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Forms of self-organization: Urban complexity and planning implications

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journals.sagepub.com/home/epb **Stefano Moroni**

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Abstract

The implications of self-organizing phenomena for planning strategies and interventions are a relatively new topic of research that is gaining increasing traction with urban planners and the emerging literature. The problem is that the concept of self-organization is at present applied in a variety of different ways in the contemporary planning debate, a fact that has generated misunderstandings, dubious definitions, and questionable practical suggestions. The aim of this article is to (1) unravel this complex issue by differentiating urban phenomena that are usually all labeled as self-organizing; (2) identify which of them is the most challenging for planning theory and practice, and (3) discuss how planning can productively relate to this form of self-organization.

Keywords

Complexity, self-building, self-coordination, self-governance, self-organization

Introduction: Re-discussing self-organization in the urban realm

The implications of self-organizing phenomena for planning strategies and interventions are a relatively new topic of research that is gaining increasing traction with urban planners and the emerging literature (as evidenced by the extensive critical overview by de Bruijn and

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Gerrits, 2018). The problem is that the concept of self-organization is at present applied in a variety of different ways in the contemporary planning debate, a fact that has generated misunderstandings, dubious definitions, and questionable practical suggestions (Pizzo, 2018; Rauws, 2016).

The aim of the article is to (1) unravel this complex issue by differentiating urban phenomena that are usually all labeled as self-organizing; (2) identify which of them is most challenging for planning theory and practice, and (3) discuss how planning can productively relate to this form of self-organization.

With the term “planning,” we refer to what is usually called urban and regional planning. And we mainly have in mind “public planning,” that is, planning by public authorities (e.g., local governments). In our analysis, the attention—in terms of legislative and empirical examples—will be predominantly on Western countries and Western cities. This focus is necessary in order to provide some coordinates for what otherwise would be too broad a discussion.

Three self-organizing urban phenomena: Self-building, self-governance, self-coordination

This section presents the features of three different self-organizing phenomena that are relevant to the urban realm, and which we shall term: (1) *self-building*, (2) *self-governance*, and (3) *self-coordination*. In our opinion, clearly distinguishing these types of urban self-organization is a first and important step toward achieving a critical understanding of the issues at stake.¹

The three types in consideration here were chosen because they are all generally labeled as “self-organizing” urban phenomena in the planning literature.² In effect, all of them have to do with non-hetero-directed forms of organization, meaning that they are not directly determined from the outside but are instead endogenously generated. While all three cases have features in common, the tripartition stems from the salient characteristics that differentiate them, as we shall show later.

First case: Self-organization as self-building

We use the term “self-building” to denote a situation in which the first occupants arrange for the building of their own homes, participating—to varying degrees and in varying ways—to the production of housing units (Duncan and Rowe, 1993: 1331). In this case, households are directly involved in the production of their homes, rather than buying them ready-built on the speculative market from a traditional developer (Clapham et al., 1993: 1355). By “households,” here we mean a group of households acting collectively or an individual household acting alone. Their involvement occurs in various ways: (1) households may personally build their home in part or in its entirety, by themselves or with the aid of relatives or friends, for instance (a practice usually termed *self-* or *auto-construction* in a strict sense); (2) alternatively, they may act as promoters by bringing together the elements of the design, land, and construction, even if they are not directly involved in the building process (what can be termed *self-promotion*); (3) or, lastly, they may be actively involved in programming and managing the building process (*self-development*) (Clapham et al., 1993: 1355).

Self-building is, therefore, a situation in which (future) residents have an active role in the building process of their (future) homes. They truly “have a say” in the building process and

the way the end product is realized and put to use. Self-building implies that the figure of the *initiator* and that of the *user* coincide.

Recently, governments across Europe have attempted to boost self-provided homes. The *Housing Strategy for England*, published in November 2011 by the UK government, includes, for instance, the objective to encourage and support individuals and groups taking the initiative to build their own homes. In the Netherlands, an adjustment of the *National Spatial Planning Act* in 2005 introduced subsidy schemes for similar reasons.

In short, the main point of self-building is the *enterprising autonomy* of individuals in obtaining their own dwelling. By “enterprising autonomy,” we mean the ability of households to undertake their own projects and actions rather than being merely passive consumers of something provided by others.

Second case: Self-organization as self-governance

Self-governance involves processes of collective decision-making and action undertaken by groups of people sharing common objectives in relative independence from public actors and institutions. Groups that engage in urban self-governance take responsibility for steering and managing community projects and services that are meant, first and foremost, to serve their own members (and are only eventually open to other users) (Rauws, 2016). In cities, typical examples are homeowner associations, local energy communities, and community gardening organizations. In a homeowner association, for instance, a set of dwelling units are individually owned by the members, and a range of common facilities (community spaces, parking lots, streets, green areas, etc.) are collectively owned through the association itself. The homeowner association is managed by a board that the members of the association appoint. Members automatically enter the association at the time of purchasing their home. By doing so, they also accept a set of basic rules, substantive and procedural, and agree to pay periodic fees for the functioning of the association itself and the management of the common spaces.

Groups that embark on self-governance may vary considerably in size, ranging from very small, closed groups—for instance, a handful of households—to wider community projects involving more people. In all cases, however, members of these groups act and plan their activities voluntarily, while governmental actors remain at a certain distance. In other words, while governments may provide favorable conditions for starting a collective initiative or promoting their long-term existence, members of these groups act and plan their moves deliberately in order to achieve a shared goal. Because these organizations have specific, purposeful ends, their members are guided by some form of internal, explicit coordination.

In brief, the main point of urban self-governance is *decision-making independence*. Self-governance is effectively *self-ruling* (i.e., intentionally producing a group’s own rules regarding, in our case, the use and transformation of spaces and buildings) plus *self-management* (i.e., intentionally administering and running common services and infrastructure in a certain place) without the direct and substantial guide or support of the public authorities.

Third case: Self-organization as self-coordination

Self-coordination can be seen neither as a specific product of deliberate human action nor as a fully natural phenomenon independent from human action. Instead, it entails an emerging process: place-based actions, interactions, and chain reactions produce certain *patterns* in which the expectations and actions of a plurality of agents tend to be spontaneously coordinated. To put it differently, although they are not intentionally organized, emergent patterns of actions generate systemic expectations and orders that, in turn, influence and

coordinate the actions and interactions of numerous individuals within that system (Marshall, 2009: 185–214).

The variety of actions at the local level and their potential to generate new spontaneous patterns (i.e., self-synchronizing supra-individual structures) imply that processes of self-coordination are highly difficult to predict, if not impossible. Individuals interact and respond subjectively to their immediate environment in trying to achieve a better fit. Such responses are based on dispersed knowledge of particular circumstances of time and space, which concern all the various individuals involved (Hayek, 1945).

Examples of emerging self-coordinating mechanisms are, for instance, real-estate markets (Andersson, 2012) and the clustering of economic activities (Holcombe, 2011), urban growth and land-use evolution (Haase et al., 2012; Marchand, 1984; Schweitzer and Steinbrink, 1998; White and Engelen, 1993), traffic and pedestrian flows (Helbing et al., 2001; Kerner, 1998), and social networks (Helbing et al., 2011).

In short, the main point here is *spontaneous alignment*: that is, the process whereby self-synchronization occurs in society without being intentionally organized by anybody. This process creates a system in which the actions of separate, independent individuals are spontaneously coordinated.

Similarities and differences among the three types of urban self-organization

All three types of self-organization are to a greater or lesser extent part of the urban realm. In this section, we discuss their key similarities and key differences (Table 1).

Three shared characteristics

Self-building, self-governance, and self-coordination share three key characteristics. First, all three phenomena represent—and effectively are—forms of organization of urban activities.

Table 1. Similarities and differences among self-building, self-governance, and self-coordination.

	Self-building	Self-governance	Self-coordination
Commonalities	<ul style="list-style-type: none"> • Introduce a certain degree of order • Not directed from the outside • Relative independence from government 		
Differences			
<i>Outcomes</i>	New dwellings and buildings	Common rules and service management	Expectations about compatible actions
<i>Reciprocal knowledge among the actors involved</i>	Present from the outset	Mainly ongoing	Absent and largely impossible
<i>Mode of interaction</i>	Collaboration required	Collaboration required	Collaboration not necessarily required
<i>Knowledge base</i>	Specific knowledge of an individual or group	Specific knowledge of an individual or group	Dispersed social knowledge
<i>Form of communication</i>	Direct (e.g., meetings)	Direct (e.g., assemblies)	Indirect (e.g., signaling)
<i>Responsibility</i>	Direct, shared, and intentional	Direct, shared, and intentional	Indirect
<i>Level</i>	Plot level	Pre-targeted groups or networks	Unconstrained

Although each does so in different ways, they all introduce a certain *degree of order* into social-spatial situations. Secondly, and as already mentioned, they are not directed from the outside, in the sense that they do not emerge under the will and guidance of external actors. It is something *endogenous* to them that generates the order in question. Thirdly, all three self-organizing phenomena emerge and develop *relatively independently* of formal public authorities. We say that they are relatively independent—and not completely independent—because they clearly emerge and develop, in their particular and specific form, under certain conditions set by governments (Zhang and De Roo, 2016). Here “relative independence,” therefore, means that governments, instead of determining them, posit the institutional background conditions within which the three self-organizing phenomena can occur.

In the case of self-building, these institutional conditions include, amongst others, public building standards. In the case of self-governance, initiatives must take place in accordance with public rules that establish the boundaries within which it can legitimately happen: public rules can, for instance, (1) establish what barriers to entry are prohibited (in the United States, e.g., the *Fair Housing Amendments Act* of 1988 expressly outlaws discrimination, based on skin color, race, ethnic origin, gender, in a person’s right of access to property or the use of private common services) and/or (2) what actions by members cannot be prevented (for instance, in 2011, Texas enacted the *House Bill 362*, which forbids homeowner associations from prohibiting solar-energy devices). Meanwhile, governments also employ a range of soft strategies to generate more favorable conditions for self-governed initiatives, for instance, by connecting up potential initiators and offering incentives.

Self-coordination also arises within a set of basic rules. These rules, too, can be public rules guaranteed by the state. These rules do not concern self-coordination *itself*, but a basic framework: the real-estate market, as a self-coordinating system, is, for instance, generated by guaranteeing certain framework rules, such as the possibility of private ownership of land/buildings and freedom of contract. In short, spontaneous social orders—that is, situations entailing the unintended reciprocal coordination of actions among a plurality of individuals—have to be distinguished from the system of abstract rules that contribute *indirectly* to their emergence.

To conclude, public authorities are not absent, but, in all three cases, they have—or, in any case may have—a particular role as guarantor of the underlying framework. How they can best perform this role will be examined after exploring the differences among self-building, self-governance, and self-coordination.

Seven key differences

The three types of self-organization differ with respect to the following elements. A first key difference regards their *outcomes*. Self-building regards specifically the material construction of new dwellings and buildings: its outcome is mainly physical. Self-governance mainly regards the creation of common rules and managing practices regarding collectively arranged spaces and services (without necessarily building new elements). Self-coordination regards the emergence of socio-spatial patterns in society (i.e., spontaneous orders of actions) which create a certain degree of expectation among citizens regarding the compatibility of their plans.

A second difference concerns the degree of familiarity among the involved actors (i.e., whether or not those involved actually know each other). In the case of self-building, the individuals involved are acquainted with each other from the outset. In the case of self-governance, the individuals involved mostly meet in the course of the process. In the case of self-coordination, individuals hardly ever even meet. This is due to the sheer number of people involved in urban self-coordinating mechanisms.

A third difference concerns the form of interaction. In the cases of self-building and self-governance, collaboration is usually the key factor, whilst in the case of self-coordination, collaboration is not necessarily required. People can interact in this case without any specific collaboration, and even through competition. As Strogatz (2003: 35) observes, in many large self-coordinating systems, “synchrony reflects competition, not cooperation.”

A fourth difference concerns the knowledge that has generated the form of order in question. In the case of self-building and self-governance, the form of order (i.e., a deliberate organization or arrangement) is generated by those who have purposely decided to create and maintain that particular kind of order. Its form will, therefore, largely depend on the (limited) knowledge that a specific individual or group of individuals can possess. In the case of self-coordination, the knowledge that generates and maintains the type of order (i.e., a spontaneous pattern) is that of the multitude of directly and indirectly interacting individuals who unintentionally contribute to its emergence and persistence. An order generated by self-coordination, therefore, embodies more knowledge than each individual or group can possess independently.

A fifth difference concerns *communication*. In the cases of self-building and self-governance, individuals can communicate directly; this is why participation in various forms is usually invoked. By contrast, in the case of self-coordination, the individuals involved neither know nor meet each other personally—as already stressed—and communicate only indirectly by leaving indications to which others respond (e.g., bids on the housing market, or desire paths through spaces). In this case, individuals are links in various chains of transmission through which everyone receives signals enabling him/her to adapt his/her programs to circumstances and situations that he/she cannot oversee completely (Hayek, 1988: 84). Incidentally, this is one of the reasons why “participation” cannot be a key strategy in the case of large self-coordinating socio-spatial systems (Pennington, 2004).

A sixth difference concerns the issue of *responsibility*. Self-building and self-governance are based upon intentional actions—single individual motivations and groups of individuals with common motivations—oriented toward a predetermined goal (Rauws, 2016). Self-building and self-governance are possible precisely because certain individuals consciously and expressly adopt certain specific ends which guide their common actions. The final arrangements are, therefore, present and prefigured a priori in the minds of the individuals involved. This cannot be said of self-coordination. In self-coordination, the individual actions constituting the system are purposeful and intentional, while the emerging patterns are not. The process of creating them is beyond people’s control. Put differently, the general self-coordinating patterns that emerge are not part of the specific aims of the individuals who contribute to their emergence: nobody acts with the objective of establishing certain specific overall patterns of actions. In this sense, self-coordination itself does not exist *ex ante*, in all of its details, in the minds of the individuals involved, but emerges *ex post*. All this has major consequences for the issue of responsibility. In the cases of self-building and self-governance, it is possible to recognize specific groups of individuals who are *directly* responsible for the main outcomes of their projects (e.g., new houses or new community arrangements). By contrast, in the case of self-coordination, such direct responsibility is inherently absent. Intentionality is distributed among all the various individuals acting: they interfere with the process of pattern formation without being able fully to understand the effects of their involvement.

A seventh key difference regards the *levels* (i.e., scale) at which the self-organizing phenomena appear and are at work. Self-building manifests itself mainly at plot level. Processes of self-governance are oriented to pre-targeted groups and social networks within the city, ranging from street communities to city-wide collectives. In contrast, self-coordination is not

constrained to any particular level of urban or supra-urban development: because it is not connected with any specific intentionality or project (as in the case of self-building and self-governance), self-coordination is not limited by the real imaginative or design capacity of a particular individual or group. Instead, self-coordination gives rise to certain intersubjective meta-conditions, which, in turn, influence the actions of different individuals and organizations at various levels.

Why self-organization as self-coordination constitutes the main challenge for planning

All the three forms of self-organization considered here pose some kind of challenge for public planning; that is, they invite reconsideration and revision of certain consolidated views and tools. This applies to any kind of planning, as a deliberate attempt to regulate socio-spatial situations, but especially to planning by formal, public authorities. The first case of self-organization considered, namely *self-building*, is a challenge because it constitutes a very special channel of access to housing. Households are not mere passive consumers in this case. Rather, they are actively involved in the actual production of their homes. Generally considered as a significant practice only in certain countries of the global South (i.e., a recourse for poor areas only), self-building is actually an increasingly significant method for developed countries as well.

The second case of self-organization considered, namely *self-governance*, represents a challenge because it constitutes an intermediate level of governance (linked to the introduction of rules and management of services) lying between public authorities and individuals or isolated families. This level of governance, which is gaining traction in many Western countries, was not always recognized as crucial in the 20th century; sometimes, it was also explicitly hampered (Beito et al., 2002; Body-Gendrot et al., 2008).³

The third case of self-organization, that is, *self-coordination*, is a challenge because its spontaneous form of coordination does not coincide with forms of top-down coordination. Furthermore, its spontaneous nature prevents planners from fully understanding and anticipating the potential consequences.

In all three cases, and if we accept that something positive can be found in them, public actors can mainly act as enablers and guarantors (ensuring that they happen without any harmful fallouts). Here we shall focus on the role that the public could play particularly in the third case, as we believe that this is the most challenging for planning (Boonstra and Boelens, 2011; Cozzolino et al., 2017; Rauws et al., 2016). In this regard, note that the question of *complexity*—so widely debated today in urban studies and planning theory—almost solely concerns our third case. It is indeed self-coordination that constitutes *the distinctive and central component of complex (urban) systems*.

But let us consider more specifically why self-coordination is, in our view, the main challenge. The point here is that orthodox planning theory (e.g., Abercrombie, 1943; Mumford, 1938) and, very often, later planning theory (e.g., Rydin, 1993: 367), have mainly considered two alternatives to be possible: (i) *top-down coordination* (i.e., public planning) or (ii) *chaos* (i.e., anarchy and disorder). The idea that coordination has to be imposed on otherwise uncoordinated socio-spatial systems is at the core of the very idea of planning. As Marshall (2009: 139) observes: “city planning is effectively premised on the idea of the unplanned city as disordered and dysfunctional.” While this traditional attitude is partially attenuated in contemporary planning practices, discussion on how planning strategies and policies can enable, constrain, or trigger urban self-coordination is still limited (Rauws and De Roo, 2016). Therefore, the remainder of this article investigates more

directly and deeply the implications of self-coordination for urban planning. Part of what follows also applies to the other two self-organizing phenomena discussed earlier, but here we shall focus, above all, on the latter, since as already noted, this is the most disruptive one as concerns planning practices.⁴

The fundamental point is that self-coordination is crucial, not for putting everything in the right place, but for generating new powers and possibilities which would otherwise not have actually existed (Hayek, 1988: 79). In these cases: “We are able to bring about an ordering of the unknown only by causing it to order itself” (Hayek, 1988: 83).

Planning for desirable and beneficial self-coordination

There are good reasons for developing strategies that allow planners to relate productively to urban self-coordination. As shown by Schelling (1978), not all self-coordinating phenomena are inherently good or desirable. For instance, certain spontaneous orders in real-estate markets are positive (e.g., efficient market relationships over time), while others are negative (e.g., residential patterns fostering segregation). Informed by societal preferences and democratically established priorities, planners can seek to promote beneficial development directions and prevent problematic issues from being exacerbated. However, the degree of control over urban development is limited because the exact outcomes of self-coordination development processes (e.g., specific socio-spatial configurations) cannot be dictated. Planning can only reduce or enlarge the space for the expression of self-coordinating phenomena in cities.

What are the possible ways in which public planners can intervene? We consider three main ways for planners to influence, and potentially channel, urban self-coordination processes: (1) by setting specific *framework rules*, (2) by installing particular *carrying structures*, and (3) by encouraging certain *piecemeal experiments*.

The following discussion derives, above all, from taking self-coordination seriously as an *empirical* phenomenon: that is, by recognizing the existence and the particular mode in which self-coordinating phenomena arise and operate. Obviously, some *values* are also implicated here, but these are minimum values, such as the right of each individual to choose his/her own life plan, the right of each individual to a sphere protected from intrusion/damage by others, the right of everyone to free association with others, and so on. Given the restricted space of an article, only some points can be underscored, but hopefully they will suffice to at least give an idea of the general perspective. Taken one by one, they are not completely novel (see e.g., Marshall, 2009; Moroni, 2007; Portugali, 2012 for some of them), but we will try to show, and elaborate on, how they are all connected together within a planning approach that fully recognizes the role of self-coordinating urban phenomena.

First tool: Framework rules

To understand the role of what have been called “framework rules” (Moroni, 2015), we must first reiterate that self-coordinating patterns are not interpreted here as *systems of rules*, but, instead, as *spontaneous orders of actions*. The latter come into existence because of the presence of certain background rules (Moroni, 2014a). Complex, self-coordinating urban orders are, therefore, not anarchic, but require certain kinds of rules, namely framework rules.

Framework rules are the opposite of *patterning rules*: instead of defining a desirable configuration in detail, they supply a general framework for urban development that “incorporates” the unplanned and spontaneous ways in which cities coevolve. In other words, they provide a general framework that allows complex self-coordinated orders to flourish. Framework rules are (1) simple, (2) relational, and (3) mainly negative.

Simple rules differ from complex rules inasmuch as they are (Moroni et al., 2018) understandable and determinate (i.e., written in a plain language that does not generate unnecessary uncertainty), entail a binary response (i.e., a clear-cut yes/no answer as regards compliance), avoid introducing complex distinctions and differentiations within each rule and are part of regulatory systems that have a low rule density (i.e., having both a small number of rules and interrelations among them). The simplicity of the rules is important because they enable a heterogeneous multitude of urban actors to navigate complex and changing circumstances. “Decentralized, complex systems require simple rules, which will allow individuals to focus on making the many other mutual adjustments which they must make in order for the system to function” (Zywicki, 1998: 147). By contrast, the complexity of rules tends to place the power of interpretation and coordination in the hands of people other than those more directly involved in the action and interaction (Epstein, 1995).

Relational rules concern only abstract and general situations: that is, standard and typical (forbidden or permissible) relationships between urban action and transformations. They do not concern specific circumstances, as happens in the opposite case of directional rules (Alfasi and Portugali, 2007; Moroni, 2015). They reconcile the actions of individuals solely in relation to their “typical features” (i.e., their repeatable, time-independent, and situation-independent aspects, such as building and transforming objects in space that have volume/extension and interact with other objects, etc.), but not in relation to their “specific features” (i.e., their unrepeatable, time-dependent and situation-dependent aspects, such as constructing or transforming building A, in neighborhood B, in city C, at time D, according to the particular goal E) (O’Driscoll and Rizzo, 1985). Thus, they can grant a form of *abstract* synchronization, but certainly not a synchronization of *details*. Overall, relational rules can reduce uncertainty, though not eliminate it. They narrow the range of urban actions and interactions to some typical and general classes, leaving room for spontaneously emerging patterns. Since these rules are nonspecific and end-independent, the social-spatial system is kept open to dynamic adjustments.

Negative rules are rules telling people what should not be done (in particular, which negative externalities must be avoided when using or transforming urban buildings and spaces), as opposed to positive rules instructing people what must be done (e.g., which specific features a building must have) (Moroni, 2015). For instance, planning should regulate not so much the *uses* of private buildings and private spaces as the undesired *effects* of such uses, regardless of what they might be. Formulating primarily negative rules fosters the openness of cities to unforeseen developments, while safeguarding important societal values. Whilst in the case of positive rules, individuals’ actions are coordinated in their details by a visible hand according to some end-state plan, in the case of negative rules, individuals’ actions are self-coordinated once certain harms are prohibited (Kasper and Streit, 1998: 97). Note that formulating positive rules requires more knowledge than is needed to formulate negative rules; as Kasper and Streit (1998: 97) point out: those who prescribe the behavior of actors have to be aware of the means at their disposal and of their abilities, as well as of the possible consequences of the prescribed behavior. By contrast, those who merely rule out certain kinds of action, as is the case with negative rules, only need to know that certain behaviors are undesirable; the specific details of the behavior, and the assessment of its effects, are left, in this case, to the actors themselves.

In short, framework rules are not *shaping devices* but, mainly, *filter devices* (Moroni, 2015). In this sense, they allow for spontaneous pattern formation as a result of the self-coordination of multiple, different actions (undertaken by citizens, architects, designers, developers, etc.) while providing planning with the means to enable or constrain a certain range of potential social or physical patterns.

Second tool: Carrying structures

In order to perform and function, cities also require certain collective structures that facilitate people's actions, interactions, and coexistence, above all, in dense and complex urban environments. Particularly, we refer here to those spaces, infrastructure and services that struggle to emerge "spontaneously" in society—because they are rarely subject to market transactions—but are nevertheless vital for triggering and enhancing self-coordination in complex urban systems (Bertaud, 2018). In a dynamic world of rapid changes, these infrastructures represent a stable and persistent background framework for all urban agents (Andersson and Andersson, 2019). Their presence not only secures welfare and equity; if correctly planned, such structures foster the city's capacity for self-synchronization (Rauws et al., 2014).

In short, planners have a major responsibility also in the provision of certain collectively relevant spaces and infrastructures, which serve the urban system as *carrying structures* (Salingaros, 1998). Upfront public intervention is often indispensable for the construction of such schemes. Basic transport networks are typical examples of urban carrying structures. The persistence of cities relies heavily on the mobility of people and goods. Mobility entails the possibility of contacts between urban agents, for example, workers and firms. It increases when the possibility of new contacts (e.g., the number of jobs and amenities) that can be reached within a specific amount of time increases (Bertaud, 2018: 143).

Public infrastructures can play a crucial role in fostering the development of extended transport networks and strengthen the city's capacity for self-coordination. Without public structures, the aggregation of privately provided roads does not generate an extended metropolitan network. Private developers usually provide local access roads to their own properties: but while this step-by-step development may work well locally, it does not solve important systemic issues like congestion. This is why cities *also* need basic public infrastructures.

Inspired by Salingaros (2005), we can briefly state three main principles for the design of such carrying structures that fit the self-coordinated complexity of cities: (1) redundancy, (2) complementarity, and (3) hierarchy. The first principle is *redundancy*. Carrying structures require a certain level of redundancy. Redundancy can be improved by providing multiple options to perform given actions (e.g., urban districts with several access roads), and by designing carrying structures that allow for multiple uses (e.g., a green pedestrian corridor that preserves environmental values, helps to ventilate the city, and provides opportunities for leisure and sports). In so doing, the level of organized complexity is potentially increased by widening the action space for citizens.

Second is the principle of *complementarity*. Bearing in mind that urban activities, in general, are less durable than infrastructures such as streets or sewage systems, carrying structures are the preferred means for networking complementary functions. The vitality of a city depends, amongst other factors, on a high degree of connectivity and interdependency among multiple elements and different functions. These connections are more meaningful and, therefore, more durable if they link a multiplicity and variety of urban elements (such as stations, cultural centers, urban parks, schools, housing, shops, etc.) so that the overall intricacy and interconnectedness of the system are increased.

Third is the principle of *hierarchy*. Carrying structures have to be provided at the basic local level, the city-wide level, and also at intermediate levels, to form the complex urban web that vital cities thrive upon. Because the development of carrying structures can be expensive, an incremental mode of development is preferable to sudden, large investments. Moreover, in this way, new projects can work with rather than against emerging social-spatial circumstances.

In addition to transport networks and infrastructures, other examples of carrying structures are blue–green networks and, more recently, data networks and digital (public) platforms. Blue–green networks play a twofold role in cities by preserving important ecosystems and controlling urbanization processes in zones subject to natural risks (e.g., earthquakes, flooding, etc.) (Carter et al., 2018). Digital platforms work as transaction intermediaries and transaction facilitators, reducing certain interaction costs among many different urban actors by connecting them for mutual benefit (Kiesling, 2018). Examples are real-time systems to monitor certain urban phenomena (e.g., environmental conditions, traffic information, etc.), apps with which citizens can report faults, damage and problems of various kinds, portals that enable citizen participation in projects but also furnish free available data, and so on (Thompson, 2016).

Third tool: Piecemeal experimentation

Fostering experimentation is a third, distinctive way in which planning can influence urban self-coordination. This includes policies that provide incentives (e.g., subsidies, tax abatements) or favorable conditions (e.g., opening up abandoned urban sites) for advancing certain types of experiment. Experiments furnish opportunities to test alternative practices to deal with the challenges faced by cities (e.g., pollution issues). They can foster new community lifestyles by enabling citizens to experience a different possible future, unlocking the practical knowledge of local actors by providing real life, co-creative test beds, and challenging existing policy routines (Evans et al., 2016).

While various theoretical perspectives have been developed, we focus here on the idea that experiments are crucial sites for shaping the futures of cities, because cities are intrinsically experimental and “machines for learning” (McFarlane, 2011). This perspective aligns with the bottom–up nature of spontaneous urban orders.

As discussed earlier, self-coordination gives rise to patterns which may or may not be socially desirable. If they are not, problems would be solved by replacing an undesirable pattern with a more desirable one. However, doing this in a totally top-down manner neglects complexity, and the results are often disappointing. By taking account of the bottom-up nature of self-coordinated changes, planning can instead seek to trigger a “symmetry break” in the pattern formation process. By promoting such local deviations via experiments, a critical point may be reached for establishing a new, more desirable pattern at system level.

Experiments differ in the extent to which they are prestructured. Grassroots experiments (Seyfang and Smith, 2007) or tactical urbanism (Lydon and Garcia, 2015; Silva, 2016) are typically somewhat informal and provisional. They produce novel bottom-up solutions through networks of citizens or community organizations, and are often closely connected to local interest and community values. On the one hand, their informal nature leaves room for truly radical action that may trigger transformative change. On the other hand, however, the fact that they are developed outside existing planning institutions may reduce their possibility to generate real impact. More structured and strategic experiments include urban living laboratories (Bulkeley et al., 2019) and niche experiments (Schot and Geels, 2008); they have an explicit learning function, and policy makers can upscale those experiments that deliver “successful” outcomes. These strategic experiments often include a range of public and private partners.

In challenging habits and routines, this kind of experimentation is typically *opportunistic* in nature, and therefore offers “laboratories” to test whether alternative practices can successfully fill the gaps between people’s needs and dominant habits. Such experiments also

explicitly embrace *temporality*. Because exploration is the main aim, and failure is a serious possibility, their design (e.g., materials or organization structures) is one that embraces a nonlinear dynamic and enables actors to act under conditions of uncertainty. Finally, because they include crude attempts to do things differently, they are *unfinished* in nature. This means that potential barriers for others to join, add to, and further adapt the experiment are, in principle, lower. Meanwhile, the probability of “symmetry breaks” reaching a critical point is increased.

In short, experimentation can foster local-level trial and error in the search for urban niche innovations that are needed for urban vitality and urban resilience. As recent studies show, the institutional conditions for experiments have a major impact on their potential to unlock urban routine (Finn, 2014; Raven et al. 2019). Nevertheless, the use of experiments must be limited to a certain extent. Continuous experiments as an ordinary planning praxis may also have counterproductive effects in the long run. They would require urban actors to readapt their behavior continually to public planners’ decisions, and thus may dismantle local expectations. Despite their significant potential in “breaking urban routines” (Rantanen and Faehnle, 2017), experiments should therefore be limited in number, length, and scale.

Concluding remarks and open questions

This article has attempted, first of all, to clarify how *different* self-organization processes take effect in urban environments. It has argued that: (1) self-organization as self-building is in essence about the *enterprising autonomy* of individuals in obtaining new dwellings; (2) self-organization as self-governance is about the *decision-making independence* of a group of individuals to decide on their own private rules and services without the direct support of external governmental organizations; (3) self-organization as self-coordination is about *spontaneous alignment*, that is, the process whereby synchronization occurs in society without being deliberately created by anybody. These self-organizing phenomena share certain features. But they also have, as we have evidenced, fundamental differences.

Secondly, the article has stressed that especially self-coordination, as a core mechanism of complex urban systems, poses a major challenge to urban planners and their established repertoire of tools. This article has considered three ways in which planners can productively relate to self-coordination: (1) particular framework rules, (2) specific carrying structures, and (3) certain piecemeal experiments. These provide opportunities for intervening via systems of *rules*, *projects*, and *policies*. In short, although self-coordination requires planners to be humble about their capacity to manage urban change, they have an important role in providing those constraining, enabling, or triggering conditions under which self-coordinating systems can emerge and evolve toward socially desirable directions.

As regards possible developments along the line of inquiry considered in this article, an issue that has remained largely implicit, but which warrants specific study, is that of *power* (Pizzo, 2018). Each of the three self-organizing mechanisms considered here implies a particular subdivision of certain forms of power, for example, between public authorities and citizens, but also among citizens. We intend to deal with this topic in a future work.

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Notes

1. For other attempts to unpack different manifestations of urban self-organization (albeit in this case two, which lead in quite different directions), see Eizenberg (2019) and Pizzo (2018).
2. For example, self-building as a practice of self-organization is discussed by De Carli (2016). Self-organization as self-governance is considered, for instance, by Morales (2010), Finka and Kluvánková (2015), and Edelenbos et al. (2018). Urban self-organization, understood in the strict sense of self-coordination, is discussed by Marchand (1984), Portugali (1999), and Partanen (2015), among others.
3. In Italy, for instance, certain laws hampered traditional forms of collective private ownership of natural resources: in particular, law no. 1766 of 1926, which is still in force, introduced rigid categories that prevented a great variety of existing and possible arrangements (Lottieri, 2010).
4. For a discussion of how the role of public regulations and interventions could change in other cases of self-organization, see, for example, Moroni (2014b).

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