolution, then in a more subtle way,"ideas (generated in the faster system) can become incorporated into slower parts of the panarchy, such as cultural myths, legal constitutions, and laws" (Ibid., p. 401).[11]

Another example of interrelations between fast and slow systems is the interplay between lifeforms and the atmosphere. While the atmosphere has set the conditions under which life can develop, lifeforms themselves have had great impact on the atmosphere, eventually changing it into the oxygen-rich one we know today. However, now it is feared that man may have a similarly tremendous impact on the atmosphere, if released greenhouse gases and other pollutants are able to change the enclosing system.

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[10]Holling (2001a) and coworkers (e.g., in Holling 2001b) in particular develop a model for adaptive (eco-)systems that go through cycles of resilience and vulnerability. They claim that layers of such adaptive systems stack up from spatially small to large and from fast to slow.

[11]By the term 'panarchy,' the original authors mean a guiding system which encompasses all other adaptive systems in a nested, but not top-down, manner—"a nested set of adaptive cycles" (Holling 2001a, p. 396).

Chapter 3
Emergent Systems: First Implications

Rand persuaded me to look at human beings, their values, how they work, what they do and why they do it, and how they think and why they think. This broadened my horizons far beyond the models of economics I'd learned. I began to study how societies form and how cultures behave, and to realize that economics and forecasting depend on such knowledge—different cultures grow and create material wealth in profoundly different ways.

Greenspan 2007, p. 53

What does it mean that unknown unknowns may come into existence, that new qualities emerge, and that a succession of enclosed and enclosing systems forms a nested arrangement? What does it mean that the enclosing systems guide the enclosed ones, and that the enclosing systems are slower than the ones they enclose?

Below, I will argue that novelty is objective (Sect. 3.2.1), that systems are ontologically real (Sect. 3.2.2), and that novelty is unique, i.e., the exact same novelty is never repeated (Sect. 3.2.3). Thus, forecasting is limited to *types* of emergent qualities, and an a posteriori explanation of emergent qualities makes similar sense, but only for an abstracted type.

Among the direct implications of a theory of ENS lies, on one hand, the potential *influence of the individual* on the course of events (Sect. 3.3.1). On the other hand, there is the emergent system which, by virtue of its own rules, exerts the *influence of the whole* on the (individual) enclosed systems (Sect. 3.3.4). How may emergence itself be influenced?

To begin, I will briefly summarize and rephrase the key elements of the theory presented in the previous Chap. 2.

3.1 Emergent Nested Systems, Fast and Slow

In Chap. 2, I argued that every system that adds a new quality to the world has emerged out of propensities of systems that have existed before. From this argument, a world follows in which systems are arranged in nested systems. I argued further that activities in the enclosed system may change the enclosing system, which, in

Table 3.1 Relations of nested systems

Role in the whole	Enclosed system	Enclosing system
Quality of the system	Generative	Emergent
Type of influence	Generative and triggering	Guiding and selecting
Means of influence	Activities	Rules
Direction of influence	Outward	Inward
Frequency of change	Fast	Slow

turn, by means of its rules, guides and selects activities in the enclosed systems (cf. Sect. 2.3). In such a relation, the enclosed system shows a relatively higher frequency of activity, while the enclosing system shows a relatively slower one (cf. Sect. 2.4).

The relations between enclosed and enclosing systems in a nested arrangement are depicted in the Table 3.1 and are subsequently summarized.

Generative and Emergent Qualities

Every nested system has two qualities. A system is both generative and emergent, in relation to enclosing or enclosed systems, respectively. By a system's generative quality, the systems enclosing it are (re-)generated. Such (re-)generation leads to the (re-)emergence of a particular quality of the enclosing system. As enclosing system, a system is, hence, of the emergent kind, in relation to its enclosed systems.

Generative and Guiding Influence

While the generative role of a system is to (re-)generate enclosing quality, the guiding role of a system is to guide the (re-)generative activities of enclosed systems. Activities in enclosed systems are thus (re-)generative enclosing systems, their qualities, and the rules that come with these qualities—unless the activities are triggering change, which happens when they do not follow the guiding influence of the enclosing system. An enclosing system's influence on the enclosed one occurs through rules that guide the activities of the latter.

Activities and Rules

Thus, an enclosed system's role can be recognized by its activities that influence outward, and the enclosing system's role can be recognized by its rules that influence inward. In relation to enclosing systems, the relevant characteristic of the enclosed one is its activities that continue the (re-)generation of enclosing quality. Vice versa, in relation to the enclosed system, the relevant characteristic of the enclosing system is its rules that guide the (re-)generative activities of the enclosed system. The enclosed system's influence is directed outward; the enclosing system's influence is directed inward.

Outward and Inward Influence

With the complementary roles of a system being both enclosed and enclosing comes the property of a circular, autopoietic regeneration of outward and inward influence

in nested systems. The enclosed system's (re-)generative activities influence the enclosing system, while the guiding rules of the latter influence the activities of the former.

This relation may become clear when again considering a central place system. Changing the rules that guide the individuals' activities, e.g., what and where to produce or buy items, may first lead to changes in the enclosed systems through inward influence; changed activities may then change the quality of the central place system through outward influence.

Another example would be when an end to the exploitation of certain natural resources is reached in a region, changing the activities of individuals. This change eventually interrupts the established working mode of the central place system, and may perhaps lead to a vanishing of the quality of a central place (e.g., the Ruhr region in Germany, cf., e.g., Wehling 2014).

Fast and Slow Change

A further characteristic of nested systems is the relation of a relatively fast change of individual's activities in an enclosed system with a relatively slow adaptation of the enclosing system. This relation can be exemplified by a political system that emerges from the activity of men, as well as what then acts back on them. If the political system had a frequency of change faster than the pace of men's activities, how could men ever follow a rule of this political system? Also, if the political system could react and adapt with an internal speed faster than the dynamics of a revolution, revolutions could not occur.

3.2 Objective Novelty in Ontologically Real Systems

Do we only perceive things as complex (epistemological), or are they complex (ontological)? The first and second section below deal with this question and bring up the emergence of novelty, versus a deterministic course of events—as an argument for an ontological reality of complex systems (Sect. 3.2.1). This argument is further supported by the ability to discern complex systems from one another by their relative speed of activity—a measure which does not depend on subjective perceptions (Sect. 3.2.2).

These considerations that involve objective novelty will bring about the question of the predictability of the future. I will argue that indeed, foresighted man may anticipate possible futures of known type, though not the particular characteristics of real novelty (Sect. 3.2.3).

3.2.1 Subjective Novelty?

With regard to the emergence of new quality and its rules, which together make for an enclosing system, one might feel tempted to ascribe the lack of imagining

such novelty to limitations of the individual, i.e., to man's subjective processing of knowledge (see also my Footnote 2 in Sect. 2.1). Miller and Page (2007) write that

> Part of the innate appeal of emergence is the surprise it engenders on the part of the observer. Many of our most profound experiences of emergence come from those systems in which the local activity seems to have arisen by magic ... (p. 45)

They go on to wonder if

> It could be that emergent activity is simply reflective of scientific ignorance rather than some deeper underlying phenomenon. (p. 46)

I argue that ascribing the surprise to our subjective limitations implies that once we overcome our subjective limitations, we would be able to avoid such surprise, e.g., by forecasting a priori the emergent quality (Fig. 3.1). This, in turn, would require a universe (or versions of one) that could be foreseen *ad infimum,* a universe of which every future state could be determined.[1]

3.2.2 Ontologically Real Systems

A nested system can be distinguished by it being enclosed by another system, and it enclosing at least one other system. For example, a neighborhood can be recognized by distinguishing it from the enclosing urban district, the enclosed micro-neighborhoods, and the other neighborhoods of the same and adjacent districts. A system, hence, can be defined by *discerning* it from other systems in a nested arrangement of systems.
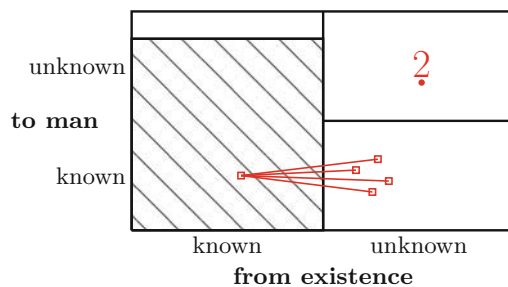
Fig. 3.1 If surprise were only a result of limited, individual knowledge (*dark hatched area*), then increasing, individual knowledge should eventually eliminate surprise. Every potential surprise could be predicted (*red lines* of possible future scenarios) as known unknowns coming into existence. In a world in which, in principle, only predictable, known unknowns can come true, however, no objective novelty—i.e., unknown unknowns—could ever come into existence

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[1]The number of possible futures increases exponentially with every change in propensities. There would quickly be more possible futures to be considered than there are atoms in the universe—whatever the implication would be of that (rather materialistic) consideration.

A possible heuristic is suggested here to distinguish systems by their speed of change (cf. Sect. 2.4). A system may be discerned either by its relative frequency of change, as compared to other enclosing and enclosed systems, or by looking at how frequent activities occur within the system. A system's borders with enclosing, enclosed, and neighboring systems are the local minimums of activities (Fig. 3.2).

For example, a neighborhood is often defined by its close-knit, intensely interacting social and economic parts. Or, in a region of central places, the economic functions vary with the centrality of the place. Each central system can be differentiated from the enclosing system by specific economic functions that lead to relatively strong activities *within* the system and relatively few activities beyond it. Hence, an urban system reaches as far into the region as its specific functions lead to activities (cf. Christaller 1933, p. 25).

3.2.3 Forever Indiscernible Causes?

Once a new quality has emerged and surprised us, there might be hope of eventually explaining the emergent quality, based on situations out of which that quality came into existence. Such hope was also expressed by, e.g., Popper (1978): "Life, or living matter, somehow emerged from non-living matter; and it does not seem completely impossible that we shall one day know how this happened" (p. 352).

In the future, it might be possible to know, in more detail, the situation that generated the propensities out of which a *type* of new quality emerged (Fig. 3.3). However, this knowledge can only be gained once the quality has already emerged, not before its first coming into existence. The explanation is only possible *a posteriori*. Hence, man might be able to recreate the situations out of which a known *type* of emergent quality, e.g., life, consciousness, or urbanity, *may* emerge.

However, the *exact* coming into existence of these qualities remains unknown. Newly emerging quality will never spare us surprise, no matter how well we understand generative situations. This occurs because emergence is realized out of the propensities of a *unique* moment in time and space. As a consequence, no two men
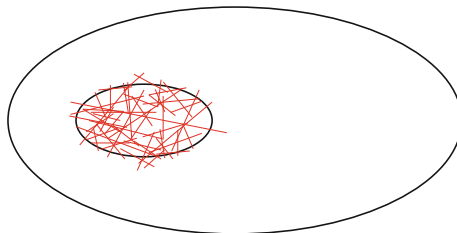
Fig. 3.2 One system enclosed by another (*black circles*) and activities of the enclosed system (*red lines*). The enclosed system's border can be distinguished by the relatively low, cross-border activity, as compared to the activity within the system

possess an identical consciousness, and no two urban places convey the same feeling of urbanity (cf. also below, Sect. 3.3.5). Similarly, no two electrons in a molecule occupy the same orbit (the so-called Pauli principle).[2]

3.3 The Power of the Individual and the Whole

What do such theoretical insights about ENS mean regarding influencing them? I suggested above that explanatory power lies in the concepts of enclosing and enclosed systems, slow and fast systems, and guiding and generative systems. In particular, in every ENS, there are two types of influences: outward influence that may generate the propensities out of which further new systems can emerge, and inward influence that, in turn, guides the activities of outward influence.

Outward and inward influence can be seen as the power of the individual (Sect. 3.3.1) and the power of the whole (Sect. 3.3.4), respectively. Where novelty comes into existence, a third power is at play: the power of emergence (Sect. 3.3.5). Neither novelty nor the significant impact of individual activities, or the guiding rules that lead to changes on such activity, can be understood in terms of statistics (Sects. 3.3.2 and 3.3.3). This section thus puts the use of statistical models into perspective regarding complex systems.

In the words of Hayek (1964):

> …it is necessary to turn aside and consider the method which is often, but erroneously, believed to give us access to the understanding of complex phenomena: statistics. (p. 339)
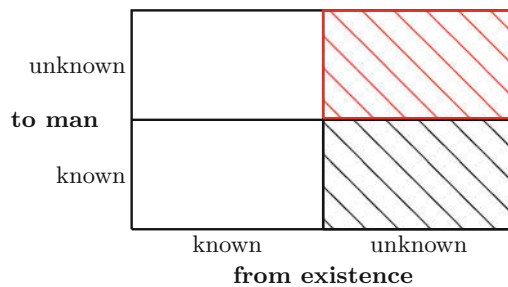
Fig. 3.3 Once quality has emerged, it may be recognized by man, and the same *type* of quality can be imagined for a future situation, i.e., a known unknown (*dark hatched area*). However, the particular instance of any new quality must be the coming into existence of an unknown unknown (*red hatched area*)

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[2]The rule may or may not be locally limited. Is it possible that remote systems are completely disconnected? This is a question not only of quantum mechanics, but also beyond the material reality. If the answer is yes, it may be possible that two qualities emerge that are exactly the same.

3.3.1 The Power of the Individual

Activities of outward influence (Fig. 3.4) change situations and, hence, propensities, out of which new quality may emerge as a new enclosing system. On one hand, emergent qualities arise without the activities of conscious minds. In evolutionary processes, purposeless mutation changes situations. Mutation is, thus, the activity that generates the propensities, out of which many emergent qualities come into existence, including life and consciousness (cf. Sect. 1.3).

On the other hand, since the emergence of conscious minds first occurred, some decisions are made with *purpose and foresight.* An individual's decisions, which might well be influenced by an idea that itself has been emergent, can be relevant, or even decisive, regarding the introduction and/or realization of a propensity.

The course of development of a complex system may be changed by an individual's activities. These may not average out with other individual's activities, but rather, they may change situations and propensities, or even realize a propensity by purposive choice. Therefore, the development of an emergent nested system like a city may be decisively influenced by one individual's (purposive) decisions. Man has "the freedom to create" (Popper 1978, p. 350).

3.3.2 Modeling Averages

Any model that is based on averages neglects the influence of individuals' activities on complex systems. Two notable suggestions of modeling complex systems should suffice to exemplify this claim: Simon's theory of near-decomposability and Haken's theory of synergetics. The conclusions of the former are based on weak and strong forces, which hold nuclear particles together. The strong forces are all consumed in the immediate vicinity of the nuclear particles and, hence, can be neglected on any more global level. The latter theory omits outward influence, in favor of inward "enslaving rules" that are bound to determine the whole's activity.

Simon (1962) argues, based on the observation of physical systems, that the higher frequencies in enclosed systems are related to internal activities which, from the

Fig. 3.4 Through outward influence, activities of the individual may generate propensities, out of which the enclosing quality might be changed, or new enclosing quality might emerge
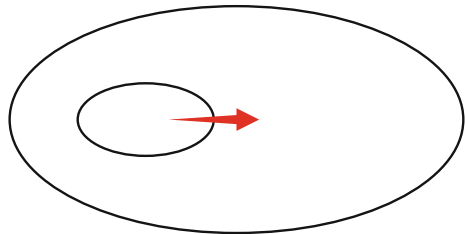
perspective of the enclosing system, average out. Thus, he concludes that the enclosing systems "can be described in terms of the average activity of the subsystems" (Simon 2000, p. 8). Systems are, hence, "nearly decomposable," with the faster activities inside systems being separable from the slower activities that keep the whole together (e.g., Simon 1962, p. 477 and Footnote 9 in Chap. 2).

Such a view of complex systems might be appropriate in steady-state situations, or in situations in which the faster system, after a disturbance, returns to a steady state before new situations can change the slower system (cf. Simon 1993, pp. 3–4). However, if the faster systems' activities—which may change the slower system, or even generate propensities, out of which new quality (i.e., another slower system) can emerge—should be considered, such an approach will not progress further.

Likewise, Haken and Weidlich conclude that it is possible to reduce the complexity of a nested arrangement by looking at the system with only slower dynamics. The theory of synergetics introduces the concept of "order parameters" (e.g., Haken 1977, p. 198), by which the enclosed systems can be considered enslaved (Haken 2012, p. 9). I.e., these systems can be considered "driven and guided by…macrostructure" (Weidlich 1999, p. 138), always adapting to the enclosing system (Ibid., pp. 138–139). Hence, here as well, the fast system may only be considered during its average activity (Ibid., pp. 137 ff.).

Similar to Simon's concept of near-decomposability, synergetics may well describe the enclosing activity of slow systems, and it may fail, in the case of emergence out of situations in the faster systems. Neither Simon nor Haken offer an explanation for the power of the individual, i.e., the influence of activities in enclosed systems. Their theories do not ascribe the timing of the decay of a radioactive nucleus, or the coming into existence of a revolution out of man's purposive decision-making.

3.3.3 The Use of Statistical Models

Complex systems are influenced by *individual* activities that may be purposive. These activities don't allow complex systems to be treated as analytical systems, and neither do these activities always average out, as just discussed. The modeling of statistical systems is, thus, a significant simplification of reality. Statistical systems (and/or models) are not complex.

Nevertheless, since statistical models which work with averages are being applied, they may be useful. Systems can be successfully modeled when based on averages—in special cases. Where systems are actually near-decomposable, i.e., where faster systems strictly follow the guiding and selecting rules (Fig. 3.5), no activities (purposive or not) may change the slower system or generate propensities, out of which new quality may emerge, and a statistical model may be applied. Also, if the individual's activity has no influence on the activity of his fellow man, as is the case in polls, a statistical model works well.

Additionally, models based on averages work—when it can be assumed that individuals only have a few choices and can only follow a few average activities. Thus, statistical models may work, e.g., in forecasting the movements of pedestrians. However, the predicted, overall activity turns out incorrect in cases when an individual makes an unforeseen decision that changes the rules guiding the average, individual activity.

If, however, a model were to simulate suggestions for innovative ideas for urban development, even when knowing the most dominant rules of individual activity, this model could only fail. Rather than activities that are, on average, predictable, e.g., voting results for elections or the movement of pedestrians, innovative ideas are emergent and, thus, unpredictable.

3.3.4 The Power of the Whole

The rules of enclosing systems reflect the power of the whole. This power guides and selects supportive and maintaining activities in the enclosed systems (Fig. 3.6, cf. Sect. 2.3.2). Hence, the enclosing system, through its rules, guides the (purposive) activities for its own well-being, i.e., for its autopoietic survival.

Thus, the above-mentioned power of individuals' activities in the enclosed system can be either extended or limited by the power of the whole. On one hand, the whole may, upon its emergence, make additional activities in the enclosed systems possible.

Fig. 3.5 In near-decomposable systems, the enclosed systems follow the guiding and selecting rules of the enclosing system
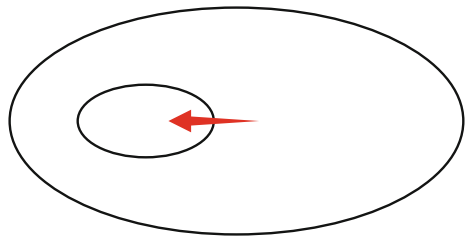
Fig. 3.6 The enclosing system, by means of its rules, guides and selects (*red arrow*) supportive and maintaining activities (*dark arrow*) in the enclosed system and, thus, guides the interrelation that makes the whole
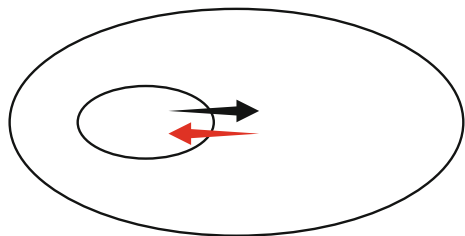
On the other hand, it may restrict formerly allowed activities. For example, after the emergence of a central place system, a central hospital might be built, and it will become the normal activity to go there—and no longer go anywhere else—for treatment.

As discussed above, models based on averages are able to represent the power of a static whole, i.e., a snapshot in time of a whole. As long as there is no change in the enclosing quality or emergence of new quality—and as long as all that matters for the whole's future is that the activities in the enclosed system strictly obey the enclosing system's rules—it might suffice to develop a model of the enclosed system's activities. (E.g., agent-based models rely on this approach, cf. Sect. 7.5.2.)

3.3.5   The Power of Emergence

Emergence is more than the reorganization of known qualities in different patterns. Known qualities in different patterns are predictable, and whether they are a surprise or not depends on subjective knowledge. This is not so with emergent qualities. Emergent qualities are the, in principle, unpredictable coming into existence of unknown unknowns, i.e., realizations of propensities that are generated by *unique* situations of complex systems (Fig. 3.7, cf. Sect. 2.2).

Propensities of situations—not devised design—yield emergent systems. Hence, emergent systems cannot be made directly from human intention. Even if the making or remaking of a type of emergent quality is intended, the desired quality might not emerge.

Though not intently, some emergent systems are clearly man-made. Activities of individuals may generate the propensities out of which enclosing systems emerge. Examples of enclosing systems that emerge through the activities of individuals include cultural systems, economies, and spatial systems, such as central place systems.

An emergent system, even of a known type, e.g., a central place system, always comes with at least some novelty. The novelty of the enclosing system emerges out of *unique* situations. As mentioned above, no two individuals possess the exact same type of consciousness, and no two cities evoke the same feeling of urbanity; each emergent system has its particularities. These particularities of emergent system cannot be foreseen.

If it is not foreseeable, can emergence be influenced? Is it possible for purposive influence to alter systems that have already emerged? Before turning to the answers to these questions in Chap. 4, a note is due regarding the notion of emergence as used in recent literature.
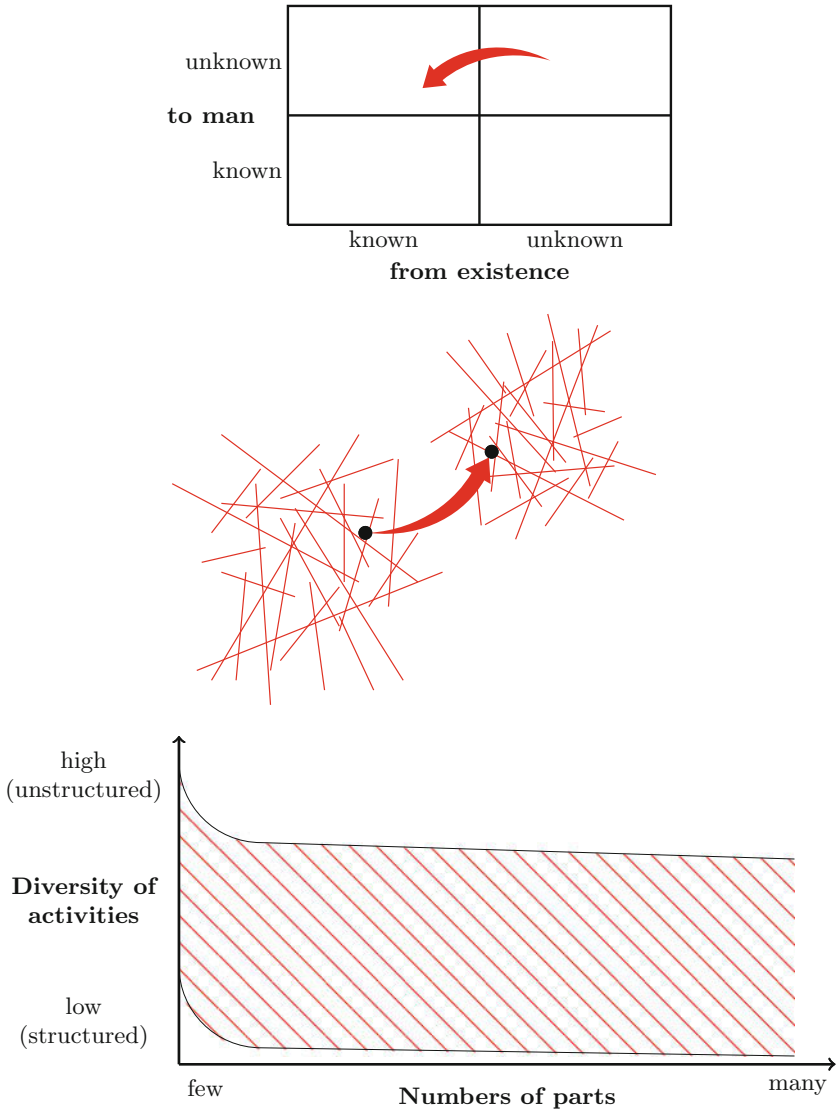
Fig. 3.7 Emergent qualities are the, in principle, unpredictable realizations of *unknown unknowns* (*top*) out of *propensities* (*center*) that are generated by unique situations in *complex systems* (*bottom*, *red hatched area*)

3.4 Emergent, Not Reshuffled

The notion of emergence is used ambiguously in literature, referring either to the coming into existence of an unknown unknown, or to the rearrangement of known qualities. According to the first meaning of emergence (which I adopt in this work), a pattern that involves no new quality, but only forms from known qualities—i.e., that can be described as a compound of previously existing qualities—is not emergent.

The second meaning of emergence is used in, e.g., modeling literature. There, emergence is often used to name a pattern that *results* from the activities of individuals, guided by the enclosing system's rules (cf. my Footnote 7 in Sect. 2.3). I.e., emergence is frequently used to describe the results in relatively fast systems, evoked by (changes of) guiding and selecting rules (Fig. 3.8). For example, Miller and Page (2007) describe emergence as a "phenomenon whereby well-formulated aggregate behavior arises from localized, individual activity" (p. 46).

There is a crucial difference between the rearrangement of existing qualities and emergence that comes into existence as new quality. The "aggregate behavior" of existing qualities describes resulting patterns, e.g., a different distribution of residential and commercial areas, or the way in which people move in a pedestrian zone (cf. the discussion of statistical models above).

In contrast, emergence, as understood in this work, cannot be foreseen and introduces new quality that is more than aggregate behavior. Emergence cannot be modeled in, e.g., life and consciousness; i.e., the political and economic systems could not have been the result of a model before they first came into existence. This difference between the two meanings of emergence is, in literature, commonly understood as a difference between "strong" and "weak" emergence (cf., e.g., Wilson 2012).
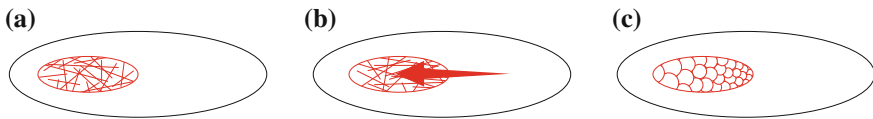
Fig. 3.8 If, in an arrangement of nested systems, the enclosed system (**a**) is subject to rules and to the selection of the enclosing system's inward influence (**b**), the change in the enclosed system is resultant, not emergent—however nice it may look (**c**)

Chapter 4
Influencing ENS

> *Knowledge of the conditions in which a pattern of a certain kind will appear, and of what depends on its preservation, may be of great practical importance. ... Once we explicitly recognize that the understanding of the general mechanism which produces patterns of a certain kind is not merely a tool for specific predictions but important in its own right, and that it may provide important guides to activities (or sometimes indications of the desirability of no activities), we may indeed find that this limited knowledge [of complex phenomena, my remark] is most valuable.*
>
> Hayek 1964, pp. 338 and 349

The Situation so Far

From the theoretical contribution introduced and discussed above, it should have become clear that nested systems—each system enclosing and being enclosed by other systems—come into existence through emergence. One characteristic of each emergent system is that each one comes with its own particular quality. Along with new quality, new rules are added to which the enclosed systems adapt their activities. The relations between the enclosed and the enclosing systems are manifested and maintained through outward and inward influence. The former may involve purposive activities, with relatively fast frequency. The latter is guiding and selective, according to the emergent system's rules, which only change slowly.

The Problem

The propensity theory reviewed in Sect. 2.2 offers an explanation for unique dispositions of unique situations. These unique situations could be what emergent quality comes into existence from. Such emergent quality is the coming into existence of an unknown unknown (cf. Sect. 2.1); as such, it cannot be designed. Design and foresight—and any future-oriented, purposive human activity, e.g., urban intervention—are principally limited in complex systems, not necessarily by subjective limits, but certainly by emergent qualities. Since emergent qualities come into

existence out of situations that are unique in time and space, they cannot be reproduced or stimulated to reappear exactly as they were before.

A particular quality that may come into existence cannot be predicted before it actually comes into existence. What exactly comes into existence in complex systems, hence, cannot be known in advance by man. Thus, in this theoretical contribution to ENS, I suggest that the *unpredictable* emergence of unknown unknowns, i.e., the system-inherent 'force' that leads to the nesting of systems, may void man's purposive activities.[1]

Why Bother?

Man's often foresighted and purposive activities change situations and propensities, yet it seems that desired situations cannot be designed. Design of emergent quality would require man to exactly know the future results of today's activities, which is not possible in complex systems. In complex systems, desired quality, e.g., the emergence of a sense of appreciation for a city's built heritage, cannot be designed, just as undesired quality may emerge, despite an attempt to design desired quality.

Yet situations and their propensities are continuously changed by man's foresighted and purposive activities. If these activities are not going to design emergent systems, then do they at least have the power to *influence* them? Is it, e.g., possible to intelligently alter the rules of enclosing systems or devise activities that change the enclosed systems? Despite every emergent quality being unique, what can be learned from the emergence of similar types of emergent qualities in different places at different times?

What to Do

From the just-developed understanding of ENS, ways to influence them may be deduced.[2] At most, situations can be changed, and, thus, a certain *known type* (cf. Sect. 3.2.3)—i.e., a known unknown, e.g., urbanity—of emergent quality can come into existence and may be purposively influenced. How far such influence may reach—i.e., how effective it can be in generating propensities, out of which a *desired* type of quality may emerge—should be worth a closer look. Hence, investigating how to influence ENS will be the topic of this chapter.

Below, I will introduce three generic approaches aimed at influencing nested systems. I will suggest levers that may change the propensities for certain types of emergent qualities to come into existence. Ways to influence ENS may be applied to trigger the emergence of new quality or to guide (re-)generative activities.

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[1]Cf. my first working hypothesis in Sect. 1.2: Properties of complex systems may void purposive development plans.

[2]Cf. my second working hypothesis in Sect. 1.2: Purposive development might become more effective if these properties could be understood.

4.1 Influencing ENS

Creative man likes to shape tangible and intangible systems in this world, such as cities, economies, and political systems, according to vision and foresight. The understanding of the world, as made of ENS, may well be the basis for purposive decision-making.

Man is able to know some unknowns, i.e., what may, in some emergent form or another, come into existence. Such known unknowns can be *types* of emergent quality, the emergence of which cannot be predicted—neither in time nor in the exact way they will be formed. I.e., every instance is different.

However, man may recognize such *types* of emergent qualities that have already come into existence (Fig. 4.1), e.g., the emergent decline or renewal of an urban neighborhood. While the general emergent quality is known, every individual realization is different, coming into existence out of different propensities.

A relevant analogy is the distinction between genotypes and phenotypes in biology. After the observation of a phenotype—i.e., any instance of a type of emergent quality—man knows that a similar development may happen somewhere else, at some other time. Even the genotype—i.e., the situation that generated the propensity, out of which emergent new quality (the unique phenotype) was realized—might be analyzed (a posteriori, however) and imitated by man (cf. Sect. 3.2.3). However, no phenotype is like any other.

Furthermore, it might be possible to understand some of the relations between enclosing and enclosed systems. For example, it might be possible to analyze the adaptation of activities upon the change of a rule, and the subsequent change—in type—of the enclosing system, triggered by the adapted activities. At least some of the rules of the enclosing systems can be discerned to understand the limits, within which activities are allowed, i.e., which activities will pass the selection of the enclosing systems.

Understanding types of emergent qualities, and the situations out of which novelty has emerged, might be helpful in *preparing the ground* for another instance of desired quality to come into existence. A situation itself is what can be influenced; it is the 'catalyst' for propensities and—in a literal sense regarding, spatial development—the

Fig. 4.1 Man may only know known unknowns, not unknown unknowns. Still, something can be learned from types of emergent qualities that belong in the realm of known unknowns (see text)
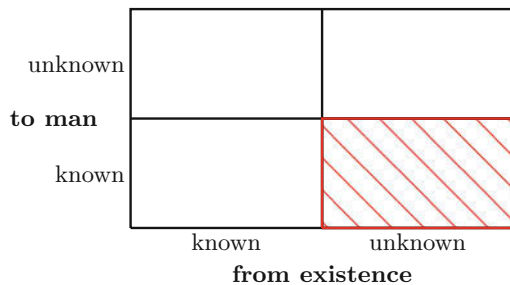
ground that can be prepared.[3] Such ground preparation will be regarded as successful if it leads to the intended "macro-mutations," as suggested in Sect. 1.3.

But even with a thorough understanding of nested systems, surprise via emergent quality is to be expected. Even with the ground well-prepared, what exactly will start to exist, and when it will start to exist, depends on emergence out of a momentary situation, from momentary propensities. *The future will be surprising.* Every influence on an ENS, including purposive, foresighted activity by conscious minds, may lead to unique changes in emergent qualities. Thus, even unwanted new quality might emerge from the propensities generated by man's purposive activities.

At least three approaches that aim to influence or even (re-)make emergent, enclosing systems can be distinguished: First, activities that manipulate the rules of the enclosing system; second, activities that trigger change in the enclosing systems; and, third, activities that work within the given rules but may still lead to changed propensities, out of which new quality may emerge. The manipulation of the enclosing system's rules seeks to influence inward the activities of the enclosed system. A change in activities of the enclosed, generative system—either as a result of the manipulated rules or as intended outward influence—in turn influences the enclosing system, potentially leading to an emergent, i.e., an (in its particular forming) a priori unknown, change of its quality and rules.

Since every enclosed system is an enclosing system itself, every intervention in an enclosed system is at the same time an intervention in an enclosing system (Fig. 4.2). Hence, every activity in a fast system must be supported by the maintaining activities

Fig. 4.2 Every activity in a nested system is both generating propensities, out of which enclosing quality may change, *and* guiding and selecting activities in the enclosed system
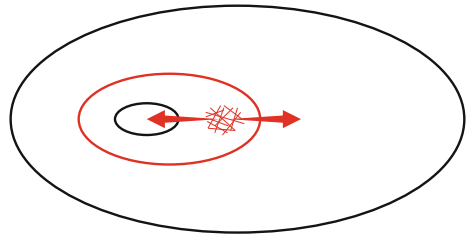
Fig. 4.3 Outward and inward influence together make for a stable, self-maintaining whole that is hard to break up
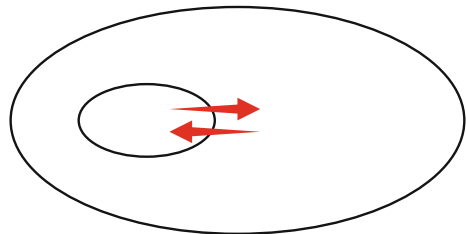
[3]Cf. the expectation expressed in Sect. 2.1: Through the understanding of the coming into existence of unknown unknowns, it can be identified and it may be prepared the ground—the ground in this case being the situations out of which (desired) novelty emerges. I.e., which are the catalysts required for novelty to come into existence, and how can those catalysts be influenced?

of even faster systems. Every influence must be seen as both a generative activity and a guiding and selecting rule.

I further conjecture that generative outward influence and guiding inward influence (cf. Sect. 2.3) are the forces that make a *stable whole* (Fig. 4.3) that is hard to break up. The nested arrangement, in which the enclosing system is "enslaving" the enclosed one into a supportive mode, produces a stable constellation, not easy to break, even by purposive activity (see also below, Sect. 7.4.4). Breaking up stable systems through revolution (outward) or suffocation (inward), however, can be initiated by mutation or purposive decision. I.e., by activities from the enclosed or the enclosing system, the whole may be destroyed (or destroy itself).

4.2   Three Generic Ways to Influence ENS

Given the above considerations, there are three ways to influence ENS. The first way is to *change the rules of inward influence* or, in an extreme case, establish a set of guiding and selecting rules, as, e.g., in a constitutional system or in a city built from scratch, such as Brasilia or Chandighar. This way may yield unpredictable results, since it intervenes in the generative relation between the enclosed and the enclosing system. In other words, an altered enclosing system might not be successful in making the enclosed systems support it.

The second way is to change the enclosing system through *activities of outward influence* or, in an extreme case, break up the enclosing system through a revolution. This may yield unpredictable results, due to the same reasons as before: The generative relations between the enclosed and the enclosing system are altered. Hence, the emergent quality might change, as well as its guiding and selecting rules of inward influence.

The third, rather trivial way is to *submit to the guiding and selecting rules,* not aiming at change but at the exploration of yet-unrealized activities. Still, this may yield different situations in the enclosed system, out of which the enclosing quality may change.

Fig. 4.4 Purposively changed or devised rules guide and influence inward
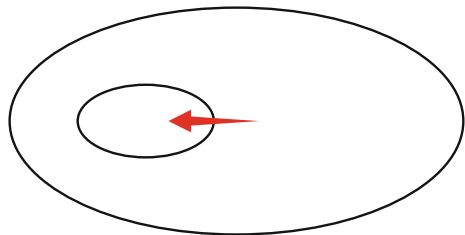
4.2.1 Changing Rules of Inward Influence

If change is aimed at, a possible way is to work on the guiding and selecting rules, i.e., to change existing ones or establish new ones. Changing rules comes with the intention to alter the activities of the enclosed, faster systems. This implies intended inward influence (Fig. 4.4), i.e., changing the conditions under which the enclosed systems operate. In other words, changing the rules means guiding and selecting the activities in the enclosed systems differently, i.e., restricting old activities and/or allowing for new activities. This can be considered an act of governance, i.e., *guiding* systems in a targeted way while not suffocating them.

Rules may be changed once in a while. However, it does not make sense to change them at a pace faster than is needed by the enclosed system to align its activities to new rules, e.g., individuals need to be given time to adapt their activity, or else the rules could never become effective.

Changing rules, or devising new rules, also means tinkering with once-emerged quality, or imitating the role of emergent quality, which is often a futile attempt to design the emergent quality itself.

In an attempt at design, what once emerged somewhere may be interpreted as a model by man, who aims to recreate the quality. In an enclosed system, it might not be impossible that the foresighted *introduction of some key rules* leads to situations, out of which a desired type of quality emerges, but it is impossible that the particular quality can be determined a priori or even devised by design.

Devised rules are designed to create conditions that are considered favorable for aimed-at emergent quality to come into existence, and they are subject to both the faster activities from the enclosed system and the more slowly changing rules of the next enclosing system. In the fast system, the new rules might lead to unexpected reactions, even revolutions. By enacting its own rules, the pressure of selection of the next enclosing system may lead to a failure of the devised rules. Hence, since every system is both enclosing and enclosed, whenever a new enclosing structure is devised, it might not be compatible with the outward and/or inward influence that is already acting upon it.

4.2.2 Changing Activities of Outward Influence

A second way to reach for an aimed-at change of rules and/or enclosing quality is to indirectly alter the working of the enclosing system through outward influence (Fig. 4.5), i.e., to intendedly carry out activities that might be in disaccord with the rules of the enclosing system. The potential impact of outward influence, due to changed activities, relies on the effect of changed situations, and their propensities, on emergent quality. This method can be seen as *'tickling'* the enclosing system through intended activities, i.e., trying to stimulate emergence. Activities may aim

at a wide range of changes—small changes or radical revolutions—by changing situations that generate propensities, out of which new quality can emerge.

Outward influence can be based on foresight. Through a posteriori analysis and an understanding of the situations out of which types of desired qualities once emerged, purposive activities might intendedly create similar situations, thereby *preparing the ground* for similar quality to emerge. Thus, situations may be created by man, who—while not being able to design emergent qualities directly—may *design for emergence*. In this way, outward and inward influence might go hand-in-hand, creating situations and devising rules.

For example, situations might be recreated in urban spaces that are associated with positive development in another place, hoping to prepare the ground for a similar positive development. However, development of an emergent quality cannot be planned further than that, since in a complex system, it cannot be known which propensities are realized—and out of which particular situation in space and time. The situations of a complex system are beyond mechanical or statistical analyzability (cf. Sect. 1.1), and are created by the activities of individuals in different roles and under the influence of various enclosing systems, e.g., cultural habits, political rules, and the constraints of the ecosystem.

Similar to rules devised in an enclosing system, activities in one system are enclosed by the next slower system, and they may also exert inward influence on the next faster system. I.e., activities, which are aimed at breaking rules of the enclosing system, might as well change the rules for the next faster system. These changes can lead to unintended results, e.g., the support for the acting system might be impeded. Any activity, even if intendedly carried out, is subject to the rules and selecting inward influence of the enclosing system, and might, hence, be rejected.[4] For any intended change of emerging quality, the subsequent change in rules and, hence, in guiding and selecting inward influence, is unclear a priori.

Fig. 4.5 Purposive activities in the nested system generate new propensities, out of which the enclosing quality may change

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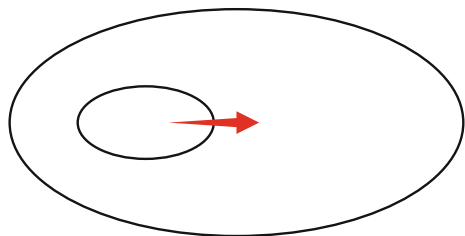
[4]This statement is not intended to argue in purely evolutionary terms. Where purposive activities are carried out, man can, in some cases, overcome, break up, or alter the selective rules of inward influence.

4.2.3   Submitting to the Guiding and Selecting Rules

The aim of acting within the existing rules is not to change the enclosing quality. Acting within the existing rules implies that activities will be carried out, in accordance with the rules of the enclosing system; this requires that the individuals in the enclosed system know what said rules are. While no effort is put into either devising or breaking rules, there might still be the change and emergence of enclosing quality—out of continuously changing situations (Fig. 4.6).

Also, activities might change the rules for the next faster systems, the subsequent activities of which might be unknown as well. Hence, even when submitting to the rules of the enclosing system, novelty may emerge out of ever-changing propensities—except that these propensities are generated with less or no intent and foresight.

4.3   Three Case Studies to Exemplify Influencing ENS

This theory of ENS should be useful to man, who is continuously trying, more or less successfully, to influence complex systems. Said theory is helpful to understand how the nesting of complex systems is due to consecutive emergence, out of situations with unique propensities. This nesting is then stabilized by the enclosing system's rules, guiding the enclosed system's activities, which are aimed at the whole's maintenance. The theory also enables the deduction of useful concepts, e.g., the suggested three ways of effectively influencing ENS.

In Chap. 6, I will exemplify the usefulness and explanatory power of my theoretical contribution on ENS. To do this, I will discuss three cases of planned and unplanned urban development, by means of the suggested three ways of influencing complex systems. I aim to demonstrate how the knowledge presented about emergent, nested, fast, and slow systems could make purposive interventions in complex systems more effective. From the examples, it will become more obvious how the nesting of complex systems influences their development—and how such influence,
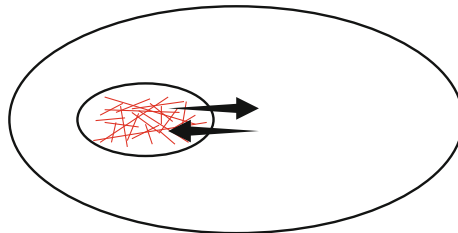
Fig. 4.6   Activity in the enclosed system (*red lines*) may be fully aligned to the guiding and selecting rules of the enclosing system. Thus, the inward influence of the enclosing system is fully effective. However, propensities may be generated, out of which the enclosing system may change

or the nesting itself, i.e., the succession of emergence that makes nested systems, can itself be influenced.

First, however, I will deduce a case-study method, appropriate to understanding ENS. My core argument will be as follows: due to *unique* emergent qualities, the focus of a case study must be on the particularities of the present case, rather than generalities that could be compared across cases. In the following chapter, I will introduce such a case-study method.

Part II
Understanding and Influencing Emergent Nested Systems: A Case-Study Approach and Exemplary Cases

Chapter 5
Understanding ENS

> *Our next advance in systems might well be through focusing on specifics rather than generalities.*
>
> Metcalf 2009, p. 15

Influencing ENS in any of the three generic ways introduced in Chap. 4 requires, first of all, to *understand* the ENS. What is needed, hence, is an approach to study complex systems, and to understand their characteristics, in terms of nested relations, emergent qualities, and outward and inward influence.

Thus, the focus of this chapter is on a case-study approach, suitable to inform decision-making in nested and emergent, i.e., complex, systems (Sect. 5.1). Such an approach can be classified as *exploratory* and *descriptive*. In order to understand *particular* situations, I will argue that a *single-case* approach should be chosen (Sect. 5.2).

Subsequently, I am going to outline such an approach for studying the single case, i.e., the complex system under study in its own terms (Sect. 5.3). I will present not only an approach to studying complex systems, but also, from my observations in urban systems, I will derive a set of five superordinate, enclosing systems that guide activities of individuals in urban systems (Sect. 5.4). The study of ENS remains a *heuristic* endeavor, involving observations and interviews to gather *empirical* evidence of the momentary situation—with no intention to predict future developments (Sect. 5.5).

5.1 Purpose of a Case Study: Understanding the Emergent Nested System for Subsequent, Purposive Activity

A common aim of case studies is to understand a case, in order to inform decision-making; the same accounts for case studies of ENS. Understanding, e.g., a complex urban system thus follows an *intrinsic motivation* of carrying out a case study:

"[T]he objective…of the study is…understanding the particular case" (Scholz and Tietje 2002, p. 11). Insights gained from the case study are to be used to deal with the case itself, e.g., the city: The *purpose* of the case study is subsequent, purposive activity (cf. Sect. 1.3).[1]

5.2 Scope of a Case Study: Focusing on the Single Case

As compared to comparative case studies, understanding an Emergent Nested System requires the researcher to focus on studying *the single case*. Studying single cases is a consequence of the decisiveness of *unique situations* that generate propensities, out of which new quality emerges in complex systems, e.g., urban systems (Sect. 5.2.1).

Thus, with the aim of subsequent, purposive activities influencing a particular complex (urban) system in mind, a suitable case-study approach has to enable the understanding of a single case's unique situations, i.e., the triggering activities of outward influence and guiding rules of inward influence on an Emergent Nested System—instead of comparing generalities across several cases (Sect. 5.2.2).

5.2.1 Unique Situations Are Decisive

Situations, propensities, and emergent qualities are unique to particular ENS, and they are relevant to how ENS develop in their own unique ways. Any given city develops like no other city anywhere else. I.e., through (purposive) activities that generate ever-changing propensities, guided by rules of enclosing systems, new qualities may emerge (cf. Sect. 2.2). In turn, these new qualities will guide subsequent activities.

Ever-changing situations intersect in different constellations in time and space, as depicted in Fig. 2.4: Concurrent strands of development generate propensities, out of which new quality may emerge. In his book *The Comparative Method*, Ragin (1987) writes:

> It is the intersection of a set of conditions in time and in space that produces many of the large-scale qualitative changes, as well as many of the small-scale events, that interest social scientists, not the separate or independent effects of these conditions. ... The basic idea is that a phenomenon or a change emerges from the intersection of appropriate preconditions—the right ingredients for change. In the absence of any one of the essential ingredients, the

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[1]The purpose of studying a complex urban system is subsequent activity (of, e.g., municipal authorities and/or citizen initiatives). Since real systems may be discerned, based on their relative speed of internal activity, the presented approach is not a soft-systems method, e.g., activity research, which works with different worldviews (cf., e.g., Checkland and Holwell 1998; Checkland and Poulter 2010, p. 191 ff.). It can be argued, however, that the case study is an intervention of the researcher(s) in the researched systems, by virtue of the unavoidable interaction between these two entities (see, e.g., Midgley 2003 and Sect. 5.5.7).

phenomenon—or the change—does not emerge. The conjunctural or combinatorial nature is a key feature of causal complexity.[2] (p. 25)

Thus, at any time, the ensemble of unique situations may change the course of events by generative propensities; out of that, new quality may emerge that can have a significant impact on the whole. Those emergent qualities are "the changes that matter,…phase shifts,…transformations. …We see changes in quantity become changes in quality. …crossing of a threshold of kind" (Byrne 2005, p. 104). For example, due to unique situations, plans created by (groups of) individuals might not work out as intended; instead, something unplanned emerges, or nothing emerges at all for a while (cf. Sect. 3.3.5).

5.2.2 Studying Single Cases

Consequently, understanding the unique situations in an Emergent Nested System must be the aim of any case study. A case-study approach has to allow the researcher(s) to focus on a single case. In such an approach, it is not averages that are important (e.g., comparing how many people in a given city use means of public transport with the use of public transport in other urban systems). Rather, particularities are important (e.g., the reasons why, in a given city, people use or do not use means of public transport) since "it is the essential characteristics rather than the generalities that make a difference" (Metcalf 2009, p. 12).

Thus, an approach to studying complex systems is required that brings each system's "specific pattern…at a given time" into focus (Ibid., p. 15). Finally, such case studies must be adjusted to reveal levers for purposive change at a particular place in time—in a particular situation, from a particular starting point.

Understanding unique situations requires an approach to thoroughly *study the single case*. For example, understanding a particular urban system requires studying that particular city and the unique situations of, inter alia, citizens' activities and the rules guiding them. "We look for the detail of interaction with their contexts. Case study is the study of the particularity and complexity of a single case, coming to understand its activity within important circumstances" (Stake 1995, p. xi).

Thus, a case-study approach, suitable to understanding ENS, must enable the "exploration of a case in order to construct a narrative [that] involves attempting to map interactions and relationships within the case, not with the aim of identifying cause and effect in order to be able to predict, but in order to achieve the richest possible picture of the ongoing processes" (Hetherington 2013, p. 78). Guided by

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[2]What interests the social scientist—a scientist of complex systems—should interest any scientist dealing with any Emergent Nested System, whether it involves human activities or not.

such an approach, "a case study is expected to catch the complexity of a *single case* [*my emphasis*]" (Stake 1995, p. xi).[3,4]

Therefore, a case study of ENS is not, at least at first, about "observing and measuring variables [for] cross-case analysis" (cf. Byrne and Ragin 2009, p. 2). For example, the percentage of a city's inhabitants using means of public transport is a variable that can be compared across cities. The variable, however, does not reveal the motivations that led people to use or not use public transport in any particular city.

An individual's decisions are not determined by an invisible force of statistics, but rather (partially, conjunctively) guided by rules of enclosing systems. The scope of studying ENS should, thus, encompass these systems' nesting relations, in order to "preserve the integrity of the case":

> Instead of disaggregating the case into its features, operationalizing such features as variables, and then testing for correlations between these variables while controlling for as many other features as possible or relevant, the case study approach aims to preserve the integrity of the case and understand it as a particular configuration of features embedded in a specific context in time. ... A case study approach ... requires an in-depth understanding of the case rather than a superficial understanding that goes little beyond the operationalization of variables. (Fiss 2009, pp. 426–427)

The relations between enclosing and enclosed systems constitute the unique characteristics a suitable case-study approach must be able to realize. In the above example of the use of public transport, only by understanding the triggering and guiding relations in a particular city is it possible to reveal the motivations that lead people to use or not use public transport. A suitable case-study approach, applicable to complex (urban) systems, must enable the researcher to identify enclosing systems that set rules and select activities in enclosed systems, as well as enclosed systems, that, through their activities, maintain a stable whole and/or trigger change.

Since, as argued in Sect. 5.1, a case study is usually carried out for the purpose of subsequent purposive activity, findings from studying ENS must be useful in deducing activities that can effectively influence such systems. From the understanding

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[3]Advocating a single-case scope does not mean denying the scientific endeavor to isolate chains of causes and effects that are applicable across a variety of systems, e.g., in various cities, at different times. An "emphasis on the specific and the contextual [is] wholly compatible with…complexity science's emphasis on the inherent localism [i.e., unique situations in time and space]…but nonetheless achievability of scientific knowledge" (Byrne and Ragin 2009, p. 4). Generalities can be identified in systems that are similar, or system representations that are reduced to similar characteristics. Through identifying such generalities, it becomes possible to know types of systems (as described in Sect. 3.2.3). However, even emergence of a quality of known type always involves unique novelty (cf. Sect. 3.3.5): One emergent quality is not the exact same as any other. E.g., "city-region might move from an industrial to post-industrial character. However, the forms available to post-industrial cities are multiple" (Byrne 2005, p. 104).

[4]A case-study approach providing a "thick description," in order to uncover underlying reasons for local particularities, is methodologically related to ethnographic studies in cultural studies and sociology (cf., e.g., Geertz 1973, p. 312). However, these approaches have not been developed to study ENS.

of the case, a foresighted choice of activities to influence the complex system must become possible.

In particular, it must become possible to identify the effectivity of deliberate changes in rules of inward influence, of inducing activities meant to change the enclosing system(s) through outward influence, and/or of acting within the existing rules of enclosing systems (cf. Sect. 4.2). I hold that case studies focusing on a single case, rather than on a cross-case comparison, and in particular focusing on the triggering and rule-setting relations of nested systems, may enable the deduction of potentially effective, purposive activities.

5.3 A Single-Case Approach for ENS

The single case has to be studied, since knowledge of situations cannot be taken from elsewhere, or from another time. More specifically, a key to understanding an Emergent Nested System is understanding the relations that are present in the situation: the enclosing and enclosed, the guiding and triggering, the slow and fast—e.g., the local context of urban space and place.[5]

This requires in-depth studies of a system, in which, by subsequent purposive activities, effective change is sought to be implemented. Understanding the enclosing systems is important, since said systems guide—through rules, at least applicable locally in time and space—the activities of enclosed systems. From the studies of both the enclosing and the enclosed systems, outward and inward influences should be revealed, and it can be assessed how stable the whole is (cf. Sect. 3.3.4). From this understanding, it will become possible to deduce potentially effective activities of outward and/or inward influence, i.e., interventions in the existing nested-system relations.

The requirements of focusing on studying a single nested system and understanding the situation can be satisfied by case studies that are structured in four distinct steps: (1) understanding enclosed systems, (2) understanding enclosing systems, (3) understanding outward and inward influence, and (4) deducing potentially effective interventions. The first three steps are concerned with understanding the Emergent Nested System; the fourth step involves potential approaches to dealing with it.

If several case studies are to be carried out, which are subject to the same, rule-setting enclosing systems, e.g., in a local urban context, it might be useful to (0) understand the general guiding rules that are initially relevant to all cases. This can be considered a zeroth step to be carried out, i.e., prior to the remaining four steps of the case-study approach (Table 5.1). (In Sect. 5.4, I will present a set of

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[5]Local validity of research results of complex systems does not mean that the spatially local influence is disconnected from more global influences, e.g., regional and national influences in urban systems. Global influences do guide local activities, which may even lead to the emergence of similar types of local qualities in different places.

Table 5.1 Overview of an approach to study ENS

Step	Aim	Scope
0	Understanding the locally relevant *enclosing systems* (e.g., cultural systems, political systems)	Systems enclosing the case-study system, and the selecting and guiding rules of these enclosing systems
1	Understanding the *enclosed systems*	The case-study system, which is enclosed by other systems and subject to their selecting and guiding rules
2	Understanding which *rules* the enclosed case-study system is subject to, *and* how the *activities* in the enclosed case-study system reject the influence of these rules	The enclosing system, and those of their selecting and guiding rules, which in particular influence the enclosed case-study system
3	Understanding the mutual outward and inward influence and assessing the momentary *stability* of the nested-system relations, i.e., the power of the whole (cf. Sect. 3.3.4)	The nested relations of the enclosed case-study system, with its enclosing systems
4	Assessing ways to *influence* the case-study system, which is enclosed by other systems	Potential interventions aiming at influencing the course of events in the case-study system, either by means of activities in the enclosed case-study system, or by means of activities in the enclosing systems

such superordinate enclosing systems, based on case studies carried out in an urban system.)

The study of a single case can start by understanding the enclosing system(s). In the next step, the enclosed systems can be studied. These first analyses can be followed by combining the understanding of both enclosed and enclosing systems and their respective outward and inward influences. This should allow for an assessment of the stability of the whole nested system, which relates to the potential effectiveness of interventions. Thus, the case study will conclude with an assessment of the potential effectiveness of suggested interventions, and/or with suggestions of potentially effective interventions.

This simple-looking approach—reflecting the aim and scope of studying single ENS and influencing them—comes with a number of implications, relevant to carrying out the case studies. Yet before reviewing these implications in Sect. 5.5, I will introduce the concept—and examples of *superordinate* enclosing systems—that can be discerned in an Emergent Nested System, such as a city.

5.4   Enclosing Sociocultural Systems

In ENS, I suggest that there are superordinate systems that can be distinguished, which are based on objective measures. This consideration is based on the hypothesis that there are enclosing systems, which, through their guiding rules, have inward influence on a large share of other systems—at the time and place of study.

Where are such general guiding rules at work in, e.g., a city? Which are the systems behind these general guiding rules? For example, it seems plausible to assume that there are local cultural characteristics that guide the activities of a large share—if not all—of a city's inhabitants, or that there are political rules—some of them deliberately devised—that guide citizens' activities.

The classifications of superordinate systems that are available to date, however, do not convince one with sound theoretical and/or empirical foundations (Sect. 5.4.1). Such a foundation, however, may be given by the theory presented in Part I of this book.

A system's speed of change is an objective measure in distinguishing it from other systems (Sect. 5.4.2). Applying this measure, I identified five such superordinate nested systems, which I hypothesize to be generally applicable in complex systems that involve social individuals (Sect. 5.4.3).

5.4.1 Weaknesses of Some Common System Classifications

There are some well-known classifications of systems. One such classification is known as the three pillars of sustainability, which implies three superordinate systems: social, economic, and technical. The three pillars of sustainability are widely used in various research and professional practices, e.g., in urban development, spatial research, and education. However, it remains unclear where to subsume other systems, e.g., political or technical systems, in this classification.

Another classification—the Political, Economic, Social, Technical, Ecologic (PESTE) framework—allows for explicit allocation of those political and technical systems. Thus, using this PESTE framework to distinguish systems in a city could help to adequately distinguish the infrastructural and political domains of urban systems. Yet the PESTE framework is not convincing—with a sound theoretical basis—of its suggested classification.

Indeed, the classification of, e.g., an urban system, into social, economic, and ecologic systems—even with the political and technical systems added—appears to be somewhat arbitrary. For example, the separation between social and economic systems seems strange, considering the economic system is itself unthinkable, without the activities of social actors, i.e., individuals.

Another classification—distinguishing man-made from non-man-made systems—was implicitly suggested by Simon (1996) in the title of his book, *The Sciences of the Artificial*. The title appears, on first sight, to be similarly odd: Why should the products of man, i.e., a natural system, be considered artificial? It is hard to understand why systems should be either/or, e.g., why a landscaped park should be classified as either natural or artificial. Given that land use is among the *seven* domains postulated by Vester and Hesler (1980, pp. 36–37, 83), another example is why the system that determines land use should be subsumed by only one of the three pillars of sustainability, or one of the five PESTE systems. Also, the mentioned classifications usually represent systems that are non-nested, but are adjoint (for no reason obvious to me).

The consequence of these seemingly arbitrary classifications cannot be, however, to renounce any attempt to identify superordinate, enclosing systems, or to distinguish systems at all. An all-is-one-indivisible-system point of view is immediately challenged by empirical evidence of the strong coherence of many, distinguishable systems, e.g., of individuals or cities, as well as their nested, mutual influences.

Thus, it should be possible to find objective, rather than arbitrary, classifications of complex systems. Furthermore, it should be possible to discern superordinate systems, i.e., systems enclosing all other systems in a given time and place. Such objective classifications will allow studies of complex systems to be scientific. Also, where systems can be objectively distinguished, their interrelations are real. Additionally, inward and outward influence are meaningful to the real system—and are not only to be used as concepts for understanding complex systems.

5.4.2   Distinguishing Empirically Evident Superordinate Systems

Against this backdrop, I return to the approach of identifying systems by their frequency of change, and/or speed of activities within—as compared to the activities and exchanges across their borders (cf. Sect. 3.2.2). Thus, as with any system, superordinate systems can be distinguished by their activities; additionally, their nested relation can be identified by their mutual outward and inward influences.

The identity of superordinate systems—as compared to other enclosing systems—is evidenced by their relatively slower frequency of change, since systems with relatively slower frequency of change enclose all faster systems in a nested relation. Once identified, these systems can be classified and labeled according to, e.g., the types of rules they are setting as, e.g., cultural systems, political systems, or economic systems.

Also, superordinate systems, distinguished by their relative speed of change, are nested, not adjoint. All faster systems can be related to these superordinate systems by identifying activities, i.e., the submission of enclosed systems to guiding rules of the superordinate systems, and/or the triggering activities of enclosed systems—potentially influencing change in the enclosing, superordinate system. Such nestedness of superordinate, and all other, systems makes for direct, as well as indirect, enclosing relations; enclosed systems may be guided by inward influence of more than one enclosing system, directly and/or indirectly (cf. Sect. 2.3.1).

To remain with the example above, the land-use system is an enclosed system influenced by a number of enclosing systems. Among them are the local superordinate systems, e.g., the cultural system, influencing through attitudes and habits; the economic system, influencing through economic utility; and the political system, influencing through land-use laws. Other systems referred to in everyday language, such as the health system and the educational system, are systems—enclosed and influenced by enclosing cultural, economic, political, and technical systems.

5.4.3 Introducing the E-CEPT Framework of Superordinate Enclosing Systems

During the course of case studies carried out (Chap. 6), I could identify five super-ordinate systems. The slowest-changing system, setting rules for other activities in the case-study city, is the all-encompassing ecosystem.[6] The next faster systems are those emerged cultural systems that are acting back on citizens' activities, by means of cultural guiding rules. Enclosed by the ecosystem and cultural systems is the economic system, that is both guiding another superordinate system, the political system, and changing upon outward-triggering political activities. Enclosed, even by the political system, are the technical systems of the case-study city, which have to follow political decisions and legal rules.

Thus, at least for the case-study city, the analysis of nested systems could be guided by what I would like to introduce as the E-CEPT framework. This framework reflects five superordinate systems (Fig. 5.1): the ecosystems (E), the cultural systems (C), the economic systems (E), the political systems (P), and the technical systems (T). The order in which these five systems are analyzed reflects the overall order of nestedness in these systems, as identified in my case studies.

Remarkably, this classification yields a distinction between the natural ecosystem and all other, man-made systems—as suggested by Simon (1996), which is expressed by the hyphen in E-CEPT. Incidentally, these five superordinate systems also approximately match with the PESTE framework, except that the broad and ambiguous 'social' realm could be disambiguated into cultural and economic systems.[7]

Fig. 5.1 Five superordinate systems guide activities in the case-study city: the ecosystems (E), the cultural systems (C), the economic systems (E), the political systems (P), and the technical systems (T)

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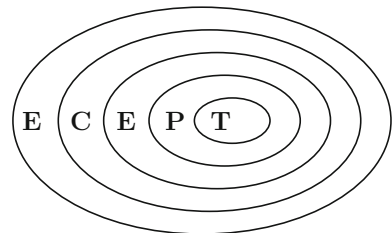
[6]This ecosystem is hardly changing its characteristics of inward influence in a time frame relevant to current decision-making. Furthermore, the case-study city is located in a mild, continental climate zone, which hardly shows extreme weather events. Because of this, I suggest that it can be considered as adequately reflected in the activities and rules of all enclosed systems.

Thus, it does not require explicit consideration in the case study. For example, the enclosing ecosystem should be adequately reflected in, inter alia, the cultural systems—with citizens having adapted to the natural environment, and this adaptation being expressed by individual activity. Also, the urban system of the case-study city appears, in its development, relatively independent of extreme climates and other environmental conditions that could constrain or trigger change.

[7]The major difference between the PESTE and the E-CEPT framework lies, besides the order of analysis, in the subtle difference between social and cultural systems. I've experienced much confusion while using the three pillars of sustainability or the PESTE framework with my students.

Although identified on a specific case, my hypothesis is that the same five super-ordinate systems, in the same nested relation, apply to many, if not all, urban systems. They even apply, more generally, to complex systems, involving social individuals, i.e., social systems.

5.5 Practical Implications for Studying Single ENS

The requirements of focusing a case study on a single Emergent Nested System, of understanding this one nested system's relations, and of deducing potentially effective interventions imply some attributes of the practice of carrying out case studies. In some ways, such case studies of ENS resemble other types of case studies; in other ways, they don't.

To understand ENS, case studies are *exploratory and descriptive* (Sect. 5.5.1); *bounded by dealing with ontologically real entities* (Sect. 5.5.2); *heuristic, iterative, and empirical* (Sect. 5.5.3); and *narrative* (Sect. 5.5.4). Furthermore, when it comes to assessing potentially effective interventions, the practice becomes *deductive* (Sect. 5.5.5).

A warning is due: While the study of an Emergent Nested System can be *non-predictive* (Sect. 5.5.6), it may well be *situation-changing* (Sect. 5.5.7).

5.5.1 Exploratory and Descriptive

For ENS, a relevant condition of a case-study approach is that it allows the case study that is being conducted to be as exploratory as possible—and as descriptive as necessary (cf., e.g., Hetherington 2013, p. 76). On one hand, an explanatory approach is directed toward an unbiased exploration of the single system, as well as situations in this system. On the other hand, the case study will yield a description, which is influenced by the theory of ENS.

With the presented case-study approach focusing on an understanding of single systems, a thorough exploration of the case is a foremost necessity. This "help[s]

(Footnote 7 continued)

The 'S' standing for the 'social' systems was often interpreted in a narrow way, reflecting the students' beliefs about the need of people to socialize and, thus, to plan compact and walkable cities—impeding the higher privacy of living in suburban sprawl—and/or the students' beliefs about the 'need' for social welfare.

But a planner's *belief* in one or the other, e.g., the belief that people need socially mixed and dense neighborhoods, dotted with urban greenery and connected by bicycle lanes, is very different from researching the *actual* guiding cultural system(s) of an urban society. Rather, what urban planners believe the needs of their citizens are is part of the guiding political system, not the cultural system of citizens. Yet I would like to argue that the *actual* cultural system of an urban population is, at least in free societies, of much greater power (i.e., inward influence in a nested system) than the convictions of urban planners.

to gain insight into the structure of a phenomenon" (Scholz and Tietje 2002, p. 11). The *exploratory* approach does not aim to select or classify information while being gathered. It enables a holistic case study, which does not require focusing on selected (disciplinary) facets of the system—or using selected case-study methods, potentially biasing the analysis.[8]

Also, the inquirer's values—or pre-defined activities—do not have to enter and bias an exploratory case study.[9] The case-study approach must not direct the focus on problems identified before the start of the case study, let alone on finding justification for preconceived, interventional activities, e.g., political decisions or planning interventions.

Yet this very approach for studying ENS will, in some ways, influence the focus of the case study. Based on a case-study approach that is structured according to the theory of ENS, such a case study will feature aspects of a "*descriptive [my emphasis]* case study…that…uses a reference theory or model that directs data collection and case description" (Scholz and Tietje 2002, p. 12).

To a certain degree, data collection and case description will be directed by the theory of ENS, i.e., by the expectation to identify faster and slower systems, outward and inward influence, triggering relations, and guiding rules. Thus, over the course of the case study, e.g., while working through the five-step approach (Sect. 5.3), the case study is shaped according to the theory of ENS. Such a case study begins with the identification of superordinate systems and reveals the unique situation in the system—at the time and place of studies.

5.5.2 Bounded by Dealing with Ontologically Real Entities

The existence of ENS provides the boundaries of a case, and implies the local and time-bound validity of knowledge about the system—and situations within this system.

Studying an Emergent Nested System means studying an *ontologically real entity*. As argued in Sect. 3.2.2, and applied above (Sect. 5.4.2) to identify a set of superordinate systems, relatively high activities within—versus relatively low activities across—an Emergent Nested System's borders allows the distinguishing of a system from its environment. Understanding these fast and slow relations will thus allow

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[8]Considering that the whole is not just a number of facets combined together, I argue that a holistic understanding of the system under study is to be preferred over an embedded case-study design. In contrast, cited authors Scholz and Tietje (2002) advocate embedded case studies, where, "in the course of analysis, the case will be faceted either by different perspectives of inquiry or by several subunits" (Ibid., p. 2). They argue that embedded case studies are "appropriate to organize different types of knowledge, such as different stakeholder or disciplinary perspectives" (Ibid., p. 4). They identify "two types of knowledge integration: the integration of knowledge from different disciplines, and the integration and scaling up of the data provided by subsystems" (Ibid., p. 25).

[9]Cf. Scholz and Tietje (Ibid., p. 26), in contrast, seem to accept that a "study team's values usually have a strong influence on the target of the study."

one to come closer to the truth about the Emergent Nested System. A case study defined by the boundaries of an Emergent Nested System therefore becomes a "link between ontology, epistemology and theory informing the research, and the practice of conducting that research" (Hetherington 2013, p. 72).

In a case study of a real Emergent Nested System, the boundaries of the system define the *boundaries of the case.* For example, a local health system—enclosed by cultural, economic, political, and technical systems (cf. my introduction of super-ordinate E-CEPT systems in Sect. 5.4)—could be a case. (In this type of case, the administrative border of a city does not matter, since medical services located in the city serve the environment as well. I.e., the health system's internal activity extends as far as the city is a central place, as defined in Chap. 1, regarding medical services to the environment.) Such a case study, according to the approach presented here, would focus on a single Emergent Nested System. I.e., a health system of relatively fast internal activity is enclosed by some superordinate systems, and is enclosing other, triggering systems, e.g., individuals coming up with new ideas that might lead to changes. The boundaries of the case are equal to the boundaries of the Emergent Nested System, i.e., the health system, its enclosing systems, and its enclosed systems.

With ENS—and situations in ENS—changing continuously, the knowledge acquired through a case study may be valid only at the *time and place* of study. At any time, an Emergent Nested System is a "realized outcome" of prior situations and their propensities (Williams and Dyer 2009, p. 88, referring to "Popper's…concept of the 'case' as a realized outcome" in the context of Popper's "propensity interpretation of probability;" see also Sect. 2.2). With any activity in a system, situations change and, thus, the system changes. As a consequence:

> Knowledge is inherently local rather than universal. ... Complexity theory challenges the nomothetic programme of universally applicable knowledge at its very heart—it asserts that knowledge must be contextual. (Byrne 2005, p. 97)

However, such contextual knowledge is important, looking at the aim of a case study to deduce potentially effective interventions. If the present is a realized outcome of the past, of a system's particular and unique history, i.e., past unique situations, then studying the present can reveal the current situations—out of which the future of the Emergent Nested System will be realized: The present at the time and place of a case study is the important point of departure for the future of an Emergent Nested System. The past is involved, insofar as it is necessary to understand the characteristics of the path-dependent present and future.

Once gained, local and time-bound knowledge is an argument for a single-case scope, when studying ENS.

5.5.3   *Heuristic, Iterative, and Empirical*

A thorough exploration of an Emergent Nested System—yielding a rich representation of the situation, and revealing facts and figures relevant to understanding said system—will employ various means of gathering a sufficiently comprehensive set of information. The methods of data collection depend on the circumstances of the case study, in particular the accessibility of sources and the kind of empirical evidence being sought.

In a *heuristic* way, the best available—and in said circumstances, the most practically applicable—methods of data collection will be chosen for a case study. For example, direct observation, semi-structured interviews, research reports, and statistical data may be used as sources of information. In addition, the abduction, and subsequent testing, of hypotheses may be used as methods of knowledge generation.

A case study of an Emergent Nested System will *iterate* from the explorative gathering of information toward a structured description of said system, based on tested hypotheses. Based on the first information gathered, abduction will lead to hypotheses concerning faster and slower systems, outward and inward influence, triggering activities, and guiding rules in the situation under study. These hypotheses will turn further investigation into a more structured endeavor—to find evidence supporting or refuting the hypotheses, thereby building up (local) knowledge about the nested emergent system under study.

Thus, iteratively, the explorative nature of the case-study approaches a descriptive nature, i.e., "information about the situational context…structure[s] the case" (Scholz and Tietje 2002, p. 13). Therefore, open and explorative interviews become semi-structured ones; their structure is partly prescribed by hypotheses to be tested, the theory of ENS, and case-study methods of ENS. Eventually, the description of the Emergent Nested System is taking shape.

This iteration also implies that knowledge about an Emergent Nested System builds up, along with *empirical evidence* supporting its description. Hypotheses relating to the description of the Emergent Nested System, which were abducted from the initial information gathered, will be tested empirically. Facts and figures are sought to evidence, inter alia, superordinate systems, rules of inward influence, activities of outward influences, and relative speeds of activities.

This evidence is also drawn from observation, interviews, literature, and/or statistical data sources. However, all empirical evidence might not be of equal quality to support or refute hypotheses concerning the Emergent Nested System. For example, where statistical data contradicts perception (e.g., about the punctuality of public transport), the perception is the empirical fact that might better evidence actual rules guiding citizens' activity.[10] Also, hypotheses abducted or found in literature might be refuted. For example, in my case-study work, I encountered a hypothesis from scientific literature that could not be supported.

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[10]Cultural conventions, myths, and popular convictions are all *real* because they have inward influence, guiding activities of individuals.

5.5.4   Narrative

Explorative and descriptive studies of ENS and their relations will be primarily *qualitative* and ideally represented as *narratives*, with data supporting the findings where adequate.

On one hand, many of the guiding rules, such as laws, require a verbal description. It may be argued that the inward influence of such rules could be expressed mathematically, similar to Haken's enslaving rules (see, e.g., Haken 2012, p. 9). However, such an exercise seems to be pointless for a first understanding of the nested relations of, e.g., an urban system.[11]

Similarly, other characteristics of ENS, e.g., activities of individuals and relative speeds of internal activities—which are discovered by studying the emergent nested system—can be adequately represented by a *narrative*. On the other hand, much information could be lost in translation—a translation that would be required if the information from interviews, observation, and literature were to be converted into a more formal representation.

Also, figures tend to not speak for themselves, but only make sense if related to, e.g., other cases. This, in turn, would lead to comparative case studies: comparing generalities, instead of exploring particularities—not doing justice to the nature of ENS, as argued above (Sect. 5.2). Thus, "one could argue that in a complex case study, the narrative rather than comparative approach to case study is likely to be more appropriate" (Hetherington 2013, p. 77).

5.5.5   Deductive

In drawing conclusions, the case-study method is *deductive*. After understanding nested system relations, the focus turns to influencing the Emergent Nested System. Potentially effective activities of outward and/or inward influence, i.e., interventions in the existing nested-system relations, may be deduced. Such deduction is based on the understanding of the case, i.e., on the particularities of the situation. There might be windows of opportunity for the stimulation of changes, due to current mismatches between enclosing and enclosed systems; i.e., when an Emergent Nested System is in an unstable state, the whole is weak, and little influence could lead to big change (see also Sect. 7.4). Or the whole is strong, and interventional efforts would disappear without a trace. Or the case study shows that already devised rules in an enclosing system suffocate the development of enclosed systems' activities, and the rules should be loosened.

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[11]This is not to argue that the (mathematical) modeling of, e.g., inward influence—and the simulation of, e.g., individuals' activities, guided by such inward influence—could not offer additional insights and deepen the understanding of a case. The mathematical modeling of ENS, however, goes far beyond the scope of the case-study approach, and the exemplary case studies presented in this work.

5.5.6 Non-predictive

I would like to emphasize here that the case-study method presented above does not yield a basis for forecasting. In particular, it is not meant to, and it cannot, deliver information to forecast emergent qualities, or their coming into existence. Emergent qualities cannot be, in principle, predicted, as pointed out in Chap. 2. Since the dynamics in complex systems continuously lead to new situations with propensities, out of which new quality may emerge, the course of events in complex systems is, in principle, unpredictable.

"[T]he concept of strong emergence (which argues that prediction is not only difficult but inherently impossible in a complex system) means that case studies of such complex systems cannot enable prediction of future activity" (Hetherington 2013, p. 77). Also, it cannot be expected that a case study could lead to an explanation of how exactly a particular emergent quality came into existence. (However, situations that lead to the emergence of a *type* of emergent quality may be analyzed, as mentioned in Sect. 3.2.3.)

After all, a retrospective explanation would be speculative in nature, i.e., based on intuitively selected facts and interpretative sense-making. In a retrospective explanation, the currently observable situation would play a role, and the narrated history of the Emergent Nested System would have to be taken into consideration as well. Hence, a case-study approach, as presented, could only reveal already emerged qualities and their impact. It cannot claim to explain exactly how the emergent qualities came into existence, or how, and which, emergent qualities will come into existence.

However, approaches other than the one presented here, such as the close observation of an Emergent Nested System over time, could *reveal* just-emerging qualities. Observing changes in a time series, or directly observing an urban system, might help identify emergence that is just happening.

On one hand, there might be hints as to which emergent qualities in a time series are causing urban data to change, appear, or disappear—indicating a qualitative leap. However, if this new category of data is missed while recording data in a time series, the new qualities could not be revealed. I.e., new quality requires a new data category.

Thus, on the other hand, either a case-study approach that "explore[s] a case in depth, over time, that is responsive to emergence within the case" (Ibid., p. 77), or close observation by, inter alia, its own citizens, might be better suited to reveal just-emerging qualities[12]: This is why I suggested that

> In analogy to earth-quake detection, urban planning would require a seismometer for detecting emergent qualities in the city. One obvious possibility could be to involve citizens as reporters or 'trend scouts' for new things they observe coming up. Hence, citizens would be early 'seismic' indicators for emerging qualities—they might not be able to predict, but they can provide a feeling for what has most recently emerged and might subsequently grow to importance. (Walloth 2014, p. 130)

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[12]However, it must be distinguished whether recent change is due to an emergent quality, or if it is just a resultant of activities following already-existing or purposively devised rules in enclosing systems. Emergent qualities may be discerned from other changes by testing whether or not the qualities can be described, in terms of existing coordinates in the city.

Through direct observation and/or interviews, the meaning of the new quality, as perceived by citizens, and the roles of the emergent quality in the nested urban system can be identified. Once identified, the emergent quality may be further explored, and/or approaches to influencing it—in the context of an Emergent Nested System— may be deduced.

5.5.7 Situation-Changing

Finally, it should be noted that carrying out a case study in a complex (urban) system might itself create new situations. If the interference of the researcher with the Emergent Nested System creates new situations, and perhaps new ideas, then new propensities open up, and something unpredictable, new, and different may emerge.

> [T]hrough interacting with the case, the emergent possibilities are altered since the case is always open to activities within and between complex systems as cases. In conducting research, therefore, the researcher of necessity opens out the range of possible emergent trajectories, whilst at the same closing others through the activities of emergence and complexity reduction. (Hetherington 2013, p. 81)

That is not to say, however, that studying the nested systems of a city (or of other complex systems) necessarily involves the characteristics of an intervention in this system—effectively changing its course. An Emergent Nested System, may, at the time of study, be a stable whole (cf. Sect. 3.3.4), suppressing triggering influences. For example, ideas communicated by the researcher may be suppressed by the selecting rules of enclosing systems. Thus, studying an Emergent Nested System may remain an act of observation, without leaving any effect on the system itself. In any case, such a case study will involve information being gathered, prior to the researcher effectively influencing said system. Therefore, the case-study results will not account for potentially new propensities created by the researcher's presence.

Chapter 6
Guiding Rules and Emerging Novelty in the Urban System of Lviv

Eine Stadt, die fähig wird, über sich zu sprechen ... hätte die Kompetenz, zu beschreiben, was die Stadt heute sein könnte: vermutlich etwas Neues ...

Schlögel 1988, p. 96 in an essay about Lviv.

This chapter is meant to demonstrate the single-case approach suggested in Chap. 5, providing accounts of three cases of ENS. The case studies were carried out in the urban system of the city of Lviv, with the aim in mind to exemplify studying single ENS.

Hence, one part of this chapter is dedicated to understanding the superordinate enclosing systems in the city (Sect. 6.2). The other part is dedicated to understanding single enclosed systems and options of influencing them (Sect. 6.3).

The three case studies allow me to demonstrate three implications of ENS theory that are relevant to (urban) development practices:

1. How real systems in urban spaces can be understood, in terms of the theory of ENS.
2. How an understanding of those cases reaches a point where the relations of enclosing and enclosed systems are revealed.
3. How the potential effectiveness of proposed, purposive interventions can be assessed.

A city which becomes able to talk about itself ... would have the ability to describe what it could be today: probably something new... *(my translation).*

6.1 Aim, Scope, and Location of Case Studies

Aim of Case Studies

Thus, in contrast to the general aim of case studies being given with the intrinsic motivation of understanding and subsequently influencing the complex system (cf. Sect. 5.1), the three exemplary case studies are *instrumental* (Scholz and Tietje 2002, p. 11): They are meant to support the theory of ENS, not (primarily) to help anybody influence the urban system I studied.

The aim of the three case studies presented is instrumental in three ways:

1. First, my aim is to demonstrate the case-study approach developed in the previous chapter. The three cases of ENS to be discussed in Sect. 6.3 should suffice to exemplify the practical application of this case-study approach.
2. Second, I aim to support the theory developed in Part I of this work, as well as the case-study approach derived from this theory, through plausible case descriptions and plausible suggestions for influencing them.[1]
3. Third, the case studies serve to show how the deduced methods of influencing ENS can be useful in informing decision-making. I.e., the case studies are expected to deliver a number of evidences that support the following hypothesis: the forces which lead to the nesting of systems have major influence on the development and 'plan-ability' of ENS.

Scope of Case Studies

Each of the three case studies focuses on one single Emergent Nested System, following the approach suggested in Chap. 5. During the course of study, the scope of each case study could be narrowed to the case system, discerned by its relatively high, internal speed of activity. The methodological scope of direct observation and face-to-face interviews, which are largely empirical studies as anticipated in Sect. 5.5, is evident throughout the case descriptions.[2]

Furthermore, to demonstrate a regular case study's final purpose of informing decision-making (cf. Sect. 5.1), the scope of each case study converges towards the deduction and assessment of potential interventions in the Emergent Nested System.

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[1]I'm well aware that producing results that appear plausible to the reader is a weak support for a theory only.

[2]All information presented in this chapter is based on interviews, unless I refer to my own observation or I provide literature reference. Information is based on interviews with 28 individuals, 11 of which were interviewed in small groups of two to four persons. Information on system qualities, based on only one interviewee's statement, is indicated as such in the text; otherwise, information has been confirmed. For nested system relations derived from single statements, I used the subjunctive mood of verbiage.

Place of Case Studies

The three case studies are carried out in one single *urban* system. With this choice, I follow up on my argument brought forward in Sect. 1.4, when I suggested that cities may serve as comprehensive examples of ENS. Furthermore, the focus on one single city underlines my claim of understanding ENS on their own terms, put forward in Chap. 5. Also, studying several cases in one larger Emergent Nested System allowed me to apply the concept of superordinate systems, introduced in Sect. 5.4, and to demonstrate its application.

The regional choice originated in my personal interest in studying post-communist cities in Central Eastern Europe: "over the last two decades... a fascinating laboratory" (Ogden 2011, p. xvi).[3] My choice fell on Lviv, a city of about 800.000 inhabitants in Ukraine.

This choice of Lviv for my case studies was supported by Lviv's City Institute, an urban-strategy think tank affiliated with city hall, that generously granted me organizational support in finding interview partners and in scheduling—and even interpreting some—interviews. But the choice of the particular place of the case studies should be of no relevance: The theory and methods suggested should not be limited to only understanding and influencing particular ENS.

6.2 Four Superordinate Systems

In Sect. 5.4, I suggested that the knowledge of the general enclosing systems is important to understanding the enclosed case-study systems, and to deduce potentially effective interventions. In order to substantiate this idea, I will describe the emergent qualities of the enclosing cultural (Sect. 6.2.1), economic (Sect. 6.2.2), political (Sect. 6.2.3), and technical (Sect. 6.2.4) systems which I identified in the city of Lviv and that set the rules for any other enclosed system, guiding the development of the city and the activity of individuals. Furthermore, for each superordinate system, guiding and triggering relations of inward and outward influence among the superordinate systems are discussed (see Table 6.1). Thus, the structure of this chapter reflects the distinction made by the case-study approach between superordinate systems and the (enclosed) case-study systems.

This neat breakdown into separate outward and inward influences of superordinate systems is misleading. Activities of enclosed systems are guided not only by the rules of one, but by many enclosing systems. For example, the decision to start a business is guided by all four superordinate systems: the cultural system encourages

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[3]Haase et al. (2011, p. 82) made the challenge of understanding post-communist cities—with respect to the "complexity of the current development"—explicit: "In our conceptualization, post-socialist transition" consists of the simultaneity and interrelatedness of a number of processes. The recognition of the complexity of the current development ... leads to the conclusion that, to date, the spectrum of terms and explanatory approaches has to be challenged again ... to come closer to what is really happening in the respective societies ... Often, it is impossible to say what has influenced a particular process of change."

Table 6.1 Influence matrix

	C	E	P	T	citizens	Section
C		←	←	←	⇄	6.2.1.2
E	→		←	←	⇄	6.2.2.2
P	→	→		←	⇄	6.2.3.2
T	→	→	→		⇄	6.2.4.1

Inward (←) and outward (→) influence between superordinate systems and citizens' activities
(⇄)

or discourages by the perception of, e.g., the ease of starting a business; the economic system guides the type of business activity; the political system influences, inter alia, the company's legal setup, with respect to taxation; and the technical system is the guide for the business's location, e.g., where high-speed internet is available and the daily commute is short.

Thus, despite my discussion of one-to-one relations here-below, the guiding of activities is actually a guidance from various superordinate systems, just as the triggering of enclosing systems originates from a number of enclosed systems at once.

With two personal stories of citizens I met in Lviv in mind (Exhibits 6.1 and 6.2), I hope to facilitate the understanding of what I'll subsequently describe: the enclosing cultural, economic, political, and technical qualities, rules, and supporting and triggering activities in the Emergent Nested System of Lviv.

Exhibit 6.1: Personal story of a young fireman

I had gone for a walk west of the city center (Photo 6.1). Behind the train station, I had passed the headquarters of Electron Corporation and the Yanyvs'ke cemetery. Then three young men came from a side street and started walking close to me along Shevchenka street. One of the three approached me, and we started a conversation in English. We continued walking outwards until we reached the last stop of tramway line #7, which we took to the city center.

The young man was in his mid-twenties and had a bit of alcohol on his breath. He said he had moved to Lviv from Ternopil, a smaller city about 130 km away from Lviv, to work for the fire department. He confirmed he had problems with alcohol, and his parents had alcohol problems as well. He told me his brother had died; I couldn't figure out whether he had been murdered,

had died in an accident or from a disease, or had killed himself. One of his two sisters was better off and had a family. She was a few years older than him and had taught him some English. It wasn't too bad for someone who had this general aura of being rather uneducated and in social distress.

In the tramway in the center of Lviv, he exchanged some words with two or three other young men, all appearing to be in similar situations. He then told me they were "bad people." He mentioned several times how happy he felt talking with me.

When I asked about what he usually did on Saturdays and Sundays, he shrugged. Then he replied that he would just walk around or stay with his friends, whom he didn't like. Some were taking drugs, which he clarified with a gesture of giving oneself an injection. They were living in the building of the fire department, being provided rooms as employees.

When I asked him about earning money, he said, "Oh! It's piling up." This was supported by a gesture of lifting his hand. I asked him how he earned money, and he briefly replied, "Don't talk," shaking his head. He paid for his ride when we took the tramway, and he gave change to almost every beggar whom we passed on the streets as we continued our walk through the center.

I tried to figure out his relationship with the city of Lviv. He told me he liked the city, making a gesture of embracing it and calling Lviv his house and his home. In Old Town, I pointed to an old house in a sorry state. I asked him if he liked it, if he would like to live there. He misunderstood my question and pulled out his cell phone to write "1600" on the screen, letting me know the house was from the 17th century.

Photo 6.1 Shevchenka street, where I met the young fireman

I asked him whether he had been to museums there. Yes, he had. So I asked him which he liked the most. He replied it was the Museum of Arms, and he also pointed out the Pharmacy Museum. When we passed by the opera house, I asked him to have a look at what was being performed. He shrugged his shoulders and said OK, but he didn't seem to be interested in what I was looking at. However, he took me into the Dominican church, where, upon entering, he asked me to make the sign of the cross.

Without being asked, he gave me his opinion about national politics, but I had to ask him about municipal politics. Like other people I talked with, he spontaneously told me he hated Russian people, as well as the president in Kiev.[4] He said he was looking toward Europe, that Europe was what he liked. When we passed town hall, I asked him whether he liked the municipal government, and he replied, "They are just after money."

Exhibit 6.2: Personal stories of a retired teacher and a self-employed sociologist

I met two ladies in Café Strudel Haus, right next to the old town square (Photo 6.2). They had chosen the upscale coffeehouse for our meeting; its name and style attempted to recreate a former Viennese coffeehouse. In the small café classical music played. One of my interviewees was a sociologist in her early thirties, the other a retired economics teacher.

The younger one and her husband have two incomes: she is working as an independent researcher; her husband is an employee of an IT company. As a programmer, he belongs to a group of privileged young professionals with a relatively high income. He rides his bicycle to work. The premises of the IT company offer sports centers, locker rooms with showers, and other amenities. As an independent researcher, she is working for clients that come from both the private and public sectors. For example, she has carried out sociological studies for Lviv's municipality.

Both women are descendants of formerly rich families who had suffered during communist times.[5] They told me about one of their family's properties

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[4]President Yanukovych governed Ukraine at the time of my studies and until February 2014, when he fled after public upheaval.

[5]The fate of their parents and grandparents are the stories of the kind that have influenced novelists like Catalin Florescu. In his novel Zaira (Florescu 2008), he describes the fate of a feudal family's daughter from East Central Europe living through the second half of the 20th century.

near the former castle of Lviv, which had been taken away by the communist government after the end of WWII. Like many other Ukrainian and Polish inhabitants, the family was moved out of the center into newly built areas to make space for native Russians to move into the city center.

The other side of the family was of Lemko origin; they had lived near Cracow before WWII. The family raised 10 children; they were rich enough to afford so many. Also, their great-grandfather had worked in France for a couple of years. Then after WWII, the communists decided to move the family—without any of their property or belongings—to eastern Ukraine, where they became very poor.

When they wanted to move back, they could not leave Ukraine to go to Poland any more (borders had changed at the end of WWII), so they decided to settle in Lviv. The other part of the family had had large estates in what belonged to Poland before WWII (Ukraine today). Their land and property were also taken by the communists, and their grandfather was sent to Kazakhstan, where he spent about 10 years of his life. The man managed to return home under a different name.

Photo 6.2 Around the corner from Café Strudel Haus, where I met the sociologist and the retired teacher

Today, both families are living in post-communist buildings in the outskirts of Lviv. The retired teacher made the point that she likes the historic center for visiting and drinking a cup of coffee, but not for living there. She appreciated the advantages that the residential area in the outskirts had to offer: less traffic, less noise, and green space, while still being connected to the city center by means of public transport.

6.2.1 Three Superordinate Cultural Systems of Lviv
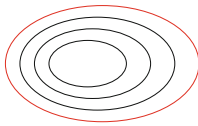
A cultural system relates to the image of the city and to the activities of citizens (Photo 6.3). This relation has shaped Lviv's economic, political, and technical systems that exist today. The overall cultural system is emergent from the activities of individuals (Sect. 6.2.1.1). By means of cultural rules— e.g., through images and narratives—the cultural system acts back on the latter (Sect. 6.2.1.2).

6.2.1.1 Emergent Qualities of Lviv's Cultural Systems

Three concurrent cultural systems guide the perceptions and activities of Lviv's citizens. These three cultural systems can be distinguished by the differences in the activities of Lviv's citizens, which can be guided by any of these cultural systems.

I will refer to the first of these three cultural systems as *communist,* since it reflects what several of my interviewees called "the old way of thinking." The second cultural system—representing the large majority of citizens—has developed through a transition based on the communist cultural system. I have therefore termed this second system *post-communist,* indicating its origin, which is dependent on the communist cultural system. I termed the third cultural system *liberal*, reflecting more than a transition. Rather, it reflects a transformation that does not depend on the former communist cultural system any more, and it is oriented more toward the western liberal cultures, which are led by the image of the individual's pursuit of happiness.

While a clear distinction between cultural systems is theoretically possible, the three cultural systems identified in Lviv do not occur independently from of the others. Rather, they exist concurrently, all to varying degrees, in the individuals' perceptions and activities. Thus, individuals who fall precisely into one of the described categories are rather unlikely stereotypes. It is even possible that the activities of the same person are guided by different cultural systems, depending on the actual role taken. E.g., while doing business, activities can be guided by the post-communist

cultural system, cautiously hedging against the odds of the "old way of thinking," while in private life activities can be aligned to the more liberal cultural system.

The Communist Cultural System

The group of citizens who is said to be guided by the *communist* cultural system is characterized by relatively low personal self-assurance. Individuals belonging to this said group are afraid of moving forward, of taking responsibility, and of changing their lives or their environment. They feel that their activities would have no impact and could not trigger change.

Also, this cultural system is characterized by citizens' demands for services offered by the public sector, in particular the municipality. "Somebody should come and fix it," is a typical way of thinking that is guided by the communist cultural system; this is often relating to the maintenance of the building one lives in.

The communist image, whether correctly describing an actual cultural system or not, may well serve as an excuse to not take control of one's own destiny. For example, the image of the public sector is that of a corrupt one—in particular of corrupt judiciary and tax officials—with thick bureaucracy. Since bribing is perceived as a common habit, those guided by the communist cultural system tend to bribe as well.

However, more than two decades after the end of communism, it is legitimate to wonder whether "such a past that impedes the future to substantiate" in western Ukraine, as Andruchowytsch (2004, p. 34) put it, does still exist.[6] In other words, is the enclosing cultural system inherited from communist times still strong enough to prevent the emergence of a different cultural system? Most of my interviewees would agree with Andruchowytsch's statement. Expanding on this train of thought, an interviewee pointed out that the communist cultural system does not only

Photo 6.3 Cultural qualities emerge from citizens' activities, and citizens' activities are guided by local cultural rules

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[6]My translation from: "Das ist eine Vergangenheit, die die Zukunft daran hindert, sich zu verwirklichen."

guide the activities of persons who grew up under communism, it reproduces itself among younger generations. However, and most interestingly, whenever my questions touched upon the communist cultural system, the interviewees distinguished themselves from their fellow citizens by attributing a more progressive culture to themselves than to other people they know.

Thus, this "old way of thinking" might well be a myth or an image, kept alive only by those who continue referring to it, because they need it to define their own *post-communist* cultural system; this provides guidance to their thinking and acting. In any case, the ongoing reference to the communist cultural system keeps it, with all its attributes, alive; therefore, it is alive, whether currently lived by anybody or only imagined. As such, it is a proper enclosing system in its own right, guiding the enclosed, post-communist cultural system. That Lviv's citizens don't feel constraint *any more*—and that they don't fear being prosecuted *any more* (the flourishing citizen initiatives mentioned below are an example of this change)—can only be verified by reference to the communist cultural system, under which things were different. By necessity, the communist way of life lives on in a post-communist one.

The Post-Communist Cultural System

There are several different forms of the *post-communist* cultural system. Common among them is the reference to the communist cultural system, in which the post-communist cultural system is anchored. Post-communist, with reference to communist, can mean holding the communist cultural system—or the image of it—responsible for the particularities of the current system, i.e., blaming it or using it as a justification and excuse.

One can seek the signs of communism in post-communist times, in order to continue to justify the use of outdated habits and activity (i). Or one can actively reject habits attributed to the communist time and construct inverse habits and activities (ii), and/or one can import cultural habits from elsewhere in an attempt to replace communist ones (iii).

(i) Leaning on the Communist Cultural System
A nestedness of the post-communist cultural system inside the communist one makes it easy for a culture of bribing to still live on, regardless of whether it is accepted or rejected by the individual citizen. For example, a bar owner I interviewed had perfectly arranged himself within the system in which "the bribe decides about the solution of a problem." To run a business is easy and almost frictionless for him, since he is used to greasing hands, in order to reduce his tax payments to a minimum, to slash his electricity bill, and to have the insufficient fire safety of his bar approved.

With reference to the municipal leaders and the national tax authorities, who, in this cultural system, are perceived to be corrupt, tax fraud is common. One of my interview partners reported that, e.g., in the tourism industry, cash payments are preferred, and that even local politicians prefer to pay their contractors in cash.[7]

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[7]My own first-hand experience, however, was different. For both my stays, I received, without asking, a formal invoice from the owner of the tourist apartment I had rented.

At the same time, with reference to the ongoing "old way of thinking," taxes are dodged; for some, a the-municipal-government-will-fix-it attitude still lives on; and, going further, the demands for services to be provided by the municipality are even increasing. Weak public infrastructure is frequently complained about. E.g., Lviv's citizens, guided by the post-communist cultural system, consider it the duty of the municipality to provide enough parking places in the very center of the city.

As is the common perception in the post-communist cultural system, change has to come "from the top," i.e., from the political system. Even some of the younger generations are said to look cynically and skeptically toward an uncertain future; perhaps they miss somebody *dictating* a future to them? "Not people are bad, the system is," I heard more than once. One student, who had found a side job, felt that the government was disenabling individuals' initiatives to start businesses.

In this version of the post-communist system, it seems usual to blame the emergent cultural system, and not the often system-reinforcing activities of the individual. What is self-reinforcing here might indeed be the old way of thinking—the idea that the public sector will care.[8] The post-communist cultural system is clearly not (yet) detached from the old way of thinking.

(ii) Turning Away from the Communist Cultural System

In another version of the post-communist system, the process of turning away from symbols of communism is dominant. One quality of this post-communist cultural system is the proactive rejection of some qualities of the communist cultural system. Distinguishing oneself from the eastern part of Ukraine—on which a rather communist cultural system is projected—seems to be important. In this image, western Ukraine is characterized by its (not only geographical) closeness to the European Union: a progressive, western-oriented attitude; a lack of corruption (!); and a focus on the development of young people.

Associated with communist times, teaming up and forming interest groups is viewed skeptically in the post-communist cultural system, since it evokes images of the communist *combines*—centrally administrated conglomerates of businesses. For example, an attempt by the municipal government—to convince the city's private language schools to run a large, joint campaign to motivate citizens to enroll for English classes—failed. The suggestion of combining efforts under the initiative of the public sector, where in a market economy competitors should compete, rather than collaborate—another image, another guiding rule—was rejected.

Likewise, individuals do not want to be "part of something" any longer, as one recent graduate working in city hall observed. Those who are engaged in community activities complain about a lack of civic society and about citizens hesitating to form groups. Lviv's citizens are said to prefer formal interventions; only activists and

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[8]This leads to the question of how to best change or even break up—perhaps using the toolbox presented in Chap. 4—the enclosing communist cultural system. The theory and methods presented in Chaps. 1–5 provide the tools for understanding this important topic throughout CEE and for finding levers to change it. In particular, in Chap. 4, I outlined a top-level toolbox for influencing ENS.

concerned citizens participated in the British Council's Future City Game.[9] Thinking in terms of "is said to now prevail over a thinking in terms of 'we.' A further train of thought distinguishes local "people who have mental constraints," i.e., who are guided by the communist cultural system, from a "new generation that comes to power." Those who mentioned this train of thought in interviews were including themselves in the latter group, of course. Stereotypes of citizen groups support this partition; I was told that people living in the outskirts have no high expectations—about life in general, and urban life in particular—and maintain their relations to villages, where they grow their own food (a very common place habit in communist times; see, e.g., Enyedi 1996, pp. 116–117; Szelenyi 1996, p. 310; Molodikova and Makhrova 2007, p. 62).[10]

(iii) Seeking to Align with the (Image of a) Western Cultural System
While on one hand, turning away from the communist cultural system relies, in some part, on a reversal of the "old way of thinking" into opposite thinking (and habits and activities), on the other hand, the western cultural system, or an image of it, offers an alternative guide. I sensed a general belief in ultimately high standards of integrity in the West, in absolutely no corruption, and in many other virtues. With this image in mind comes an often strong will to overcome the heritage of the communist cultural system; however, some stated goals and concerns, e.g, governance transparency and zero corruption, seem to be overly unrealistic.

Photo 6.4 Single family houses in the village of Bryukhovychi, about 8 km northeast of the center of Lviv

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[9]According to its organizer, the British Council, the Future City Game "is a team-based process designed to create new thinking and activities to improve quality of life in cities" (British Council 2014). In Lviv, the game was hosted by the Center for Urban History of East Central Europe (Lviv Center 2009).

[10]The people in the communist high-rise buildings don't exist as a homogeneous group in CEE cities: Social groups and income levels are very heterogeneous today, since "living in large housing estates is considered to be a good and normal living arrangement for most people, including those of higher social status" (Haase et al. 2011, p. 259, see also, e.g., Milstead 2008, pp. 62, 63, 89, and Vais 2009).

The image of the western cultural system is powerful and often exaggerated. Studying at a university, owning a car, moving into a house outside the city (Photo 6.4 left and right), and starting a family are cornerstones of a stereotypical, forceful dream of western life. An image of the western cultural system is utilized in yet another version of the post-communist system, seemingly whenever a counterstatement is sought against the communist influence.

In contrast, the occasional references to Austrian and Polish times—the times before communism—seem less powerful to me. Hentosh and Tscherkes (2009, p. 273) noted that the history of the "Golden Age" of Habsburg has "become popular among the inhabitants of Lviv." However, the only confirmations I could find of this alleged cultural guide were from the story I was told about an old lady who had been shaking her head when seeing that road workers were "taking out the good old Austrian cobblestones," and the acknowledgment by people that the construction work carried out during Austrian times was of good quality (Photo 6.5). This guiding quality should be termed post-Austrian-post-communist.[11]

Also, the opera, a symbol of Habsburgian times, is not very popular with Lviv's citizens any more. Rather, they prefer to attend a performance of "Global Rock Hits" in the philharmonic building. More often than Austrian construction, I heard people referencing "Polish buildings" meaning houses from the interwar times. However, this reference, while more frequent, does not seem to evoke strong feelings—similar to those about western culture—that serve as part of the guiding cultural systems. "Polish buildings" appears to be a term to classify an architectural epoch (influenced by the modernist movement, see Photo 6.6).

The Liberal Cultural System

There is a third cultural system that is guiding and selecting the activity of some of Lviv's inhabitants. This third cultural system does not require a reference to, or

Photo 6.5 Austrian architecture and town planning shaped Lviv during the 19th century. The photo shows Svobody Av., a wide alley running along a section of the former city wall and on top of the river Poltva

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[11]Indeed, there are coffee shops that try to reconnect with the famous, end-of-the-19th-century Viennese coffee shop culture, e.g., the Wiener Kaffeehaus and the Strudelhaus, but such shops can be found in many countries. Furthermore, while editing this text, I came across an announcement for a workshop titled "From idea to matter. 3D printing [of a] monument to Franz Josef" (Museum of Ideas 2014a).

anchor in, any (post) communist way of thinking. Such a new cultural system must be based on the unconscious emancipation from, or ignorance of, much of the old cultural systems. It does not exist out of a tendency to lean on the old cultural system, nor is it rooted in the deliberate negation of the old way of thinking. Such a cultural system *emerges* on its own terms from activities of citizens who are living according to their own standards.

The new cultural system I identified in Lviv involves a more liberal way of thinking. For example, those of my interviewees who were (partly) guided by the liberal cultural system perceived starting a business as easy. This perception did not result from complying with a corrupt way of doing business, nor from a defiant conviction that things should have finally changed, two decades after the end of communism. Rather, this conclusion was reached from a self-reliant assessment of the actual legal system, unconsciously ignoring the guidance of one's perception by post-communist standards. In this liberal cultural system, corruption is not a justifiable option any longer, but an alien, odd, and maybe somewhat old-fashioned habit that has lost its place.

Part of the liberal cultural system is an emerging culture of taking responsibility. Among some of Lviv's citizens, a "growing feeling of ownership" can be observed. They form community associations and take over the responsibility of maintaining the upkeep of their houses' staircases, roofs, and basements from the municipality (see, Sect. 6.3.1). These citizens, denoted as "activists and people who care," participated, as mentioned above, in the British Council's Future City Game (British Council 2014), and/or they engage in one of the many citizen initiatives.[12]

Photo 6.6 Four examples of "Polish" architecture in Lviv: Office building at Shevchenka Av. 7 (*left*), the doors of an administrative building at Tyutyunnykiv St. 2 (*top center*), a cubistic school building at Generala Chuprynky St. 1 (*bottom center*), and a modernist villa at Parashchuka St. 8 (*right*)

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[12]The reverse argument, of course, is not implied; i.e., not everybody who engages in citizen initiatives is necessarily guided by the liberal cultural system.

The liberal cultural system encourages individuals to actively seek inspiration for a way of life by their own standards. Ideas are eclectically chosen from around the world, some young people bring ideas home from abroad, and more and more bicycles appear on the streets. Other ideas are developed in reaction to situations in the city, e.g., crowd-funded poles are installed to prevent sidewalks from being full of parked cars. Such ideas and activities are obviously not guided by a post-communist cultural guide any longer. Eventually, a new and unique cultural system emerges.

The involvement of citizens guided by the liberal cultural system may indicate a comeback of a civil society—a middle class of the educated and concerned—already observed in its nascence by Schlöogel (1996/2002, p. 232) in 1996. The urbanites of today have particular habits and means; their civic engagement is possible even without social status and financial means. Today's urbanites are enabled through, e.g., online communication: Money can be collected by means of crowd-funding, information can be exchanged via online forums, and information can be disseminated for all. E.g., somebody puts the mini-bus ("marshroutky") lines on online maps. The new urbanites are distinct as a middle class rebuilding a cultural foundation and being concerned about education.[13]

6.2.1.2 Outward Influence From, and Inward Influence To, the Cultural System

The cultural enclosing systems of Lviv are not only emergent from, and supported and triggered by, activities of Lviv's citizens, they also guide the activities of citizens and influence the economic, political, and technical systems. Subsequently, I will discuss outward and inward influences identified between these cultural systems and Lviv's citizens, as well as inward influences from these cultural systems on the economic, political, and technical systems. Outward influence from the economic, political, and socio-technical systems on the cultural system will be discussed in Sects. 6.2.2, 6.2.3 and 6.2.4.

Outward Influence From, and Inward Influence To, Citizens' Activities

An urban culture emerges in Lviv, guided by aspects of the different cultural systems presented above. An image of Lviv as a city—and the inhabitants as citizens—did appear over recent decades (i). This ties citizens closer to their urban environment (ii). Among the resulting activities guided by the new urban culture are various citizen initiatives (iii). Thus, inward influence of the cultural systems on citizens' activities, and outward influence from citizens' activities on the cultural systems, is a mutually reinforcing, i.e., autopoietic, process that maintains emergent qualities of the cultural systems in Lviv.

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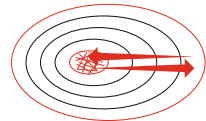
[13]In fact, some of my interviewees—young university teachers—claimed that even with dual-income households, they could hardly ever afford to buy a car, since the rent for a flat consumes one salary by itself. In another interview, a sociologist added that the basic expenses for food amount to another 50 % of one salary.

(i) A Reestablishing Image of a City

Related to the "comeback of urbanites" are the diminishing reverberations of the demographic changes that were enforced in the aftermath of WWII. With most of the original population lost during and after WWII (Hentosh and Tscherkes 2009, p. 257), the context was stripped from the city's material structure some 70 years ago: With the people went the meaning, and the mainly new, formerly rural inhabitants had no identification or connectedness with the old material substance and history of the city (cf. Schlögel 1996/2002, p. 230). Thus, for many new citizens of Lviv, who moved in after the end of WWII, urban life in general, and the city of Lviv in particular, must have been an alien matter.

However, this unfamiliarity of Lviv's citizens with urban life and the city's material structure—and its history—is diminishing now. Lviv has been attributed various urban images by my interviewees; e.g., it is perceived as a student city, a city of science, a cultural center, a European city, a city of traditions, a city with a local heart, a place of creative people, and a city of modern industries, e.g., IT companies and tourism-related businesses. Citizens perceive the city to have a particular atmosphere.

(ii) A Growing Sense of Belonging

A positive sense of belonging to Lviv is developing. It is fueled by the increasing number of tourists who are coming to visit the beautiful city, and by the perception that more and more people talk about Lviv and want to move there.[14] Overall, the third generation of these families who moved in after WWII is developing a new connection with the city.

Also, the above-mentioned distinction from eastern Ukraine, which is put on a level with the communist way of thinking, contributes to the image of the city among its citizens: For eastern Ukrainians, an interviewee said, "Lviv is Europe without visa." Geographically, there is a desire of being close to the EU—closer than to Eastern Ukraine—supported by the perception of being well-connected by an international airport, railroads, and a street network linking into Poland.[15, 16]

(iii) Developing Civic Engagement

The developing urban culture and identification with the city might show up nowhere else better than in the activities of citizens, related to the urban space and place. A directory published in 2008 presents no less than 152 public organizations active in

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[14]The number of tourists visiting Lviv has increased from 0.6 to 1.7 million p.a. between 2007 and 2013 (GIZ 2011b, p. 36 and Lviv Convention Bureau 2013).

[15]The distance between Lviv and the most eastern parts of Ukraine is about as large as the distance between Lviv and Frankfurt (Main) in Germany, i.e., slightly more than 1,000 km. This, of course, doesn't imply similar, cultural closeness.

[16]Much remains to be done in the field of infrastructure, however. Train rides may be slow. For instance, it took me more than five hours to travel the 270 km over the Carpathian to the border with Slovak republic. It took me another three hours (including much waiting time) to cross the border by train. The train ride to Warsaw takes half a day or longer. Since Ukraine is not in the European Open Sky agreement, only Ukrainian-registered airlines can pick up passengers. An agreement with the EU had been prepared (European Commission 2013) but was then postponed (Kyiv Post 2014a). The airports are owned by the central government that regulates access and fees (see, e.g., LWO aero 2014 for references to national resolutions concerning airport fees).

the city of Lviv (Yaremko 2008). Not included are more recently established—as well as temporarily existing—initiatives, e.g., for the preservation of single monuments (the Saving Mercury initiative collected money to restore a sculpture on a building, see left Photo 6.7); against alien architectural styles coming into the historical center (an initiative of many citizens actively prevented a proposed hotel project); and for cultural and park-related activities.

One example of a more recent citizens' initiative is Lypneva, which had the goal to improve (public) transport, public spaces, and neighborhood and city-wide community buildings (right Photo 6.7). The initiative was engaged in various activities, e.g., putting up bus timetables; printing information flyers; organizing lectures, workshops, and events in collaboration with the municipal government; crowdfunding for street furniture; and disseminating selected examples of urban development from other cities by means of dubbed videos and consultations with the municipal government.[17]

In one activity of another initiative, Trotuar (officially translated "Let's Go", literally "sidewalk"), an old fridge was given a license plate and 'parked' on the sidewalk in the manner cars are often parked (Trotuar Lviv 2015). This activity was reported by local news stations. Another initiative developed a network plan for bicycle lanes. (The plan had not yet become effective at the time of my research, but by the end of 2013, 30 km of bicycle lanes had reportedly been built; see Week 2014.)

Another example of a citizens' initiative established after 2008 is the initiative for adult and lifelong studies, targeting people aged 55 and above. While most of my younger interviewees would have attributed "the old way of thinking" to the generation who had passed their 30th birthday at the time of the end of communism, my interviews with the elderly revealed different results—forward-looking citizens learning to speak English and to use computers.

Photo 6.7 Citizen initiatives collected money to save the statue of Mercury (*left*) and to install poles that prevent cars from parking on the sidewalk (*right*)

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[17]When the founder and head of Lypneva was hired by the municipal government, the activities of Lypneva were discontinued.

Inward Influence on the Economic System
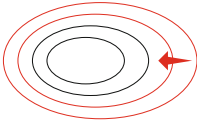
Cultural rules also set the guide for economic activity in Lviv. For example, whether an individual is guided by the post-communist or the liberal cultural system, each of these individuals has an influence on the perceived ease of setting up a business—and thereby on the rate of business creation in Lviv. Also, the type of business is guided by images of the city: In a city of creative people, the business should somehow reflect creativity—be it by decoration of the premises or by the creative act of inventing a business itself. Thus, individually decorated cafés and startups, based on new products and service ideas, are the result.

Other aspects of the cultural system, as described above, set limits to the economic one. Where the image of corruption is guiding activities, there will be fewer domestic and fore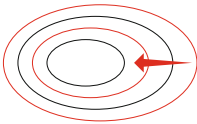ign investments. Where it is seen as communist to form business alliances and associations, joint advertising campaigns will not be possible. And where the image of a Western European, free-market economy with a good amount of competition and zero corruption is leading, the same might be sought by local businesses.

Inward Influence on the Political System

In a very similar way, those guided by the image of Western European, local governance with high transparency and zero corruption will seek to implement the same in Lviv. One interviewee was excited to report that, while most cities in Ukraine tend to ask for guidance from Kiev, the city hall of Lviv calls other cities in Europe to ask for their experience and expertise.

The alignment of the political system to the cultural (and economic) system's rules seems to pay off: One interviewee positively acclaimed that the city has changed for the better since politicians gained an understanding of its key assets in the area of tourism. In a similar vein, activities by city hall are guided by the images of Lviv as a creative city—supporting the transfer of innovation from research to business through the newly created Innovation Center (see, Sect. 6.2.3).

But also, the (post) communist aspects of the cultural system are concurrently guiding activities of the political system. When citizens demand maintenance and repair work on houses, the municipality tries to meet these demands. The center for administrative services provision, the heritage protection office of the municipality, and the regional administration are in charge of this and similar kinds of demands.

Where the common perception is that taxes are dodged, the political system has to work within a very limited budget, and even politicians may pay for services, such as externally conducted studies, in cash. This duality of mindsets also reflects in the two leading, oppositional parties present in the city council (see, Sect. 6.2.3).

Inward Influence on the Technical System

Finally, the activities of citizens with their technical infrastructure—their buildings and transport facilities—are guided by cultural rules as well. For example, a habit of commuting from home to work without having to transfer can be a very strong and selective rule, guiding the use pattern of public transport and eliminating attempts to change it (see also the case study on public transport, Sect. 6.3.3).
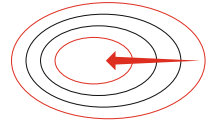
Similarly, a sense of belonging may guide built-heritage conservation by citizens. But in a post-communist cultural system, where this sense of belonging is not dominant and where a negative attitude toward any collective activity—including owners' associations—prevails, built-heritage protection can hardly be guided by an enclosing system (see also the case study on built-heritage conservation, Sect. 6.3.1). As a result, rarely ever is the responsibility for maintaining and renovating shared property in multi-family houses taken over by a building's occupants from the municipality. I was also told by one interviewee that a playground was vandalized soon after it had been built.

Rules of the liberal cultural system guide the activities of citizens with their technical infrastructure as well. E.g., as mentioned above, for those who are guided by an image of a western lifestyle, owning a house in the outskirts and a car becomes a personal goal.

6.2.2 Economic Superordinate System of Lviv

Just like the cultural enclosing system, the economic superordinate system guides activities of Lviv's citizens. Among these activities are trade activities (present in small shops, in markets, and in kiosks, as shown in top right and bottom left Photo 6.8) and activities in the tourism sector (e.g., activities of operating hotels and tourist apartments). In turn, these citizens contribute to the stabilization or generation of new qualities of the existing, enclosing, economic system with their activities.
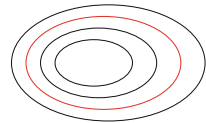
In order to understand the power of the economic system, as well as the power of an individual's economic activities, I will first provide an overview of the economic system's qualities identified in Lviv (Sect. 6.2.2.1). I will then discuss the economic system's outward and inward influence on the cultural, political, and technical systems (Sect. 6.2.2.2).

6.2.2.1   Emergent Qualities of Lviv's Economic System

The economic activities of Lviv's citizens are guided by what I have identified as dominant qualities of the economic system. The economic system seems to favor the SME—in particular the tourism-related business, as well as typical, central-place activities. However, out of some startups in the IT and BPO service sector, large companies have grown over the past decade that seem to be appreciated and reinforced by a self-sustaining, autopoietic regeneration to other systems. In turn, industries from communist times either closed down or are struggling to remain in business.

Small and Medium Enterprises

At the heart of the economic system of Lviv is the SME. Lviv's businesses range all along the value chain—from the sales of a self-sustaining farmer's excess produce or flowers (in markets or on the sidewalk, as shown in top left and right Photo 6.8); to trade activities (present in small shops, in markets, and in kiosks, as shown in bottom left Photo 6.8); and further to professional services, such as lawyers.

At one end of the socioeconomic spectrum, some people earn their living today by importing food products from Poland to resell them in Ukraine, where prices are higher. At the other end, a range of IT start-ups is being founded (more on this in the second case study on entrepreneurship in Lviv, Sect. 6.3.2).
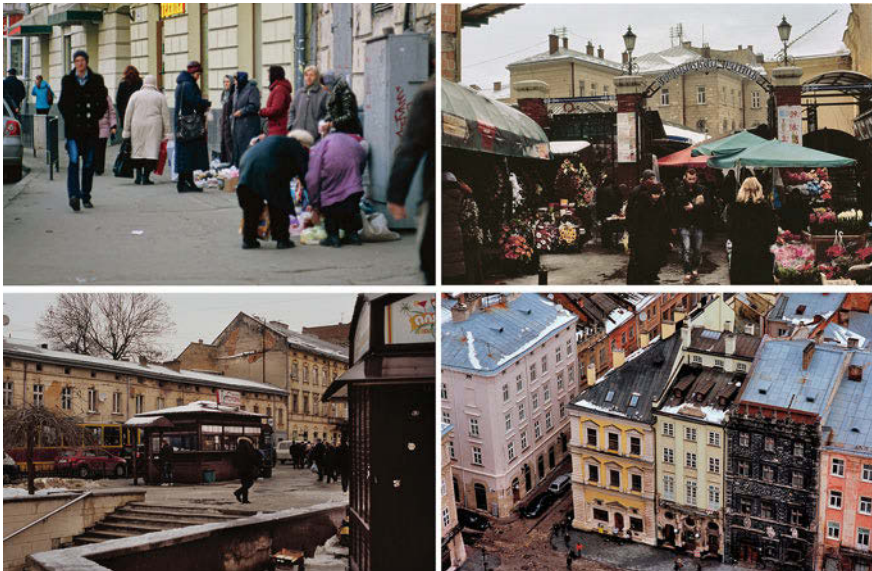
Photo 6.8   Produce and flowers are sold on Lviv's sidewalks (*top left* street vendors at Ivano Franka St.), as well as on public markets (*top right* Lviv's Flower Market at Soborna Sq.). Shopping for basic needs is possible at the many kiosks that can often be found close to public transport stops (*bottom left* kiosk at Mytna Sq.). Tourists, who come to visit the Historic Center (*bottom right* northeastern corner of Old Market Square with the Black House) sustain hotel and restaurant businesses

Tourism-Related Business Development

Restaurants and coffee shops are opening in Lviv that are suitable with the SME structure of the local economy—and are sustained by the growing inflow of tourists, new hotels, and tourist apartments. Particularly striking is the amount of coffee shops that have opened in the historic center over the past couple of years.[18] Apart from their role in selling coffee and cake to tourists, individually decorated coffee shops also play a role in sustaining the image of the creativity of Lviv's citizens (cf. Sect. 6.2.1); some coffee shops also offer places for creative and/or busy locals to gather and exchange ideas.

In this way, the growth of tourism fuels the growth of creativity, of entrepreneurial experience, and of the city's economic prosperity. As one interviewee put it, the growth of tourism (and IT, see below) enables "dreams to develop in Lviv." The tourism industry is also supported by festivals that take place in the city.

Central-Place Activities

There are other economic activities and occupations, such as jobs in banking and in the public sector, as well as in the field of the arts (see, Sect. 6.2.1). These activities (along with some of the SME activities, e.g., lawyers) self-sustain the central role of Lviv as a cultural and administrative center of its geographically enclosing region.[19] Some new business developments in the educational sector and in childcare were reported by interviewees of mine. Also, the municipality is providing a number of jobs, e.g., to garbage men and street cleaners.

IT and BPO Companies

According to (some) citizen's perceptions, IT and BPO companies are considered the economic future of Lviv (as opposed to the "old-style" manufacturing that was largely lost and which, as one interviewee pointed out, led to environmental problems).[20] Typical services offered by existing companies include desktop, mobile, and web software production (see, e.g., Eleks 2015; Arivo Solutions 2015). Another recently started outsourcing company is doing engineering work for Škoda, a Czech car manufacturer. Further growth potential may come from beyond the geographies of the Ukrainian, Polish, and Russian-speaking markets, which the IT and BPO companies were said to mainly offer their services to, as of the time of my studies.

Growth is mainly limited by the availability of the skilled workforce. Only about 400—out of the approximately 2,000 annual graduates from the technical university (among them, about 1,500 are IT graduates; see LvivTravel 2014)—are becoming

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[18]I visited Lviv the first time in the summer of 2009. My perception was that about 80 % of the coffee shops (not restaurants) that were open for business during the winter of 2013 did not exist in 2009.

[19]Cf. my reference to Christaller's Central Place theory in the introduction to this book (Chap. 1).

[20]One exemption is the Electron Corporation. It has established joint ventures with Western European companies and extended its product portfolio to include assembly from sourced parts of, e.g., tramways. Despite its transition from a communist business to a market-oriented business, the Electron Company was not mentioned much by my interviewees. Consequently, the guiding role of this (type of) business in the local economic system appears to be less powerful.

programmers. (Since not every graduate of any given university will become a programmer, many graduates do not find adequate jobs. They often work in restaurants, hotels, and travel agencies—or go abroad.) Furthermore, one of my interviewees, a mentor for startup companies, expressed his concerns about the quality of the education in the public universities.[21]

Industrial Plants

At the time of my studies, two important industrial plants remained from the communist era. The plant of the Electron Company once manufactured TV sets and is now finishing tramways, (trolley) buses, and other equipment from imported hardware and locally produced software. A first tramway vehicle was introduced in Lviv at the end of 2013 (Electron Corporation 2013). And the LAZ bus factory still had about 300 factory employees until it shut down operations in early 2013 (Ukraine Business 2013).[22]

6.2.2.2 Outward Influence From, and Inward Influence To, the Economic Systems

The economic system is subject to both inward influence from the cultural system and outward influence by any citizens' activities, as well as by the political and technical systems. In turn, the economic system supports or triggers change in the cultural system and guides activities in the political and the technical systems. (Inward influence of the cultural system on the economic system has already been discussed above.)

Outward Influence From, and Inward Influence To, Citizens' Activities
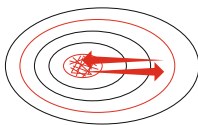
Activities of Lviv's citizens may trigger change and may even lead to the emergence of new qualities in the economic enclosing system. Such changed or new qualities, in turn, change the rules that guide the economic activities of citizens.

For instance, from the conception and implementation of Lviv's first IT outsourcing company, a qualitative transition emerged in the economic system. This transition now guides some citizens into doing IT businesses, rather than working for industrial companies. Starting an IT business or finding a job at one of the IT and BPO companies is now being strived for by graduates of the technical university. Also, in

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[21] Often, my interviewees referred to the private Catholic university as a good example. It is perceived to offer a good learning environment.

[22] A culturally motivated, unfriendly relation between the bus company (or in particular, its Russian owner) and the city (or more particularly, some city officials) was reported to me. This report was confirmed by a newspaper article (Centre for Transport Strategies 2014).

Further, I was told that the bus company did not pay taxes in Lviv, and it was said to deliver the good buses to eastern Ukrainian cities, leaving Lviv with experimental models—some built with full-price, lower-quality, southeast Asian parts.

an economic system that favors creative business, it is harder for industries to find a positive environment for relocating a manufacturing plant to Lviv.

From the cultural image of Lviv being a city of creative citizens, the activities of adding some creativity to businesses followed first. Then new quality emerged, and new rules started to guide economic activities. The result is most visible in the aforementioned number of recently opened coffee shops that are, apart from some chains, individually themed and decorated. As one interviewee reported, even people selling toys and other consumer goods imported from China and other Asian countries think they are in a creative business.

Economic activities of actors, musicians, and other artists are contributing to the quality of Lviv's economic system that guides citizens into further creative businesses. There are, on one hand, the established performing arts, including the opera, the philharmonic orchestra, and a variety of theaters. On the other hand, local artists produce plastic, visual, and performance art. For example, Oles Dzyndra is producing hand-blown glass works, organizing exhibitions and events, and running the Museum of Ideas, where a small restaurant is also serving local food (Ukraine Trade Invest 2015; Lviv Alive 2015).

Outward Influence on the Cultural System

Changes in the economic system trigger change in the enclosing cultural system. For example, increasing entrepreneurial activity can lead to an economic quality that itself has outward influence on the cultural system. In Lviv, the perception of the city as full of creative people has strengthened, at least by related economic activities. Increased activities of business creation in turn contributes to a weakening of the post-communist image; i.e., the perception of corruption and of the lack of ease of doing business may be changed. Thus, business startup activities may have a significant impact on the emergence, and the maintained (autopoietic) existence, of the liberal cultural system.
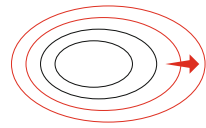
Further outward influence from the economic to the cultural system is due to Lviv's tourism businesses and central-place activities. On one hand, the rising economic activity related to tourism fuels the positive image of Lviv, i.e., the perception of Lviv as a beautiful city. On the other hand, the economic, central-place quality of Lviv sustains the cultural qualities—both the (post) communist, "the-municipality-should-care" attitude, and the reemerged urban image and sense of belonging.

Inward Influence on the Political System

Inward influence of the growing IT, BPO, and tourism businesses on the political system can be observed as well. As can be expected in a nested system, the enclosed political system is being guided by the enclosing economic system. This shows up, for example, in the activities of the municipality, which is now supporting the IT and BPO sectors' industrial and entrepreneurial activities. Similarly, there is political support of the tourism industry (both points are discussed in Sect. 6.2.3).
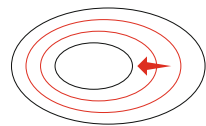
Inward Influence on the Technical System
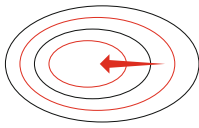
Economic rules also guide the use of the technical infrastructure in a city. For example, the qualitative change in economy—from industries to businesses with a creative touch—sets new rules for the use of older buildings. (I'll discuss this point in the case study on built-heritage conservation, Sect. 6.3.1.)

6.2.3   Political Superordinate System of Lviv
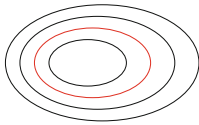
Local specificities of the political system are guided by the local cultural and economic systems, and they emerge from, and guide the activities of, Lviv's citizens. For example, the guiding influences of the cultural systems of Lviv described above (Sect. 6.2.1) are reflected by the political camps. But not only is the local political system influenced by the local cultural system, there is also inward influence from national and international politics that guides the activities of Lviv's municipal government (Photo 6.9).

6.2.3.1   Emergent Qualities of Lviv's Political System

Among the particular characteristics of the political system in Lviv are two political camps, which are strongly guided by the local cultural systems; the media relations of politicians; the guiding influence of national and international politics; and a sense of triggering change, i.e., making best use of limited financial resources. While on one hand, tension between the political camps may block decision-making, there is, on the other hand, a strong drive to implement international, best-governance practices. It may be disputed whether personal relations between the local media

Photo 6.9 The national government makes decisions concerning Lviv's airport. Thus, the municipality cannot decide on measures to attract, e.g., airline companies that could bring more tourists to the city

and the mayor are helpful in supporting change, or are only supportive of the post-communist cultural system catering to citizens' images of an all-controlling political class. Due to a limited, local financial budget, the municipality has to align with national and international rules in order to receive funding. But there is also genuine local development of initiatives, in which the city strives to make best use of its human and financial resources, i.e., to *effectuate* development (see also Sect. 7.4).

Old and New Political Systems

The guiding influences of Lviv's different cultural systems manifest in a set of some-times opposing political forces. On one hand, conflict between individuals guided by different cultural systems, e.g., the post-communist and liberal one, is observable (i). On the other hand, there is a powerful drive for change coming from all those who either seek to turn away from the communist past or who are guided by new images of the liberal cultural system (ii).

(i) Tension between Municipal Politicians
Since Lviv's cultural systems are enclosing the political system, politicians are, in their activities, guided by the various cultural systems presented above (Sect. 6.2.1). In the perception of my interviewees, two cultural guiding influences are dominant: a post-communist one that continues via an old way of thinking, and one that encompasses selected images of the post-communist and the liberal cultural systems. The latter culture is in opposition to, and/or freed from, said "old ways of thinking."

As one interviewee working in city hall put it: "There are two types of systems: a closed, oppressive, and power-centered one, and an open, transparent one." Another interviewee related the age of councilors with their political culture, mentioning that two-thirds of the councilors were older than 40—thus being guided by a "post-soviet-era mentality" and being motivated by "personal wealth growth;" meanwhile, 20 years after the fall of communism, "new people" were eventually coming to power.

Although such perceptions may be heavily stereotyping, the effects of the cultural opposition on the political system were manifest.[23] Mistrust, the blocking of decisions, and tension between two 'blocks'—associated with two parties in the city council—characterized the situation in city council at the time of my studies.[24] The opposition could easily block decisions, since it provided the majority of Lviv's city council. Thus, for example, the introduction of electronic tickets in public transport was blocked (see, Sect. 6.3.3).

Also, activities of strengthening one's own position could be observed. For example, City Institute was established as an in-house think tank of town hall—working

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[23]I suggest that these viewpoints show that the current, superordinate, guiding systems in Lviv—and probably in many other CEE places—have not yet overcome the post-communist phase. They are not emancipated from their past, and they largely operate via reference to the 'bad' communist habits that need to be replaced by 'good' ones.

[24]I suggest that this situation was not like those in other countries—a result of two established, almost equally strong, catch-all parties. Rather, the situation in the city council was the result of a political quality that had emerged, over time, from citizens' and politicians' activities, and it was influenced by the different cultural enclosing systems of Lviv.

closely with the mayor and some of the councilors and supporting decisions regarding sociological studies, strategy papers, and the setup of other units, such as the Lviv Innovation Center (see, Sect. 6.2.3.2).

(ii) Eagerness to Catch Up with Western European Best Practices
Achieving international standards of good governance, of transparency, and of compliance in town hall is one of the aims of City Institute. For example, there are activities to improve moral judgment and personal integrity (e.g. Lviv City Council 2014, p. 31; Ukrainian Catholic University 2014). Another aim is to transform what is seen as a mere administration into a municipality that does cater to its citizens.

In many endeavors, the post-communist cultural system is guiding: There is an "old way of thinking" that is sought to be replaced by a new way of thinking. For example, the goal for Lviv's utility providers is to replace the "old" mindset with a new one that is oriented toward customer friendliness and shows a service attitude. Also, participation in international projects is aimed at reflecting the willingness to overcome old habits and to learn and apply what is seen as international best practice in urban development (e.g., ESMAP 2011).

Media Relations

The perception of some of my interviewees was that the local government is using local media to influence citizens regarding topics relating to Old Town. Reports relating to Old Town's built heritage have been perceived by some of my interviewees as being featured on local TV relatively often. The media's focus on Old Town is perceived as a "huge centralization" of attention to the center of Lviv, which is said to "absorb all the culture."

The media's focus on Lviv's historic center may be influenced by the municipal government, which is guided by the enclosing economic system that encourages growing tourism—and for which the built heritage of Old Town is an important asset. For example, one interviewee perceived a "media phenomenon" that was mobilizing citizens against unwanted real estate projects.

Media coverage may be facilitated through the personal relations between the mayor and one of the region's main media holdings, TRK Lux. The relations between the mayor and a key media company was pointed out by some of my interviewees, catering to their doubts about the impartiality of media and strengthening the post-communist qualities of their cultural guiding systems.[25]

While political influence on the media is perceived, it is also seen that—in relation to Old Town conservation—the collaboration between the police and the municipality could be improved: Rarely are the police seen enforcing rules of built-heritage protection. These perceptions, which are initiated and/or could be changed by activities of the political system, support the continued existence of the post-communist cultural system.

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[25]Indeed, TRK Lux is reported to be "close to the city mayor of Lviv" through "a long-standing business partner" and the mayor's wife, who holds shares in the media company (Internews 2012, pp. 17–18).

National Political Influence

Centralization of political power puts Ukrainian cities under the rule of the central government. In particular, a relatively small local budget is usually being complemented by national funding. National financial resources may be granted for, e.g., urban infrastructural projects. (Public services, such as schools, hospitals, and the water supply are paid directly by the central government anyway.) However, these resources are only granted if the local government complies with the rules set by the central government.

An interviewee noticed that it had recently become more difficult to comply with the government's rules, in order to receive funding. Further national regulations limit local self-governance. For example, national regulations define "a very detailed and compulsory tender procedure" for bus routes, leaving "no scope for developing [a local] tender procedure" (Berger 2011, p. 7).

As a result of the centralization of power, central-place services of the city—such as schools and hospitals, transport infrastructure, and large (sporting) events—depend on national resources. Thus, the city's existence as a central place depends on national rules, not local ones.[26]

International Political Influence

The local political system of Lviv is also influenced by rules attached to international funding. International authorities are involved in the field of public transport (EBRD 2012) and in economic development. One example is the financing by the US-based Civic Research and Development Foundation of the Innovation Center (see below). Another example is the activity of the German GIZ, which, in Lviv, is active in urban development (see, e.g., their publication on an integrated, urban-development concept for Lviv, GIZ 2011a).

Urban development is further guided by, e.g., aspects of built-heritage conservation, in order to retain the UNESCO status of Old Town. Further rules come from international organizations that organize events, such as the 2012 Euro football championships.

Since international funding is seen as important for the development of Lviv, the city council has little choice but to adopt the international consensus of governance, best practices, and sustainable urban development. Thus, these international authorities are equally putting their mark on political decisions.

Creating Conditions and Preparing the Ground

By making use of available human and financial resources, the municipality seeks to enable and trigger development of the city in areas where it can do so effectively. Financial means are limited, and the municipality has limited ability to carry out large projects—aside from nationally or internationally funded (infrastructure) projects. Therefore, the approach is, according to one interviewee, "to create conditions."

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[26]The report by a hired consultancy firm on the public transport system is largely ignorant of the guiding rules of the central government, to which the local government has to submit (Berger 2011). However, the decentralization of power to local governments is key on the agenda of the mayor's own party (Boy 2014).

The hope is that relatively small, triggering activities that can be managed within the local budget prepare the ground for developments that will not require public funding once started (cf. Sect. 4.1). In this vein, the municipality provides organizational support and facilitation for cultural events. This reflects an attitude of making the best things possible happen with *what is available*, in terms of human and financial resources. In doing so, the municipality does, unconsciously, have outward and inward influence from its position in the nested system.[27]

Where the local budget is not sufficient, the municipality may seek national or international funding. With grants, it becomes possible to trigger and support larger developments, e.g., business clusters. For example, GIZ supported the tourism alliance's participation in an international tourism fair (ITB Internationale Tourismus-Börse Berlin, see VisitLviv 2011). And the above-mentioned Civic Research and Development Foundation supports the Innovation Center that fosters technology transfer from universities and entrepreneurial activities by means of, e.g., the promotion of meetings between students and entrepreneurs to create a mentoring network (Lviv Innovation Center 2011).

6.2.3.2   Outward Influence From, and Inward Influence To, the Political System

The political superordinate system is enclosed by the economic and cultural systems. Municipal decision-making supports enclosing economic qualities—in particular tourism and IT and BPO industries—by means of organizational activities, which include setting up and participating in business associations and public outreach. With similar support of cultural events and the daily activities of politicians, there is an outward influence from Lviv's political system to its cultural one.

The political superordinate system also encloses the technical system, and all citizen activity, with guiding rules. Thus, the municipality may try to influence the activity of citizens and their use of technical means. In turn, citizens influence municipal decision-making through their individual activities and through citizen initiatives.

Outward Influence From, and Inward Influence To, Citizens' Activities
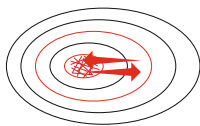
While on one hand, the municipality tries to influence citizens' activities through, e.g., laws and the media, there are, on the other hand, also citizens and citizen initiatives who influence the political system. The activities of citizen initiatives, such as crowdfunded poles or a fridge parked on the sidewalk, do not go unnoticed by the municipality. Indeed, the issue of car parking in the inner city, as well as the initiatives' activities, were mentioned by interviewees from town hall.

With the aforementioned TV broadcasts on Old Town, it is, in turn, the municipality that tries to guide the activity of citizens (in this case, in relation to the technical

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[27]This is the beginning of what can be a way of *effectuating the city*; I will briefly come back to this approach in Sect. 7.4.

systems). Also, regulations that prescribe, e.g., the materials for window frames and the colors of facades, dictate rules over citizen's activities (see also the case study in Sect. 6.3.1).

Outward Influence on the Economic System

The municipality has identified three key economic sectors, which it supports by means of organizational activities, of setting up and participating in business associations, and of public outreach (i). In particular, the IT and BPO sector has been growing over the past decade, but reduced political-reform activity may decrease the inflow of foreign investments now (ii).
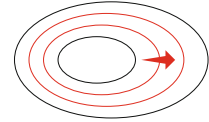
The effect of political outward influence on the economic system shows that it is not the economic system which is enclosed by the political one, but vice versa (see Sect. 5.4 on the E-CEPT superordinate systems).[28] This is why political activity can support economic qualities, trigger change in the economic system, or even render the economic system unstable—specifically in the case of an unstable political environment that changes frequently.

(i) Triggering Growth of Selected Economic Sectors
On one hand, the municipality's activities of outward influence are supportive of the emerged economic system, in that they follow its guiding rules. Such guiding rules come from what started as outward influence of citizens' activities, out of which emerged IT and BPO companies and a local tourism industry. Consequently, both economic sectors are key to the recently published competitiveness strategy (Lviv City Institute 2010a): a document that is supposed to guide municipal decision-makers to support, facilitate, and accelerate the growth of the emerging IT, BPO, and tourism industries.[29]

Tourism-related activities of the municipality aim to support this strategically relevant economic sector. The municipal government created the Tourism Alliance as a representation and communication forum of the sector's businesses (Touristic Alliance 2015). With the aid of GIZ, a presentation of Lviv at the international tourism fair in Berlin has been organized (VisitLviv 2011). Furthermore, Lviv has become the first Ukrainian city to promote itself internationally, in line with the strategic goal of tourism and business development (Lviv City Hall 2012).

With the municipality's support, the IT and BPO Cluster—a business association—seeks to improve the environment for IT and BPO businesses in Lviv. The cluster

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[28]Throughout history, however, it has been attempted to rule economic systems by political will, i.e., with long-term political rule; Ukraine was one of such countries. Eventually, the activities of individuals, who were guided by the ideas of cultural and economic systems, were able to break up the political system. Trade, the exchange of goods, and the creation of businesses were longer-lasting qualities than the enforced rules, which intended to make production a state affair.

[29]The competitiveness strategy is a document informed by the study of a consultancy firm in 2008; the study identified tourism, as well as BPO, as key to the economic development of Lviv (Foundation for Effective Governance 2009 and Lviv City Institute 2010a). In 2013, another study, carried out by a local institute financed through the Canadian government, identified different key sectors (City Institute 2013a).

has plans for, e.g., a noncommercial housing project—for which the municipality granted land, offering apartments to employees of IT and BPO companies at a low price.[30] Also, educational projects, e.g., a master's program in IT Management and English courses at the technical university, are initiated by the association, with the support of city hall. Within the guide of Lviv's competitiveness strategy, a business-services workgroup has been set up (Lviv City Institute 2010b), and a website aims at luring investments into the strategic economic sectors of the city (Invest in L'viv 2015).

With the participation of the IT and BPO Cluster, the municipality demonstrates how the political system closely follows the guiding rules of the emerged economic qualities. By doing so, it also demonstrates how the political system itself reinforces the emerged economic system, supporting it with its own activities.

With the Innovation Center, an entity was set up in town hall that aims to foster an environment for entrepreneurial activities. Initiated by City Institute and financially supported by a foreign economic aid agency and local companies (CRDF 2011), the Innovation Center now resides in an office in city hall and has a small team. The team is working on achieving the goals of the Center, inter alia, "the technology commercialization for Lviv-based scientific institutions and scientists" (Lviv Innovation Center 2011). Goals should be reached by bringing together investors, mentors, and knowledge, and by offering space for business incubation. (These efforts are closely related to the growing startup culture in Lviv. See Sect. 6.3.2.)

On the other hand, the same and other activities of the municipality that aim at economic development are guiding inward influence.[31] For example, the municipality's initiative of supporting trade of local products may guide citizens into doing business in these politically facilitated sectors. With the goal to increase the demand for local products, the municipality supports and organizes fairs and marketing campaigns. In this case, the municipality tries to assist, in particular, with its human resources, i.e., to create a marketing policy and an organization to market local products. With the limited financial resources available to city hall, training programs are also organized.

(ii) Decelerating Activity of Political Reform

For some years, reform activity of the national political system had sustained the emergence of a positive investment climate. By 2012 or 2013, the drive to draw foreign investors into the city seemed to have diminished, along with the deceleration—or, as some interviewees' expressed it, even reversal—of political change in Ukraine. By then, the national political system did not continue to support, by means of its activities, the enclosing economic system as it had before. Only the aspirations for, and hopes about, a free trade assignment with the EU—and resumed reform activity

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[30]The housing project is targeted at young IT professionals and their families, offering houses on the urban fringe for people who can afford owning one or more cars.

[31]Generally, what triggers outward is also equally rule-setting inward, and vice versa, in nested systems (cf. Sect. 2.3).

in order to adopt EU standards—had positive outward influence on the economic system.[32]

Yet at that time, the power of the whole had not grown strong enough to simply 'enslave, the enclosed systems, in particular the political system, to perform autopoietic activities—sustaining a positive investment culture, while reforms slowed down. Also, investment activity in the economic system had not succeeded enough to allow the emergence of a positive cultural image of, e.g., a country where foreign investments are possible—without fighting (too many) odds, such as corruption. Such a cultural image itself could have guided continued national—and international—investment activity.

Outward Influence on the Cultural System

Two types of activities of the political systems influence outward on the cultural system: first, activities of citizens acting in the political system (i) and, second, cultural activities that are started or supported by the political system (ii). The first type of activities is carried out by, e.g., members of the city council. The second type of activities is, e.g., cultural events that are supported by the municipality via it providing finances and/or a location.
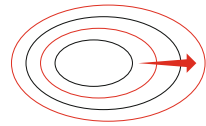
(i) Outward Influence of Politicians' Activities

With every activity, each individual who belongs to the political system triggers change in, and/or contributes to, the continued existence of enclosing cultural systems.[33] For example, councilors acting according to the rules of the (post) communist or the liberal system strengthen it. However, councilors acting on their own terms, coming up with, e.g., their own moral judgments, may challenge the established cultural system and may possibly trigger change. Also, employees of affiliated entities, such as the Innovation Center, influence the cultural system. E.g., establishing a mentor network for startup companies may support the recently emergent, liberal cultural system, but it will not support the post-communist culture.

(ii) Outward Influence by (Cultural) Activities of the Municipal Government

The image of Lviv as a city of creative citizens may be supported by cultural events. Support is provided by the municipal government, which grants facilities and organizational support for festivities. In some cases, a small financial support of 200–500 EUR is possible as well. Furthermore, one aim of the municipality is to create a

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[32] Such anticipation of change in an enclosed system may have an effect on the emergence of the enclosing economic system—yielding new rules, according to which Lviv's citizens, politicians, and economic actors, such as investors, carry out their activities. But also, (anticipated) change in an enclosed system, e.g., the political system, may disturb the enclosing economic system, with the decline or emergence of significantly different economic systems. For example, the emergence of new business sectors was seen after the fall of communism in Lviv and other CEE cities.

[33] This outward influence relates to what is known in everyday language as *being a good example* and/or *being a trendsetter*. While neither role implies the rule-setting or even enforcement of activity, both roles are those of individuals who may trigger change. In this sense, their activities lead to situations and propensities, out of which novelty in the enclosing system may emerge. Only if a new trend or fashion reaches a *critical mass* does *autopoietic* regeneration between nested systems set in.

cultural strategy for Lviv.[34] Knowingly or unknowingly, the engagement of city hall in (selected) cultural activities may support the reemerging cultural qualities of urbanity and of urbanites—and the function of Lviv as a central place of the region (cf. Sect. 6.2.1).

Inward Influence on the Technical System
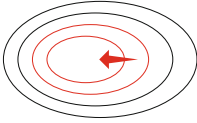
Finally, there is inward influence from the superordinate local, national, and international political systems on the superordinate technical system. Framing the available set of rules of the technical system, inward influence by the political system guides the activities of Lviv's citizens with their technical infrastructure—in particular, with means of transport and the built heritage in Old Town. The municipality's activities influence the use patterns of the technical infrastructure, e.g., by building or upgrading roads and/or tramline tracks via national and international funding (see, e.g., Usov 2009 and Public Tenders 2012).

Since the municipality is required to accept external financial support and to submit to rules attached, the use of this infrastructure by Lviv's citizens is also indirectly guided and limited by national and international political rules. Funding is granted if the municipal goals are brought in line with the policies of the donors. E.g., a study of the public transport system admits that the "EBRD has agreed to fund the project at the request of the city, which has made the promotion of electric transit a main focus of the study... [i.e.] the promotion of non-polluting electric transit" (Berger 2010, p. 17 and cf. also Berger 2011).

Some rules that guide activities in the city are set by the central government, e.g., the process of tendering public transport operators (Ibid., pp. 7 and 26). A national law prevents any municipal efforts to impose parking fees, and it renders parking penalties ineffective. The airport, the gateway for tourists coming to Lviv, is a national affair as well; the municipality has no means of granting landing rights to airlines or reducing airport fees.[35]

By winning international sporting events, further infrastructures are being built by means of national and international financial resources, e.g., a new arena and a new airport for the 2012 European Football Championships and a new arena for the 2015 European Basketball Championships (foreseen at the time of my research in 2013).[36] The city has also been vying to host the 2022 Winter Olympic Games.[37]

The political system furthermore influences the technical system via the built-heritage protection office's activities and regulations. As mentioned above, through

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[34] Since the cultural system emerges from and encloses, inter alia, the political system, an effective cultural strategy needs to focus on triggering activities, rather than setting rules for them.

[35] Thus, changing the framing rules requires negotiations with the national government. As a result of such negotiations, the airport fees for airlines were removed within their first year of operating a route to Lviv, in order to attract airlines bringing in tourists from new destinations.

[36] The basketball games should have taken place in Ukraine, but the decision was reversed in 2014, due to the conflict in the east part of the country (Lviv City 2014).

[37] The bid to host the Winter Olympics has been withdrawn, as of summer 2014 (Kyiv Post 2014b).

media coverage, rules are trying to be established and to guide citizens' activities, in relation to the built-up structure in Old Town.[38]

6.2.4   Technical Superordinate Systems of Lviv

Out of the interaction between individuals and technical artifacts, complex technical systems—that are non-mechanic and non-statistic—emerge through outward influence. A technical artifact may be a building, a tramway, or any other piece of technical infrastructure, often visible in the spatial layout of a city.
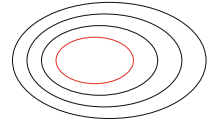
The technical system is guided by cultural, economic, and political rules. E.g., street layouts and building structures guide activities—they enable and restrict—but only if considered as stable and valuable from a cultural perspective and/or through economic and/or political guiding rules. Thus, the way, e.g., a building is utilized is specific to the current circumstances, which are influenced by the local culture, local economy, and local political environment via inward influence (Sect. 6.2.4.1, Photo 6.10). In turn, the technical system is an enclosed system, influencing the cultural, economic, and political systems via outward influence (Sect. 6.2.4.2).

6.2.4.1   Emergent Qualities of Lviv's Technical System

From Lviv's citizens' activities of use and/or operation of the built-up structure, of open spaces, of market places, and of roads and utility networks, particular qualities emerge. The same emerged qualities, specific to the local circumstances, guide

Photo 6.10 Out of citizens' activities emerge particular qualities of utilizing the material environment. The photo shows the interior of the Coffee Mining Manufacture, a coffee shop in the Old Market Square

[38]Of course, the activities that aim to be rule-setting inward are also influencing outward. The activities of the municipality related to built-heritage protection support emerged cultural images and economic qualities, in particular the tourism industry's promise to bring prosperity to Lviv—a city with a beautiful, Central European Old Town.

subsequent activities via inward influence. For example, specific use-patterns of residential and commercial real estate have emerged and are reflected in individuals' activities, as well as (unwritten) rules that guide such activities.

Other infrastructure is subject to the similar emergence of qualities. E.g., sidewalks serve not only pedestrians, they are also used by drivers for parking and by vendors to sell their goods. Also, means of public transport are used by a large share of citizens, who make use of the minibuses, in particular. And while the road conditions are poor and are seen as such, the outdated utility networks don't create much public awareness or activity response (yet).

Built-Up Structure

A variety of (i) residential, (ii) office, and (iii) commercial uses of built-up structure has emerged across the varied, urban morphology of Lviv. Photo 6.11 provide an overview of the urban morphology, along an approximately 8 km-long walk from the city center to the airport.

Lviv's Old Town reflects the compact European city; its street layouts were formed by the Magdeburg Law during the 14th century (e.g., Hentosh and Tscherkes 2009, p. 255). Beyond Old Town, the cityscape largely follows the geomorphological facts, i.e., a river (now flowing underground) and several elevations.[39] The center of Lviv remains the city's central business district; however, there are only low-rise buildings in the center, and (mainly residential) high-rises are outside it. But there is life after working hours: The historic center is the prime location for gastronomic offers.

(i) Residential Use

From the historic center to the communist blocks of flats and beyond, Lvivians make use of the built-up structure for private housing. In Old Town, former single-family houses were divided into flats at the beginning of communist times, and they were then sold at symbolic prices to their long-time tenants after the end of communism. As a result, the sense of belonging of flat owners is largely limited to their own apartment; this, in turn, results in the dilapidation of the common areas, i.e., entrance halls, staircases, basements, roofs, and facades, that are still in the property of the municipality (see Sect. 6.3.1).

Next to the Old Town houses that typically had been built as mansions for single families and/or their businesses, there are tenement buildings from the late 19th century. This was a period of growth and prosperity for Lviv: About 4,000 four or five-story residential buildings were built between 1873 and 1900, i.e., about three new buildings per week (cf. Klijanienko 2008, p. 37). Like Old Town buildings, these houses are often in a very dilapidated state. They had not been properly taken care of since the end of WWII. (During the communist era, the attention was directed toward newly built, residential high-rises.)

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[39]The covered river is the reason for controversial discussions about its future—leave it underground or not—and it was the theme of the" Poltva—stink or inspiration" student workshop in 2011 (Museum of Ideas 2011), as well as of further workshops and publications (Museum of Ideas 2014b).

Today, about 95 % of Lvivians (cf. GIZ 2011b, p. 18) live in residential blocks of flats that were built in communist times. In these blocks, the common areas, and the over-dimensioned open spaces in between the blocks, are often neglected. These buildings from communist times require renovation. This is even truer for the younger, concrete-slab buildings than for the older brick buildings (cf., e.g., Palacin and Shelburne 2005, p. 6); the former were originally thought of as an intermediate solution to accommodate fast urban growth, along with quick industrialization.

Some of the high-rise areas, particularly those in the immediate vicinity of now-defunct industrial zones, are notoriously depressed living areas; one of them reported to suffer from the smell of a sewage plant nearby. Elsewhere, new high-rise buildings are being constructed (Photo 6.12), densifying and sometimes extending the existing, communist, built-up structure.

Photo 6.11 Urban morphology of Lviv. *Top row* (from *left* to *right*), showing buildings from before the first World War: Lviv National Scientific Library at Stefanyka St. 2, balconies of the building at Stepan Bandery St. 3, a house at Kyivska St. 25. Center row (from *left* to *right*), showing buildings in the former urban fringe: Post-communist apartment building at Yevhena Konoval'tsya 79, an old factory at Antonovycha St. 102, a modernist villa at Parashchuka St. 8. *Bottom row* (from *left* to *right*), showing communist and a post-communist buildings: Communist blocks of flats made from bricks at Sadova St., communist concrete-slab high-rises at Petlyury St., and a post-communist shopping center at the outer ring-road (Vygovskogo Ivana St.)

(ii) Office Use

The center of Lviv is also the center of its professional services and (public) administration activity. Consequently, downtown floor space is also used for offices. Much of this space is located in buildings from the late 19th century, as well as the first half of the 20th century. But a new building has also been erected to be a bank at the edge of the historic center. Furthermore, a share of the built-up structure is dedicated to higher education, the most prominent examples being the main university building and the buildings of the technical university.

Free office space in the center of Lviv is not abundant; e.g., the Innovation Center was not able to find workspace in or near Old Town. Hence, office space used by IT and BPO professionals is located in the vicinity of communist high-rise buildings, and entrepreneurs may start their businesses in their parents' flats in one of these high-rises. A hotspot has emerged for IT professionals in a restaurant close to one of the large IT and BPO companies, and unlikely places like a restaurant in an indoor swimming pool have become the locations for, e.g., my meeting with one of the key figures of Lviv's entrepreneurship community (see Sect. 6.3.2).

While urban brownfields in the areas of interwar and communist industrial sites (cf. the centermost photo in the picture series, Photo 6.11) are waiting for a new quality of use to emerge, more office locations, as well as residential developments for IT and BPO companies' employees, are planned far outside the city center, i.e., near the airport.

Photo 6.12 Post-communist residential high-rises at Vasylya Stusa St. 37 (*left*) and at Kubanska St. 4 (*top right*) (both near the Catholic University), as well as at Lubinska St. 154 (near the airport)

(iii) Commercial Use
Buildings in the historical center and surrounding areas host a variety of other commercial activities. Many ground-floor spaces—and occasionally, second floors and/or basements—are used by restaurants and coffee shops. In the historic center, as well as in the adjacent areas, some flats have been converted into tourist apartments, and entire houses into hotels. As mentioned before, a co-working space has opened on the second floor of a building at the corner of Old Market Square.

Public Urban Space

Public urban space is being used by citizens and visitors of Lviv for, inter alia, leisure activities, individual and public transport, and selling and buying goods in markets. For leisure use, there is a focus on pedestrian zones and parks in, and close to, Old Town (i). When driving a car or riding a bicycle, the bad road conditions become obvious (ii). Once in the center of the city, the car owner is faced with a shortage of parking places, despite a relatively low car ownership rate (iii). In addition to covered market halls, open spaces are used as markets, but sidewalks are used to sell produce and flowers (iv). While a majority of Lvivians contributes, by daily use, to a particular culture of public transport (v), the weaknesses of Lviv's utility infrastructure goes largely unnoticed by the city's inhabitants (vi).

(i) Leisure Use
The historic center is particularly attractive for leisure activities, e.g., for having a coffee or just strolling around, as the young fireman preferred to do (see Exhibit 6.1). In addition to the pedestrian zone of the historic center, parks are used for taking walks. The growing sense of belonging may show up in the emerging quality of the city as a place to have fun, i.e., the appropriation of public space to enjoy one's leisure time.

However, the habit of neglected common property, observed in residential built-up structures, has been observed in public spaces by some of my interviewees. I was told about people tossing their waste on the street, about a vandalized playground, about lakes in parks that need to be cleaned, and about pavement that needs to be renewed.[40]

(ii) Transport Use
The key problem of the city is, as one interviewee put it, the bad condition of the roads. The technical condition of Lviv's streets has implications on their use: for driving a car, for parking a car, for traveling by any means of public transport, for cycling, and for walking. Many inner city streets are paved with cobblestones, even

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[40]In line with my theory of ENS, which suggests a powerful role in the relatively slowly changing cultural rules, I hold that perceptions of citizens are very important for any further development to occur. Not even a quantitative argument presenting the city as clean (e.g., compared to other cities of similar size) could be as powerful as the citizens' own perceptions. Their perceptions are guided by their habits, their activities, and, thus, their relations to their public spaces (Quite in contrast to my interviewees' perceptions, I observed the city's public spaces as clean, and Lviv's citizens actually putting their garbage in garbage cans. However, since I'm not living, acting, and communicating in Lviv in the long term, my perception is not quite as relevant as its citizens' perceptions.).

the main streets in the center. The old pavement is very uneven, full of potholes, and urgently in need of repair (Photo 6.13).

The condition of the streets decreases the comfort of riding in basically any vehicle—in particular the minibuses, buses, and tramways. As one interviewee put it: "The streets are so bad, it is better to own a large, comfortable car." In the outskirts, where the communist high-rises are located, some of the larger roads and infrastructures of intersections are being repaired bit by bit—an endeavor that requires funding from the national and/or international level (see Sect. 6.2.3).

Some streets in the center of the city are narrow and allow only one car at a time to pass the other cars parked along the street. And even on streets wide enough to fit two lanes, there is often not a sufficient place to fit a bicycle lane and/or to allow for the parking of cars. Cycling is dangerous, since drivers are not used to bicycles on the streets, and streets are too damaged to ride a bike safely.

Walking and cycling may also be unhealthy, since—despite a still low rate of car ownership, which is at about 150 cars per 1,000 inhabitants (Berger 2010, p. 10)—air pollution caused by traffic exceeds threshold values during peak times (cf. Fornalchyk and Kachmar 2010, p. 65).

Prochasko (2007) observed:

> An inconceivably disproportionate number of cars causes huge traffic jams, and it also simultaneously causes an excess of moisture and a lack of water—polluted air that seems to exist of nothing but car exhaust. The air in Lviv is polluted, even compared to other Ukrainian cities. There is also an apparent helplessness regarding public transport, combined with a complete lack of cycling infrastructure. This general impression of a petulant chaos proves that the times in which Lviv was still living in happy harmony with its urbanistic solutions are long over. (p. 119, *my translation*)

(iii) Car Parking

Parking cars wherever drivers please has become a rule. This habit is supported by the national legal situation, according to which one cannot even be fined for parking a car

Photo 6.13 Many streets (*left*, Horodotska St.) and sidewalks (*right*, Kostia Levytskoho St.) are in bad condition

on the sidewalk or in a no-parking zone. This legal situation makes any commercial parking places uneconomic to operate. Also, citizens hold that it is a public duty to provide enough parking places (for free). Neither public parking nor the commercial development of parking places are easy, since the high groundwater level prevents anyone from building underground parking. Thus, parking places remain scarce, and parked cars are an annoyance.

(iv) Markets

A variety of public areas are used as market places. A small square in the historic center is used for a tourist-oriented market of regional goods. In between the historic center and the original Old Town, the grounds that once had been prepared for the construction of a hotel building have been turned into a two-story market, where mainly food products are sold.[41]

Just across Old Town, there's a flower market (top right Photo 6.8). And close to the train station is an Eastern European bazaar, an accumulation of mostly two-story shacks, where mainly textiles are sold (left Photo 6.14). On Lypneva square, a reportedly improvisational-looking, open-air market had been removed (right Photo 6.14) by the municipal authorities, in order to have tourists not see it when passing by on their way to the airport.[42]

As a result, goods are now sold out of plastic bags on the sidewalk (cf. top left Photo 6.8). The use of sidewalks for selling slaughtered chicken, other produce, and/or flowers can be observed in various spots across Lviv.

(v) Use of Transport Infrastructure

Habits of operation and use reflect the particularities of Lviv's various means of public transport. As I will describe in more detail in the case study in Sect. 6.3.3,

Photo 6.14   The market shacks at Gorodotska St. (*left*) are just around the corner from Lypneva Square, where an open-air market was removed (*right*)

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[41] The story goes that an Austrian investor lost his money on the construction of a hotel in a feigned corruption deal. Although I could not verify this story through any source, I hold that such stories are part of the strong, post-communist cultural system.

[42] This intervention has also lent the name of the market square to the Lypneva citizen initiative. All in all, it was certainly not a wise move to just *physically* eradicate the merchants' market stands, since the use of Lypneva square as a place to sell and buy products was a part of the local cultural, economic, and technical systems.

Lvivians rely to a large degree on means of public transport. In particular, they make use of so-called marshroutky minibuses for point-to-point transfers. About two-thirds of trips are carried out by common ways of transport.[43]

Mainly, Lvivians make use of the tramway and marshroutky networks. Some routes are operated by buses and trolley buses as well. Most of the vehicles (as well as tramway tracks and roads) are old and uncomfortable to use, not only by western European standards, but also as perceived by local citizens. Schedules are largely missing for all means of public transport; marshroutky minibuses are often operated according to demand.

One interviewee mentioned that suburban rail networks connecting the residential areas of communist high-rises are underdeveloped. In an attempt to shorten the individual trip time, as compared to the means of public transport, there are more and more cyclists appearing on Lviv's streets—despite the missing bicycle path network and safety concerns.

(vi) Utility Networks

A number of technical networks is used by Lviv's citizens each and every day. Communication, electricity and gas, freshwater and wastewater networks, and garbage collection and disposal are key to urban life; everybody uses them. Thus, there are activities between these networks and citizens, and there is a perception about the networks—a perception that influences the way they are used, operated, financed, and renewed.[44]

Yet my interviewees didn't talk much about these networks, apart from briefly reflecting their perception that the utility networks were outdated; the exception to this was a reference to the telecommunication networks, which one interviewee considered to be inadequate. As long as the provision of utilities is working, the technical state of the infrastructure remains hidden to most citizens. This is also true with respect to energy efficiency: As long as a district heating network is working and heating costs are low, energy losses are of no importance to citizens.[45]

With regard to the utility infrastructure, only one interviewee mentioned that, "Lviv is not better developed than other Ukrainian cities," and that there is "no system in place to upgrade old infrastructure." For example, the sewage system continues to deteriorate, and new wastewater treatment plants are required. Also, a large landfill for solid waste (that has been in operation since 1958), located about 15 km north of the city, might be closed any time for environmental reasons. But the city has no alternative landfill, and the issue seems to be without influence on the activities of citizens and to not be on anyone's mind.

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[43]This is about twice as much as in western European cities, and about the same share as in other post-communist cities.

[44]The brief overview provided here is insufficient for a good understanding of the complex system. Thus, in order to understand the habits of use—the operation of a complex technical system, and the images that guide such activities—a more comprehensive study of activities between individuals and the technical artifacts is required. Two such exemplary studies are provided in Sects. 6.3.1 and 6.3.3.

[45]A major upgrading project is being supported by EBRD funds (EBRD 2014 and Usov 2013).

6.2.4.2   Outward Influence From, and Inward Influence To, the Technical System

Activities between citizens and technical artifacts create situations with propensities, out of which new qualities may emerge in the enclosing superordinate political, economic, and cultural systems. In Lviv, there are many such activities supporting or triggering enclosing qualities that guide the use of the built-up structure, of the public space, and of the traffic infrastructure.

Outward Influence From, and Inward Influence To, Citizens' Activities

From the daily activities of citizens with their technical infrastructure, and from new ideas of using them, new qualities emerge that can be influenced. For example, the idea of opening a co-working space in Old Town has changed the use of that building (through outward influence), and this new use may guide the activities of individuals with this particular building or other buildings (through inward influence). Citizens may start using the co-working space, or they may carry on the idea and open other co-working spaces in Lviv.
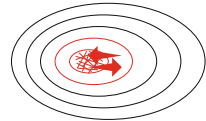
Similarly, a habit of using wireless connections in coffee shops has emerged. This habit may guide the activities of other citizens, who will now consider going to a coffee shop to surf the web or type away on their notebooks. Also, this habit guides the activity of coffee shop owners, who offer wireless connections.[46]

Further new qualities could also become the case for using roads for cycling, and for new approaches to dealing with the problem of parking-spot shortage. Thus, the changing situations for a potential emergence of new habits opens up to anybody with the ambition to influence the future of the city, i.e., every citizen who cares, citizen initiatives, and urban developers.

Outward Influence on the Political System

By their daily activities with the technical system, the built-up structure, and the infrastructure, Lviv's citizens support existing, emerged, and devised political rules, or they trigger changes. For example, Lvivians adopted the pedestrian zone that was established in the historic center.
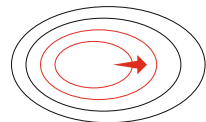
This new rule was able to guide individuals' activity, and a new understanding of how to use the streets and places emerged. Now, by means of outward influence, this political decision is being supported by citizens' everyday activities.[47]

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[46]Once people start looking for co-working spaces and/or wireless connections in coffee shops, these habits become economic factors as well, triggering change in the enclosing economic system.

[47]This is an ideal case of how a devised—not emerged—rule in an enclosing system, i.e., the political system, successfully guides the activity in enclosed systems. In such ways, the resulting activities in the enclosed systems maintain the rules, perhaps even leading to the emergence of a locally particular use-pattern or cultural understanding. For decision-makers in Lviv, it would be of interest how newly devised rules affecting the public transport infrastructure could be similarly successful. With the case study in Sect. 6.3.3, I am providing an example of an analysis of the urban transport system to show how insights for decision-making can be created.

Activities of citizen initiatives, such as the aforementioned Lypneva, aim at triggering the further adoption of Western European standards of their public transport infrastructure, which are run by Lviv's municipality. The municipality, however, faced with a public expression of discontent, decided to readjust the newly designed route network at the beginning of 2012.

Outward Influence on the Economic System
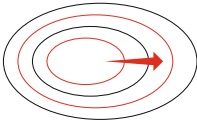
In relation to local infrastructural and spatial arrangements, citizens' activities may lead to the emergence of particular, local, economic qualities. In Lviv, part of the local economic system is the above-mentioned use of sidewalks for selling goods, such as produce and flowers, and the use of roads by privately operated minibuses. Also, the existing built-up structure allows for transforming homes into tourist apartments, ground floors into coffee shops, and second floors into co-working spaces. The aforementioned habit of using wireless networks in coffee shops triggers change in the economic system: The local understanding of a coffee shop includes the quality of wireless provision.

Outward Influence on the Cultural System
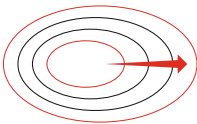
Use-patterns of technical artifacts, of infrastructure, of ways of transport, and/or of built-up structure may emerge as qualities of the cultural superordinate system of a place. For example, the use of minibuses for point-to-point trips has become a 'normal' habit in Lviv; not only has a use of the technical means emerged, but also a cultural 'norm.' In other words, the outward influence of using the technical means of public transport has led to the emergence of a particular culture of using the technical means of public transport in Lviv.

Similarly, cultures using open spaces and various types of built-up structures—from Old Town's built heritage to the communist blocks of flats—have emerged from activities between citizens and these buildings. Cultural qualities are longer-lasting than the faster-changing trends when using technical artifacts, such as wireless networks in coffee shops. Cultural qualities that emerge from the activities between citizens and the physical structure exert inward influence on the economic, political, and technical superordinate systems.

6.3 Three Cases and Three Ways of Influencing ENS

In this section, I will describe three urban systems, in order to exemplify the application of the suggested theory and case-study methods. Thus, the purpose of this section is to demonstrate ways to understand and influence the emergence of novelty in complex systems, *not* to provide advice about the development of Lviv.

From the three case studies subsequently presented, two items will become clear:

1. Nested relations are an influencing factor of emergent systems' development.
2. An understanding of triggering activities and guiding rules is key to choosing the most effective options for influencing an Emergent Nested System.

The three case studies will demonstrate how the nestedness of complex systems and the emergence of new quality in enclosing systems have a strong influence on the nested system's development. It will become clear that individuals' relatively fast activities lead to the emergence of the relatively slowly changing, enclosing systems: cultural, economic, political, and technical.[48]

This leads to some exemplary insights into how the nesting of complex (urban) systems influences their development, and how the succession of emergence, which leads to the nestedness of systems, can be dealt with. The three case studies demonstrate the three generic ways to influence ENS, as described in Sect. 4.2. It will become clear how the nested-system relations of outward and inward influence—between an enclosed system and the four superordinate systems—enable or disable purposive interventions.

The first of the systems discussed below is characterized by the activities of dwellers within Lviv's built heritage (Sect. 6.3.1). The second is characterized by the activities of entrepreneurs (Sect. 6.3.2), and the third is characterized by citizens' usage of means of public transport (Sect. 6.3.3).

The first and third of these case studies relate to systems that are subject to planned developments, while the second case study relates to the emergence of quality that is unplanned. The first case study shows a strong, nested-system relation between the enclosed and the enclosing systems—maybe too strong to be changed by devised new rules of inward influence. The second case study exemplifies how changes coming from an enclosed, triggering system are rightly adopted by the enclosing political one, providing an example of outward influence. The third case study demonstrates what—again in a system with strong, nested-system relations—an alternative approach to working within the given set of rules could have looked like.

The first and third case studies also demonstrate the power of the whole (as described in Sect. 3.3.4). The second case study demonstrates the power of the individual (as described in Sect. 3.3.1). All of the case studies demonstrate the power of emergence (as described in Sect. 3.3.5).

Furthermore, the case studies demonstrate three insights from the studies of ENS. The case studies show the following:

1. How purposive interventions in urban space can be understood through the theoretical contribution of ENS.

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[48]Each case-study system is enclosed and, thus, guided—though to varying degrees—by all four superordinate systems: cultural, economic, political, and technical. It is, thus, an important suggestion of this work that any enclosed system in a city can hardly be labeled as being purely a cultural, economic, political, or technical system; they are, by their very nature, mixed systems. Thus, in regard to purposive interventions, each complex (urban) system has to be analyzed by utilizing methods that span across multiple disciplines.

2. How the suggested ways to influence ENS could make interventions more effective.
3. How to be more realistic about the limits, within which possible outcomes of interventions in complex (urban) systems can be foreseen.

6.3.1 Case Study 1: Built Heritage

This first case study exemplifies one approach to inward influence, in which the devised rules struggled to change the strong, once-emerged, nested-system relations. By means of inward influence from the political system, policymakers aim to change the activities of Lviv's citizens, in relation to their Old Town dwellings (Photo 6.15). This approach, however, has shown itself to be less effective in the present case, where emerged cultural qualities are guiding citizens' activities.

In order to understand the nested-system relations and possible ways of influencing them, this section is structured into five respective subsections. These subsections deal with the enclosed and enclosing systems, the whole, the current approaches to influencing, and the suggested ways of influencing. This structure reflects the case-study approach suggested in Sect. 5.3.

Context of the Case Study

In the case study discussed here, policymakers try to change the way that dwellers in the historic center perceive and treat their building stock. Expressed in terms of ENS, the intervention aims at inwardly influencing the enclosed dwellers/dwellings system, in order for dwellers to change their activities in relation to their dwellings. Owners should be motivated to renovate their property and to take responsibility for the common areas of the building they live in.

A particular focus of policymakers' intentions lies in regulating dwellers to renovate windows and doors in a particular way and to take care of the common spaces—entrance areas, corridors, staircases, roofs, and basements. Rules and guidelines have been created in the political system: Some are legal, others are financial, still others are restrictive, and even others are motivational. Their inward influence aims at
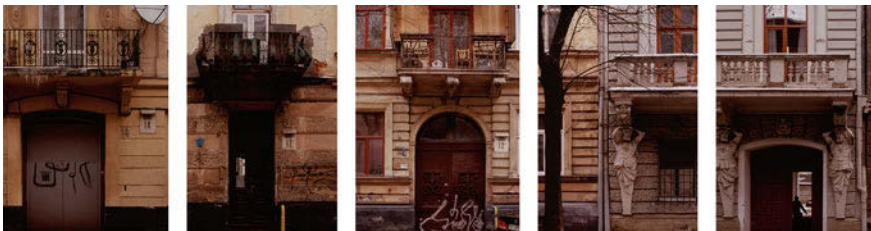

Photo 6.15 Lviv boasts much built heritage. The photo series shows a selection of houses along Hoholya Street, featuring different styles from around 1900

changing the activities of those citizens who are living in Old Town apartments: making them care more about the buildings they live in. Ideally, the changed rules would trigger situations, out of which a new culture of caring about historical buildings could emerge.

Yet it seems to be difficult to guide change in citizens' activities, due to emerged, cultural, guiding rules. These existing, enclosing qualities from the cultural system, together with citizens' activities, form a stable whole that is not easy to break. Where citizens' activities are guided by those emerged qualities, any change of activity would require the existing, stable whole of nested-system relations to be broken up.

The realization that inward influence from the political system does not lead to the aimed-at emergence of an overall, new culture of caring about built heritage suggests that the focus of policymakers should be on triggers in the enclosed system. I.e., the focus should be on new situations coming from the variety of citizen's activities, out of which new propensities can arise, perhaps leading to the emergence of a new culture of caring. Thus, in this particular example, the (rather disappointing) results of the first approach of relying on inward influence could mean the need for a pivot: changing to an approach that makes use of outward, rather than inward, influence.

Structure of the Case Study

This section is first structured to understand the relations of the Emergent Nested System—one system enclosed by other systems—with the whole, then to discuss ways to influence it. If a nested system relation should be analyzed, and/or the ways to influence this Emergent Nested System should be assessed, I suggest first delimiting the enclosed, faster system (Sect. 6.3.1.1). This can be followed by an analysis of the faster system's enclosedness by cultural, economic, political, and technical systems (Sect. 6.3.1.2).[49]

From these two complementary perspectives, it will become clear that, in this case, the nested system relations are strong and stable (Sect. 6.3.1.3), which suggests an explanation for why the current intervention of inward influence does not work as well as had been hoped (Sect. 6.3.1.4). From this complete analysis, I suggest ways of influencing by triggering change *within* the dwellers/dwellings system (Sect. 6.3.1.5).

6.3.1.1 The Faster, Enclosed System

Relatively fast internal activities discern a system from its environment (cf. Sect. 2.4). In the case of the dwellers/dwellings system, the activities take place between dwellers and their dwellings. These activities are relatively fast, as compared to enclosing systems, in particular the four superordinate CEPT systems presented above. The residents of Old Town use their houses every day, while they hold (and slowly adapt) their images about their dwellings, about Old Town houses in general, and about Old Town as the urban ensemble or neighborhood they live in.

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[49]Having the general analysis of these enclosing CEPT systems in mind from Sect. 6.2, I will present only the (additional) aspects that specifically relate to the enclosed system of built heritage.

Activities Within
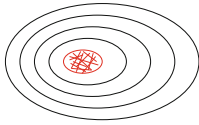
The enclosed system can be discerned by analyzing the activities of Old Town dwellers with the Old Town built-up structure. Residents use entrances and staircases, and they can decide each and every time they exit or enter whether they will clean, repair, or repaint something or not. Those who live upstairs might be affected by leaks in the building's roof, and almost every dweller is concerned about shallow insulation. Dwellers frequently take action against the shortcomings of the built structure, e.g., shallow insulation, high humidity, and incoming noise. It is popular to install new windows with plastic frames that conduct little heat to the outside.

Speed of Change
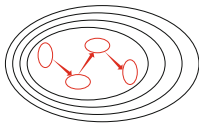
Additionally, the dwellers/dwellings system can be distinguished by its relatively fast speed of change, as compared to the rate of change of enclosing systems, such as the guiding cultural, economic, political, and technical systems. In the dwellers/dwelling system, change is brought about by redefined uses, by restored and/or repainted parts of the building, and by dwellers moving in and out. (In contrast, the image and the sense of worthiness an individual has of the Old Town built-up structure belongs to the enclosing cultural system, which is changing much slower than the frequency of activity between dwellers and dwellings.)

6.3.1.2   The Slower, Enclosing Systems

The dwellers/dwellings system is enclosed by systems that guide the activities of dwellers, in relation to the buildings they live in. As a result of the particular qualities of Lviv's superordinate CEPT systems, specific activities are carried out in the dwellers/dwellings system.

For example, ground-floor space is converted into shops (without permission), and old, wooden window frames are replaced with new, plastic ones (although it is forbidden now). Additionally, new qualities may emerge in the superordinate systems from Lviv's citizens' activities, in relation to their built heritage; these qualities show up in, e.g., the opening of coffee shops and possibly in the opening of one co-working space in the historic center.

Some emerging qualities that guide activities that take place between dwellers and dwellings belong to the technical superordinate system. Those technical qualities are frequently changing, e.g., the use of coffee shops for surfing the web. Other qualities that are part of the economic or cultural superordinate systems are relatively long-standing, e.g., the habit of placing small grocery stores and/or tourist shops in the ground floors of old buildings.[50]

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[50]Both this case study and the third case study (about Lviv's public transport system) may leave a first impression of dealing with nothing else but technical systems. I.e., the qualities that are emergent from the activities between citizens and technical artifacts are no more than qualities

In order to understand the dwellers/dwellings system and possible ways to influence it, I will subsequently discuss the qualities of the four superordinate systems that are related to Lviv's built heritage.

The Cultural Enclosing System

The different cultural systems identified in Lviv and described in Sect. 6.2.1 guide the activities of citizens, in relation to Old Town's built heritage. A post-communist view of property maintains, in particular, that (part of) the property is owned by the municipality. A lack of cultural significance and of valuation of built heritage persists, due to the detachment of dwellers' histories from the history of the city (Photo 6.16). The findings of the analysis of the cultural systems of Lviv, presented in Sect. 6.2.1, also hold for the discussion of the enclosing systems of the dwellers/dwellings system.
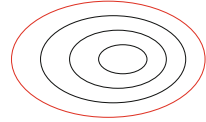
Where the cultural systems set the guiding rules, the enclosed systems follow them. For example, general mistrust in the public sector is guiding the activities of its dwellers, in relation to the common areas of their buildings that belong to the municipality. While citizens tend to mistrust institutions, they still expect the municipality to remove their garbage and to maintain the common, publicly owned areas of buildings, i.e., corridors, staircases, basements, and roofs. Whenever the municipality fails, mistrust and the post-communist cultural system are sustained.

A cultural impediment to a proper culture of caring about built heritage exists in Lviv: As in other former communist countries, many people who are now urban

Photo 6.16 Where a lack of cultural significance and of valuation of built heritage persists, original staircases (*left*, Majera Balabana St. 29) and ornaments dilapidate, holes may be cut in old wooden doors to let the cats walk in and out (*center*, Tomashivs'koho St. 8), and new window frames and satellite dishes are installed (*right*, Akademia Bohomol'tsya St. 3)

(Footnote 50 continued)

of technical systems. However, I suggest that such an understanding of complex (urban) systems is insufficient. As argued in footnote 47, each and every complex urban system is influenced by guiding rules of enclosing systems, e.g., the E-CEPT systems. Thus, these enclosed systems have to be understood, not only from relatively short-lived trends, such as using technical artifacts, but also through long-standing cultural norms, as well as economic and political rules.

dwellers were alien to cities, including their built-up structure, when they arrived some 30–70 years ago. When the vast majority of the population of Lviv was driven out of the city after WWII, they were replaced by Russian soldiers, peasants from the countryside, and residents from cities further east. This replacement population had been less under the influence of the rapid Central European urbanization since the second half of the 19th century (Hentosh and Tscherkes 2009, p. 257).

The inflow of mainly rural inhabitants continued until the early 1980s. These new dwellers were lacking a cultural relation with the pre-WWII built-up structure (see Sect. 6.2.1.2), and, as rural citizens, they had not been socialized with urban habits. Therefore, it is not surprising that a sense of belonging to the buildings they live in had (and in some cases, still has) to develop, and that a deep understanding of the historical meaning—or, in the words of an interviewee: "the historical value and beauty"—of the built heritage, is missing.

Yet there is *some* understanding of the value of the built heritage. Some citizens—including all of my interviewees—do understand that the historical area surrounding Old Market Square is beautiful and valuable. One interviewee called the city "an open air museum." For some Lvivians, the old, ornamented buildings with gently colored facades are *somehow* 'special.' There is true valuation as well; e.g., Professor Bevz of the technical university, together with his students, is building a catalogue of ornaments, characterizing the houses in the built-heritage areas.[51]

Also, the perception of what is historic and valuable is confined to the blocks of the historic center around Old Market Square, and it does not include the extensions of Old Town built in the 19th century. While large parts of the city feature built heritage, only one part is being perceived as such. This perception is perhaps a hint that a true understanding of built heritage is missing, and that "beautiful and valuable" is a meaning constructed through repeatedly mentioning it; it is something that is not felt innately.

Tourists coming and visiting the historic center may support the creation of a sense of value and the perception that—as one interviewee put it—the built heritage is the business card of Lviv. The listing of Lviv's Old Town as a world heritage site by UNESCO strengthens such a perception. The subsequent image is that the beauty of historic Old Town is worth preserving, and it is emphasized by activities and communications of the municipal government, such as the intervention discussed below (e.g., posters by GIZ, depicted in Photo 6.17).

Hence, feelings of belonging in and valuing the historic center are only just emerging, due to the valuations of UNESCO, tourists, and Lvivians, who recognize it as being special. The historic center (but less so the other areas in Old Town) becomes valuable by offering an experience that differs from the places where most Lvivians live, i.e., in communist, residential high-rises. However, few personal activities of, e.g., renovation, seem to be guided by this understanding.

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[51]Indeed, Professor Bevz has already built up an amazing collection of photos and sketches of details found on old houses; he calls them "inventory cards."

The Economic Enclosing System

Being enclosed by the dominant, post-communist cultural system, hardly any economic quality of the built-up structure can emerge from the activities of dwellers in Lviv. Investments into the structures and common spaces of houses that have been divided into individually owned apartments are rarely carried out.[52] Due to the way Lvivians deal with shared property, as well as their preference for living in more recently built houses, this lack of economic emergence occurs.
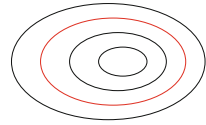
As a legacy of the post-communist cultural system, the notion of ownership of, and investment into, real estate and the idea of preserving pre-communist buildings is hardly meaningful for some dwellers, who are guided by the post-communist cultural system. For example, as mentioned above, one interviewee unsuccessfully asked his neighbors to join a common effort to repair the building's roof. Instead of investing in the preservation of the building—and thereby recognizing its value as a whole, as well as the importance of a well-maintained structure for their own apartments—dwellers go for the low-hanging fruits that promise an immediate increase in comfort, i.e., changing windows, doors, and heating systems.

Even if aimed at by some, taking proper care of and renovating the Old Town building stock is beyond the economic affordability of typical apartment dwellers, and it is not a priority of those who have sufficient financial means. Where citizens of various wealth groups are living together in the same building, the financially

Photo 6.17 Educative posters placed in a public space by GIZ, a German Federal Agency for International Cooperation that engages in urban development in Lviv

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[52]Since it was set by the law of privatization after communism, ownership structure may be the largest impediment of built-heritage renovation. Furthermore, apartments have been 'sold' for symbolic prices to individuals since the end of communism. Thus, in order to carry out a proper renovation of the built structure, one has to deal with a number of individual apartment owners. The legal guide of privatization also kept the common areas—corridors, staircases, basements, roofs, facades—and the common grounds the property of the municipality.

weak, like pensioners, cannot afford to join into an effort of renovation. The large investment backlog, as well as fragmented ownership structures, in each building render investments in old buildings unattractive. Positive attributes, such as prestige or an understanding of the historical value of the building, do not outweigh the drawbacks.

Thus, those sufficiently affluent are left with two choices: carry out the investments of common property on their own, or move out. All too often, they're moving out because it is not their priority to invest in Old Town apartments and buildings. Rather, they invest in homes for themselves or their children in the urban fringe. Sought-after properties are typically apartments located in the villages surrounding Lviv. These apartments can be found in new houses or complexesor in old or new high-rises.

Tangible economic value of Lviv's built heritage lies in its capacity to attract tourists. Thus, the historic center is an important asset of Lviv's urban economy. Tourists who enjoy the picturesque scenery contribute to the economic value of the historic center. However, this value is usually not perceived by dwellers. Those who currently own the apartments—often the elderly, living on a small pension—are neither guided by nor sustaining the economic quality of the historic center, such as tourist activities.

The municipality, which supports and promotes tourism (see, e.g.,VisitLviv 2011 and other tourist websites, see, e.g., Lviv Travel 2015), cannot afford area-wide renovations of the buildings' common areas. Also, some university employees I interviewed were concerned about the continuing dilapidation of built heritage. They feared that in order to attract mainstream tourists, not much detail of the built-up history needs to be preserved—other than some pretty facades. One interviewee supported this concern through his perception that a specialist for the history of the city was non-existent in the municipality.[53]

The Political Enclosing System
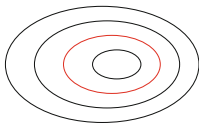
 Regulations and incentives aim to influence the activities of apartment dwellers—so far without sweeping success. On one hand, regulations aimed at maintaining the visual appearance of built heritage are not always being obeyed. On the other hand, incentives to encourage and guide renovation projects barely even function under the given cultural and economic guiding rules.

Rules for the preservation of built heritage have been established. No alteration may be made to the visual structure of an Old Town building. In particular, facades may be painted only in certain, selected colors.

But owners do not always obey. One old building crashed after the removal of a supporting wall, and here and there, ground-floor windows are enlarged to become entrance doors for small businesses. Legally, one can only be penalized when caught in action. But even then, it is often too late to prevent the alteration (see Photo 6.18). Additionally, control activity was perceived as low by my interviewees.

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[53]The Department for the Protection of the Historic Environment of Lviv was not considered to have adequate expertise by some of my interviewees. Rather, the Department's first task had been seen as engaging in media campaigns.

The municipal government aims at influencing the type of alteration which is carried out. For example, an annual forum is held to discuss and inform citizens about the creation of owner groups to take over the common-property parts of houses from the municipality (City Institute 2013b). Furthermore, the municipality advises interested citizens about the creation of owner groups. Also, with the help of GIZ regulations and financial incentives, the municipality tries to make apartment dwellers refurbish the original, wooden window frames, instead of replacing them with plastic ones (GIZ 2012a, 36 ff.).[54]

The Technical Enclosing System

Frequently, new qualities of use emerge in Old Town's buildings. Guided by the cultural, economic, and political systems, many options still remain for using Old Town's buildings in various ways. E.g., the location of the built heritage in the center of Lviv generates propensities for using it for gastronomic purposes.
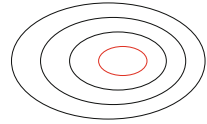
The poor condition of the technical infrastructure—heating and insulation, water, electricity—inside buildings may require upgrading. Thus, cases of use that allow for generating income may be preferred, such as the recently opened co-working space at a corner in the Old Market Square. The use of built heritage for dwelling might be declining, in particular where buildings are exposed to polluted air from the often congested roads surrounding the historic center or to noise from the tramways crossing it.

**Photo 6.18** The construction of a side-entrance to the building at Virmens'ka St. 30 was stopped after neighbors alarmed city officials (*left*). In many other places, additional doors have been cut into the walls of historic buildings (*right*, Tomashivs'koho St. 4)

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[54]Besides the historical value, wooden window frames are more permeable to humidity, while plastic window frames may lead to mold on walls.

6.3.1.3   Outward and Inward Influence in the Nested System

Outward and inward influence in the dwellers/dwellings system reinforces existing habits and existing guiding qualities—with the result of a continuing dilapidation of Old Town's built-up structure. Inward influence originates from the enclosing systems discussed above. Outward influence from the activities of citizens in Lviv is supporting the enclosing qualities, rather than triggering change. This makes for a relatively stable whole.
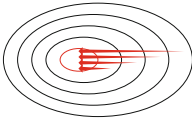
Inward influence immediately follows from the guiding rules of the enclosing cultural, economic, political, and technical systems discussed above. E.g., the emerged quality of a residential unit in a subdivided house only guides the maintenance inside the apartment, not the common areas. Or the emerged quality reflected in a coffee shop with a wireless internet connection is autopoietically regenerated, as long as Lvivians make use of it. In contrast to rules of such *emerged* qualities, inward influence from rules *devised* by the political system may not be able to guide citizens in carrying out activities of outward influence that are required to maintain the devised rules.
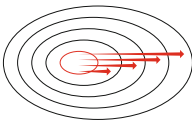
At the time of my studies in Lviv, outward influence from dwellers' activities was largely of the reinforcing kind. E.g., few apartment dwellers seemed to care about the legal ban on plastic window frames or the obligation to use wooden window frames instead. Also, the apartment I had rented in the historic center had been refurbished with plastic window frames.

Young people I interviewed had a preference for not living in the built-heritage area, where they said that the buildings "smell old" and that too many elderly people were living. Recently introduced laws often don't take effect, since long-standing habits dominate and are reinforced by such activities as cutting doors in ground-floor walls in the built heritage.


Photo 6.19   The parts of Old Town beyond the Historic Center are less valued than the area around Old Market Square (buildings at Bohdana Khmel'nyts'koho St.)

A result of this relatively stable whole—maintained by outward and inward influence between enclosing rules, guiding activities of citizens, in relation to their dwellings and to the enclosed system itself—is an ongoing dilapidation of Old Town's built-up structure. In particular, houses beyond the pedestrian zone around Old Market Square are dilapidating (Photo 6.19). So far, they are not valued much; i.e., an emerged quality of—e.g., a cultural image, an economic quality, a political meaning, or a technical quality—is missing.

The uses that have emerged in the historic center around Old Market Square—inter alia, coffee shops, souvenir shops, and a co-working place—are missing in the areas of Old Town beyond it. Wherever the main quality is residential use, buildings are dilapidated, due to a lacking culture of maintaining real estate—even if one's own property is under the same leaking roof.

6.3.1.4   Changing the Rules of Inward Influence

Guided by cultural and economic qualities of Lviv, and by the support of international organizations, the municipality devises rules to impose a proper attitude toward renovating Old Town buildings. However, although some positive effects can be observed, no new culture of caring about built heritage has emerged (yet).
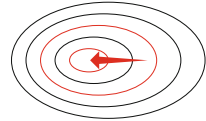
Through creating new rules, the municipal government believes it can change the self-sustaining, nested system relations, and it believes it can make apartment dwellers care more about their property, or even assume responsibility for the common (but still municipal) areas of the building. Besides, e.g., the rule on facade colors, the main influencing activity is a collaboration between Lviv's municipal government and GIZ, which promotes, inter alia, the use of wooden window frames for built heritage. The GIZ program comes with financial support and offers, e.g., hands-on training for local craftsmen (cf. GIZ 2012b, p. 22).

The inward-influencing rules purposively devised by the municipal government are themselves selected by cultural and economic images of Old Town, e.g., the beauty of old buildings in Lviv, Lviv as a tourist center, an actual understanding of the historical heritage and value of Old Town, and/or the (imagined) view of foreigners about the local assets.

Changing the rules of inward influence has some impact, though this approach can certainly not stand alone if a breakthrough in, e.g., the emergence of, a culture of caring about built heritage, should be reached. For example, the approach followed by the GIZ program introduces rules in the enclosing political system, and it thereby aims at directly producing change in the activities of the enclosed dwellers/dwellings system, and indirectly at the emergence of a new culture that will make dwellers care about historical buildings.

On one hand, the GIZ program has achieved tangible results, including a response from the enclosed dwellers/dwellings system. General awareness has risen, which was evidenced by a dweller calling the authorities after observing that a door was being cut into the ground floor of an old building in the middle of the night one Friday before Christmas.

On the other hand, however, no general breakthrough could be reached in widely changing the apartment dwellers' activities regarding a higher sensitivity for appropriate restoration of the built heritage (yet). Thus, no widespread change in the habit of installing new windows with plastic frames can be seen.

It seems that the dwellers/dwellings system is largely insensitive to the new rules that are devised. While the existing nested system is self-reinforcing, the new rules have not created such reinforcing activities in the dwellers/dwellings system. Change in the activities of apartment dwellers may be guided by laws and fostered through incentives and know-how, but change in the enclosing systems would need to emerge from Lviv's citizens' activities, in order to renew the guiding rules for the perception and treatment of the built heritage.

For such change in enclosing systems to emerge, the adoption rate of the GIZ program might have been too low, yielding too little triggering activity. Change should have been catalyzed by the example of the citizens, who participated in the GIZ program during the first 27 months since it started in 2011. However, only about 500 individuals participated. (They represent only about 1 % of the approximately 55,000 citizens living in the target area of the GIZ program.)

6.3.1.5 Triggering Change by Outward Influence
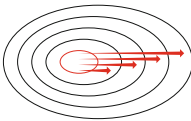
There are dozens of possible uses for built heritage, out of which a new culture of protecting it could emerge. Every day, through the decisions and activities of anybody in touch with Lviv's Old Town, the existing cultural, economic, political, and technical enclosing systems are either reinforced or not. The outward influence of the dwellers/dwellings system could lead to the emergence of new qualities, e.g., a new culture of caring about built heritage.

As a result of the nested system's aforementioned analysis, a more effective way to change would involve *enabling* new uses, instead of imposing new rules. The municipality would then need to foster a *variety* of uses. New quality may emerge out of ever-changing situations created by the new variety of uses.

Not all activities carried out in relation to Old Town buildings support the relatively stable whole (cf. Sect. 6.3.1.3). E.g., one person went through all the effort to buy out the dwellers of the apartments in a house in the historic center and thoroughly renovated the entire building (Photo 6.20).

There are other examples of diverging activities. E.g., there is the above-mentioned case of one of my interviewees, who succeeded in having the other apartment dwellers put money together to renovate a staircase. There are also the first two floors of a

corner house in Old Market Square, which have been turned into the aforementioned co-working space, as well as other office spaces in other buildings. My tourist apartment was in an Old Town building as well. I suggest that these activities are often singular when they begin, and they offer the potential of a general change in the enclosing system's qualities.

An alternative approach to achieve change in the enclosing systems is, thus, by enabling and fostering change *within* the enclosed dwellers/dwellings system. Eventually, changes in individuals' activities create new situations in the enclosed systems that will open up new propensities, out of which new enclosing qualities may emerge.

With more ideas that are created and more activities that are possible, more situations might become reality, out of which changes in the enclosing system could emerge. The key to success might, thus, lie in triggering, enabling, and fostering a variety of activities that are not directly opposed to the municipality's goal of maintaining the built heritage. In other words, there will be new activities coming up in the dwellers/dwellings system that can lead to greater changes.

The task of the municipality then becomes to scout for trends in the system, support them (with rules or incentives) if required, or break up existing rules (if possible) that inhibit new trends from prospering. The key to success is to allow for, or even stimulate, new activities that will not allow the existing enclosing systems to be supported any more, so that new qualities will emerge. Metaphorically speaking,

Photo 6.20 House "Medelin" in the Historic Center has been carefully renovated (Koliifvshchyny Sq. 1)

the task is to stir the soup.[55] In other words, the task of the municipality is not to enforce a change in the citizens' habits, but to let new habits emerge and prosper— while focusing on the selection of those habits that are in line with the municipality's goals. Once a renewed enclosing system has emerged, it will be supported by the reinforcing activities of Old Town dwellers—something that the designed, but not emerged, rules for wooden window frames cannot count on.

6.3.2 Case Study 2: Entrepreneurship

The second case study is about the growth of entrepreneurial activity, as well as the question of how a quality of local entrepreneurship emerges in Lviv. Unplanned entrepreneurial activity has changed the rules of enclosing systems. Not only in the cultural and economic systems, but also in the political superordinate system, new rules of emergent qualities are now guiding the activities of Lvivians.

The first entrepreneurial steps—i.e., the founding of IT outsourcing companies— occurred about two decades ago. These steps may have resulted in the decisive activities that created an initial situation, out of which a locally specific culture of entrepreneurship is still emerging. The activities of Lviv's Startup Club may have had similar influences, and the activities of the Innovation Center may perhaps influence the emergence of a particular entrepreneurial quality in Lviv's economic and cultural systems.

This is, thus, a case study of outward influence as a powerful means in the development of ENS. It shows how outward influence may successfully trigger change, and how a new quality may be emerging in the complex urban system. At the same time, this second case demonstrates how it is possible to identify qualities emerging from enclosed systems, and to provide them with a guiding frame from the political system—if so desired.

Context of the Case Study

The mid-1990s was a time of change for enclosing systems, after the end of communism in CEE. To trigger emerging qualities in the enclosing systems, all that was required was a few citizens trying out something new to Lviv. At this time, cultural and economic qualities of IT and BPO businesses emerged and started to be sustained by continued activity in these fields.[56]

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[55]The principle of active stirring is evocative of the energy input required for new forms to shape in dissipative systems (Nicolis and Prigogine 1977).

[56]I learned about a similar emergence in the ecosystem surrounding the volcano Mount St. Helens in Oregon, USA. After the volcano erupted in 1980, the former flora and fauna had been eradicated. In an amazingly fast transformation, life reoccupied the devastated area. In a video called "The Landslide and Return of Life," an interesting aspect of the ecological development of the area is mentioned: A couple of years after the outbreak, life of all kinds was flourishing again; the variety of species—flora and fauna—had actually been enlarged (NOVA 2010). Since then, the variety is diminishing again (U.S. Department of Agriculture 2015).

Now a new, particular quality of entrepreneurship is about to emerge from within the given cultural, economic, political, and technical enclosing systems of Lviv. Thus, this (latent) emergence of a quality of entrepreneurship in Lviv can be traced back to a single, initial, triggering event: the founding of the first IT and BPO company, which emerged out of the technical university.

Recently, the entrepreneurial activities of citizens have been identified by the political system. Since the entrepreneurial activities are politically desired, new guiding qualities are being allowed to emerge by the municipality. In particular, the Lviv Innovation Center was set up to support the transfer of technology from universities to businesses, and to support founders in starting up their (technology) businesses. With its own activities, the Innovation Center supports the continued existence of emerged economic and cultural entrepreneurship systems, and it guides the activities of some citizens by guiding them in their startup activities.

Structure of the Case Study

As before, this section is initially structured to facilitate an understanding of the ENS and their interrelations; then I discuss ways to influence them. Again, I will start by looking at delimiting the enclosed, faster system (Sect. 6.3.2.1), then the enclosing qualities of the cultural, economic, political, and technical superordinate systems (Sect. 6.3.2.2).

By means of the present case study, it will become clear how activities in an enclosed system may lead, through outward influence, to changes in the emergent qualities of enclosing systems (Sect. 6.3.2.3). Adopted by the enclosing, e.g., political system, the nested relation is stabilized (Sect. 6.3.2.4). In a manner similar to the first case study, I suggest from this analysis that observation, understanding, and—if desired—fostering of tendencies of development in enclosed systems may be an effective way of influencing complex (urban) systems (Sect. 6.3.2.5).

6.3.2.1   The Faster, Enclosed System

The entrepreneurship system may be discerned by its relatively fast, internal activities, as compared to systems, e.g., the superordinate CEPT systems, enclosing it. Entrepreneurial activity is more frequent than changes in the superordinate CEPT systems.

(Footnote 56 continued)

In analogy to the time of turmoil after the end of communism in CEE, the time after the outbreak of the volcano involved little enclosing, emergent quality and rules. Thus, all sorts of activities were possible, and flora and fauna of many kinds developed. From these activities emerged an ecosystem—a whole of many faster and slower, enclosed and enclosing systems—specific to that area (and different to the one that had been there before). The particular qualities of that ecosystem allowed for some species to stay; others vanished.

Activities Within
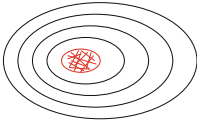
The enclosed entrepreneurial system of this case study can be discerned by the activities of individuals, who are interacting with each other and with surrounding systems, in order to reach their goals of setting up and running new businesses.

On one hand, there are activities between individuals exchanging ideas and receiving advice for starting up a business. Individuals—with means and interests that are similar or complementary—collaborate, exchange ideas and experiences, gather for training sessions and workshops, and meet with potential business partners. For example, the Lviv Startup Club began as a small community of freelancers, and soon, up to one hundred individuals were attracted to its (bi-) monthly meetings. These individuals came to find partners, pitch ideas, and raise money.[57]

On the other hand, there are activities between individuals of the entrepreneurial system and other systems of the city, such as the public transport system and the tax system. Particularities of Lviv's entrepreneurship activities include where individuals meet to share startup ideas (e.g., a coffee shop) and whether or not they work from home. If they don't work from home, further particularities would be where they work and how they commute there. From these activities, new qualities of, e.g., technical systems of transport or built-up structure can emerge, such as the use of coffee shops for (informal) meetings.

Also, the activities of institutions regarding, e.g., seeking support or paying taxes may lead to the emergence of different qualities, e.g., in the political system of Lviv, such as the creation of the Innovation Center.

Speed of Change
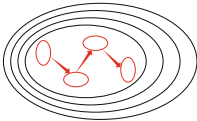
The entrepreneurial system in Lviv can also be discerned through frequently changing activities. For one of my interviewees, this course of activities involved developing a business idea while in university, becoming an employee to earn some money after graduation, eventually starting a new company when dissatisfaction with the employment situation increased, running out of money, taking on freelance projects to gain a cash flow, and finally realizing the original startup idea.

While dozens of entrepreneurs—who are part of this enclosed entrepreneurial system—meet up, develop ideas, and start their businesses, the enclosing cultural, economic, political, and technical systems do not change very much. As compared to the enclosed entrepreneurial system, the enclosing CEPT systems remain relatively stable.

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[57]The Startup Club matured and started to organize six formal conferences per year, centered on themes of specific interest to Lviv's startup founders, such as game development, social media, e-commerce, internet marketing, and services of outsourcing companies (all of which relate to qualities of the particular, emergent, startup system in Lviv). Also, the Lviv Startup Club gave presentations at the university to inform students about ways to become an entrepreneur. Today, the Startup Club still facilitates, advises, and finds investors by means of more informal, individual meetings; the organizer of the Startup Club acts as a business angel and mentor.

6.3.2.2 The Slower, Enclosing Systems

The enclosed system of entrepreneurship is nested in the slower, enclosing systems that guide the activities of entrepreneurs: cultural, economic, political, and technical. New qualities emerge from the activities of entrepreneurs in Lviv in all four superordinate systems. These new emergent qualities guide entrepreneurial activities. However, since the entrepreneurship culture of Lviv is still emerging, it cannot be known in detail yet; it has to stabilize itself first. Frequent, activities are continuously triggering change to the emergent quality, and no fixed rules are guiding activities into the support of one typical, Lvivian, entrepreneurial culture yet.

Understanding the rules under which the entrepreneurial system develops helps in understanding the regime under which the entrepreneurial system operates—and how it can be influenced. These particular emergent qualities of Lviv's entrepreneurial system will be discussed below.

The Cultural Enclosing System

A cultural quality of entrepreneurship in Lviv has not yet fully emerged. Entrepreneurs are guided the positive image of the existing IT and BPO companies, which have grown large from startups. Of the three cultural systems identified in Lviv (see Sect. 6.2.1), it is mainly the liberal one which is guiding activities of entrepreneurs. (Where activities are still guided by the post-communist cultural system, the options for founding a successful business are rather inhibited.)
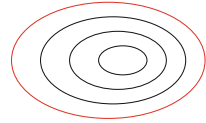
Among the qualities of Lviv's superordinate cultural systems is an emerging quality of entrepreneurship, which is still weak and not yet defined—regarding its properties of guiding qualities. One interviewee observed up- and downswings in interest in starting a business, with the last spike occurring around 2009 or 2010. Another one put it like this: "Something is happening, but I'm not sure what is developing into which direction."

Key to the development of an entrepreneurship culture in Lviv seems to be the positive image of IT and BPO companies, which are connected to startup companies in two ways. First, these important businesses began as startups themselves.[58] With their success, a positive image of the industry has developed. Second, when programmers quit their jobs at one of the now-large IT and BPO companies, they often do so to develop their own startup business. What was once seen as a strange occupation—being a programmer—has become "cool" today. Thus, many IT outsourcing businesses can be found among recently founded startups, some of which were even founded by former employees of the now-big outsourcing companies.

[58]The growth of Lviv's IT and BPO companies began when a first company was founded around 1995 by professors and assistant professors of the technical university. They had taken courses at international IT companies, and they then won initial projects for, e.g., General Electric. Subsequently, IT outsourcing businesses had grown to about 4,000 employees by 2011 (Sergiychuk 2012).

On one hand, the entrepreneurs I interviewed were mainly guided by what I termed the liberal cultural system in Sect. 6.2.1.1. My interviewees perceived it as easy to start a business without bribing officials or dodging taxes.[59] Also, taking responsibility for one's own life, incorporating ideas gathered from around the world, and understanding the notion of ownership are qualities of the enclosing, liberal cultural system.[60] As a driving force, the image of startup environments in the US is already part of this emerging entrepreneurship culture, and it guides the activities of some citizens.

On the other hand, whenever the post-communist cultural system does shine through, it may inhibit activities of (potential) entrepreneurs, as well as investors. Those individuals guided by a (post-) communist cultural system would need to navigate (the image of) corrupt judiciary and tax systems, as well as a heavy bureaucracy; these are unfavorable conditions for a technology entrepreneur, especially in the startup community.[61] When investors are guided by the concerns about corruption in a post-communist culture, they may not take the risks to invest. The resulting lack of financial means prevents some who could become entrepreneurs from starting their own businesses.

Success is a driving force of an emerging entrepreneurship culture. It is possible, that the opening and operating of many coffee shops—while not being as center-stage as IT startups are—is already reinforcing the entrepreneurial spirit and increasing the local knowledge of starting and operating a business and of handling employees.

The Economic Enclosing System
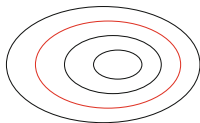
While local economic qualities, which are reflected by SMEs, as well as IT and BPO companies, provide positive examples for venturing into self-employment as an individual or as a startup team (i), no proper economic quality of entrepreneurship has emerged in Lviv yet.[62] This missing economic quality of enterpreneurship hinders entrepreneurial activity—just as other economic qualities inhibit it (ii).

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[59]In contrast, many citizens of Lviv who are predominantly guided by the post-communist cultural system are not in a situation to become entrepreneurs. They say, e.g.: "It is impossible, you can't do it!" For them, the image of a Western (and thus particularly non-communist) way of life drives them to earn money as employees after graduation, in order to soon be able to maintain a family, buy a car, and own a house outside the city. Other citizens guided by the post-communist cultural system, such as a student who has a job in a bar, call and wait for a "change from the top" to happen first, since they perceive that the government discourages starting a business.

[60]Thus, due to their (autopoietic) support of the liberal cultural system, activities of entrepreneurship may be highly welcome in Lviv, in order to overcome the (post-) communist way of thinking.

[61]The post-communist cultural system may seem to drive certain individuals into entrepreneurship and self-employment. These are individuals who attempt to 'turn away' from the former, communist, large-scale industrialization—especially regarding mass employment. Thus, they may choose to start up their own economic activities, even if they are guided by the post-communist cultural system.

[62]A *local economic quality* may be identified as *a particular way of doing business* in a certain place at a certain time in history.

(i) Guiding Local IT, BPO, and SME Qualities

The emerged economic qualities of Lviv's IT and BPO industries drive some individuals to become self-employed or start up their own companies in this sector. Most entrepreneurs follow the guiding rules of Lviv's IT and BPO industries and start their own outsourcing businesses.

Outsourcing businesses are seen as opposed to startup businesses beginning with an "original idea," i.e., an idea not copied from elsewhere. Such original ideas—mainly in the field of e-commerce and mobile applications were perceived by one of my interviewees as accounting for only 5 % of startups. Some of the more original startups are also seen as successful, e.g., Kartinka.net and G-Recorder. (The former offers photo services for online shops, and the latter an application that records Skype calls.)

(ii) An Entrepreneurial Economic Quality to Emerge Still

It may well be a sign of a missing, emerged, economic quality for startup companies—in addition to the economic qualities of IT, BPO, and SME businesses—that the team of Kartinka.net did not stay in Lviv but moved to Kiev. Instead of an economic quality of entrepreneurship, other readily emerged, economic qualities of the existing IT and BPO companies, as well as of, e.g., the real estate market, are guiding human and financial resources into alternative activities.

For example, little investment capital is guided into startup businesses, since an economic quality of entrepreneurship has not yet (fully) emerged in Lviv. Interviewees reported only two startups that received investments from investors based in the European Union or the United States, and they reported some startups that received a few thousand Euros of (local) seed funding. The few, local business angels were "hesitating" to invest, as one interviewee perceived it.

As a result, entrepreneurial activities are often self-financed by also doing freelance work, or by living on savings from, e.g., a former employment. Furthermore, the typical entrepreneur is not able to pay wages to employees or freelancers, who could be hired to shorten the startup phase of the venture.

The square-meter prices for office space in the city center was around 10 EUR at the time of my studies, so rents for both living and office spaces are often unaffordable. (A startup center that offers space for lower rents is missing. Lviv's Polytech business incubator was never mentioned by any of my entrepreneur interviewees; its website was last updated in 2008; see Lviv Polytech 2008.) Therefore, entrepreneurs may live with their parents and work from home. As a consequence, it is financially difficult for individuals, whose parents are not living in, or own a dwelling in, Lviv, to work on a startup business.

All in all, potential founders and cofounders are guided by Lviv's economic qualities into competing jobs, rather than into startup businesses. In particular, a dominant, guiding, economic quality for graduates of technical studies, in particular

the information sciences, has emerged from the now large IT and BPO companies, who pay above-average wages from the get-go.[63,64]

There is no adequate, economic quality yet that would have the power to guide financial capital and individuals into startup businesses, and graduates into a job at a startup. The (perceived) positive examples of successful startups are just too scarce: One interviewee who began a startup himself did not know of any successful startups; another remembered three.

The Political Enclosing System
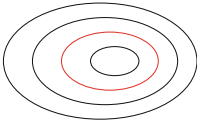
Regarding national and local rules, laws, and policies, activities of entrepremneurs are not only guided by the system of taxation, but also by the legal protection of small businesmses. Additionally, they may be guided by new qualities that emerge in the local political system. With the Innovation Center, such a local quality has emerged in Lviv.

Individuals guided by the post-communist system perceive the rules of the political system differently from those guided by the liberal cultural system. While those interviewees belonging to the first group perceive poor legal protection as an obstacle to creating a small businesses, those belonging to the second group feel that this is not an obstacle (any more), since the formerly poor legal protection has improved over recent years.

Furthermore, the post-communist political system justifies different forms of individual choices, with regard to obeying tax rules and laws. For the first group, the political system is corrupt, which gives them an excuse to dodge taxes, but the second group disagrees with this view. Belonging to the second group, one entrepreneur mentioned that new business ideas may be developed and tested before a company is incorporated—by a network of self-employed freelancers who, as individuals, pay a very low, flat-rate tax (2 or 4 %, respectively—with or without value-added taxes being invoiced to clients).

The activities of Lviv's municipality provide guiding rules for business activities in the IT and BPO sectors and, in particular, for (potential) entrepreneurs. With Lviv's Innovation Center, town hall has launched an initiative to support entrepreneurship, by means of training and network-building. The initiative of the Innovation Center (more on this in Sect. 6.3.2.4) shows how an entrepreneurial quality may emerge in

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[63]A graduate programmer has the choice between being hired—subsequently earning a salary that could be four times as high as the average local salary—and beginning a startup business—not earning anything at the beginning.

[64]Also, there is already a scarcity of IT staff. Of the approximately 2,000 annual graduates of the technical university, only about 400 are said to become programmers. Established IT companies absorb a large share of the qualified graduates, offering high salaries, modern offices, sports centers, showers, good working conditions, and relatively safe and stable jobs. Overall, programming jobs grew from a few hundred at the beginning of the millennium to about 10,000 a decade later.

the political system from the activities of citizens, which provides a new guiding framework for entrepreneurial activity.[65, 66]

Such activity by the municipality—if it comes to the attention of the target group of citizens—does influence decisions. And it may, in this case, increase interest in forming a startup business and, thus, eventually, the frequency of entrepreneurial activity in Lviv.

The Technical Enclosing System

Entrepreneurial activity is largely scattered across Lviv, with no particular location having yet emerged as a hotspot for entrepreneurs. However, during the time of my studies, I could identify some activities and locations, out of which a localization of the startup community could potentially emerge.
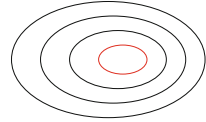
All too often, Lviv's startup activities are carried out in residential units of the communist high-rises, without much interaction between startups. Since office rents are high, startup founders often use their own or their parents' flats as offices (cf. above); these are often located in the communist residential high-rises. Since these are dotted around the city center, distances between startups may be large and involve half an hour or longer of travel time (by means of public transport). That I did not hear remarks concerning trip times may be due to the limited activity between members of the startup community.

As a consequence, Lviv's entrepreneurs can hardly be located in one distinct spot in the city, or even a few distinct spots. Thus, meetings may take place where the chance to run into other entrepreneurs is low. For example, one of my interviews with a member of the startup community took place in a restaurant located in an indoor swimming pool on the outer ring road.

Yet there are activities, out of which a local cluster could emerge. First, there is the potential for meeting and working in the many coffee shops in the historic Old Town (at least in winter, when fewer tourists crowd the city).[67] Second, there

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[65]Thinking in terms of the theory of ENS, I suggest that, as long as the quality in the political system emerged from the activities of citizens, there is less risk of lacking autopoietic support—and of an expensive but ineffective intervention. This is as compared to policies devised after, e.g., international best practice (see also Sect. 7.4.4).

[66]The same activities of the Innovation Center may also trigger change in the economic and cultural systems, since activities of any nested system have both inward *and* outward influence. E.g., the Innovation Center is guiding—by means of incentives, such as training offers and investor contacts—individuals toward carrying out entrepreneurial activities. At the same time, these activities of the political system may trigger change in the existing economic quality.

This ability to trigger change via activities of the political system in enclosing systems may be exemplified by a complicated tax regime, which is the generative basis of a shadow economy. Once the political system changes this tax regime, it will no longer be supported by individuals' activities. Then, these changes in individuals' activities lead to situations and propensities, out of which different, new, local, economic qualities can emerge.

[67]Looking at the experience of Berlin or, more recently, Leipzig, one might think that these old, run-down houses near universities—with many coffee shops within a short distance—were an ideal environment for an entrepreneurial community to emerge. However, due to different guiding rules, in particular Lviv's economic system, I do not think that this experience can be transferred to Lviv.

is the potential to use the co-working space in Old Market Square, or for another co-working space to open elsewhere in Lviv. (However, there are, particularly in Old Town, many competing-use cases of Lviv's built-up structure; some of them have more stable economic qualities than the entrepreneurial system, see Sect. 6.3.1). Third, the infrastructure of, e.g., restaurants and coffee shops in the vicinity of the larger IT and BPO companies may be part of a well-prepared ground for a localized startup community to emerge. For example, not far from the technical university and the train station, close to the office building of an IT and BPO company (Soft Serve), the canteen-like restaurant A La Minute may emerge as such a meeting point. Nearby is an old factory building that, at first sight, could offer space to meet and work (Photo 6.21); it may be a good location to test whether a business incubator will work within the enclosing cultural, economic, and political systems of Lviv.

### 6.3.2.3   Outward and Inward Influence in the Nested System

There is both outward and inward influence, but it may still be too early to speak about a strong, emerged whole of an entrepreneurial system. At the time of my research in 2013, outward influence by the activities of some entrepreneurs, of many self-employed citizens, and of a few investors seemed to be able to trigger change in the superordinate enclosing systems. At the same time, however, there did not

Photo 6.21 An old factory building near existing IT and BPO companies, not far from the technical university, the train station, and good residential areas, could potentially offer space for startup businesses (Heroiv UPA St. 73)
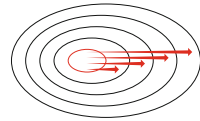
yet exist a stable nested system of entrepreneurship in Lviv to guide a specifically Lvivian type of entrepreneurship.

The various sources of existing inward influence on entrepreneurial activity have been discussed above. Inward influence from cultural and economic systems—largely (still) without entrepreneurial qualities—is only able to guide activities in the vague direction of businesses, particularly IT and BPO.
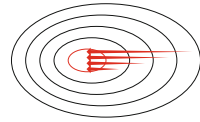
Since emergent qualities and guiding rules of entrepreneurship are (still) largely lacking, entrepreneurial activity in Lviv does not, in any way, evoke the impression of being guided towards coherent, steady activities.[68] Rather, there are periods when business foundations are more frequent or less frequent; thus, there are peaks and valleys. For reasons discussed above, startup activity is also spatially scattered. Regarding only the types of businesses, there are two clear trends: the first is toward IT startups; the second involves gastronomical business activities (which are centered in the tourist areas of Old Town).

   Thus, a ground upon which a particular quality of entrepreneurship may grow does exist. This has been evidenced by repeating startup activity; by meetings for, and with, entrepreneurs; and by individuals who know the community, including my interviewees. "Something is happening" in the field of entrepreneurship, as one interviewee expressed it. On this fertile ground, local rules of emerged qualities guide activities, e.g., rules of the liberal cultural system, of the positive image of programmers, and of the emerged economic quality of IT and BPO services.

6.3.2.4   Adopting Emergent Quality in the Political System

It is striking how the first signs of a quality of entrepreneurship are emerging in Lviv—despite a dominant, post-communist cultural system unfit to foster entrepreneurial activity; despite neither the economic system nor the political system being in any way structured to foster startup activities; and despite office space that is by no means affordable to first-time founders. In such a case, it is possible that—by means of purposive activities—the emergence of a particular entrepreneurial system can be triggered and guided. The Innovation Center demonstrates how potentially effective rules can originate from the political system: The quality that guides the political system in this particular respect has emerged from local citizens' activities, rather than being devised on the grounds of (imported) ideas that are disconnected from the actual complex urban system.

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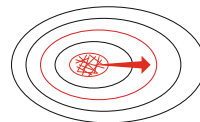
[68]Where inward influence of enclosing systems is guiding activities, these activities may appear to be guided by an 'invisible hand.' This is not just valid for economic systems; for example, the coherent light emitted within the "enslaving" rules of a laser demonstrate such guiding influence as well (Haken 2012, p. 9).

Emerged Quality of the Political System

In town hall, the Innovation Center has been founded, with the aim to develop, strengthen, and stabilize structures of entrepreneurial activities in Lviv. The Innovation Center was set up after one person had the idea for it. Expressed in the terminology of ENS, the quality of the Innovation Center emerged from triggering activities of outward influence. In other words, the Innovation Center reflects a quality of the political system that is emergent from local activities of outward influence, rather than an idea imported from another urban system.

The Innovation Center tries to create structures, such as a mentoring network, a startup community, and courses to train students and young entrepreneurs in starting a business. Meetings with students at universities are planned, and the word of Lviv being a good place for startups should spread across Ukraine. Thus, the Innovation Center now sets guiding rules, and it may trigger change in enclosing systems.

Effectivity of the Emerged Quality

Both outward influence from, and inward influence on, the Innovation Center might play an effective role in the emergence of a quality of entrepreneurship in Lviv (which cannot be designed or devised). As mentioned above (Sect. 6.3.2.3), such an emerged political quality is potentially more effective—in guiding activities and becoming autopoietically self-sustaining—than a designed one (cf. Sect. 4.1).

The Innovation Center is being run in a way that reflects the best knowledge about Lviv's entrepreneurial "ecosystem," i.e., what is known by the Innovation Center's director.[69] The competitiveness strategy adopted by Lviv's city council is guiding its focus on IT-related startup businesses (but not on, e.g., coffee shops). Financial means are provided by the city council, the Civic Research and Development Foundation, and local IT companies (Lviv Innovation Center 2011). As a first step, Lviv's municipality provided an office in town hall to three young citizens, and it mandated them to build the Innovation Center.

There is both outward and inward influence by the Innovation Center. On one hand, structures, such as a mentoring network and training courses, are guiding the activities of individuals. On the other hand, the operation of a 'deal generator,' as well as other activities that promote business relations between investors and entrepreneurs, may trigger the emergence of an actual economic quality of entrepreneurship.

6.3.2.5 Identifying and Stabilizing Emerging Qualities of Entrepreneurship

To conclude this case study, in this subsection, I will point out exemplary options for purposively employing and influencing outward influence in a complex (urban) system. Two complementary groups of influencing activities may be discerned:

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[69]According to my interviewee, the "ecosystem" is comprised of about 50 relevant educational and research institutes, as well as the city council, which guides town hall's activities in supporting whatever is related to a 'knowledge economy.'

1. Influence that aims at increasing the variety of possible activities of outward influence.
2. The introduction of guiding rules to select and stabilize some of the outward activity.

The first type of influence is important, since an increased variety of activities may lead to more propensities, out of which new quality may emerge. The second type of influence allows for the purposive support or the rejection of emerging qualities, e.g., by means of activities carried out by the political system.

Increasing Variety of Outward Influence

Increasing the variety and frequency of activities increases the variety and frequency of situations, out of which new quality may emerge. For example, it is now possible in Lviv that a quality of entrepreneurship will emerge from the activities of IT entrepreneurs, of mentors, and of angel investors—during the operation and use of a co-working space, and due to the experiences gained while running coffee shops.

Thus, one goal of purposive influence of complex systems may be to increase the variety and frequency of activities in enclosed systems. One way to reach this goal is by breaking up the existing rules in the political system, which constrain the variety of activities. For example, the startup activities of the first IT and BPO businesses, which became very successful, large companies, took place half a decade after a revolution—when political and economic qualities had been broken up. At this time, the qualities of the superordinate systems may have been less stable. Hence, the activities of citizens were less strictly guided, i.e., relatively unconstrained. Ideas could prosper, since guidance by enclosing systems—in particular the political system—was weak.[70] Wherever the rules—no matter whether they are of cultural, economic, political or technical nature—are limiting the activities too much, there may be no possibility for such variety to prosper. Thus, the situations and their propensities—from which the new, locally specific, enclosing quality is to emerge—rarely happen.

Therefore, increasing the variety of activities and/or maintaining a high level of variety may become goals of urban development. I suggest that this can be achieved by, inter alia, eliminating constraining (legal) rules. Doing so, the political system can play a role in the emergence of new quality. In other words, a variety of activities may prosper when the political system allows for new guiding qualities to emerge. For example, this second case study shows that the startup community seems to

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[70]Such a breakup of guiding qualities may allow for a greater diversity to prosper, as in the case of the ecosystem after a volcano erupted, mentioned in footnote 55. It is not my intention to imply that this breakup needs to be a radical destruction of the existing systems—as it was in the case of the volcano eruption—or even a 'velvet' revolution—as in the case of the end of communism in CEE. Quite in contrast, even in times of comparably stable enclosing (political) systems, it may be possible for new quality to emerge and guide the activities of decision-makers, as in the case of Lviv's Innovation Center. In this case, there were no (or few) convictions, ideologies, laws, rules, or planned competing activities by the municipality—that could suppress the emergence of entrepreneurial quality.

struggle in finding a location where it could grow.[71] The first case study has shown, inter alia, that ownership structures are a major obstacle when rethinking buildings' uses. Thus, it could be asked whether there are any rules of the legal system that restrict the variety of potential uses.

Clustering could create synergies among businesses, as well as an environment for the exchange of experience, for the creating or testing of ideas, or for any kind of networking. Any activity out of which a cluster could emerge may be interesting to observe, regarding an active (political) development of Lviv's startup community.

In Lviv, another hint concerning political guiding rules comes from my interviewees' diverging views on the tax system. If it is not yet as simple as some have perceived it, why not (push to) simplify it?

Guiding the Activities of Outward Influence

Where a variety of activities is present, the (political) goal may be to support some of them, because a type of emergent quality from these activities is foreseen or hoped for. Thus, at first, it is required to identify the activities of outward influence present in the complex (urban) system (i). Second, an approach is required to concentrate and align activities to locally increase the frequency of wanted ones (ii). This approach would be one of 'working with outward influence' by providing a guiding frame of inward influence to those activities—the guiding frame being carefully aligned with the existing enclosing qualities and enclosed activities.

(i) Identifying Activities of Outward Influence
Prior to any influencing activity, it must be known which activities are present that can be influenced. Thus, the identification of activities that may lead to the emergence of a new quality is a prerequisite for effective influencing. For enclosing systems, such as for the political system (with respect to any system of frequent citizen activities), it is important to understand the subtle specificities of local activities. Knowing the activities in the enclosed systems may provide a clue about the *type* of quality that could emerge from these activities. While in the case of Lviv's Innovation Center, such an understanding might have come intuitively, a structured understanding may follow the suggested case-study methods presented in Chap. 5.

(ii) Concentrate and Align Local Activities
Guiding rules could stabilize an autopoietic cycle of activities and their emergent qualities. The goal of guiding rules is to synchronize some of citizens' activities and

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[71]This brings about the question of how *spatial* density may influence emergence. Since activities within a system are key when creating new situations, there should be a link between the frequency of propensities and the spatial density. As with many other measures, a correlation between novelty and spatial density depends on the locality itself; it cannot be compared across cases. E.g., the population density of innovative hotspots, such as Silicon Valley, is only 1/10 of the population density of Lviv's prototypically compact, European inner city. I.e., it is still less than 1/2 of the population density of the entire city of Lviv (Elbert et al. 2009, p. 13 and GIZ 2011b, p. 18). In summation, density alone does not make for novelty, and, thus, densifying a city will not necessarily yield variety.

to increase the frequency of those activities—for new quality to emerge in the CEPT systems that will henceforth guide more citizens into doing the same activities.[72]

The case of the Innovation Center shows how emergent quality may be adopted by, e.g., the municipality, in such a way that new rules will guide the identified activities of outward influence and support autopoietic regeneration. On one hand, where there is an alignment of activities in the enclosed system(s) by guiding rules, there will also be a reduction of variety (cf. footnote 55). On the other hand, the increased frequency of similar activities may lead to the emergence of a particular type of quality, e.g., a culture of entrepreneurship.

It should be noted that, despite this section's focus on enclosed activities and political guiding rules, the latter may only become effective if they pass the selection of the enclosing cultural and economic systems. For example, since activities of entrepreneurs are also guided by the economic and cultural systems, an understanding of, and alignment to, those enclosing systems could help the Innovation Center become (more) successful.

In other words, guiding rules by the political system may only be effective when they 'tune in' to the subtle nuances of the local superordinate systems, reflected in citizens' activities. Thus, in order to be able to provide an effective guiding frame to selected activities, the continued observation and understanding of the activities is required.

Furthermore, as it is for any activity in ENS, the activities (of the political system), have a double role: They influence by providing guidance to enclosed activities, and by supporting or triggering change in enclosing systems. E.g., the Innovation Center not only guides entrepreneurial activities, it also supports the continued existence of emerged economic and cultural entrepreneurship systems.

6.3.3 Case Study 3: Public Transport

The third case study is about a reform of Lviv's public transport system. When said reform became effective, users got upset and eventually achieved the reintroduction of some bus lines that had been eliminated. Thus, the planned intervention was not fully adopted and led to protests.

This third case study demonstrates the difficulty of implementing rules that are at odds with the established modes of autopoietic regeneration between enclosed and enclosing systems. In particular, this third case study shows how inappropriate consideration of both the enclosed system—i.e., the system made up of the activities between the technical/transport infrastructure and its users—and the enclosing system—in particular, the cultural one—produced an unstable change, which is supported by neither outward nor inward influence. At the same time, this third case suggests that changes that would have fit the existing guiding rules may have worked out well.

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[72]Aligning activities by guiding rules is evocative of the analogy of coherent laser light (again, cf. footnote 68).

Context of the Case Study

New rules and structures guiding individuals' activities in the public transport system started to emerge soon after the fall of communism, when publicly owned and operated buses ceased to serve the city. These buses were old, and public budgets didn't allow for their operation any more. Private operators filled the gap and started to serve routes—using converted, second-hand delivery trucks at first, then using minibuses later. Over time, a public transport system emerged with a network of about 70 bus lines, reflecting an actual demand by public transport users.

The bus route network and schedule had been changed, effective January 1, 2012. As a result, citizens had to wait in the cold of winter for their rescheduled and rerouted buses. Where transfers had become necessary, users had to pay for a second ticket. As a first reaction, users of the public transport system complained by phoning up and writing the municipal transport office; they even blocked streets.

Of course, the changes were intended to be acclaimed by the users of the public transport system. The idea of transport planners involved was to improve the transport system of Lviv. They planned on doing this by reducing a number of bus lines; adding some larger buses to the fleet that largely consisted (and still consists) of minibuses; and eventually working toward a star-shaped network, with transfer stations dotted along the inner-ring road (Berger 2011, p. 78). Ideally, the new schedules should have changed—literally overnight—the activities of its users, but it turned out differently.

The broader context of this third case study reveals that users' activities are guided by, inter alia, the cultural system and, in particular, a specific local culture of using various means of public transport. Those local habits of riding buses and tramways were not considered (appropriately), due to a technocratic planning of the public transport system. As mentioned above, the technical infrastructure—in this case bus lines—is a technical artifact, i.e., it is not itself a complex system. It only becomes part of a complex system through an environment that interacts with these technical artifacts. For the public transport infrastructure, this environment is mainly made of the users of the infrastructure. The activities of those users led to the first emergence, and continued autopoiesis, of the public transport system—in a nested-system relation of outward influence.

If the technical infrastructure is changed without appropriate consideration of enclosed—i.e., users—and enclosing—e.g., cultural—systems, a disruption of the established, nested-system relations may result. Such a disruption occurred between the current modes of infrastructure use and the changed infrastructure. Users simply did not follow the new, guiding rules laid out by the transport planners. Instead, they chose to protest, achieving the reintroduction of some bus lines.

Structure of the Case Study

As in the presentation of the two previous case studies, this section first describes the particular enclosed and enclosing systems (Sects. 6.3.3.1 and 6.3.3.2). Then it continues with an analysis of outward and inward influence between these systems (Sect. 6.3.3.3). As an intermediate result, based on the first analysis, it becomes clear

that additional inward influence—devised without knowing the emergent, nested-system relations—does not turn out as planned (Sect. 6.3.3.4).

By means of this third case study, I will finally exemplify how changes may be achieved effectively: with appropriate consideration of the enclosed and enclosing systems. It follows my suggestion that, instead of introducing substantial changes in the route network and the rolling stock, interventions aligned to the existent, emergent, nested systems could have been more efficient—at least for the beginning of the public transport reform (Sect. 6.3.3.5). Such aligned interventions would be informed by a third way of influencing complex systems: working *within* the existing rules of the existing nested systems (cf. Sect. 4.3).

6.3.3.1 The Faster, Enclosed System

Similar to the dwellers/dwellings system discussed in Sect. 6.3.1, the enclosed system discussed below can be discerned by the activities of users, in relation to the technical infrastructure—in this case means of public transport. It can also be discerned by the system's relative speed of change, as compared to other systems in Lviv—in particular the slower-changing, superordinate cultural, economic, political, and technical systems.

Activities Within

Activities between the public transport infrastructure and its users and operators delimits the transport system from other systems. Citizens of Lviv choose to ride the bus or the tramway, choose to pay the fare or not, choose the bus over the tramway or vice-versa, talk positively or negatively about these means of transport, and keep the bus doors open for those who are running to catch the bus. Drivers choose alternative routes around an accident site; mechanics do, or do not, manage to repair a vehicle on time; and private operators do, or do not, declare all the fares they charged to the public authorities. Such activity is carried out many times, each and every day, and it makes the transport system a relatively fast enclosed one.
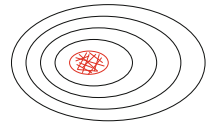
Speed of Change

Individual users of the transport system may change their use pattern or their individual perception of, and activities with, the technical means of public transport at any time. And so they do, sometimes depending on other circumstances, e.g., the relocation of their office. And they make new perceptions, brought home after visiting other cities.
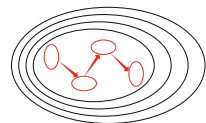
Within the public transport system, the speed of change is relatively high, as compared to the systems enclosing it. Said systems are, e.g., the cultural system—which provides the general guidelines for, inter alia, the use of means of public transport—and the political system—which aims at planning and implementing change from time to time, by means of inward influence.

6.3.3.2　The Slower, Enclosing Systems

From the activities of individuals—operators of the minibuses and users of this means of transport—new guiding rules emerged in the cultural, economic, political, and technical enclosing systems. In turn, the individual users of Lviv's public transport system are guided by rules of the four superordinate systems.

I suggest that understanding the emerged qualities that guide activities in the public transport system will facilitate a discussion about potentially efficient interventions in the system. Subsequently, I will discuss those qualities of the enclosing CEPT systems that guide activities in Lviv's public transport system.

The Cultural Enclosing System
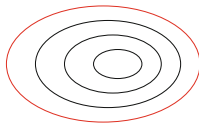
Over the two decades of minibuses being in service, a specific post-communist culture of public transport use has emerged. Since this emergence, the use of Lviv's specific network of largely non-transfer connections—served by minibuses—has become part of the local culture. There is now an expectation of point-to-point service, as offered by the many minibus routes for a single-ride fare.

Since many of the minibus routes are connecting residential areas with office or industrial areas, travel times are believed to be shorter on small buses than on large buses, and transfer stops are believed to be fewer. And since minibuses run according to demand, there is no habit of consulting a bus schedule. (The obvious downsides of this are less frequent, irregular departures during off-time hours, and remote bus stops remain unserved at some times of the day.)

In another, contrasting perception guided by the post-communist cultural system, the minibuses are dismissed, and the larger buses are appreciated. This contrasting second perception is guided by a counter-image to the perceived post-communist reality, in which the introduction of marshroutky minibuses was born out of necessity: The privately operated minibus lines could have begun because the end of communism left the public sector without a means to continue serving a planned network with large buses.

In this alternative perception, there is an appreciation of larger buses for space and comfort. This perception is nourished by a projected image of a western, efficient, and well-working public transport system. According to the same perception, the minibuses don't offer much comfort. They are overcrowded during peak times, and many passengers have to stand up during the bumpy rides.

The Economic Enclosing System
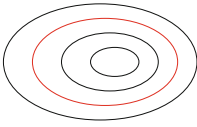
Economic rules guiding the public transport system are emergent from citizens' activities within the transport infrastructure, and are guided by the culture of using it. First, use of the public transport infrastructure has opened up business opportunities, some of which were tapped and have subsequently become qualities of the economic system. Second, users' and operators' activities guided by rules set by the political system led to the emergence of further specific qualities in the economic system.

One of the characteristics of the economic enclosing system is that it reflects the actual demand of transport services by its users. Demand is high, with Lviv's citizens making about twice as many rides per year as the average EU citizen.[73] (Much commuting takes place between the areas of the communist, residential highrises and the city's center, where economic and cultural activities are located. An estimated 2/3 of users who are of employable age demand connections between their home and their workplace.) This economic quality, related to Lviv's public transport system, used to be sustained by the operation of the above-mentioned, approximately 70 bus lines that had been in service before the reform became effective on January 1, 2012.

Further guiding rules of the economic enclosing system have emerged from transport users' and transport operators' activities, under the rules of the political system. The withdrawal of the public sector from the operation of bus lines—this activity having had economic reasons itself—opened up economic propensities for private operators in the 1990s.[74] Furthermore, an (intended) lack of a method for counting the actual number of passengers enables these operators to exempt a share of their turnover from taxation, and to be profitable despite low ticket fares. (This latter rule, once it had emerged during activities guided by the political system, makes it particularly difficult to influence the economic system of public transport from the political system—without risking a breakdown of the former.)

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[73]Various estimates of the number of public transport rides—divided by about 1 million citizens living in Lviv and in close vicinity to the city—range from 163 to 303 trips per person per year (Berger 2011, pp. 16 and 22 f.). In the EU, the average number of trips amounts to 132 per person per year, but this figure is already inflated (as compared to the Western European average) by the inclusion of CEE countries, where the average number of trips is often more than 150 per person per year (UITP 2014, p. 2).

[74]This example shows that, wherever the political system sets rules, these rules influence the economic activities of individuals. The economic activities of individuals may then lead to the emergence of new rules in the enclosing economic system. However, since the economic system encloses the political system, the rules of the enclosing economic system may restrict the activities of the political system, i.e., the possibilities of political influence.

The Political Enclosing System
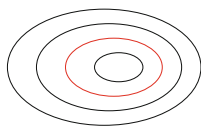
Lviv's municipality seeks to regain influence over the public transport system by devising policies and by investing into the infrastructure. Today's activities of the municipality attempt to overcome the status quo that emerged after the end of communism. The municipality uses national and international funding to alter and improve the public transport infrastructure. It is thereby guided by local cultural and economic enclosing systems, as well as an image about "normal," i.e., Western, means of public transport.

The public sector created a status quo when it withdrew from the operations of bus lines after the end of communism. The old buses were taken out of service, and only tramway and trolley-bus lines were operating any longer. The conditions that were set by the municipality left a gap in the transport system that was filled by private enterprises who, nevertheless, depend on the goodwill of the public sector, i.e., a particular quality of Lviv's political system, in order to be able to operate profitably (see above).

Government and international funds accessible to the municipality guide the selection of projects to improve the transport infrastructure. On one hand, the EBRD has been supporting a recent study about Lviv's public transport (the study leading to the reform discussed below, see Berger 2011, p. 5). The EBRD also provides loans for the modernization of the tram and trolleybus infrastructure, for the extension of a tramline, and for improvements of roads and of the district heating network (Usov 2009, EBRD 2012, and Reconstruction and Development 2014). Road infrastructure is also being improved through national funds and, thus, guided by rules that may be alien to Lviv's local transport culture. On the other hand, sources for creating or improving means of transport that may better serve (to influence) the local transport culture, e.g., bicycle lanes, sidewalks, and/or a suburban rail network, still remain to be found.

Furthermore, Lviv's policymakers—guided by the image of a "normal," Western transport system—invited advisers from the outside, i.e., from a foreign cultural, economic, political, and technical context, to help draw up a public transport reform. Perceiving an actual public transport system that was "not normal," the reform that became effective in January 2012 aimed at replacing minibuses with normal-sized buses and reducing the number of bus lines and private operators. Also, public hearings, that seem to be "normal" and Western, were organized—with only few citizens attending.

After the reform, analyses of its partial failure were guided by the same foreign images. As a result of these analyses, inappropriate timing, a lack of prior communication, and an incomplete implementation of the changes were identified as the main obstacles to success. In particular, the lack of implementation of an e-ticket system to allow users to not pay twice for transfer connections is seen as obstacle to success.[75]

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[75]These commonly identified failures stem from the same way of thinking that led to this inconvenient situation. When cultural guiding rules are neglected, why should the managerial and

The Technical Enclosing System

Many infrastructural artifacts that could be included in users'
activities are absent. Thus, there are no particular activities
guided by emerged technical quality. However, additional tech-
nical artifacts are sometimes imagined. E.g., some interviewees
of mine talked about the missing bus schedules and route net-
works maps, the missing covered bus stops, the missing real-time information dis-
plays, and the missing bus lanes.[76] Means to take bicycles onboard the vehicles
are missing as well. Last, but not least, transfer tickets—electronic or not—are not
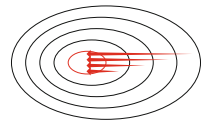available.
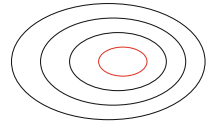
The implementation of such new technical artifacts could be guided by rules from
the political, economic, and/or cultural systems. For example, some compare their
own local experiences with using western cities' public transport systems. From such
a perspective, Lviv's minibuses are 'not normal'; the number of operators should be
reduced, and the entire—both municipally and privately owned—fleet should be
tracked using Global Positioning System units. This could lead to new technical
quality emerging.

Further guided by images of a "normal" public transport system, new technical
qualities are imagined and—to a certain extent—even lived. Also, the daily, negative
experience of crowded minibuses, of shaky rides with little comfort in slowly moving
or ruthlessly driven old vehicles on congested and potholed roads, and even of holes
in the floors of old minibuses can become a driver of change.

6.3.3.3 Outward and Inward Influence in the Nested System

Both outward and inward influence led to a stable whole—the transport system in
Lviv. This stable whole is maintained, in particular, by an emerged culture of using
public transport and of citizens' expectations and activities reflecting this culture. In
an autopoietic way, citizens' recreate the guiding rules with their activities. Initial
outward influence has led to the emergence of Lviv's particular public-transport
quality.[77]

Today, the use and operation of Lviv's means of public transport
supports this specific public transport system through outward
influence. Each and every activity regarding the existing modes
of transport, in particular of the minibus connections, sustains
the existing guiding rules of inward influence.

(Footnote 75 continued)

technocratic approach to public transport reform have been successful, even with improved com-
munication and an e-ticket system?

[76]Route networks are available on some websites; however, these websites, such as Easyway (2015),
mainly rely on users entering and updating information. They are, thus, not reliable sources of
information. E.g., when I arrived at Lviv, the bus line connecting the airport with the city center did
not follow the route displayed online.

[77]The emerged transport system is only one possible system that could have emerged from these or
other activities of users—under these or other guiding rules of enclosing systems (cf. Sect. 8.1.3).
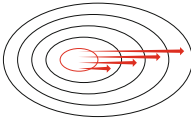
Guided by rules of the cultural, economic, political, and technical systems, as presented above, activities of public transport users support the continued existence of the emerged, stable whole. The discussion above revealed the strong inward influence by the cultural system on the activities of public transport users in Lviv. Taking direct connections, riding minibuses, and using demand-driven service frequencies have become normal for Lvivians.[78] They expect that the network will work in this particular way, and their activities are guided by these expectations.

Since the system's guiding rules are closely followed by citizens in their use and operation of public-transport means, the transport system is being autopoietically recreated. It is a stable whole, which is slowly changing because it is dominated by *cultural* guiding rules.

6.3.3.4   Changes Devised by the Political System on the Technical Enclosing System
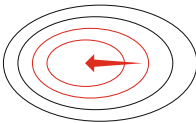
As described in Sect. 6.3.3.2 above, Lviv's municipality seeks to regain influence over the public transport system. A reform became effective January 1, 2012. With this reform, the stable, emerged public transport system was altered.

Since the public transport reform was guided by cultural rules that were not part of Lviv's local urban system, but imported from western Europe, the results of changes to the transport system were not fully acclaimed by Lviv's citizens. During the process of conception, there were already first signs indicating how foreign cultural rules may actually seem strange to local systems. For example, not many citizens participated in public hearings because the related guiding rules did not fit with the emerged, particular urban system of Lviv.[79] As one of my interviewees analyzed the situation: Citizens "did not want to go there [i.e., to the public hearing]; they simply want a network of buses from their house to the city."

Devised Rules of Inward Influence

Lviv's transport planners assumed that copying elements of other cities' infrastructural schemes would make for a fast and effective public transport system in Lviv as

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[78]Although this might be interpreted as a purely economic matching of supply and demand, I suggest that the activities of users of the public transport infrastructure are also guided by cultural rules and political qualities, and that the outcome is emergent from the situations guided by all of these enclosing systems (cf. also the quote preceding Chap. 3).

[79]Public hearings have been organized for the revision of public transport schemes, as well as for the planned introduction of electronic tickets. The latter are seen as key to the hub-based system, assuring that users may transfer without paying for another ride. One interviewee, who had engaged in a citizen initiative, told me that those who attended the public hearing understood neither the goal nor the advantages of electronic tickets.

well.[80] Part of the guiding images may have come along with funding by the EBRD, which paid a western consultancy, Louis Berger, to support municipal employees in revising the transport scheme.

Two rules of the public-transport reform impacted users most: First, the number of bus lines was brought down from almost 80 to fewer than 50.[81] Second, the number of bus lines going through the city center has been reduced to 4 from around 30.[82] However, after protests that were expressed via mail and phone calls reaching city hall, as well as street-blocking, about one out of five of the canceled routes was reintroduced.

Effectivity of Devised Rules

My observations suggest that politically devised changes in Lviv's public transport infrastructure have not passed the selection of the enclosing, emerged cultural and economic systems' rules. Protests show how devising change in a nested system, without considering nested-system relations, could lead to the rejection of changes

Photo 6.22   Even after reducing the number of minibuses (*left*, on Ivana Gonty St.) passing through the center, the streets in Old Town remain congested (*right*, Soborna Sq.)

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[80]This description is not to imply that being open to inspiration, influences, and specific experiences from elsewhere is wrong. Rather, the point is that, in a nested system with previously emerged rules, the deliberate introduction of new rules has to consider how activities in the enclosed system would need to change—in order to support the new rules in the enclosing system, as well as keep in mind whether or not such change appears to be feasible (see also Sect. 7.4.3). Without this kind of regard, new rules might provoke activities of rejection—guided by rules of existing, emerged, enclosing qualities.

[81]16 routes—among them all 4 routes passing through the center—are now being served by the publicly owned transport company that also operates Lviv's 9 tramlines and 11 trolley-bus lines. The other 36 routes are operated by private operators.

[82]The many minibuses passing through the center were identified as one cause of the notoriously congested streets around the historic center. As a solution, the goal is to eventually establish a hub-based network. A part of this solution is that large vehicles should pick up their passengers at transfer stations, dotted along the ring road. These transfer stations are to be served by other buses, including minibuses, transporting passengers to and from the residential high-rise neighborhoods and the suburbs. Reducing the number of vehicles passing through the center (left Photo 6.22) also aims at decreasing inner-city congestion, as well as redundancies with tramlines and trolley lines. However, even after the public-transport reform, streets remain congested (right Photo 6.22).

or even to conflict. In fact, sociological research commissioned by the municipal administration—based on focus-group interviews and questionnaires—underlined the discontent of public-transport users right after the changes. (However, after about one year, which was around the time of my field studies, the same type of research revealed that the level of (dis)satisfaction had returned to the level that existed prior to the changes.)

My own research, however, shows that one year after the changes had been implemented, they were still disputed. Some interviewees challenged the core concept of the reform—i.e., small buses serving the densely populated, high-rise areas, and larger buses going into the compact center—on the basis that the large vehicles are too big for the inner city, but they are fine for the high-rise areas. Also, a student and user of the public transport system reported his perception that whomever he talked to about the changes, i.e., his friends and their friends, didn't like the results and would prefer to have them taken back. Other interviewees linked the engagement of advisers "from outside the country" with their perception that "the new routes are not working."

The activities of Lviv's transport planners and policymakers are ineffective because of differences between the guiding rules from which citizens and transport planners respectively orient their activities. While transport planners seem to be guided by their image of Western systems of public transport, transport planning, and political decision-making, Lviv's citizens are largely guided by the local post-communist cultural qualities described in Sect. 6.2.1. E.g., they are guided by the expectation that they can hop on a minibus and reach (close to) the destination without transferring. (This culture of using Lviv's means of public transport is, as pointed out above, a long-standing habit, which emerged more than two decades ago.)

Further implications of the public-transport reform relate to citizens' mistrust towards public authorities. The statement of one of my interviewees, who reported knowing that the operators of minibus fleets who paid the highest bribes got assigned the most lucrative routes, is revealing—whether it is true and/or representative, or not. It may be perceived as political arbitrariness that the majority of private operators has been forced out of the market by the requirement to add a share of large buses to their fleets.[83] Other interviewees of mine, young university teachers, could not believe public hearings had actually been held, perhaps because consultations do not fit into a post-communist perception of governmental bodies.

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[83] According to the hired advisory, one goal is to protect the investments (to be) carried out by the municipality, in order to "ensure that... competition remains fair" (Berger 2011, pp. 22, 35, and 65). For example, by cutting down direct minibus connections into the center and by prohibiting minibuses from stopping in between assigned bus stops, private operation will be made more uneconomic. This is an absurd logic that must feel like a slap in the face to all those citizens who have successfully fought off the planned, economic structures of communism. The same document suggests continued subsidies for public transport, i.e., a planned dependency of the municipality on external donors (both national and international) (Ibid., p. 21).

Thus, the municipality's activities might even increase some citizens' mistrust toward activities carried out by the political system. Government intervention in the individual freedom regained after the end of communism is a sensitive topic in CEE. Authorities are mistrusted, in particular when they aim to control: It is said that some bus drivers even went to doctors claiming health issues, which had been 'caused' by position-locating electronics that had been installed on their buses in order to track them.

The theory of ENS also justifies criticism of the conceptual separation of technical artifacts—from the complex system they become part of when being used. The approach, followed by the political system, relies on the misconception of independence of technical artifacts (i.e., the route and the vehicles) from its users and, thus, from the complex system the infrastructure becomes part of when being used—and from guiding superordinate systems. By planning the public-transport network, new rules were devised as if there were no emergent whole, which is self-sustained by the activities of individuals who are guided by the rules of a number of enclosing systems.

6.3.3.5   Working Within the System

Where a complex system is stabilized by enclosed activities, changes may most effectively be introduced by working within the given guiding rules of the emerged whole. In the case of Lviv's public-transport system, with guiding rules being part of the slowly-changing cultural system, activities of the political system or of citizen initiatives—the latter are also possible—that are in accordance with the actual public-transport system's guiding rules could create new situations—that could lead to emergent changes in the enclosing systems. Thus, I suggest a more subtle, alternative approach to achieving the desired change.

This suggestion reflects the third approach of influencing nested systems, as suggested in Sect. 4.2. This third approach would indirectly aim at achieving change by exploring as-yet-unrealized activities within the given guiding rules.[84] One observable, given rule is, e.g., that today's users of the public-transport infrastructure use functioning, point-to-point services. Another is that they do not want to be bothered (yet) with public hearings.

It could be an additionally useful fact that some person(s) put(s) the local bus lines on online maps. Also, since minibuses have become part of the local culture, there may be opportunities to build more modern, comfortable versions by local companies, and even sell them to the many other cities in which minibuses are part of the public-transport system.[85]

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[84] Alternatively, a more radical approach to triggering change in a nested system could be guided by yet another question: What would it take to break up the existing guiding rules and trigger change (without knowing what actual change will occur, of course)? Radical and resource-intensive as it may be, this, too, is a very different approach from looking at best practices from Western Europe.

[85] Minibuses are operated in many cities in CEE, as well as in the developing world. E.g., in the Slovak city Košice, two minibuses were recently put into service in 2010 and 2011 (Zoznam 2015).

Some offerings, such as the introduction of means to take bicycles on buses, could be made. Guided by the rules of enclosing systems, such activities would hardly lead to (hefty) rejections, but they could lead to new situations. Alternative routes could be offered, in addition to existing ones, and transfer stops could also be offered—one by one—where transfers and wait times are more attractive. If the young public-transport user, who told me he would pay 50 % more for better comfort and larger buses, is not alone, why not offer such connections—in parallel to the (privately operated) minibuses?[86]

Other propensities of the current situation could be identified by further research, i.e., interviews with more citizens. Eventually, the intention is to *look for propensities within the actual local circumstances* that can be used for triggering change—instead of, e.g., being guided by an artificial and alien benchmark of a 'normal,' Western system.

It could even be possible that, eventually, a hub-based scheme will be part of a new, emergent public transport system in Lviv. In a complex, Emergent Nested System, such a hub-based scheme would need to be supported by the activities of users of the transport infrastructure and implemented with respect to actual guiding rules of actual qualities. For example, in the current implementation, transferring and purchasing a new ticket after each transfer is at odds with the emerged culture of using minibuses point-to-point. As one interviewee put it, citizens "like their taxi-buses" for providing fast mobility services.

Some interviewees even agreed with a hub-based system in principle, provided that transfer stations will be equipped with information systems. Introducing real-time network information would not be against any of the above-mentioned enclosing qualities; it may even be supportive of a feeling of trust in the municipality—as part of an emerging, liberal cultural system. Also, allowing small businesses, such as shops, small cafés, and newspaper stands, to operate at those transfer stops may lead to supporting, i.e., autopoietic, activity.[87] Eventually, point-to-point and transfer schemes might coexist, at least for awhile.[88]

However, it has to be noted that, as for any change in any emergent system, the exact results of change cannot be predicted. If, as is the case in Lviv, the political system identifies room for improvement in the transport system, then purposive, fast activities could lead to desired change.

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[86]In the Romanian city of Iaşi, some lines are served by both larger buses and minibuses. Some people wait for the next larger, more comfortable bus; others choose the—sometimes faster—minibuses; many don't care which one they take.

[87]One interviewee, who is connected with the municipality, told me of the achievement of nicer bus stops with fewer kiosks. However, my perception is that these micro-shops have become part of the local culture over the past decades, and, along with more attractive transfer stops, more—not fewer—kiosks might be supportive. A professor from the technical university favors the hub-based system and suggests making the hubs points of interest for, e.g., shopping.

[88]Whether hub-based or point-to-point connections are to be preferred is undecided. This is true even on the international scale in the aviation industry. Some aircraft manufacturers and carriers believe in hub-based connections (i.e., building or operating large aircrafts); others believe in the point-to-point connections (i.e., building or operating regional-sized aircrafts). However, both coexist.

Part III
Reflections and Outlook

Chapter 7
Purposive Decision-Making and Foresighted Activities

> *In practice, being sensitive to novelty could mean actively monitoring planning applications, or informal proscribed behavior—such as skateboarders or rollerbladers appropriating spaces they are not supposed to—to see if there is a pattern of use by individuals doing what they want to do…*
>
> Marshall 2009, p. 272

In Sect. 1.3, I argued that a goal of human activity is often to influence the course of events with purpose and foresight. The previous chapters should have shown that it is possible to create and invent new forms of activities, businesses, and infrastructures. This is possible precisely because there is novelty that emerges, and that can fit in and propel a specific situation—e.g., a given place at a given time—into its particular future.

In other words, the complexity of our world and the emergence of novelty are the very reasons why purposive and creative changes are possible. Man can influence propensities, as well as the selecting rules that provide options when choosing emergent qualities. While plans may not work out as intended, there are—among the propensities of a current situation—those plans that can lead to the emergence of a desired type of quality. With the theory presented in Part I, it is not only possible to account for surprising novelty to emerge, but this theory also enables the influencing of ENS.

There are, thus, implications about how to form practices, such as urban planning, while developing complex systems; these can be learned from my work. A shift is required in practice from a planning-based approach—and from external 'best practices' and external financial resources—to the *effectuation* of a less rigidly defined vision, using mainly internal (and often contingent) resources. Such internal resources encompass local means, such as particular skills and (human) resources; local trends; and developmental tendencies, which are guided by local rules of, e.g., cultural, economic, political, and technical systems.

The suggested theory is predictive—not in the sense that it allows exact forecasting, but in that, e.g., it can be predicted that frequent activities of individuals will generate an enclosing, emergent quality, and that the latter will act back on

individuals' activities. Considering the predictions of ENS, potentially effective ways to influence—whether generative or rule-setting—can be chosen.

For example, a process of purposive change in a complex urban system could involve the following five steps:

1. Understanding the relative frequencies of change in systems and, thus, their relative positions in the nested system. This is enabled by, e.g., single-case methods, or, where possible, methods and instruments to physically measure the speed of change.
2. Discovering ongoing activities, latent emergent qualities, and potentially game-changing triggers. This requires individuals who are constantly in touch with the complex systems and/or the engagement of individuals from within the enclosed systems.
3. Conceiving a vision for development of the ENS, in order to purposively influence it. A vision may be conceived by abduction; however, the vision and, in particular, the resulting ways to influence must be closely aligned with the present situation in the complex systems.
4. Choosing among ways to influence the ENS, in order to drive it toward the conceived vision. Here, all three generic ways of influence (inwards, outwards, and within), as well as combinations, are possible. It should be considered that emergent qualities provide for more stable systems than the devised rules allow. It should also be considered that each and every system has its own optimal time for being influenced, i.e., a time when change is latent anyway, and the stabilizing autopoiesis is weak. The principles of effectuation—working with given means and adapting the vision to change emergent qualities—may well serve to guide the selection of properly influencing activities and rules.
5. Prior to carrying out interventions, these may be tested by a variety of methods. While (computer) simulations fall short in modeling emergence, testing hypothetical activities and rules on individuals from the complex system may yield new ideas. Overall, the suggested process of conceiving, testing, and then aligning potential interventions follows the classical scientific method.

7.1 Understanding the Nested System by Objective Frequencies of Change

The abruptness of change in cities depends on spatial and temporal perspectives. As illustrated by Batty et al. (2004), urban traffic jams occur over minutes, stock market crashes over days and weeks, market cycles in housing prices over months and sometimes years, while the process of urban gentrification can take decades

Resilience Alliance 2007, p. 8

One key to understanding and influencing ENS is an objectively measurable quantity: the frequency of change that identifies systems and their mutual—i.e., generative and guiding—relations. Everything else follows once the relative frequencies of change have been identified. Subsequently, relations between systems are known as generative or guiding; also, potential windows of opportunity for effecting change during times of bifurcation can be identified (see below, Sect. 7.4.5).

In practice, different methods must be used to measure frequencies of change. Man's senses may be fooled or biased, so they are inadequate as the sole way of enabling the recognition of (relative) frequencies of change. However, there are various, other tools that can be used. Such tools are readily available in the physical and material domains, and the frequency of use of, e.g., means of public transportation may be measured by counting the use of personalized tickets.

Thus, an adequate toolbox may need to be set up, in order to study the social and psychological realms. Errors in identifying relative frequencies of change will have a significant impact on the effectivity of any intervention—e.g., activities planned to trigger change, where rules are required to govern activities. (The case studies in Chap. 6 are based on my personal perception of relative frequencies of change; therefore, they may be flawed.)

Objective knowledge about systems matters, in order for influence to be effective. Where subjective perceptions and constructed worldviews replace objective knowledge, decision-makers can divert further and further from reality. (I do not only mean a material reality of, e.g., built-up structure, but also immaterial reality of, e.g., cultural systems or individuals' perceptions.) When further and further detached from reality, interventions will be less and less effective. Thus, advancing and applying measurement methods for detecting frequencies of change will allow for coming closer to the objective reality of complex systems.

7.2   Being an Engaged Observer and Engaging Reporters of Change

> [One] approach would also be proactive in looking out for such novel, curious, idiosyncratic things which have somehow come into being, and not been snuffed out, and by their very survival must be functional or viable in some way that might yet be exploited…They may be marginal to today's norm, but indispensable to tomorrow's
>
> Marshall 2009, p. 272

Next to the knowledge of relative frequencies of changes comes the timely identification of even subtle changes in enclosed activities, as well as of enclosing qualities and guiding rules. In Lviv, single activities, such as the opening of a co-working

space or the publication of public-transport schedules on the internet, may be early indicators—for change, for latent new qualities that are about to emerge, for a small revolution to come, and/or for a point in time where purposive influence may effectively drive change in a desired direction.

Productive use may be made of even subtle, small changes—or be the very reason—for pursuing a larger vision of change. Obviously, an early detection of newly emergent qualities is of paramount importance, in order "to deal with them—in whatever way—before they become dominant" (Walloth 2014, p. 130).

In practice, a very sensitive observation of the local, particular activities and (unwritten) rules is required. A first case study may already identify ongoing change. Continued observation will show where activities and rules slowly diverge from the status captured in the case study. Over time, a feeling for change in the particular complex system, such as a city, has to develop. From the part of the observer, this requires increased awareness about, and sensitivity toward, new activities and the formation of new patterns, i.e., the resultants of emerged quality. Where measurement methods are available, continued observation of frequencies could indicate subtle changes as well.

Besides, those whose activities are guided by enclosing rules may detect change very early. For example, where a large number of enclosed and enclosing systems must be observed for effective decision-making, 'trend scouts' may be engaged to "provide a feeling for what has most recently emerged and might subsequently grow to importance" (Walloth 2014, p. 130). In urban systems, citizens may be engaged as 'seismometers'—to detect change before it ripples through the complex system. This way, it would be possible to stay in touch with, e.g., the developments of the emerging culture of entrepreneurship in Lviv. Furthermore, citizens engaged as trend scouts may, "[t]o a certain extent,…even anticipate what may come, i.e., they generate emergent thoughts, which would be, in a sense, a simulation of emergence in an interactive setting" (Ibid., p. 140).

Engaging such 'reporters of change' would, of course, yield subjective perceptions. Also, such reported observations would need to be verified. However, for the decision-maker, the knowledge of subjective perceptions, i.e., knowledge of what citizens think, is objective knowledge. While citizens' perceptions and thinking are subjective, such perceptions and thinking are real and, thus, part of the complex system.

Thus, important complementary and objective knowledge about individuals' subjective perception is gained through these reported observations. It may help in understanding why some activities are being carried out; what hidden, guiding rules are at work; when and why individuals break laws; and which latent qualities are about to emerge (even if not correctly perceived by the individual yet).

7.3 Conceiving a Vision of Change

> It matters very little whether a particular vision is realized; what matters much more are the possibilities that it opens up, the influence it exerts on our thinking, and its ability to encapsulate social aspirations
>
> Williams and Sharro 2011, p. 163

Foresight would be of no great value if activity were not targeted toward achieving a vision. As argued in Sect. 1.3, understanding ENS in evolutionary terms—with mutation and natural selection—would mean reducing man's ability of foresighted activity to either a kind of noise leading to mutations, and/or to consider it as an activity of selecting among developments that have appeared without purpose.

Neither option does justice to man's ability to be creative and to conceive and pursue visions of the future; this includes reflections on "possible outcomes of acting," i.e., of man's ability "to generate virtual worlds and virtual futures [i]n order to be able to favorably change the contexts" (Deacon 2011, p. 458). Thinking in terms of ENS enables researchers to pursue a target through purposive influence—both inward and outward.

A vision, possibly conceived through abduction, is required to guide foresighted activities toward desired change in a complex system. Aligned to the local situations, a vision may lead to the anticipation of possible future situations and types of emergent qualities. In Lviv, for example, those who started the co-working space may have anticipated that a new type of quality would emerge from citizens using such a space.

A vision—or target state, or anticipated type of emergent quality—is itself a guiding rule for the triggering activities that are carried out during an intervention. In other words, the vision and the activities ideally form an autopoietic nested system. In this system, the vision, if not put together from bits and pieces of other places' visions, is emergent from the local situation itself (conceived by one or more human minds).

Existing and new local activities support the continued existence—and eventually, the realization—of the vision. What is important is that at any point in time, the vision of an imagined target state is required to guide purposive decision-making and foresighted activities.

Implementing a vision will lead to new situations which, in turn, may lead to propensities, out of which new quality can emerge. This adds to the means available to purposively influence the course of events.

Implementing a vision leads to new situations, which may even lead to more or less radical changes of the initial vision. And thus, with new qualities emerging over the course of time, it may become necessary to change the vision.

A vision for the development of a complex system is something 'bigger' than, e.g., approaches that try to copy natural systems. Conceiving a vision is something nature cannot do. It is an act of creating something "artificial" (cf. Simon 1996 and Sect. 5.4),

involving creative (generative) and rational (selective) thinking.[1] In practice, the rational-thinking part would need to select a vision that may be realizable, given the current situation and the types of potentially emergent qualities.

7.4 Choosing Among Means of Influence

> Human life abounds with contingencies that cannot easily be analyzed or predicted but can only be seized and exploited
>
> Sarasvathy 2001, p. 250

As argued in Chap. 4, it is possible to prepare the ground for the emergence of a type of desired novelty. In other words, it is possible to influence emergence. In the same chapter, I identified three generic ways to influence emergence: working on guiding rules, triggering activities, and working within given rules. The discussions of the case studies in Chap. 6 have shown how these three approaches can be applied.

In this section, I will draw on learnings from the case studies and review the three generic ways to influence ENS (Sects. 7.4.1–7.4.3). Furthermore, I will conjecture more specific ways to influence ENS (Sects. 7.4.4–7.4.6).

7.4.1 Working on Guiding Rules
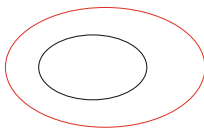
Inward influence may mean granting freedom, so that activities can prosper in enclosed systems. In other words, policymakers, (urban) planners, and others who have the means to change rules in one or more enclosing systems may prepare the ground by breaking rules up, i.e., by *reducing* guiding rules. This will allow for a variety of activities to prosper in enclosed systems.

Preparing the ground by granting freedom is very different than the common activity of drying out the ground, i.e., of suffocating activities, by designing restrictive rules—all with the possible danger of provoking a revolution. When undesired qualities—even such qualities as crime and unemployment—should not be reproduced, suppression by guiding rules may not be successful: What if, as in the case of Lviv's public transport system, there are emerged cultural qualities, which change even more slowly than the political ones (i.e., the former overrule the latter)? And what if, as in the case of Lviv's aim to gain control over the remodeling and renovating of the built heritage, there are not enough resources available to support the

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[1]Interestingly, and in line with my theory of ENS, the process of thinking is currently conceptualized as being composed of a fast and a slow system: The fast system generates thoughts, associates, and requires quick—and indeed subconscious—decisions. The slow system guides the faster one, whenever we are in a state of conscious thought. In other words, the slower-working (emergent) consciousness is able to inwardly influence the activities of the faster, enclosed "associative machine" (cf. Kahneman 2011).

guiding rules by fast activities, such as frequent controls and strict enforcement by, e.g., a municipal police force?

Where slower, enclosing systems are too restrictive, they can cut off the very source of their existence, i.e., the activities of the relatively faster systems, out of which the former continuously reemerge. (Relatively fast activities of autopoietic regeneration are a precondition to the existence of the whole.) Where fast activities are suffocated by slow ones, the slower systems may stop existing as well—since the faster system cannot maintain autopoietic support any more, and/or the faster system may start a revolution, breaking up the slower one. Thus, I agree with Marshall (2009), an evolutionary urbanist, who advises to "avoid suppressing unsolicited functional novelty, or new ways of doing things that 'spontaneously' emerge—or would emerge if they had the chance" (Ibid., p. 271).

Loosening restrictions should be considered in a variety of situations. I suggest that loosening restrictions should be considered, even in such situations when tightening them would be the first reaction that would occur to the policymaker or planner, e.g., when trying to fight criminal activities. The emerged, enclosing rules that stabilize the undesired situations may be broken up by alternative activities—once such alternatives are allowed.

Therefore, (desired) activities and alternative situations must be enabled, and individuals have to be free to try out different activities. The activities of individuals— some of these activities are creative, but more often, they are purposive—will lead to a variety of new propensities. Thus, enabling activities by planners and decision-makers can support the purposive activities of individuals in shaping the environment, e.g., in starting a citizen initiative or in opening a business. E.g., the activities that led to the current relevance of IT and BPO businesses in Lviv started in rather turbulent times, when all kinds of guiding qualities and rules—including cultural, economic, and political—were breaking up and changing.[2]

Enabling activities and situations does not mean making them, creating them, or designing them, but rather getting out of the way of individuals who can then be creative. Only variety that developed in an enclosed system is able to trigger change in enclosing systems—other than planned, designed variety, which turns the process inside-out and tries to implement change that is potentially alien to the whole. Whenever a relatively slower, enclosing system, such as the political system, tries to create variety in an enclosed system, the result is not variety, but additional restrictions. Artifacts that are meant to increase variety in the enclosed system restrict activities in the enclosed system. Thus, creating variety in an enclosed system is not a viable alternative to its development.

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[2]Notably, no politically planned, rule-setting interventions, such as infrastructure investments targeted at IT and BPO businesses, had been carried out, *prior to* the first activities of entrepreneurship in Lviv. Thus, a new system emerged within unbiased, local rules of existing superordinate systems. This new system could thus become a particularly strong, stable, and inherently autopoietic system. In other words, the system of IT and BPO businesses emerged without 'purposive design' by (local) politicians; it is maintained by the activities of Lviv's citizens, instead of by continued subsidies (cf. Sect. 4.1).

Consequently, instead of following attempts for creating variety, a (political) environment in which variety is able to prosper—and which leaves freedom for developments—is sufficient. In Lviv, several such environments have been tried out over recent years: most recently, the Innovation Center for activities of entrepreneurs; The Tourism Alliance; and a platform for language schools—to mention just a few. Within such environments, variety may or may not develop: While within the environment of the Tourism Alliance, new activities were carried out, language schools did not join a common advertising campaign.[3]

Designed rules, in contrast, may never be able to evoke supporting activities in enclosed systems. When decision-makers set legal constraints or offer incentives (both are types of rules with the aim of guiding activities), the rules may not fit into the system at the given time and place. As a consequence, activities of individuals may not follow the rules that are alien to the emerged nested system.

Designing rules without understanding the context, i.e., the whole emerged nested system, is tinkering without much chance of success. The outcome of such tinkering is rules that are alien to the emerged system—rules that will not be incorporated into the functioning of the whole, such as in the case of Lviv's built-heritage protection.

Thus, prior to devising rules and/or allowing for new activities, a thorough understanding must be gained about the complex system to be influenced. In the words of Solá-Morales (1999), who theorized the approach to urban acupuncture that I will briefly review below, such kinds of purposive activity in complex systems require "ample reflection of the whole." E.g., in Lviv, it would have surely been wise to understand the rules—visible in habits and established use patterns—according to which the particular transport system worked prior to implementing change.[4]

7.4.2 Triggering Activities
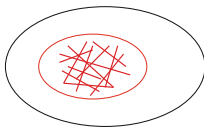
Another way of preparing the ground for new quality to emerge is to carry out fast activities. These can be activities carried out according to visions of the future of, e.g., a city, which a policymaker, a planner, or a citizen initiative conceived. Such fast activities change propensities, out of which

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[3]The ambiguous role of rules as constraints is explained by Deacon (2011, p. 203), using the analogy of a combustion engine (which is a mechanical, not a complex, system): Work is enabled by the (quite material) environment, which is given by the cylinder and piston. Without these constraints, no useful output could be gained from the combustion. Thus, on one hand, constraints are required—but only to the extent that they are enabling, not suffocating.

[4]The basic study carried out by Berger (2011) proceeded without any such field research, claiming that "information was sufficient to allow…to proceed with a general approach to forecasting" (Ibid., pp. 10, 75). Simulation to support the decision-making worked with generic habits of public transportation users and was relying on "[p]ublished data…of…population by city zone, car ownership by area…, gross national product and family size." Thus, nothing reflected the specific rules at work in Lviv.

new qualities can emerge. The activities may comply with the existing rules of enclosing systems or not; they will, in any case, influence the course of events.

If activities are purposively chosen, the complex system can be brought into situations, from which a type of desired quality may emerge. As Ireland and Zaroukas (2014) point out, designers need to engage at the level of its components and interfere with the persistence [i.e., autopoiesis] of the system to enable novelty "and effect new identity(s)" (Ibid., p. 246). In the case of Lviv, for example, such relatively fast, triggering activities may be able to generate a different culture of using means of public transport.

A complex system, such as a city, can only develop under conditions that make it un-steerable and unmanageable, i.e., when it cannot be regulated. Systems that can be regulated are settled and mechanized. They resemble a compound of parts, specialized to perform some functions—functions that have become centralized. And all of these parts are organized to maintain the status quo (von Bertalanffy 1968/2006, pp. 68 ff. and 73). In such mechanized systems, complexity has reduced dramatically, and these systems do not allow for novelty to emerge any more. (Only complex systems can give rise to novelty.)

Paradoxically, a steady flow of resources into an enclosed system may lead to its mechanization. Such is the unfavorable role of the political redistribution of resources, such as subsidies, when they lead a system to arrange itself into a comfortable, steady state. E.g., in Lviv, subsidies of public transport may prevent novelty to emerge. Only when the steady state is disturbed, development—as well as the emergence of new quality—becomes possible again.

Thus, in order for continued and effective development, it is necessary to continuously drive the complex system out of its equilibrium, and out of steady-state situations. A complex system, such as a city, requires continuous disturbance for, e.g., the emergence of new ideas and of cultural, economic, and other novelty.[5] This, of course, is a concept much different from what is being targeted by most current policymaking.

When triggering change, the size of the project matters less than the frequency of activities, i.e., the speed of change. It is important that the activities of interventions are relatively frequent—about as frequent as activities in enclosed systems. It does not matter whether the conceived vision resembles a small plan or a big plan. A piecemeal plan is not the only one that can work; implementing bold visions to pursue larger-scale "social improvement and human progress" (Donald and Williams 2011, p. 5) can also work.[6]

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[5]Although the condition of maintaining a system out of equilibrium is, at first sight, evocative of the theories of dissipative systems (e.g., Nicolis and Prigogine 1977) and of synergetics (e.g., Haken 1977), I do not mean a *steady state* far from equilibrium. Rather, I only mean constant activities, from which new quality can emerge. This means that even situations that are maintained far from equilibrium—such as are visible in Bénard cells, lasers, or an established arrangement of central places—will not develop further unless they are perturbed.

[6]How bad would the traffic situation be in many cities, if subways had not been constructed? How would Paris look without its "iconic buildings and parks…, made visible and linked by wide boulevards," if it had not been altered by "Haussmann's radical solutions…[which] were partly

In fact, success of triggering change is not a matter of the scale of the vision pursued. Even small changes may never be realized if they rely on infrequently devised activities, each hinging on a decision made by the slower, political system. Meanwhile, big changes may be successfully realized by a series of fast activities, which are, ideally, adapted to their enclosing and enclosed systems, or to emerging new quality.

Triggering activities for change is an option open to anybody, i.e., to individuals and citizen initiatives, as much as to planners and policymakers. While, in an urban system, activities of individuals are predestined to lead to change, since individuals can react quickly and carry out a fast succession of activities; institutionalized activities, in contrast, may have the problem of longer decision times, making them not adaptable to faster change. Generally, policymakers and planners, being part of an enclosing, relatively slow, guiding system, don't carry out the fast activities which lead to change.

If policymakers want to change the course of events purposively and more effectively, fast activities are required, e.g., in order to support devised rules. Thus, for policymakers, it is required to bridge the gap between slow and fast activities (cf. Walloth 2012). Activities aligned to policymakers' visions may then be carried out by individuals, who are left with relative freedom in decision-making. For example, the members of Lviv's Innovation Center enjoy relative freedom to develop and implement their concepts, to interact with fast-acting stakeholders, and to follow and contribute to an emergent culture of entrepreneurship, which is largely independent of the rules of the political system. In such a way, variety may be increased, change may be triggered, and a complex system may be developed, even by the slower, guiding political system.

The approach known as urban acupuncture reflects an approach of carrying out small activities, which are quickly implemented, and requires few resources. This approach may thus lead to the emergence of new quality.[7] Long before urban

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(Footnote 6 continued)

a response to the emergence of an urban working class and the threat that is posed to the social order" (Owens 2011, pp. 79, 81)? Even today, a large-scale change of, e.g., a public-transport network can be useful and successful—and can be even more so, if carried out with a better understanding of the existing, enclosing qualities.

With the implementation of bold visions, there is only more at stake—more resources, more potential rejection by existing guiding rules of emerged qualities, more risk of a revolt in the enclosed systems, and higher visibility in case of failure. E.g., one can only imagine how many financial and organizational resources would be required to reach a critical mass of beautifully restored Old Town houses in Lviv—such that a new understanding of the value of built heritage could emerge, and the remaining, individually owned properties would be renovated by private initiatives.

[7]Solá-Morales (1999) describes urban acupuncture as "interventions at crucial points provoking comprehensive reactions that improve the whole organism. The general view consists in understanding the system and the actual effects of each intervention, without having to resort to major surgery or constant treatment." The theoretical vantage point of urban acupuncture differs from my theory, in that urban acupuncture "views cities as living, breathing organisms" (Casagrande 2015). In contrast, I hold that the effectiveness of 'acupuncture' in complex systems, i.e., of punctured (small and fast) activities, can readily be explained by the theory of ENS and does not require resorting to organicism.

acupuncture was theorized, it had been applied in the famous conversion of a main shopping street into a pedestrian zone in the Brazilian city of Curitiba: The conversion was carried out over a weekend and had a major impact on the city's development (Power 2009). However, similar activity in a different place may not be successful—as a deserted, pedestrianized street evidences in Perm, Russia (Walloth 2014, p. 126).

7.4.3   Working Within Given Rules

Activity may be carried out with purposively little influence on enclosing and enclosed systems. There may be circumstances—in which hitherto non-habitual activities can be carried out within the existing guiding rules—that do not aim to change emerged quality. Furthermore, there may also be circumstances in which fast, generative activities are carried out hand-in-hand with the implementation of new rules, in order to increase the chances for new, emergent quality.
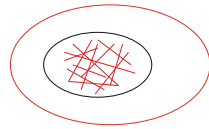
7.4.3.1   Working Within Existing Guiding Rules

In some cases, it may be wise to carry out activities that are not meant to disturb the complex system—with its existing qualities and guiding rules. If activities are aligned to the existing, emerged qualities, then the risk of suppression by guiding rules is low.

This approach may be understood by considering my suggestion for the case of public transport in Lviv. I suggested that alternative means of transport could be offered on major point-to-point routes; this would introduce more comfortable, faster, larger, and cleaner buses, with means of transporting bicycles at a slightly higher price (cf. Sect. 6.3.3.5). This way, the local culture of point-to-point transfers will not be disturbed at first. (In contrast, it could even be supported in a possibly undesired way.)

Activity could be carried out within given rules, in order to pave the way for further activities of change. In this approach, the hope would be that, while not being rejected by existing, enclosing qualities, new activities, and new guiding qualities could emerge—e.g., a new way of using public transport in Lviv.[8]

The so-called generative design method can be understood as an approach to working within existing, guiding rules. The one guiding rule that the generative design method regards as most important is, in the purest sense of an autopoietic system, the rule that secures the continued existence of the whole (cf. Sect. 3.3.4).

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[8]Cf. the suggestion by Vester (1976, p. 25) of a "jiu-jitsu" principle to "utilise already-existent forces and energies and to control and divert these in the desired directions.".

Thus, in advocating a piecemeal approach to support the existing qualities, Alexander et al. (1987) hold that "[e]very increment of the construction in the growing city must be designed to preserve wholeness at all levels" (Ibid., p. 29).[9]

7.4.3.2   Working Within New Guiding Rules

In other cases, activities may be carried out aligned to newly-devised rules. Thus, two or three generic ways of influencing may be combined. Inward and outward influence, i.e., rule-setting and generative activities, can be conceived as mutually supportive—in order to reach a 'critical mass', and then to reach autopoiesis. E.g., political rules, such as laws and incentives, can be complemented by the activities of a number of individuals, who start acting according to the new rules.

By aligning activities to newly introduced rules (and by the potentially subsequent inhibition of undesired, existing activities), a new, self-stabilizing cycle may be brought into a complex system. Such a self-stabilizing cycle comes with considerable potential to change the course of events.

Alexander et al.'s *New Theory of Urban Design* (Ibid.) may also be applied as such a combined approach to new, guiding rules and aligned, triggering activities. This will be the case when the guiding rules of the generative method are no longer part of the existing whole, but part of the intervention. Then the task is less to maintain existing wholeness, and more "to create it" (Ibid., p. 2). The activities of the intervention will be influenced by a single rule of "overriding purpose," which guides the "process…that would create wholeness," i.e., "every decision at every instant" (Ibid., pp. 5, 6, 16, 19). A powerful, 'big plan' of wholeness is created, rather than a piecemeal approach to the development of the existing place.[10]

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[9]In a different—and, in practice, possibly complementary—approach to urban acupuncture, the generative methods do not view cities as living and breathing organisms, but rather as wholes, in the general sense of system theories. Although Alexander et al. (1987) perceive something like biological form in an organically grown city, they are not actually referring to organicist analogies, but rather to "wholeness" that "we experience as organic…simply because they share with organisms this self-determined, inward-governed, growing wholeness" (Ibid., pp. 2, 10, 13).

In further alignment with the theory of ENS (and underlining the general applicability of the generative method), Alexander et al. (Ibid.) refer to the continuous, autopoietic regeneration of the whole [10], as well as to the uniqueness and unpredictability of every emergent whole [10, 14, 23]. Furthermore, their notion that "parts are also whole" is evocative of a concept of nested systems. Mehaffy (2008, p. 57) adds that the nature of the emergent result of generative activity cannot be known in advance, whereas the general aims of participants—i.e., general guiding rules—may be known.

[10]While rule-setting and triggering activities are in line with the theory of ENS, I have doubts about the focus of Alexander et al. (1987) on the creation of (geometric) centers. On one hand, the notion of nested centers—implicit in his question of "what kind of laws at how many different levels, are needed, to create a growing whole" (Ibid., p. 19 and Alexander 2002a, pp. 151ff.)—is evocative of nested systems. On the other hand, the purposive *creation* of centers contrasts with my theory, in that I hold that the *quality* of a center can only *emerge* and its embodiment must be a resultant of the quality's guiding rules; it cannot be made.

Thus, although it could appear that piecemeal interventions are the preferred ways to influence complex systems, the theory of ENS does not suggest that making big plans is wrong; it can even help in conceiving and implementing them successfully by matching triggering activities with existing (or even new) guiding rules.

7.4.4 Considering Stabilities

Where quality emerges, the rules of slower, enclosing systems and the activities of faster systems are mutually supportive and aligned, and there is autopoietic regeneration of a stable whole (cf. Sect. 2.3). Local rules of emerged quality and resulting activities sustain the local quality without any external stimulation or steering. Once a slower-changing quality has emerged, disturbances—i.e., faster activities, which are directed against the emerged quality—may have little or no effect.[11] Such stable, emerged systems aim at self-sustenance, such as in the case of Lviv's culture of using means of public transport, when users were successful in asking for the reintroduction of six bus lines (cf. Sect. 6.3.3).
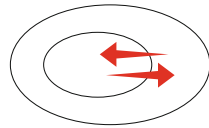
The task for decision-makers is to identify and exploit such stable, autopoietic systems. On one hand, knowing the stable wholes can help to avoid expensive but nevertheless ineffective, interventions. On the other hand, emerged, stable qualities may be taken as a starting point for new activities, such as the emerged quality of IT and BPO businesses, together with the perception of Lviv as a city of creative technology businesses and coffee shops.

Furthermore, when it comes to the self-sustenance and resilience of a complex system such as a city, stable emerged qualities can also be of great value: Rules and activities that belong to the emerged quality of a place will be continued as long as possible, even in the case of a disruption of the whole. For example, when there is a sense among citizens of the built heritage's value after the significant destruction of buildings by, e.g., a fire, storm, or earthquake, citizens would rebuild the destroyed properties, due to considering their historical context.

7.4.5 Making Productive Use of Instabilities

Frequencies of activities and of change of emergent qualities allow the determining of the right timing for a potentially effective intervention. Whenever a quality is unstable, i.e., when it is about to change—even if only slightly—due to a change in

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[11]In comparison, designed systems are less resilient. They can be more easily disturbed. Where the mutually reinforcing dialectic of guiding rules and sustaining activities is missing, or where it is designed instead of emerged, disruptions may easily break up such a designed system. E.g., where entrepreneurial activity is guided by attractive subsidies, but where there is no local culture of entrepreneurship, such activity will decline once there is a growing demand and/or the rising wages for employment exceed the subsidies for startups.

generative activities, it can be more easily influenced. In other words, when some of the generative activities are diverted, and when the emerged quality is not fully supported autopoietically, there is the potential for ways to effectively influence change in the emergent quality.

These phases of more and less stability of ENS are alternating, as depicted in Fig. 7.1. This phenomenon, as well as the importance of novelty for change during phases of instability, have been comprehensively studied regarding economic systems.[12]

However, limiting a theory of cycles of change to economic cycles falls short of its potential application to any complex system. On one hand, I agree with Schumpeter that "innovations are at the root of cyclical fluctuations" (Schumpeter 1939, p. 173). On the other hand, I would add that innovations and fluctuations do not only occur in economic systems. For example, in an urban system, new ideas, new activities, and new infrastructures may be at the root of change, i.e., the emergence of a new quality.[13]

Fig. 7.1 Phases of more and less stability of ENS are alternating. At points of bifurcation, a number of nested systems are going through phases of lower stability (*red lines*)

time

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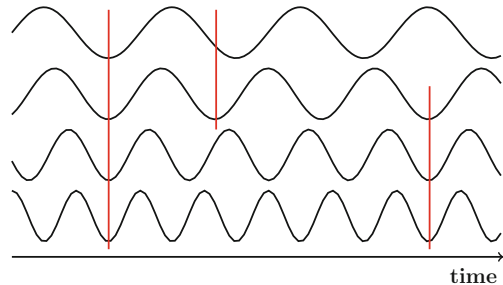
[12]Initially, Kondratieff suggested one long wave—with cycles lasting for several decades—to characterize economic up- and downswings (cf. Schumpeter 1939, p. 172). Later, Schumpeter recognized not only "the simultaneous presence of cycles of different order, i.e., of different span and intensity" (Ibid., pp. 169, 179). He also "attribute[d] the origin of business cycles to discontinuous changes arising from innovations" (Festré 2002, p. 229).

Even the notion of slower-changing systems enclosing—and guiding—faster-changing ones is implicitly present in Schumpeter's writings:

> If waves of innovations of shorter span play around a wave of a similar character but of longer span, the sequence of the phases of the latter will so determine the conditions under which the former rise and break as to make a higher unit out of them, even if the innovations which create them are entirely independent of the innovations which carry the longer wave. (Schumpeter 1939, p. 180)

[13]Maybe Schumpeter (Ibid., pp. 183–184) had the same idea about cycles being of a "nature" other than economic. For example, he wrote that "the economic process ought really to be thought of as an infinitely complex composite of many synchronous waves of different nature, quite apart from the class which interests us here. One of the most important tasks of the theory of the future lies in this direction.".

Thus, a good time to intervene in a complex system is during a phase of change. For example, in Lviv, it could be considered that a gentrification of Old Town could save the built heritage. The right time to promote investments and lure the gentry in will have arrived once the activities of Old Town dwellers and users, such as shop owners, do not fully support the existing use-patterns any more. This time may have arrived when dwellers start moving in and/or out more often, when they change the purpose of residential space into commercial or office space, and/or when their understanding of the historic value increases or declines. (Consequently, substantial changes, which are the results of a number of emergent qualities, may take decades. Such long-lasting change can be observed, e.g., during the aforementioned processes of gentrification.)

With each system having its own frequency of change, as depicted in Fig. 7.1, there are points in time when change is about to occur in several nested systems. At such points of overlapping unstable phases, so-called bifurcation may occur. Then the system may develop toward either one future or another (see Fig. 7.2). In other words, to use another commonly known expression, the system is at a tipping point (see Fig. 7.3). Although the time of a tipping point can be recognized by the number of nested systems going through phases of lower stability, the future after bifurcation remains subject to the emergence of a priori unpredictable, emergent, enclosing qualities—particular to place and time.[14] In fact, as mentioned by Schmidt (1990), bifurcation will lead to new patterns with *sudden new properties*. In such bifurcation, the change of parts predominates, such that the *new qualities* cannot be derived in an exclusively analytical way from existing parts and their qualities (Ibid., p. 36).

At a point of bifurcation, a complex system is highly sensitive to interventions, and its future may be influenced with little effort. E.g., after the end of communism, all kinds of guiding qualities were put into question, so it was easy for a new quality

Fig. 7.2 Bifurcation diagram. When one or more nested systems are going through unstable phases (as shown in Fig. 7.1), there may occur bifurcation, i.e., the system will develop in one direction or another. In ENS, bifurcation may involve the emergence of novelty
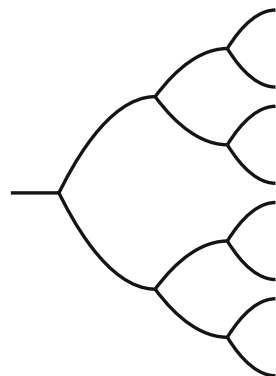
[14] As understood here, bifurcation refers to a complex system's ability to produce new quality, in the case of developing toward either one future or another. This understanding differs from the common understanding of bifurcation theory, which does not require emergent quality.

of IT-service businesses to emerge in Lviv—despite the previously predominant, guiding quality of large-scale industrial works.

In this context, it is also important to understand that whenever systems are in phases of lower stability or even at a point of bifunction, it is more easily possible for sudden, unwanted change to occur. Revolutions occur when a share of generative activities no longer support the existing, emergent quality. This is the case when citizens start creating and supporting 'alternative' movements, such as during the Velvet Revolutions, which tapped, in several geographies, current instabilities of cultural, economic, and political qualities. (And since every emergent quality is different, the guiding qualities—and the resulting formation of the Velvet Revolutions—were distinct from place to place.)

7.4.6 *Effectuating ENS*

The three generic ways to influence ENS—as well as phases of higher and lower stability—suggest that influence that is effective works within the means of, and with great sensibility toward, the current local situation. A new rule will more easily be accepted if it is not suppressed by other enclosing rules, and if it is supported by enclosed activities.

One example for purposive, foresighted, creative activity that those who seek to influence the course of events engage in—hoping that their visions will emerge—is the above-mentioned co-working space in Lviv's market place. It is, as an enclosed activity, not suppressed by existing, enclosing rules. Furthermore, an emergent rule of using such a space is supported by the activities of those who use it. While introducing something new to Lviv, the co-working space is still within the propensities of the current situation.

Seeking to purposively influence the course of events—based on local and current propensities—is, in principle, similar to what is known as *effectuation*. Paraphrasing the argument of Sarasvathy (2001, p. 245) regarding the terminology of ENS, effectuation-based decision-making begins with a set of propensities of the current and local situation; it then chooses between potentially emergent types of qualities, which may be achieved by influencing rules and/or activities.

Fig. 7.3 Whenever a system is at a point of bifurcation, it is also at a tipping point
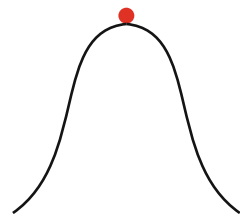
The classic example of understanding effectuation, as opposed to causation-based decision-making, is the following:

> Imagine a chef assigned the task of cooking dinner. There are two ways the task can be organized. In the first, the host or client picks out a menu in advance. All the chef needs to do is list the ingredients needed, shop for them, and then actually cook the meal. This is a process of causation. It begins with a given menu and focuses on selecting between effective ways to prepare the meal. In the second case, the host asks the chef to look through the cupboards in the kitchen for possible ingredients and utensils and then cook a meal. Here, the chef has to imagine possible menus based on the given ingredients and utensils, select the menu, and then prepare the meal. This is a process of effectuation. It begins with given ingredients and utensils and focuses on preparing one of many possible desirable meals with them. (Ibid., p. 245)

In analogy to this example, one could imagine a first urban developer, who, in a classical causation-based approach, sets out to build something, according to a previously decided plan. Alternatively, one could imagine a second urban developer, who sets out to create the best possible outcome after gathering the available means, e.g., knowledge about local guiding rules; about ongoing activities of citizens; about available human, infrastructural, financial, and cultural capital; and about available built-up structure and the local rules of using it. The second urban developer would explore new propensities and exploit unexpected ones—seeking to realize propensities that open even more propensities, and committing individuals to activities, in order to support the emergence of a type of desired quality (cf. Ibid., p. 252).

Tapping locally available means is a much different approach than importing concepts, best practices, and/or funding from elsewhere. Understood as working with and influencing local activities and rules, effectuation ties in with the process of purposive change in complex systems suggested in this chapter. For example, effectuation integrates purposive goal-setting, which in turn allows for larger goals than piecemeal development does, and it is more targeted and more effective than simply muddling through. Targeted, foresighted activity can prepare the ground and choose among situational propensities, in order to influence the course of events in such a way that a vision of the future can be achieved.

Just as triggering change by purposive activities is an option open to anybody, individuals and citizen initiatives can apply the method of effectuation, as much as political actors can. An approach well-suited for small, fast-acting groups is the following: conceiving a vision; gathering the local community's resources; carrying out activities to help a just-emerging quality—such as a culture of entrepreneurship in Lviv—stabilize; observing ongoing changes; and continuously trying to tap all local potential.

Effectuation, if the insights from the theory of ENS are considered, is also a wise approach for a municipality. For example, part of the governance approach of the city of Lviv is, unknowingly, an approach of effectuation—seeking maximum exposure to propensities with minimal resources available. Among the activities that try to seize current propensities for new qualities to emerge are the enabling of cultural events and markets for local goods, as well as the initiatives for tourism and for IT

businesses. The Innovation Center is an example of individuals that were sent on a mission to make use of existing situations and to trigger and shape new ones. These are initiatives very close to what one would suggest in an approach of effectuation, based on the theory of ENS. (What is currently missing in Lviv is the application of knowledge about fast and slow activities and rules.)

Eventually, it might be increasing austerity requirements—and tightening communal budgets in many parts of the world—that will lead to a shift from urban planning to the effectuation of cities. In an Emergent Nested System, the triggering of change does not need to consume large amounts of resources; if done right, it works under the conditions of austerity.

7.5 Applying the Scientific Method to Test Possible Interventions

> If no one wants to shop in city centers, or sit outdoors chatting or playing chess, but people prefer to shop out of town and chat or play chess over the internet, then this may or may not be a matter for regret. But trying to restrict shops to the city center, or contrive public vitality will be fighting a losing battle
>
> Marshall 2009, p. 274

From a vision of, and knowledge about, a local Emergent Nested System, hypotheses follow that offer potentially effective ways to influence. These hypotheses can be tested, either by applying modeling methods, or by engaging individuals in workshops or in real-life test runs. An example for the latter approach is the making of a first, short stretch of a pedestrian zone; this is what was carried out in Curitiba (cf. Sect. 7.4.2 above). Also, the aforementioned offering of some fast, comfortable bus connections in Lviv may be a real-life test run. In workshops, individuals' reactions to interventions can be tested as well, allowing for new, emergent ideas to come up—a feature that cannot be matched by computerized modeling methods.

7.5.1 Applying the Scientific Method

Part of a truly scientific approach to change is the testing of hypothesized ways to influence an Emergent Nested System. Possibly, the initial hypotheses will need to be adjusted or even rejected after testing. I.e., they will be adapted to the improved understanding of the actual situations of the Emergent Nested System.

At the core of every hypothesis-testing must be an understanding of how the actual Emergent Nested System could develop. Such an understanding is to be based on the objective measure of slower and faster nested-systems relations, including guiding, triggering, enclosing, and enclosed relations.

It is important to remember that the approximation of effective influence cannot be based on subjective perceptions (see above, Sect. 7.1). Applying the theory of ENS provides the basis for an understanding of ENS which does not rely on an individual's or a group's subjective worldview. Rather, it is led by objective, testable knowledge—even though the validity of this knowledge may be limited in time and space (cf. Byrne 2005, p. 97).

Applying the scientific method—of conceiving, testing, and adapting hypotheses—requires recognizing that the testing area is dynamically changing. Monitoring change of inward and outward influence, and of the autopoietically stabilizing activities of emergent qualities, provides the requested information during an intervention.

In complex systems, the scientific method is, however, bound to a particular time and place. The same activity carried out in the same place, and at only a slightly later time, may still have a similar effect. However, if carried out at a much later time or in a different place, results may be much different. Thus, the case of a complex system is always to be understood as a single case, as argued in Chap. 5, and tests must be run on the particular systems—whether these tests are computer models, or they involve individuals. As a further consequence, the transfer of best practices of developments in complex systems is hardly a good practice at all.

7.5.2 Using Models for Alpha Tests

Regarding the informing of decision-making in, e.g., urban systems, one of the first ideas that may come to mind is building a model and simulating future developments. For the simulation of future developments, a variety of modeling techniques is commonly applied.

The most popular modeling technique among urban and regional planners today is probably agent-based modeling (ABM). ABM simulates the patterns that result from the activities of agents, i.e., of virtual individuals who follow a set of selected behavioral rules. In other cases, several modeling techniques are combined, such as in forecasting the average passenger flows of the public-transport system in Lviv (Berger 2011, pp. 75ff.).

One issue with modeling is that it cannot simulate emergence. Since emergence is an unknown, a computer is not able to know what is going to emerge, or to invent it: "If no novelty enters into the system then all that is gained is a recombination and/or reconfiguration of the information fed in at the beginning" (Ireland and Zaroukas 2014, p. 262).

There is nothing emergent coming out of any (computer) model. E.g., ABM can only aggregate and vary—according to a given algorithm or to (pseudo-)random triggers—(a subset of) guiding (behavioral) rules, but it cannot invent new ones.

The resulting pattern may be surprising, though the simulation shows that it is, in principle, predictable. Therefore, the results of modeling remain within the realm of known things.

In the purposive development of ENS, (computer) simulations may, however, be considered as alpha tests. Potential interventions or policies can be tested against activities of agents that have been modeled, according to local guiding rules. (To clarify, this forecasting is often made without carrying out any studies of local citizens' behaviors. See also Footnote 4 in this Chapter.) For example, in Lviv, a model reflecting the rules guiding public-transport users' *actual* activities could have helped to raise doubts about the public-transportation reform. (However, where the guiding rules are so obvious, a model and a simulation may not be necessary anymore.)

While potentially useful, a (computer) model may dangerously mislead decision-making in ENS. Even a first test may well be misleading, since a model does not consider the case that interventions lead to new, emergent qualities. For example, in the case of Lviv's public-transport system, ruling out the vision of a hub-based network based on the outcome of a computer model might be wrong, because propensities may actually exist for new, guiding rules to emerge—triggered by, e.g., the introduction of better and faster buses serving a number of original hubs.

7.5.3 Engaging Individuals as Beta Testers

A better testing of potential interventions requires the engagement of individuals from the Emergent Nested System. For example, in an urban system, a question of interest that can be answered by individuals is: How would citizens react to the implementation of a certain intervention? Would they start inventing workarounds to bypass new rules? Could new ways of doing things, i.e., new qualities, emerge? Or could the intervention cause citizens to become upset and trigger a (small) revolution?

These questions may not be answered by running simulations of (computer) models. Computer models are reductionist, in that outcomes are rearranged from known bits and pieces. In other words, computer models do not produce more than a sum of known parts.

In contrast, by engaging individuals from the actual complex system, their reactions and new ideas may be synthesized. This may help decision-makers to learn about potential reactions and potential emergent qualities.

During the process of pursuing a vision, testing hypothetical activities and hypothetical guiding rules on individuals may yield helpful insights for decision-makers. Thus, engaging individuals as 'beta testers' can lead to a better idea about the influence of envisaged interventions on emergent qualities and on continued or altered autopoiesis. In a way, this is replacing modeled agents with real individuals, allowing

for emergent, creative thought; for something unexpected; for the unknown unknown to come up.[15] (Still, such an approach does not yield a forecast of what will happen.)

In practice, a group of individuals—e.g., citizens of a city or a neighborhood—will be gathered and exposed to hypothetical interventions. How do they react? What ideas come to mind, when considering the conditions changed by the intervention? Do some individuals' ideas 'resonante' with other individuals? Is it possible for a critical mass to be reached via single ideas?

This approach must be distinguished from participatory approaches that involve asking for people's (existing) wishes. Rather, this approach to engage individuals from the complex system, e.g., citizens from an urban system, is meant to trigger individuals' minds, so they may come up with emergent ideas—thus supporting the decision-makers in testing a variety of hypotheses.

The *mental* processing of hypothetical changes in the nested system will reveal potential reactions and, possibly, emergent ideas and behaviors—of individuals and groups. By means of workshops or even real-life tests, decision-makers can scrutinize a number of hypothetical interventions and revise, if necessary, the conceived ways of influencing. Thus, engaging individuals allows for hypotheses to be validated or refuted, and then improved or changed. (This involves knowing that, of course, the results of the test are ultimately valid only at the moment—and in the laboratory setting—of the workshop.)

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[15]However, emergence of novelty is not a necessary outcome. Even for men, it requires creative invention that is not a necessary outcome of a thinking process, nor can it be forced. The insight is attributed to Henry Ford that, if he had asked them, people would have wanted a faster horse—but not a car. In a city as well, it is possible that citizens may only ask for a rearrangement of known things, such as a new layout of residential areas or apartments, instead of inventing something new.

Chapter 8
A Second Look at ENS Theory

*For the reductionist, only particles in motion are ontologically
real entities. Everything else is to be explained by different
complexities of particles in motion, hence are not real in their
own ontological right. But organisms, whose evolution of
organization of structures and processes, such as the human
heart, cannot be deduced from physics, have causal powers of
their own, and therefore are emergent real entities in the
universe. So, too, are the biosphere, the human economy, human
culture, human action.*

Kauffman 2008, p. 3

The previous chapters have demonstrated how a theory of ENS may serve to delimit
and understand complex systems, and how it can help to overcome current limitations
in decision-making. Wrapping up this work, I will briefly reflect on the key findings
of my theory and will point out which questions were answered, and which are still
to be answered.

8.1 Key Findings of a Theory of ENS

This contribution has carried out its course, based on the works of some seminal
scholars of the past century, most notably—in the order of their first works cited—
Ludwig von Bertalanffy, Warren Weaver, Karl Popper, Herbert Simon, and Herman
Haken, as well as (with *urban* systems in mind) Walter Christaller and Jane Jacobs.
Amalgamating many of their ideas—and rejecting some—I was able to develop a
theory of ENS.

This theory is distinct from other theories of emergence that are known to me, in
that it focuses on nested relations of relatively fast (generative) and relatively slow
(emergent) systems. From this theory, I deduced three generic ways to influence ENS
and subsequently suggested and applied a suitable case-study approach.

Emergence Derived from a Logical Construction of Unknown Unknowns

I deliberately attributed a proper meaning to *emergence*. In other words, I left the word 'emergence' to denote, though not to explain, the qualitative leap of the coming into existence of novelty. This novelty is, in principle, unpredictable. (Yet another way of putting it is that a theory of emergence that could explain how emergent qualities come to be would take its meaning from emergence, and this explanation would lead to resultants.)

My vantage point was a logical construction of types of knowledge: What is not known to the universe (because it has never come into existence before) and what cannot be imagined by man (as a recombination of existing elements, even if altered) are unknown unknowns, i.e., real, ontological novelty. If I had approached this work from an empirical standpoint, I might have based the theory on the observation of phenomena, whose coming into existence could not be explained—based on sensual experience and on knowledge accessible to men. This approach, however, would have led to an epistemological concept of emergence, rather than an ontological one.

There are, in our world, qualitative leaps that can be observed, described, and influenced—although their existence cannot be explained from what has been there before. Thus, although it cannot explain emergence, the purpose of my theory is to still allow the deduction of (testable, falsifiable) hypotheses.

A Theory Informed by Complexity and System Sciences

There was a philosophical treatment of emergence that started at the beginning of the 20th century (see, e.g., Stephan 1999). This treatment included the notion of novelty, but it did not include system theories or complexity theories because they had not been developed yet.

Since system sciences and complexity sciences have been well-developed over the second half of the 20th century, I was able to conceptualize a theory of emergence by considering these recent insights, largely independent of the original concepts of emergentists. The results are similar, in that I try to offer a general theory of emergence.

However, one difference lies in the way I deal with strong emergence, i.e., emergence related to the coming into existence of real novelty. Involving unknown unknowns and rejecting patterns—that result from rearranged, known elements—as emergent, mine is a theory of strong emergence. Another difference is that I aim to prepare the ground for deducing methods to influence emergent qualities.

As much as I could, my intention was to reduce disciplinary biases from a general theory of emergence in complex systems. I believe that the urban cases present a highly interdisciplinary background to exemplify emergence in nested systems. This is why urban studies are extremely valuable to system sciences and to the advancement of general, disciplinarily independent theories.

8.1.1 Fast and Slow Systems are Ontologically Real

Furthermore, the distinction between fast and slow systems was not known at the time of the early emergentists. I also did not find evidence that it had been brought into the context of emergence theories at the time of my studies. Distinguishing systems through their relative speed of activities enabled me to develop a theory of ontologically real ENS. I hope that knowing that enclosed systems change faster than their enclosing systems will allow for further, new theories and practical applications.

I suggest that the related notion of a high frequency of activities within a system— as well as the notion of a low frequency of activities across the borders of a system— enables the distinguishing of ontological boundaries in real systems. As a consequence, boundaries and, thus, systems, are no longer necessarily *relative, subjective, or constructed*, i.e., observer-dependent.

8.1.2 'Emerging' Patterns are not Emergent

Knowing that a slower-changing, enclosing system guides activities in enclosed systems, it becomes possible to tell resultants apart from emergent qualities. Patterns appear from relatively fast activities, which are guided by relatively slowly-changing rules of emergent, enclosing systems.

This led me to reject the notion of emergence used in most of today's literature. This notion is highly related to patterns that 'emerge'—in the sense that they appear— from elements, which interact according to given rules. This notion has been exploited in computer-aided approaches; e.g., such 'emergence' can be observed in the widely applied, agent-based simulations yielding computer-generated resultants.

8.1.3 Purposive Influence is Possible with Inward and Outward Influence in ENS

Central to my theory of emergence are inward *and* outward influence. The simple implication of inward influence in ENS, which may well be immaterial, is that the physical (i.e., material) domain cannot be closed. In other words, the physical domain cannot be causally closed if immaterial emergent quality, such as a conscious mind, may have an influence on the activities of men, who are *consciously* changing physical artifacts; there is influence from a non-physical domain that causes change in the physical environment. Inward influence, and that, e.g., conscious thought or a cultural context may have inward influence, seems to be difficult to accept, even for scholars

who have deeply studied theories of emergence (e.g., Kim 1992, cited in Stephan 1999).[1]

Outward and inward *influence* are concepts that I deliberately softened from the original concepts of upward and downward *causation*. A subtle yet crucial difference is whether given activities are *causing* change, or they are just *influencing* the system to change. 'Influence' should reflect the contingent nature of any activity on any situation that generates propensities, out of which new quality may emerge—without it being possible to discern, predict, or reproduce casual chains.

Change in complex systems may well be contingent on voluntary decisions. It can be theorized that any influence in complex systems leading to emergence may be an insufficient but non-redundant component—of an unnecessary but sufficient situation (cf. Mackie 1980, p. 62). Being insufficient means that the one component alone does not lead to emergence; rather, it must be part of such a situation. The component is required, i.e., it is non-redundant, if such a situation leads to the emergence of a particular quality. For such emergence, however, the situation itself is unnecessary, which means it is only one of many possible situations that may lead to the emergence of a particular quality. At the same time, such a situation is sufficient, in that it generates the right propensities for the emergence of a particular quality. The question of exactly how such influence relates to our understanding of (discernible and reproducible) cause and effect remains for further theory and research.

Thus, a consequence of the conceptualization of ENS, involving outward and inward influence, is that they leave an effective role for the individual who may make purposive decisions. These decisions might be based on an understanding of the situation, on possibilities of outward and inward influence, and on foresight. Man is able to make decisions, and take actions, that will deliberately shape the environment.

Furthermore, this concept of emergence accounts for man's individual, purposive activities, and it leaves the concept of a man who is performing given rules that are determined by, e.g., biology—or a society that yields *collective* behavior—far behind. With man "capable of detecting, reasoning about and acting on the macro-level properties (the emergent features) of the societies of which they form part" (Gilbert 1995, p. 151), the potential arises for foresighted activities to purposively influence ENS.

Fast, flexible, purposive activity remains in the hand of the individual—and is not possible for aggregates. Thus, the "guiding question" suggested by Holland (2000,

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[1]Some domains may be closed. E.g., our entire universe may be a zero-sum game, but this is wild hypothesizing. Also, the physical domain may be closed, depending on what—other than matter—is considered as belonging to it. But it seems to me that many scientists seek out a closed physical domain, which only includes what we know about the material world today. In order to reach such a closed physical world, some philosophers claim that there is nothing but matter in the universe. Such an exclusively material world would imply that my brain—as an unconscious, material entity— determines what I do, and that consciousness has no actual inward influence. I.e., I only think I can choose what I do.

Because we have been separating research into disciplines for a long time, it may be hard to imagine that, in fact, there is a coupling between non-material entities and material objects—e.g., between my mind and my keyboard, when I intentionally type this text.

p. 248) is misleading: "How can the interaction of agents produce an aggregate entity that is more flexible and adaptive than its component agents?" His conception was that the emergent systems become ever-more adaptable, implying a high speed of adaptability. But this notion of a higher speed of change in the emergent system than in the systems it emerged from is contrary to my conception of fast, generative systems and slow, emergent systems.

8.1.4   Nestedness Defines the Development of Complex Systems

The initial observation at the beginning of this work was that planning in complex systems is prone to failure. And a first finding of the theory was that systems are nested like onions. This led to the implicit question of *how the nestedness of complex systems influences their development*.

The theory of ENS integrates emergence and nestedness, showing that the same forces that lead to establish and maintain the nesting relation, i.e., the very process of nesting, define the development of the complex system. Emergence—i.e., the coming into existence of real novelty as an enclosing quality, which sets new rules of inward influence—is a defining element of nested systems.

Other defining elements are activities of outward influence that, in an autopoietic sense, either are aligned to the rules of the enclosing system, or are not aligned—in which case they may trigger changes in the enclosing system. Any activity in the enclosed system may lead to the further coming into existence of real novelty. Thus, activities of outward and inward influence are defining elements of a nested system.[2]

Once established, the relations of nested systems may well overrule purposive efforts to influence the system. Interventions may be in conflict with nested system relations, and activities suggested by interventions may not contribute to the established, self-regenerating (autopoietic) activities of the system. Such activities may be rejected by the existing—often unwritten, e.g., sociocultural—rules. Therefore, the nesting relations in a complex system can be strong, opposing players during planned interventions. For this reason, planning in complex systems is prone to failure, if nested-system relations are not considered.

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[2]One may wonder if a theory of nested systems alone, leaving aside the notions of emergence and relative frequencies of change, could have explanatory power. Such a version would also relieve the theory of the question for the (ontological or epistemological) nature of emergence and of, in principle, unpredictable novelty.

In fact, with a theory of enclosing and enclosed systems alone, and/or with outward and inward influence, guiding rules, and generative activities, it could be analyzed which systems are stable or prone to change—and the rules and activities that stabilize and destabilize the system. Even the effectivity of rule-based interventions or the risk of revolutions could be predicted.

However, such a theory would be incomplete, since it would not address the question of how nested systems come into existence. The theory of ENS explains that nested system come into existence through the emergence of novelty.

If nestedness is a defining feature of complex systems, then it suggests that understanding the processes of nesting is key to understanding complex systems. Understanding the nested-system relations, in turn, is a precondition to effectively influencing a complex system. An insight—that system-inherent forces of nesting may overrule interventions—called for new methods to influence complex systems, based on outward and inward influence in a nested relation. Furthermore, that insight called for a single case-study method, in order to understand a particular Emergent Nested System—so that it can be influenced effectively.

I suggested that single-case methods apply to understanding ENS. A single case study yields a description of a situation, as well as the unique facts of enclosing and enclosed systems, and allows for an understanding of particular nested relations. A single case study is based on empirical findings, i.e., qualitative facts, which are often expressed as narratives and are often quantitatively supported and/or complemented by data.[3]

8.1.5   *Influencing Complex Systems Means to Influence the Nesting Processes*

The second question to be answered was *how complex systems may be effectively influenced*. As a consequence of the nesting process defining the development of complex systems, influencing ENS means influencing the process of nesting, i.e., the process of first (diachronic) emergence and further (synchronous) autopoiesis.

Effectively influencing complex systems must involve working within the enclosing and enclosed relations, i.e., the rules of inward influence at play, as well as the activities of outward influence that maintain the whole. Thus, the nested relations of relatively faster and slower, enclosed and enclosing systems allowed me to deduce

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[3]The single-case approach may appear as a step backward, since much effort has been made to overcome (1) purely qualitative and (2) non-comparative accounts of cases. Quantitative methods are often perceived as synonymous with a rigorous, scientific method, and comparative methods should be warrantors of building up generalized, scientific knowledge about the world.

However, I hold that scientific knowledge has to be gained about a single case, whenever the situation in an individual, Emergent Nested System must be understood, in order to influence *unique* situations. (This argument is also due to the emergence—and the changes in emergent qualities—that arises from the propensities of such unique situations.) This knowledge can be produced by another researcher at the same time and with little deviation, and it yields a close-to-reality picture about the real ontological system being studied. It also opens new possibilities, e.g., the deduction of ways to influence said system.

Furthermore, my argument is not, in any way, against quantitative and/or comparative methods in case studies. The single case-study approach may well include quantitative data, and it may be brought into a comparative study, out of which more general knowledge about *types* of emergent qualities can be extracted. I.e., this knowledge can be useful to recreate situations, out of which a desired type of emergent quality may emerge. However, depending on the situation, a narrative case study without the use of mathematical modeling may be better than an imposed mathematical model (von Bertalanffy 1968/2006, p. 24), and it may be better adaptable—due to its minimal rigidness—to dynamically changing situations, and to the various kinds of systems that can be studied.

three generic ways—and further practical methods—to influence complex systems, i.e., to deal with emergence and unknown unknowns.

These approaches open the door for purposive activities of effectively changing complex systems. It is for such purposive (i.e., not random) activities that the understanding of ENS is indispensable. For example, the theory of ENS suggests that effective interventions aim at *influencing* development, rather than *implementing* change based on forecasts.

Planning can fail because of novelty coming into existence, or because the existing, unchanged system and its own, inherent dynamics are stronger than devised efforts to make change happen. That understood, it is time to think about alternative methods of driving systems into a desired direction. Forecasting and planning that is based on "business as usual" —i.e., on the premise that no novelty is going to arise, and that interventions are able to change the course of events as planned—becomes less important.

Rather, we might want to find methods that more subtly influence the system from within: the rules that characterize it and the activities that maintain it. This leads to a shift from planning to effectuating, i.e., to driving change. This shift involves knowing that it cannot be known what the exact results of an intervention will be. Furthermore, this shift requires an understanding of the system to be influenced, i.e., emergent quality and autopoietic activities.

Understanding a system means studying it thoroughly, and changing it means finding the levers of change within the system: Changing the very relations of nestedness that define the system and make it what it is, so it can become different. This requires working, at first, with what is there: the rules and activities of the system. With these resources, changes may be *effectuated*.

8.2 Outlook

A view of the world in which complex systems generate real novelty allows there to be a new horizon for research and practice. Real novelty is not the rearrangement of existing elements—at least not in a material sense. Real novelty comes from strong emergence, a concept largely neglected until now.

Living with the knowledge that real novelty may emerge doesn't make things easier. A deterministic, materialistic worldview involves pretending like the future is predictable. It is not.

But there are upsides:

For example, we can prepare the ground for novelty and for real innovation, such as new products, new services, new cultural qualities, and new ways to work together, communicate, socialize, organize both public and private living spaces, and simply get along. Furthermore, we don't need to blame the failure of forecasting, the uncertainty in our models, or our limited cognitive ability. This is no longer a reason

to belittle man—something that has become too fashionable in 'critical sciences.' The future cannot be known in advance, no matter one's cognitive capacity.

However, what is more important is that the theory suggested in this work is predictive. It is not predictive in the sense that it allows for forecasting the course of events. However, it is predictive in the sense that, e.g., it can be predicted that fast-moving actors will generate a slower, enclosing system; that the latter will act back on the first; that there can be effective methods to purposively influence ENS; and that our universe can be framed by one system of fastest speed and another system of slowest speed.

Postlogue

Today, students are rarely given the opportunity to do their PhD on an open topic, covering a broad subject. The common PhD is on a defined subject, which is a new side branch, somewhere at the end of a longer, multifold branch of another type of research. I had this once-in-a-lifetime chance to be at the right place at the right time, to learn about the PhD program I then joined. This has given me the possibility to study what I believe is one of the most complex systems: the city. The subject gave me both inspiration and empirical stimulation for thinking about how not just cities, but complex systems in general, might work.

A PhD that is broad cannot be detailed in every aspect. As much as I enjoyed connecting thoughts from many scientific areas, the theory remains incomplete. Any attempt to work broadly across disciplines bears the risk of overlooking some work that has already been carried out elsewhere. With the decision to work in the field of general system and complexity theories, I had to give up the aspiration to study, and cover in this work, the many existing disciplinary conceptions of systems. It was, however, extremely fun and insightful to look into various fields—from particle physics to entrepreneurship theories, and from emergence theories to urban studies, to name just a few.

This work also reflects my personal journey into some of the knowledge of men. It was an endeavor of my formation and a time of enjoying the sciences, the brilliant works of others, and the capabilities of one's own mind. (For example, how is it that I can consciously direct my thoughts?) Working on the theory itself was exciting research—carried out less with the aim of a specific method for application in mind, and more just for the sake of doing deep studies, just because I could. I believe that many discoveries and inventions are not made by building a method which was perceived as required, but from free, deep, intellectual studies. Such was the joy of my PhD studies, for which the abovementioned persons and organizations provided an enabling environment, and of which this present writing is a result.

With a sketch of a different worldview, this work intends to provide an alternative paradigm and to open the discourse for a new branch of research. This new branch would not be at the end of another branch, but close to the center of research's

gravitation point. It addresses the questions of how the universe works, how complex systems work, and why things are as they are, whether physical, biological, social, or otherwise.

Whether I have produced real novelty or not, I've tried to walk down new paths, cross many disciplines, and allow for possibilities out of which there is the potential that something could have emerged—a new quality that implies its own application and is not necessarily an answer to currently missing knowledge. Thus, much of the conception of ENS brought forward in this work may prepare the ground for further studies, in both general and particular systems. Many times, the reader may have thought of possible ways to test the concepts or applications. Such testing may be carried out in the future work, but it cannot be carried out during the time available for a PhD project. This work shall be the soil in which much more can grow at a later time.

Glossary

Activity   In this book, activity is understood in the widest possible sense. Activities include any type of interaction. Activities can be targeted↑ or untargeted↑. Even thinking about not acting is an activity. In this work, it is assumed that in every system↑, there is activity within and across its boundary↑. Activity is, thus, a constituting element of a system. In nested systems↑, activities in enclosed systems↑ generate propensities↑, out of which novelty↑ can emerge (see also upward influence).

Autopoiesis   Autopoiesis, as understood in a very general sense in this work, denotes the ability of a whole↑ to maintain itself. Autopoiesis of a whole requires rules↑ that guide autopoeitic, i.e., self-regenerative, activities↑. Thus, an autopoietic whole must include at least an enclosing system↑, setting rules for activities of an enclosed system↑.

Border   (see boundary)

Boundary   A boundary demarcates an entity, such as a system↑, from its environment. A boundary does not have to be constant in time and space; i.e., it may be changing over time. According to the theory of emergent nested systems↑, the boundary of a system can be discerned by a local minimum of activities↑. I.e., within a system, there is high activity, as compared to the activity of exchange with its environment across the boundary.

Causation   (see influence in nested systems)

Comparative case study   (see single case study)

Complex system   In this work, a complex system is understood as a system↑, from which a new quality↑ can emerge↑.

Complexity   Complexity can be understood, in the context of the theory of ENS, as a measure for the propensities in a system, out of which novelty↑ can emerge↑. The more situations↑ that generate propensities↑ out of which novelty can emerge in a system, the more complex the system is. This definition of complexity transcends the one introduced by Weaver (1948). In his definition, complexity is a measure for the number of parts, and their interaction, in a non-organized and non-random way.

Complexity theories   Theories to deal with complexity↑, as understood by Weaver (1948), were developed and applied to explain such things as (extreme) weather events and the adaptive capabilities of social and ecological systems↑. One of these theories, chaos theory, is a theory of deter- ministic chaos, i.e., of predicting a deterministic course of events that is highly dependent on the initial point of departure. Chaos theory explains how small changes can have tremendous effects, a phenomenon commonly referred to as the butter y effect. The butter y effect is a result of nonlinear amplification (see, e.g., Kent 2009, p. 203).

Diachronic   Referring to activities happening successively, i.e., literally 'through time'. In my theory of ENS, a new quality↑ emerges↑ diachronically at first, then it is maintained synchronically↑. The synchronous regeneration of an emergent quality is part of a system's autopoiesis↑.

Downward influence   (see inward influence)

Effectuation   Effectuation was originally introduced by Sarasvathy (2001) as a theory of entrepreneurship, describing the targeted activities↑ of entrepreneurs in (business) environments that are highly unpredictable, due to a variety of contingencies. For example, the success of a product cannot be forecast if the organization building and marketing the product is dependent on the entrepreneur's decisions, and if a potential market demand for a product is contingent on the product itself. This theory can be interpreted as a problem of complexity↑, according to Weaver (1948). But such an interpretation would neglect the novelty↑ that is often coming into existence in the course of the creation of products and markets (an issue that Schumpeter comprehensively discussed in, e.g., Schumpeter 1939). Thus, in this book, effectuation is understood in a much wider sense. It is understood as a general way to influence↑ ENS—applicable not only in business, but also in, e.g., urban development.

Emergence   As understood in this book, emergence is the coming into existence of a new quality↑. Novelty is realized during situations↑ that generate propensities↑, out of which a new quality emerges. As understood in this work, emergence is creative and inventive, as it was according to Popper (1977): It brings something new into the universe. A quality emerges↑ diachronically↑ as an enclosing system↑, characterized by rules↑ that subsequently guide the synchronous↑ activities of the then-enclosed system↑. Examples of emergent systems are cultural systems that produce cultural norms, guiding activities of men. The understanding of emergence used in this book is often denoted as strong emergence, to distinguish it from socalled weak emergence. Weak emergence refers to a formation of patterns that can sometimes be surprising, such as segregation clusters in cities. It may require computation to determine patterns of weak emergence, but it does not require novelty coming into existence.

Emergent quality   The emergent quality is the distinguishing, unique property of a system↑. The emergent quality is always novel↑, in the sense that it could not have been predicted in its particularity before it came into existence. The emergent quality is, at first, diachronically↑ generated from activities↑ in existing systems. It manifests as an enclosing system↑ through rules↑ that henceforth guide

synchronous↑ and autopoietic↑ regenerative activities↑ of systems that are then enclosed↑.

Enclosed system   In nested systems↑, there are systems that are enclosed by other systems.

Enclosing system   In nested systems↑, every system is enclosing other systems (see also emergent quality↑).

Epistemology   Epistemology refers to the way things are perceived, as opposed to the way they are (see also ontology↑). In system sciences, it has long been held that systems↑ only exist in the eye of the observer, making system science concerned with epistemological entities, rather than ontological↑ ones. I hold that systems are ontological entities, i.e., they exist as systems, independent of the observer. My argument is based on the objectively different frequencies of change↑ and on activities↑ of systems.

Frequency of activities   The frequency of activities in an enclosed system↑ relates to the system's complexity↑, i.e., to its ability to generate propensities↑, out of which novelty↑ can emerge↑. Furthermore, a system itself can be ontologically↑ delimited as a local maximum of activities, as compared to its boundary↑, that can be distinguished by a local minimum of activities.

Frequency of change   A measure for the time that passes between changes in the emergent quality↑ of a system↑. The relative speeds of change of two systems allow the determination of the nested relation of these systems, i.e., the determination of which of the two systems is enclosing↑, and which is enclosed↑.

Generative activity   In ENS, the diachronic↑ emergence of a new quality, as well as the synchronous↑, autopoietic↑ regeneration of the whole↑, depends on generative activities in enclosed systems↑. At first, activities lead to situations↑ that generate propensities↑, out of which a new quality↑ may emerge. Once a new quality has emerged, it is regenerated by activities of the enclosed system.

Guiding rules   Guiding rules are a constitutive property of an emergent quality↑. Only by means of guiding rules can a quality have influence and be maintained over time. Inward influence↑ of enclosing systems↑ is due to guiding rules that align and select activities in enclosed systems↑. It is through such aligned and selected activities that the whole↑ is autopoietically↑ regenerated and that the emergent quality can sustain itself.

Influence (in nested systems)   Influence in nested systems can be either exerted by generative activities↑ or by guiding rules↑. Influence by generative activities is directed from the enclosed system↑ towards the enclosing system↑, i.e., it is directed outward (see also outward influence). Influence by guiding rules is directed from the enclosing system to the enclosed one; it is directed inward (see also inward influence).

Interaction   (see activity)

Inward influence   The influence of an enclosing system↑ exerted on an enclosed system↑ is denoted in this work as inward influence. Inward influence is exerted by guiding rules↑. In other conceptions of emergence, the same direction of influence is usually denoted as downwards influence, implying a hierarchical relation I intentionally avoided in this book.

Nested system relations   The set of nested systems relations includes both inward↑ and outward↑ influence. Inward influence describes the influence of guiding rules↑ of enclosing systems. Outward influence describes the generative activities of enclosed systems. The nested relation further manifests itself in relatively fast frequencies of activities↑, as well as frequencies of change↑ of enclosed systems↑—as compared to the relatively slow frequencies of activities and change of enclosing systems↑.

Nested systems   Two systems, one of them enclosed by the other, make the simplest nested system. In the theory presented in this work, consecutive emergence↑ of a new quality↑ leads to ever-new enclosing systems↑ and, thus, a succession of enclosed and enclosing systems. Nested systems come into existence from activities↑ that generate propensities↑, out of which a new quality↑ can emerge. Thus, existing systems tend to 'build' their own 'nests.' For example, from the activities of men, enclosing political and cultural systems emerge↑, which henceforth guide the activities↑ of men.

Novelty   Novelty in my work denotes ontological↑ novelty. Ontological novelty cannot be known in principle because it is of a quality↑ that is new to the universe, and it cannot be imagined as a rearrangement of what exists. Thus, novelty is objective↑; i.e., it does not depend on the knowledge or the cognition of the observer. In the theory of ENS, novelty comes into existence as an emergent quality↑, out of propensities↑ generated by situations↑ in existing systems↑.

Objectivity   Something is objective if it is independent of who is observing it, i.e., if different observers, suppressing subjective biases, can come to the same result about the ontology↑ of a thing.

Ontology   Ontology refers to the way things are, as opposed to epistemology↑, which refers to the way things are perceived. In the theory of ENS, systems↑ are ontologically real entities; i.e., they exist independently from the observer within ontologically real boundaries↑ that can be objectively↑ distinguished by frequencies of activities↑ and change↑.

Outward influence   In nested systems↑, the generative activities↑ of enclosed systems↑ exert influence on the enclosing systems↑. Outward influence may lead to the emergence↑ of a new quality↑ or to the breaking up of, and/or changes in, an existing quality.

Part   A (theoretical) entity stripped of its nested system relations↑. For example, an enclosed system↑ can be seen as part of a whole↑.

Propensities   Propensities are tendencies of development that are inherent to a situation↑. This interpretation of propensity is attributed to properties that lead to change in a particular setting in time and space. This interpretation differs from the meaning of frequency, which abstracts the likelihood of change from a particular setting. For example, according to this interpretation of propensity, it is an inherent property of a completely symmetric dice to show all sides equally often, if thrown many times. In this interpretation of frequency, there is an abstract, equal likelihood for this to happen (see, e.g., Popper 1990, Ulanowicz 1996). In the theory of ENS, this interpretation of propensity is relevant, since it allows the emergence of novelty to be related to particular situations in existing systems.

Furthermore, propensities allow for novelty, while likelihoods can only consider existing qualities.

Relations of nested systems   (see nested system relations)

Rules   (see guiding rules)

Selection   (see guiding rules)

Self-organization   A concept related to the formation of (resulting) patterns from the activities↑ of parts↑, usually taking the existence of guiding rules↑ for granted. The concept of self-organization does, thus, not apply to my theory of ENS (see also Footnote 7, Chap. 2).

Single case study   A case study focusing on the understanding of the particularities of a particular situation↑, rather than being comparative in relation to other case studies.

Situation   A moment in time and space with a number of activities↑ and guiding rules↑ at work in a given Emergent Nested System. A situation is an infinitesimally slim slice of the course of events, at a place and moment in time that generates its own propensities↑, out of which a new quality↑ can emerge↑.

Speed of activity   (see frequency of activities)

Speed of change   (see frequency of change)

Superordinate system   An enclosing system↑ that can be identified as both influenced outwards↑, through the generative activities↑ of a number of enclosed systems↑, and by it guiding↑ the activities of these enclosed systems. In studying ENS, it may be helpful to first identify the superordinate systems that influence many or all of the enclosed systems to be studied. See Sect. 6.2.

Synchronous   Referring to activities happening at the same time, as opposed to diachronic↑ activities. In the theory of ENS, autopoietic↑ activities in enclosed systems↑ happen synchronously with the existence of guiding rules↑ in enclosing systems↑.

System   A system is understood in this work as an ontologically↑ real entity that can be distinguished from its environment by a local minimum of activity↑ defining its boundary↑. The system itself shows relatively frequent activity inside, as compared to the activity across its boundary. Further, a system can be distinguished by its particular emergent quality↑—that cannot be explained by the study of the system's parts↑. Together, the emerged system, which is enclosing, and the parts, which are enclosed systems, form a whole↑.

System theories   A wide variety of work relating to systems↑. Some theories aim at describing general system principles that are applicable to a variety of systems, such as autopoiesis↑, self-organization↑, and system boundaries (see, e.g., Troncale 2011). The theories by Nicolis and Prigogine (1977) and Haken (1977) introduce concepts similar to guiding rules in this work. Other system theories are disciplinary, including theories of cities as systems (e.g., Portugali 1999).

Targeted activity   Purposive activity, voluntarily carried out with foresight (see also untargeted activity).

Type   According to the theory of ENS, each emergent quality↑ is unique. However, in some cases it might be useful to classify emergent qualities, e.g., for comparative studies (cf. also single case studies). Also, for devising generative activities↑

and guiding rules↑ that could lead to the emergence↑ of a desired quality, it is necessary to distinguish types of emergent qualities. For example, where a thriving urban neighborhood is targeted, it will not be possible to design the exact quality that emerged elsewhere, but it may be aimed at the emergence of the same type of emergent quality. In other words, the unique, emergent quality is an instance of a type of emergent quality. The type of quality can be predicted, as opposed to the particular quality of the instance.

Untargeted activity   Activity without foresight, such as biological mutation (see also targeted activity).

Upward influence   (see outward influence)

Urban systems   In this book, I generally refer to any complex system↑ in a city as an urban system, but I also refer to the whole↑ of a city as an urban system. Although the system of many cities is a complex system as well, this is not referred to in the context of this book.

Whole (see also emergent quality and system)   A whole is the entirety of the emergent quality↑ of the enclosing system↑, including its guiding rules↑, the enclosed systems↑, and their generative activities↑. A whole is discernible by its unique, emerged quality. It comes into existence through the diachronic↑ emergence of a new quality, and it is autopoietically↑ and synchronously↑ maintained by generative activities that are aligned by guiding rules↑.

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