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Complexity as a Domain between Order and Chaos: Implications for Organizational Scholarship

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Abstract

Organizations are grappling with increasingly complex challenges, including those stemming from technological disruptions, geopolitical uncertainty, and climate change. Despite the increasing acknowledgement of the complexity inherent in many organizational problems, complexity theory has had limited impact on mainstream management scholarship. Synthesizing contemporary complexity literature, we conceptualize complexity as a systemic property of a certain – and, we argue, rather broad – domain of organizational problems, and complexity theory as a theory of change in such organizational contexts. This view of complexity implies that complexity theory has important implications to organizational scholarship at large, indicates limitations of using conventional scientific methods, and suggests that the credibility and replication crises in many branches of organizational research may not be treatable simply by better statistical designs. Instead, methodological choices in complex organizational domains should take account of the properties of non-linearity and emergence, and organizational scholars should embrace complexity theory not only as an explanatory framework but also to inform research design.

Keywords

complexity, emergence, non-linearity, organizational change, replication, research methods, wicked problems

Introduction

The application of complexity theory to organizations has a long history, dating back to early work by Simon (1962). Complexity theory has been applied to shed light on a variety of organizational problems, such as organizational design (Levinthal and Warglien, 1999; Siggelkow and Rivkin, 2005), organizational adaptation (Brown and Eisenhardt, 1997; Boisot and Child, 1999), group dynamics (Okhuysen and Eisenhardt, 2002; Madden et al., 2012), and innovation (Damanpour, 1996; Ethiraj and Levinthal, 2004b). With its focus on nonlinearity and complex causal relationships, it has apparent appeal when it comes to the study of a social world that successive generations of scholars have argued is increasingly volatile, uncertain, and dynamic (Bettis and Hitt, 1995; D'Aveni et al., 2010), and confronted with increasingly complex problem contexts, such as climate change, geopolitical tensions, and the transformative impact of artificial intelligence (Turner and Baker, 2019; Kreienkamp and Pegram, 2021).

Despite the growing interest in complex organizational problems, complexity theory has had limited influence on mainstream management scholarship. We argue that this limited uptake reflects both an epistemological challenge and what is more of a sociocultural problem. In terms of epistemology, complexity theory's focus on non-linear, emergent properties clashes with the linear causal assumptions of dominant research methods (Stacey, 1995; Anderson, 1999). In sociocultural terms, there is also a cross-disciplinary “translation problem”, where complexity is often imported as a loose metaphor rather than developed into actionable theories for organizational phenomena (Burnes, 2005; Rosenhead et al., 2019).

However, this lack of impact does not reflect lack of importance. On the contrary, the complex nature of organizational systems means that complexity is a fundamental feature of organizational scholars' object of study. Thus, the problem is not only that complexity theory's potential insights for organizational scholarship have had limited practical impact; perhaps more importantly, the lack of appreciation of the nature of complexity means that organizational scholars still largely approach their subject as if it followed Newtonian causality.

In this essay, we outline how a better understanding of complexity theory could inform organizational research and practice and help us better tackle, or at least understand, both complex global problem contexts and the scholarly challenges in the study of complex organizations. To do so, we briefly revisit and synthesize the existing literature on organizational complexity over the last 60 years, discussing how our understanding of complexity in organizations has evolved over time. Based on this synthesis, we conceptualize complexity as a domain of organizational problems that poses unique challenges for research and practice. Dissecting the characteristics of the complexity domain, we discuss how complex problems are qualitatively distinct from ordered or chaotic ones, and what managers and organizational scholars can do to embrace complexity theoretical understanding in an actionable way.

The Evolution of Complexity Literature in Organizational Research

Complexity theory is a trans-disciplinary branch of knowledge with a long history of applications in organizational research as well. Organizational phenomena have been routinely framed as

"complex" (e.g., Barnard, 1938; Lawrence and Lorsch, 1967; Gavetti et al., 2005) and central concepts in complexity theory, such as feedback loops and emergence, have provided useful theoretical entry points for debate among organizational scholars (e.g., Simon, 1962; Levinthal, 1997; Colbert, 2004). In order to synthesize organizational complexity theory, it is informative to first have a brief look into how the treatment of complexity in organizational research has evolved and what kind of perspectives have proven fruitful for contemporary scholars. For this purpose, a summary of the literature on complexity theory in organizations is shown in Table 1. In the evolution of this literature, three broad stages can be identified.

---------- *Insert Table 1 about here* ----------

First, the early applications of complexity theory tended to draw associations between general theories of complex systems and identifiable, tangible characteristics of organizations, for instance the structure of organizational tasks (e.g., Simon, 1962; Thompson, 1967; Aiken and Hage, 1968). These early scholars focused on aspects of complexity theory where there were clear parallels to be drawn to organizational contexts. This applied to understanding the different elements constituting organizational systems, interdependencies between these elements, and where the structure of these interactions lay within the boundaries of these systems. In other words, in these early contributions, the key theoretical concepts in complexity were used primarily for labeling or describing what scholars already saw occurring in the organizations they studied, rather than

importing fundamentally different theoretical or methodological approaches to the study of organizations.

The second stage can be seen to begin in the 1990s. While some continued to use concepts from complexity theory to describe well-known organizational processes (e.g., Damanpour, 1996; Kostova and Zaheer, 1999), other organizational scholars went further, bringing in novel theoretical and methodological ideas from other disciplines and borrowing more heavily from the natural sciences (e.g., from the work of Prigogine and Stengers, 1984; Kauffman, 1993). These conceptualizations of complexity theory tended to be more wide-ranging and speculative, boldly invoking such concepts as "far-from-equilibrium dynamics," "dissipative structures," "energy," "entropy," and the "edge of chaos" (e.g., Stacey, 1995; Brown and Eisenhardt, 1997; Anderson, 1999; McKelvey, 1999). This was an exploratory era of ferment in the evolution of the field, where a variety of perspectives borrowed from the natural sciences were experimented with; some, such as the NK framework of adaptive search (Kauffman, 1993; Levinthal, 1997),[1] gained traction, many did not.

The third stage can be seen from the early-mid-2000s onwards, when this eclecticism fades as scholars focus more specifically on the concepts that can be applied operationally to organizations. Over this period, operationalization of complexity is mainly concerned with the interactions between organizational agents (e.g., Siggelkow and Rivkin, 2005; Snowden and Boone, 2007; Martin and Eisenhardt, 2010). While some research continues to draw, in a metaphorical way, on

concepts borrowed from natural sciences (e.g., Chiles et al., 2004; Colbert, 2004), attention broadly moves to the application of a more rigorously defined set of terms that are put to work to analyze organizations as complex adaptive systems. Further, organizational complexity research starts to exhibit more consistent links to the Carnegie School tradition, with its focus on organizational decision making and adaptation under bounded rationality (Gavetti et al., 2007).

The Nature of Complex Organizational Systems

While recent organizational literature has been relatively consistent in how it has conceptualized complexity (see Appendix 1 for a list of definitions in the literature), it is useful for us to elaborate on some of the definitional issues of complex systems to better understand the impact of complexity in organizations. Synthesizing the core elements of contemporary applications of complexity theory, we can adopt the integrative definition of a complex organizational system as comprising: (1) multiple locally directed organizational elements that (2) interact in a non-linear way to (3) produce emergent outcomes. These three features are generally seen as foundational in the contemporary literature on organizational complexity; while some works cover all three explicitly in their definitions (Snowden and Boone, 2007; Madden et al., 2012; Beck and Plowman, 2014), others focus their definitions on the elements and their interactions (Siggelkow and Rivkin, 2005; Schneider et al., 2017), but also in this latter set of works, emergent outcomes are generally seen as the reason why the interactions are considered the focus of interest in the first place .

Unlike many other theories on organizations, complexity theory is not bound to any particular level of analysis but pertains to a category of phenomena that can be observed across different levels of an organizational system (Andriani and McKelvey, 2009). Table 2 illustrates how these three definitional features of complex systems may manifest at different levels of analysis. For example, in their study of groups as complex systems, Okhuysen and Eisenhardt (2002) examine how (1) group members, each equipped with their individual set of knowledge and information (2) interact by sharing, questioning and integrating the group members' information in a way that leads to (3) the emergence of novel, unforeseen approaches to task execution.

---------- *Insert Table 2 about here* ----------

A couple of points about the three definitional features of complex systems warrant further explanation. First, one of the core characteristics of complex systems is that system-level coordination is either impossible or impractical (Chiles et al., 2004; Amaral and Uzzi, 2007); consequently, the elements of such a system exhibit locally directed behavior, acting in a boundedly rational way on "limited and local information" (Amaral and Uzzi, 2007: 1033) regarding the past, present, and potential future behavior of the other elements. Examples of locally directed behavior could be that firms in a complex supply chain act in their own private interests (Levy, 1994), members of teams contribute to team tasks in ways that are consistent with their individual goals and motivations (Okhuysen and Eisenhardt, 2002), and individual decisions in

organizational configurations are enacted at the level of the subunit the decisions pertain to (Rivkin and Siggelkow, 2003).

Second, nearly all definitions of complex organizational systems see interactions as a defining feature of such systems (e.g., Simon, 1962; Eisenhardt and Piezunka, 2011; Schneider et al., 2017). These interactions can take many forms but are typically driven by the flow of information and resources across an organization in processes such as knowledge transfer, negotiation of boundaries, resource complementarities, performance feedback, organizational learning, and the like (Wageman, 2001; Puranam et al., 2012). However, for a system to be considered complex, the collective impact of these interactions needs to be non-linear at the system level (MacIntosh and MacLean, 1999; Snowden and Boone, 2007), so that the dynamics of the system "are not linearly dependent on the state" (Scheffer, 2009: 356). The most common sources of such non-linearity are feedback loops involving several different elements: for example, element A influences element B, element B influences element C, and element C in turn influences element A. Organizational systems are often characterized by complex networks of both one-way interactions and reinforcing and balancing feedback loops.

Third, non-linearity in a complex system goes beyond simple feedback loops and contingency relationships; instead it entails causally complex and unpredictable patterns of interactions that have the potential to generate emergent system-level outcomes (McKelvey, 2001; Snowden and Boone, 2007; Turner and Baker, 2019). For example, Siggelkow's (2002) study of Vanguard's

strategic change efforts shows how a change in one strategy element, emphasizing high-quality service, cascaded throughout the organization and necessitated changes in other strategy elements, such as in-sourcing accounting and investing in information technology, that over time led to the emergence of a new internally consistent strategy configuration. Thus, in a complex organizational system, interactions between the elements may lead to unanticipated, emergent, system-level order. This is a fundamental tenet of complexity theory that categorically distinguishes complex organizational systems from ordered and chaotic ones (Anderson, 1999; MacIntosh and MacLean, 1999; Snowden and Boone, 2007), but its implications for organizational scholarship are frequently underappreciated by organizational scholars. We will next look into some of these implications.

Complexity Theory as a Theory of Change

The above discussed characteristics of complex systems mean that small changes in such systems frequently lead to unanticipated system-level outcomes. This happens when a change in the behavior of one element leads to changes in the behavior of other elements, which in turn leads to further changes, potentially generating an avalanche of change throughout the entire system (Amaral and Uzzi, 2007). Such an avalanche of change can eventually lead the organizational system to reach a new state of spontaneous order (McKelvey, 2001). Thus, changes in system-level order are causally connected to changes in individual elements. However, while some general patterns might be consistently observed at the level of the system as a whole, such as a tendency for suboptimal stable equilibria (Rivkin and Siggelkow, 2003), the nature of complexity means

that predicting the precise nature of these emergent outcomes is futile. For example, identifying exactly what kind of a stable equilibrium will unfold may be no more than guesswork, even if the causal connections between the elements can be traced with a high degree of accuracy (Bettis, 2017).

To illustrate the emergence of spontaneous order from an avalanche of change, we can use a simplified model of a system driven by interactions between locally directed elements. Figure 1 demonstrates, using a simple cellular automaton,[2] how different locally directed elements interact in non-linear ways to generate emergent outcomes when the automaton is set to a position in the parameter space that generates complex behavior. In the figure, the top row illustrates the behavior of an ordered system and the bottom row the behavior of a chaotic one. The middle row illustrates the behavior of a complex system, residing "at the edge of chaos" (e.g., Brown and Eisenhardt, 1997; Anderson, 1999). This represents emergent order, rather than stable order (top row) or chaotic behavior (bottom row). At the edge of chaos, perturbations (such as the addition of an active actor as highlighted in Figure 1e) are neither locally contained (as in the top row) nor do they lead to chaotic fluctuations (as in the bottom row). Instead, they generate new, emergent order. However, even if the general nature of this order can be predicted from the starting conditions, the exact outcomes are impossible to estimate beforehand.

---------- *Insert Figure 1 about here* ----------

One way this figure is useful is in illustrating a core theme in the complexity literature that has implications for organizational research more broadly: the intractability of the outcomes of complex processes. While in the above, highly simplified model, complex behavior occurs with a specific set of parameter values, many organizational phenomena of interest are characterized by extensive networks of interactions and tend to occur in this domain of complexity that generates emergent order (Daft and Lewin, 1990; Thiétart and Forgues, 1995; Anderson, 1999). Furthermore, phenomena residing in the complexity domain "at the edge of order and chaos" are frequently of more interest than ordered or chaotic ones, for two reasons. First, the balance of stability and evolvability may give complex systems evolutionary advantage over both chaotic systems that lack stability and ordered systems that lack evolvability (Brown and Eisenhardt, 1997; Burnes, 2005). Second, phenomena in the complexity regime are neither simple enough to be trivial nor chaotic enough to be unanalyzable, making such phenomena the ones most likely to warrant scholarly attention (Simon, 1962). This means that the intractability illustrated in Figure 1 is a fundamental feature of a broad range of organizational phenomena of interest.

Between Order and Chaos: Implications for Research and Practice

Another way that Figure 1 is useful is that it illustrates how complex phenomena are qualitatively distinct from both ordered and chaotic ones. This distinction reflects fundamental differences in the underlying structure of causality. In ordered domains, causal relationships are stable and

tractable; in complex domains, causality is non-linear and emergent; in chaotic domains, causality from the perspective of decision makers is effectively unknowable or hidden. Thus, organizational phenomena or management problems that reside in the domain of complexity require different managerial and scholarly approaches from those in ordered or chaotic domains. Whether a phenomenon is best conceptualized as ordered, complex, or chaotic depends not only on its intrinsic properties but also on the researcher's theoretical framing, methodological choices, and level of analysis. For example, what appears chaotic at one level (e.g., crime patterns) may exhibit order when reframed over different spatial or temporal scales. Nevertheless, for reasons outlined above, most problems of interest in organizational research reside at least partly in the domain of complexity. Table 3 outlines the key differences between these domains, both in terms of their underlying causal logic and the implications for scholarship and practice.

---------- *Insert Table 3 about here* ----------

The three domains differ significantly in terms of analyzability. The domain of order is causally tractable but limited to relatively simple optimization problems in fields with well-defined managerial tasks, and even in such fields, many problems tend to the complexity domain. At the other end of the spectrum, chaotic problems – somewhat paradoxically – pose less of a managerial problem than complex ones: as it is obvious that causal relationships at the level of the chaotic system are unknowable, managers can focus on preparing for potential outcomes (e.g., having procedures in place in case of a robbery) rather than trying to influence or predict them.

Furthermore, the lack of emergent order in chaotic systems benefits scholars in two ways: on the one hand, it directs the researchers' attention away from levels of analysis at which empirical evidence is unobtainable, and on the other hand, it may allow for statistical analysis at higher levels of analysis where, unobstructed by emergent patterns, the population of chaotically behaving elements may exhibit statistically ordered behavior (Weaver, 1948). In the domain of complexity, in contrast, the dynamics of interest can neither be causally traced nor statistically abstracted.

Implications of complexity for managerial practice

Despite the uncontrollability of complex processes, organizational complexity theory suggests several tools that managers have at their disposal in order to increase the probability of favorable organizational outcomes. First, managers can try to influence the structure of complexity of an organizational system or subsystem so that it is appropriate for the tasks being undertaken (Levinthal and Warglien, 1999). While some scholars have argued for the application of the law of requisite variety that states that an organism needs to be as complex as its environment to survive (Ashby, 1956; Boisot and McKelvey, 2010; Schneider et al., 2017), a more commonly suggested recipe is to either simplify the decision-making context or otherwise design the pattern of interactions, for example in terms of the hierarchical structure or modularity, to make the desired behavior of the organizational system more likely (Ethiraj and Levinthal, 2004a; 2004b; Campagnolo and Camuffo, 2010; Fang et al., 2010).

Second, managers have the responsibility to set system-wide conditions and behavioral rules that facilitate the emergence of beneficial outcomes (Marion and Uhl-Bien, 2001; Eisenhardt and Piezunka, 2011; Madden et al., 2012; Thietart, 2016). For example, Madden et al. (2012) argue that a complex organizational system needs to exhibit the conditions of agent diversity, role interdependence, and high quality and quantity of social interactions in order to generate the desired type of emergent outcome, organizational capacity for compassion. Managers that want to facilitate the emergence of an organizational outcome need to ensure that sufficient background conditions, such as the diversity of actors and their interactions, are in place.

Third, the intractability of complex organizational problems means that attempts to find analytical solutions are frequently futile, and managers should rather aim to develop simple rules or heuristics (Davis et al., 2009; Bingham and Eisenhardt, 2011; Bettis, 2017; Vuori et al., 2024) to facilitate decision making in complex settings. However, while heuristics are useful in economizing on time and effort (Bettis, 2017), unforeseeable emergent changes in the problem context can easily turn useful rules and heuristics into harmful ones. Thus, managers in complex contexts also need to be highly adaptable to be able to discard these heuristics when they have outlived their usefulness (Tsang and Zahra, 2008; Bingham and Eisenhardt, 2011).

Finally, managers can impose small, tactical interventions that may have multiplicative even if uncontrollable effects on complex organizational processes (Stacey, 1995; Okhuysen and Eisenhardt, 2002; Siggelkow and Levinthal, 2005), as shown in Figure 1. For example, Okhuysen

and Eisenhardt (2002) studied group dynamics as complex self-organizing processes, finding that small formal interventions can be used to facilitate "the emergence of new, unpredictable approaches to task execution" (p. 383). Because of the unpredictability of the results from such interventions, they are best used in situations in which the need for novelty, flexibility, and innovativeness outweighs the benefits of routines and stability.

Implications of complexity for research

Acknowledging the complexity of organizational phenomena also has important implications for how these phenomena can be studied. Some complexity scholars have used complexity theory as a general explanatory framework, arguing that it provides a more accurate view of organizational phenomena than traditional, linear theories (Chiles et al., 2004; Madden et al., 2012). A complex systems approach has been used to explain the self-organization of various organizational outcomes that can occur without a centrally coordinated effort, such as the emergence of organizational collectives (Chiles et al., 2004), the emergence of interorganizational collaboration (Beck and Plowman, 2014), or the emergence of organizational capacity for compassion (Madden et al., 2012).

Some studies go further, using complexity theory not only to explain but also to operationalize the phenomena under study. This involves a focus on complex processes, and explicit attention is given to the interactions and feedback loops that lead to emergent organizational outcomes. Complex organizational processes have been examined both empirically through process research

(e.g., Siggelkow, 2002; Garud et al., 2011) and computationally through the use of simulation studies (e.g., Gavetti and Levinthal, 2000; Siggelkow and Levinthal, 2003; Siggelkow and Rivkin, 2005). This latter group of studies use complexity theory as a methodological framework guiding the design of either empirical or computational studies of organizations.

However, if we accept that complexity is a common feature of organizational phenomena, it also has important implications for research that does not study complexity directly or draw on complexity theory explicitly. This is because of a frequently overlooked aspect of complexity: the compounding effect it has on uncertainty. This is illustrated in Figure 2, which reproduces the evolution of the complex system in Figure 1 and shows how a tiny temporal (Figure 2d-2f) or spatial (Figure 2g-2i) uncertainty in the input can lead to a very different emerging order.

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As Figure 2 shows, even minor disturbances in the inputs to a complex system have an impact on the outcomes that can not only be disproportionate in magnitude but also exhibit unforeseeable causal patterns. The difficulty to trace causal relationships between variables poses challenges to familiar avenues in quantitative research premised on empirically investigating such relationships (Tsoukas and Hatch, 2001). This has significant implications on organizational research more broadly, as we will next discuss.

Complexity and the Replication Crisis

The ubiquity of complexity in organizational settings poses severe challenges for empirical research. As Figure 2 suggests, even the smallest measurement error in the explanatory variables or omission of a relevant variable – both of which are unavoidable in social sciences – can lead to a disproportionate error in the dependent variable. This means that the assumptions behind the validity of methods such as multivariate regression, including that the error term is independent and identically distributed, do not hold. Furthermore, the significant, systematic, and untraceable impact on the error term means that common remedies, such as heteroscedasticity corrections or the use of instrumental variables, are of little use.

The impact of complexity on the viability of quantitative methods can be a major contributor to the replication crisis (Aguinis et al., 2017; Köhler and Cortina, 2021; Pagell, 2021) and the related credibility crisis (Bergh et al., 2017; Byington and Felps, 2017). This is because both stem from the inability to successfully replicate many significant research findings in organizational research. Complexity generates statistically observable causal patterns, but these patterns are very sensitive to the initial conditions. Furthermore, the complexity theoretical view suggests that the impact of these conditions is impossible to discern in practice, and crafting better-specified models, with the inclusion of additional control variables and moderators, does not solve the fundamental intractability of the system-level patterns. Consequently, most studies in the management sciences are practically impossible to reproduce, and claims that the replication crisis exists because

"sources of error such as design flaws and researcher motives have been ignored" (Köhler and Cortina, 2021: 510) downplay the role of the fundamental nature of organizational systems.

Based on our synthesis of complexity theory, most of the proposed remedies to the replication or credibility crises, such as calls for constructive replication studies that would retain "the virtues of previous tests but none of their major flaws" (Köhler and Cortina, 2021: 497) or tackling questionable research practices like data manipulation and HARKing (Hypothesizing After Results are Known; Byington and Felps, 2017), appear somewhat naïve in terms of ignoring the epistemological intractability of complex systems. Furthermore, some of these remedies may even be counterproductive. For example, a lot of the literature pushing for better statistical reporting is concerned with the possibility of false positives (Bettis, 2012; Goldfarb and King, 2016), whereas the abundance of potential confounding factors in complex organizational systems suggests that statistical tests can be also expected suffer from a high likelihood of false negatives, where a theoretically true hypothesis is rejected (i.e., not supported) because the hypothesized and existing causal relationship is masked by emerging causal processes that cannot be accounted for. Thus, inability to replicate prior findings may tell more about the nature of the problem than about the quality of the original study.

Naturally, even in the study of complex organizations, there are questions where quantitative methods are less problematic. Instead of trying to understand complex, system-level outcomes, quantitative scholars can define their questions of interest at a more tractable level of analysis. For

example, strategy scholars, instead of trying to uncover drivers of firm-level performance, may focus on explaining more piecemeal aspects of the strategy process, such as the firm's location choices (Barber and Blake, 2024) or the language that the CEO uses (Parker et al., 2024). However, as Figures 1 and 2 suggest, even relatively simple organizational processes can exhibit complex behavior, and thus such reductionism cannot fully solve the problem of causal intractability.

Furthermore, the key questions that many strategy scholars grapple with concern organization-level performance in its many forms. The challenges of using organizational performance as the dependent variable have long been recognized (March and Sutton, 1997); the present essay does little to provide relief from such concerns but rather suggests that the nature of organizations presents a fundamental challenge that is not easily alleviated by improving the scholarly process. This is not to say that we think the strategy field should move away from trying to explain firm performance or other system-level outcomes – on the contrary, our hope is that embracing the tenets of complexity theory would allow the field to find new ways of tackling these challenges.

Integrating Complexity into Organizational Research

How can a better understanding of complexity improve organizational scholarship, then? Though one criterion of good theory is parsimony, we encourage scholars to more concretely incorporate elements of complexity science – such as local agency, non-linear interactions, and emergent outcomes – in their theorizing and include recursivity and feedback loops in models of phenomena that allow us to investigate emergent outcomes rather than simplifying them away. For example,

Grewatsch, Kennedy, and Bansal's (2023) suggestion of building on systems thinking may provide a useful starting point for such developments. In general, we encourage more critical perspectives on causal assumptions, given that linear causality often fails in complex systems and emergent patterns may not be traceable to single events.

Methodologically, our discussion suggests that traditional quantitative methods tend to be limited in their applicability to organizational studies. Instead, approaches like process research (Langley, 1999; Langley et al., 2013) might be more fruitful in increasing our understanding of complex organizational systems. While most process research thus far has been qualitative, developing techniques of quantitative process research, such as sequence analysis (Klarner and Raisch, 2013; Biemann and Datta, 2014), might prove valuable to tackle the complexity of our field of study. Building on configurational research approaches, such as qualitative comparative analysis (Fiss, 2011; Misangyi et al., 2016; Greckhamer et al., 2018), could also open up new avenues for studying complex organizational phenomena.

However, we wish to stress the implications of the fundamental intractability of many of the most complex organizational and societal systems and the importance of organizational scholars to accept and work within epistemological limitations. While some of the so-called "wicked problems" (Rittel and Webber, 1973; Buchanan, 1992) can be informed by complexity theoretical approaches, some may escape managerial control to such an extent that they may even be beyond the complexity domain and tend to chaos. Regardless, holistically tackling such problems requires

developing analytical approaches that go beyond the current tools of complexity theory. In both complex and chaotic problem domains, acknowledging our inability to empirically trace the causal processes of interest may be an important step toward addressing such problems in practice.

Conclusion

Complexity theory has proven to be a useful perspective for studying various types of organizational systems, but the applications of complexity theory in management research have thus far been mostly disconnected and limited in their impact on the field. As we have argued above, complexity theory's limited influence in organizational scholarship arises not from its intrinsic value as a way of understanding the world, but from a mismatch between the non-linear, emergent nature of complex systems and the prevailing linear, reductionist methodologies of the field. In this essay, we have aimed to clarify the nature of complexity as a domain distinct from order and chaos, and to advocate methodological and theoretical adaptations that better accommodate the properties of complex systems.

The prevalence of complexity in organizations suggests both the need to develop better theoretical understanding of complexity concepts specific to organization science, such as different types of intra- and interorganizational interdependencies (Raveendran et al., 2020) and feedback loops (Karhu et al., 2024), and the need to develop a broader empirical toolbox to study complex organizational phenomena. Such efforts would be crucial steps for translating the insights from

complexity theory into an increased understanding of some of the most pressing problems faced by complex organizational and social systems.

References

Aguinis H, Cascio WF and Ramani RS. (2017) Science's reproducibility and replicability crisis: International business is not immune. *Journal of International Business Studies* 48: 653-663.

Aiken M and Hage J. (1968) Organizational Interdependence and Intra-Organizational Structure. *American Sociological Review* 33: 912-930.

Amaral LAN and Uzzi B. (2007) Complex Systems—A New Paradigm for the Integrative Study of Management, Physical, and Technological Systems. *Management Science* 53: 1033-1035.

Anderson P. (1999) Complexity Theory and Organization Science. *Organization Science* 10: 216-232.

Andriani P and McKelvey B. (2009) Perspective—From Gaussian to Paretian Thinking: Causes and Implications of Power Laws in Organizations. *Organization Science* 20: 1053-1071.

Ashby WR. (1956) *An introduction to cybernetics,* Oxford, England: John Wiley and Sons.

Barber B, IV and Blake DJ. (2024) My kind of people: Political polarization, ideology, and firm location. *Strategic Management Journal* 45: 849-874.

Barnard CI. (1938) *The Functions of the Executive,* Cambridge, MA: Harvard University Press.

Baumann O, Schmidt J and Stieglitz N. (2019) Effective Search in Rugged Performance Landscapes: A Review and Outlook. *Journal of Management* 45: 285-318.

Beck TE and Plowman DA. (2014) Temporary, Emergent Interorganizational Collaboration in Unexpected Circumstances: A Study of the Columbia Space Shuttle Response Effort. *Organization Science* 25: 1234-1252.

Bergh DD, Sharp BM, Aguinis H, et al. (2017) Is there a credibility crisis in strategic management research? Evidence on the reproducibility of study findings. *Strategic Organization* 15: 423-436.

Bettis RA. (2012) The search for asterisks: Compromised statistical tests and flawed theories. *Strategic Management Journal* 33: 108-113.

Bettis RA. (2017) Organizationally intractable decision problems and the intellectual virtues of heuristics. *Journal of Management* 43: 2620-2637.

Bettis RA and Hitt MA. (1995) The new competitive landscape. *Strategic Management Journal* 16: 7-19.

Bettis RA and Prahalad CK. (1995) The dominant logic: Retrospective and extension. *Strategic Management Journal* 16: 5-14.

Biemann T and Datta DK. (2014) Analyzing Sequence Data: Optimal Matching in Management Research. *Organizational Research Methods* 17: 51-76.

Billinger S, Stieglitz N and Schumacher TR. (2014) Search on Rugged Landscapes: An Experimental Study. *Organization Science* 25: 93-108.

Bingham CB and Eisenhardt KM. (2011) Rational heuristics: the 'simple rules' that strategists learn from process experience. *Strategic Management Journal* 32: 1437-1464.

Boisot M and Child J. (1999) Organizations as adaptive systems in complex environments: The case of China. *Organization Science* 10: 237-252.

Boisot M and McKelvey B. (2010) Integrating Modernist and Postmodernist Perspectives on Organizations: A Complexity Science Bridge. *Academy of Management Review* 35: 415-433.
Brown SL and Eisenhardt KM. (1997) The Art of Continuous Change: Linking Complexity Theory and Time-Paced Evolution in Relentlessly Shifting Organizations. *Administrative Science Quarterly* 42: 1-34.
Browning LD, Beyer JM and Shetler JC. (1995) Building Cooperation in a Competitive Industry: Sematech and the Semiconductor Industry. *Academy of Management Journal* 38: 113-151.
Buchanan R. (1992) Wicked Problems in Design Thinking. *Design Issues* 8: 5-21.
Burnes B. (2005) Complexity theories and organizational change. *International Journal of Management Reviews* 7: 73-90.
Byington EK and Felps W. (2017) Solutions to the Credibility Crisis in Management Science. *Academy of Management Learning & Education* 16: 142-162.
Campagnolo D and Camuffo A. (2010) The Concept of Modularity in Management Studies: A Literature Review. *International Journal of Management Reviews* 12: 259-283.
Carlile PR and Rebentisch ES. (2003) Into the Black Box: The Knowledge Transformation Cycle. *Management Science* 49: 1180-1195.
Chen M, Kaul A and Wu B. (2019) Adaptation across multiple landscapes: Relatedness, complexity, and the long run effects of coordination in diversified firms. *Strategic Management Journal* 40: 1791-1821.
Chiles TH, Meyer AD and Hench TJ. (2004) Organizational Emergence: The Origin and Transformation of Branson, Missouri's Musical Theaters. *Organization Science* 15: 499-519.
Colbert BA. (2004) The Complex Resource-Based View: Implications for Theory and Practice in Strategic Human Resource Management. *Academy of Management Review* 29: 341-358.
D'Aveni RA, Dagnino GB and Smith KG. (2010) The age of temporary advantage. *Strategic Management Journal* 31: 1371-1385.
Daft RL and Lewin AY. (1990) Can Organization Studies Begin to Break out of the Normal Science Straitjacket? An Editorial Essay. *Organization Science* 1: 1-9.
Damanpour F. (1996) Organizational Complexity and Innovation: Developing and Testing Multiple Contingency Models. *Management Science* 42: 693-716.
Davis JP, Eisenhardt KM and Bingham CB. (2009) Optimal Structure, Market Dynamism, and the Strategy of Simple Rules. *Administrative Science Quarterly* 54: 413-452.
Dewar R and Hage J. (1978) Size, Technology, Complexity, and Structural Differentiation: Toward a Theoretical Synthesis. *Administrative Science Quarterly* 23: 111-136.
Eisenhardt KA and Piezunka H. (2011) Complexity theory and corporate strategy. In: Allen P, Maguire S and McKelvey B (eds) *SAGE Handbook of Complexity and Management.* London: Sage, 506-523.
Ethiraj SK and Levinthal D. (2004a) Bounded Rationality and the Search for Organizational Architecture: An Evolutionary Perspective on the Design of Organizations and Their Evolvability. *Administrative Science Quarterly* 49: 404-437.

Ethiraj SK and Levinthal D. (2004b) Modularity and Innovation in Complex Systems. *Management Science* 50: 159-173.
Fang C, Lee J and Schilling MA. (2010) Balancing Exploration and Exploitation Through Structural Design: The Isolation of Subgroups and Organizational Learning. *Organization Science* 21: 625-642.
Fiss PC. (2007) A set-theoretic approach to organizational configurations. *Academy of Management Review* 32: 1180-1198.
Fiss PC. (2011) Building Better Causal Theories: A Fuzzy Set Approach to Typologies in Organization Research. *Academy of Management Journal* 54: 393-420.
Garud R, Gehman J and Kumaraswamy A. (2011) Complexity Arrangements for Sustained Innovation: Lessons from 3M Corporation. *Organization Studies* 32: 737-767.
Gavetti G and Levinthal D. (2000) Looking Forward and Looking Backward: Cognitive and Experiential Search. *Administrative Science Quarterly* 45: 113-137.
Gavetti G, Levinthal D and Ocasio W. (2007) Neo-Carnegie: The Carnegie School's Past, Present, and Reconstructing for the Future. *Organization Science* 18: 523-536.
Gavetti G, Levinthal DA and Rivkin JW. (2005) Strategy making in novel and complex worlds: the power of analogy. *Strategic Management Journal* 26: 691-712.
Goldfarb B and King AA. (2016) Scientific apophenia in strategic management research: Significance tests & mistaken inference. *Strategic Management Journal* 37: 167-176.
Greckhamer T, Furnari S, Fiss PC, et al. (2018) Studying configurations with qualitative comparative analysis: Best practices in strategy and organization research. *Strategic Organization* 16: 482-495.
Grewatsch S, Kennedy S and Bansal P. (2023) Tackling wicked problems in strategic management with systems thinking. *Strategic Organization* 21: 721-732.
Johnson JL and Burton BK. (1994) Chaos and Complexity Theory for Management: Caveat Emptor. *Journal of Management Inquiry* 3: 320-328.
Johnson N. (2009) *Simply complexity: A clear guide to complexity theory,* Oxford: Oneworld Publications.
Karhu K, Heiskala M, Ritala P, et al. (2024) Positive, Negative, and Amplified Network Externalities in Platform Markets. *Academy of Management Perspectives* 38: 349-367.
Kauffman SA. (1993) *The Origins of Order: Self-Organization and Selection in Evolution,* New York: Oxford University Press.
Klarner P and Raisch S. (2013) Move to the Beat—Rhythms of Change and Firm Performance. *Academy of Management Journal* 56: 160-184.
Köhler T and Cortina JM. (2021) Play It Again, Sam! An Analysis of Constructive Replication in the Organizational Sciences. *Journal of Management* 47: 488-518.
Kostova T and Zaheer S. (1999) Organizational Legitimacy Under Conditions of Complexity: The Case of the Multinational Enterprise. *Academy of Management Review* 24: 64-81.
Kreienkamp J and Pegram T. (2021) Governing Complexity: Design Principles for the Governance of Complex Global Catastrophic Risks. *International Studies Review* 23: 779-806.

Kurtz CF and Snowden DJ. (2003) The new dynamics of strategy: Sense-making in a complex and complicated world. *IBM Systems Journal* 42: 462-483.
Langley A. (1999) Strategies for Theorizing from Process Data. *Academy of Management Review* 24: 691-710.
Langley A, Smallman C, Tsoukas H, et al. (2013) Process Studies of Change in Organization and Management: Unveiling Temporality, Activity, and Flow. *Academy of Management Journal* 56: 1-13.
Lawrence PR and Lorsch JW. (1967) Differentiation and Integration in Complex Organizations. *Administrative Science Quarterly* 12: 1-47.
Levinthal DA. (1997) Adaptation on rugged landscapes. *Management Science* 43: 934-950.
Levinthal DA and Warglien M. (1999) Landscape Design: Designing for Local Action in Complex Worlds. *Organization Science* 10: 342-357.
Levy D. (1994) Chaos theory and strategy: Theory, application, and managerial implications. *Strategic Management Journal* 15: 167-178.
MacIntosh R and MacLean D. (1999) Conditioned emergence: a dissipative structures approach to transformation. *Strategic Management Journal* 20: 297-316.
Madden LT, Duchon D, Madden TM, et al. (2012) Emergent Organizational Capacity for Compassion. *Academy of Management Review* 37: 689-708.
Maguire S, McKelvey B, Mirabeau L, et al. (2006) Complexity science and organization studies. In: Clegg SR, Hardy C, Lawrence T, et al. (eds) *SAGE Handbook of Organization Studies (2nd Edition).* Thousand Oaks, CA: SAGE Publications, 165-214.
March JG and Sutton RI. (1997) Organizational Performance as a Dependent Variable. *Organization Science* 8: 698-706.
Marion R and Uhl-Bien M. (2001) Leadership in complex organizations. *Leadership Quarterly* 12: 389-418.
Martin JA and Eisenhardt KM. (2010) Rewiring: Cross-Business-Unit Collaborations in Multibusiness Organizations. *Academy of Management Journal* 53: 265-301.
McKelvey B. (1999) Avoiding Complexity Catastrophe in Coevolutionary Pockets: Strategies for Rugged Landscapes. *Organization Science* 10: 294-321.
McKelvey B. (2001) What Is Complexity Science? It Is Really Order-Creation Science. *Emergence* 3: 137-157.
Misangyi VF, Greckhamer T, Furnari S, et al. (2016) Embracing Causal Complexity: The Emergence of a Neo-Configurational Perspective. *Journal of Management* 43: 255-282.
Morel B and Ramanujam R. (1999) Through the Looking Glass of Complexity: The Dynamics of Organizations as Adaptive and Evolving Systems. *Organization Science* 10: 278-293.
Okhuysen GA and Eisenhardt KM. (2002) Integrating Knowledge in Groups: How Formal Interventions Enable Flexibility. *Organization Science* 13: 370-386.
Okwir S, Nudurupati SS, Ginieis M, et al. (2018) Performance Measurement and Management Systems: A Perspective from Complexity Theory. *International Journal of Management Reviews* 20: 731-754.

Pagell M. (2021) Replication without repeating ourselves: Addressing the replication crisis in operations and supply chain management research. *Journal of Operations Management* 67: 105-115.
Parker ON, Short CE, Titus VK, et al. (2024) Accentuate the positive? Strategic negativity amid the hazard of high expectations. *Strategic Management Journal* 45: 1851-1874.
Pich MT, Loch CH and De Meyer A. (2002) On Uncertainty, Ambiguity, and Complexity in Project Management. *Management Science* 48: 1008-1023.
Plowman DA, Baker LT, Beck TE, et al. (2007) Radical Change Accidentally: The Emergence and Amplification of Small Change. *Academy of Management Journal* 50: 515-543.
Plsek PE and Greenhalgh T. (2001) The challenge of complexity in health care. *BMJ* 323: 625-629.
Prigogine I and Stengers I. (1984) *Order Out of Chaos: Man's New Dialogue with Nature,* New York: Bantam.
Puranam P, Raveendran M and Knudsen T. (2012) Organization Design: The Epistemic Interdependence Perspective. *Academy of Management Review* 37: 419-440.
Raveendran M, Silvestri L and Gulati R. (2020) The Role of Interdependence in the Micro-Foundations of Organization Design: Task, Goal, and Knowledge Interdependence. *Academy of Management Annals* 14: 828-868.
Rittel HWJ and Webber MM. (1973) Dilemmas in a general theory of planning. *Policy Sciences* 4: 155-169.
Rivkin JW. (2000) Imitation of Complex Strategies. *Management Science* 46: 824-844.
Rivkin JW. (2001) Reproducing Knowledge: Replication without Imitation at Moderate Complexity. *Organization Science* 12: 274-293.
Rivkin JW and Siggelkow N. (2003) Balancing Search and Stability: Interdependencies among Elements of Organizational Design. *Management Science* 49: 290-311.
Roberts KH. (1990) Some characteristics of one type of high reliability organizations. *Organization Science* 1: 160-176.
Rosenhead J, Franco LA, Grint K, et al. (2019) Complexity theory and leadership practice: A review, a critique, and some recommendations. *Leadership Quarterly* 30: 101304.
Scheffer M. (2009) *Critical Transitions in Nature and Society,* Princeton: Princeton University Press.
Schneider A, Wickert C and Marti E. (2017) Reducing Complexity by Creating Complexity: A Systems Theory Perspective on How Organizations Respond to Their Environments. *Journal of Management Studies* 54: 182-208.
Siggelkow N. (2002) Evolution toward Fit. *Administrative Science Quarterly* 47: 125-159.
Siggelkow N and Levinthal DA. (2003) Temporarily Divide to Conquer: Centralized, Decentralized, and Reintegrated Organizational Approaches to Exploration and Adaptation. *Organization Science* 14: 650-669.
Siggelkow N and Levinthal DA. (2005) Escaping real (non-benign) competency traps: linking the dynamics of organizational structure to the dynamics of search. *Strategic Organization* 3: 85-115.

Siggelkow N and Rivkin JW. (2005) Speed and search: Designing organizations for turbulence and complexity. *Organization Science* 16: 101-122.
Simon HA. (1962) The Architecture of Complexity. *Proceedings of the American Philosophical Society* 106: 467-482.
Singh K. (1997) The Impact of Technological Complexity and Interfirm Cooperation on Business Survival. *Academy of Management Journal* 40: 339-367.
Snowden DJ and Boone ME. (2007) A Leader's Framework for Decision Making. *Harvard Business Review* 85: 68-76.
Sommer SC and Loch CH. (2004) Selectionism and Learning in Projects with Complexity and Unforeseeable Uncertainty. *Management Science* 50: 1334-1347.
Stacey RD. (1995) The science of complexity: An alternative perspective for strategic change processes. *Strategic Management Journal* 16: 477-495.
Thietart R-A. (2016) Strategy dynamics: Agency, path dependency, and self-organized emergence. *Strategic Management Journal* 37: 774-792.
Thiétart RA and Forgues B. (1995) Chaos Theory and Organization. *Organization Science* 6: 19-31.
Thompson JD. (1967) *Organizations in Action,* New York: McGraw-Hill.
Tsang EWK and Zahra SA. (2008) Organizational unlearning. *Human Relations* 61: 1435-1462.
Tsoukas H. (1998) Introduction: Chaos, Complexity and Organization Theory. *Organization* 5: 291-313.
Tsoukas H and Hatch MJ. (2001) Complex Thinking, Complex Practice: The Case for a Narrative Approach to Organizational Complexity. *Human Relations* 54: 979-1013.
Tuertscher P, Garud R and Kumaraswamy A. (2014) Justification and Interlaced Knowledge at ATLAS, CERN. *Organization Science* 25: 1579-1608.
Turner JR and Baker RM. (2019) Complexity Theory: An Overview with Potential Applications for the Social Sciences. *Systems* 7: 4.
Vuori N, Burkhard B, Laamanen T, et al. (2024) Heuristics in Organizations: Toward an Integrative Process Model. *Academy of Management Annals* 18: 670-711.
Wageman R. (2001) The meaning of interdependence. In: Turner ME (ed) *Groups at Work: Theory and Research.* Mahwah, N.J.: Lawrence Erlbaum Associates, 197-217.
Weaver W. (1948) Science and complexity. *American Scientist* 36: 536-544.
Zhou YM. (2013) Designing for Complexity: Using Divisions and Hierarchy to Manage Complex Tasks. *Organization Science* 24: 339-355.

Table 1. Evolution of organizational complexity literature.

Stage (representative works)	**Illustrative definitions**	**Properties of complex organizational systems highlighted**
Early foundations (Simon, 1962; Lawrence and Lorsch, 1967; Thompson, 1967; Aiken and Hage, 1968; Dewar and Hage, 1978)	A complex system is a system "made up of a large number of parts that interact in a nonsimple way," such that "given the properties of the parts and the laws of their interaction, it is not a trivial matter to infer the properties of the whole." (Simon, 1962: 468) A "complex organization is a set of interdependent parts which together make up a whole because each contributes something and receives something from the whole, which in turn is interdependent with some larger environment." (Thompson, 1967: 6)	Diverse activities Interactions between parts Hierarchical structures Near decomposability System-wide adaptation
Exploratory borrowing (Levy, 1994; Bettis and Prahalad, 1995; Browning et al., 1995; Stacey, 1995; Brown and Eisenhardt, 1997; Levinthal, 1997; Tsoukas, 1998; Anderson, 1999; Boisot and Child, 1999; MacIntosh and MacLean, 1999; McKelvey, 1999; Morel and Ramanujam, 1999)	"The science of complexity is concerned with the fundamental logical properties of the behavior of nonlinear and network feedback systems." (Stacey, 1995: 480) "Complex adaptive system models" … "are characterized by four key elements: agents with schemata, self-organizing networks sustained by importing energy, coevolution to the edge of chaos, and system evolution based on recombination." (Anderson, 1999: 216) Systems "in the critical complexity category" are "in a state far from equilibrium or at the edge of chaos" with "the possibility of emergent simple-rule deterministic structures." (McKelvey, 1999: 300) Complexity theory is concerned with "the operation of nonlinear feedback on generative rules in densely interconnected, nonequilibrium systems. The dynamics and evolution of such a system are influenced by the operation of any number of positive and negative feedback loops within the system." (MacIntosh and MacLean, 1999: 301)	Autonomous actors Interactions between actors Nonlinear behavior Simple rules Path-dependence and self-reinforcing feedback loops Multiple local optima Self-organization and emergent properties Disequilibrium behavior Operation at the edge of chaos

Convergence on adaptive systems (Rivkin, 2000; 2001; Pich et al., 2002; Kurtz and Snowden, 2003; Ethiraj and Levinthal, 2004b; Siggelkow and Rivkin, 2005; Plowman et al., 2007; Snowden and Boone, 2007; Martin and Eisenhardt, 2010; Billinger et al., 2014; Schneider et al., 2017)	Strategic complexity is defined by "the number of elements in a strategy and the interactions among those elements." (Rivkin, 2000: 824) A complex system is "a set of interdependent decisions" in which "ostensibly localized adaptation can have serious consequences for overall system performance." (Ethiraj and Levinthal, 2004b: 161) A complex system "involves a large number of interacting elements" whose "interactions are nonlinear, and minor changes can produce disproportionately major consequences." (Snowden and Boone, 2007: 71) A complex adaptive system is a system "composed of unique, relatively autonomous, partially connected actors." (Martin and Eisenhardt, 2010: 266) Complexity science conceptualizes organizations as "complex systems made up of interdependent agents that interact, learn from each other, and adapt their behaviors accordingly. These ongoing interactions lead to emergent outcomes, often unplanned and unexpected." (Beck and Plowman, 2014: 1246)	Multiple autonomous elements Interactions between the elements Nonlinear behavior Self-reinforcing feedback loops Difficulty of finding optimal configurations Emergent outcomes

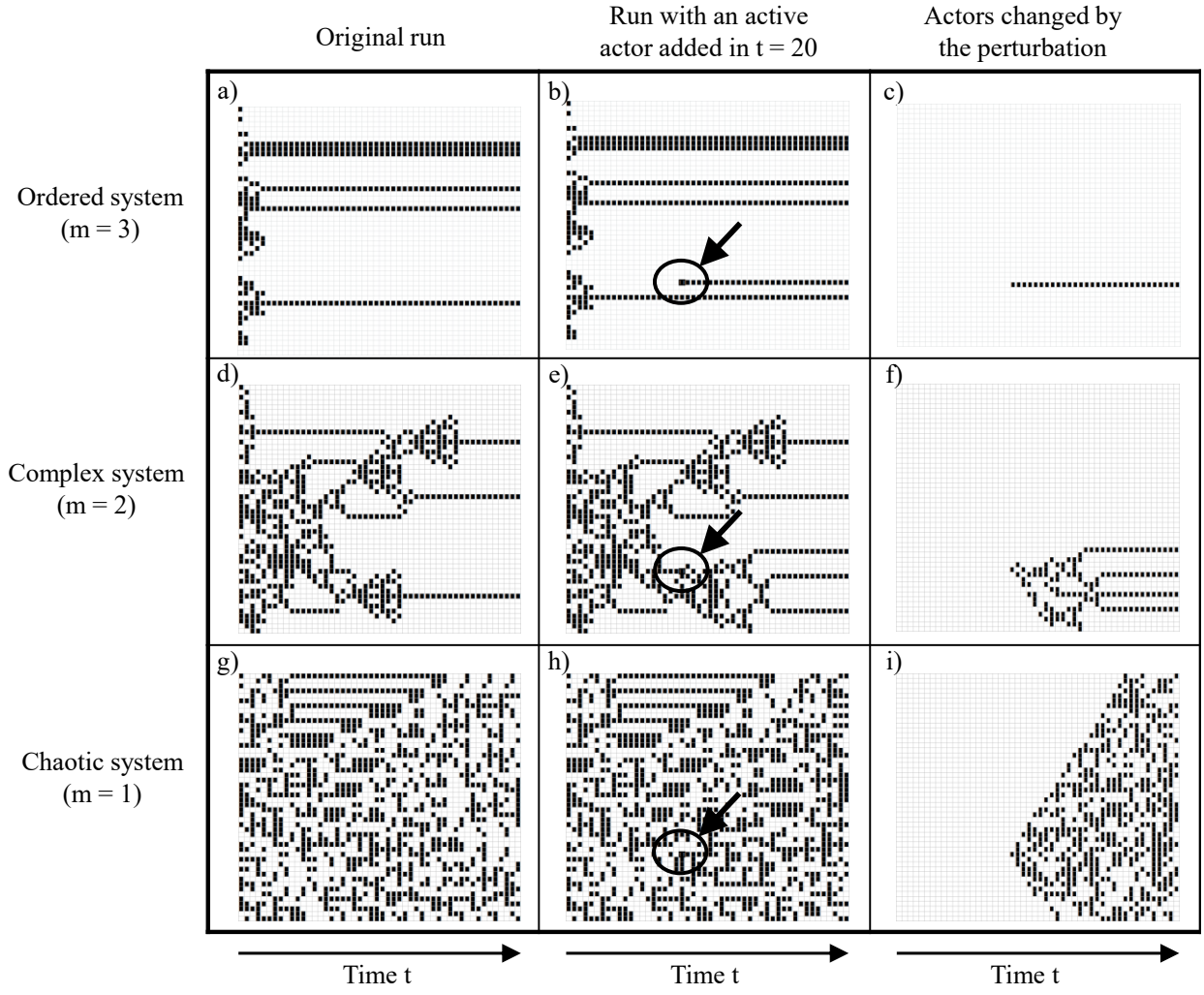
Table 2. Examples of complex organizational systems.

	System	Autonomous elements	Interactions between the elements	Emergent outcomes
Levy (1994)	Supply chain	Firms in the supply chain	Flow of goods and information	Fluctuation patterns in inventory levels
Okhuysen & Eisenhardt (2002)	Group	Group members	Sharing, questioning and integrating information	Novel approaches to task execution
Rivkin & Siggelkow (2003)	Organization modeled as a choice configuration	Individual organizational decisions	The dependence of decision payoffs on other decisions	Potentially suboptimal stable equilibria
Madden et al. (2012)	Organization	People	Communication of and responses to pain triggers	Organizational capacity for compassion
Tuertscher et al. (2014)	Collaborative technological system	Technological subsystems and their providers	Architectural and human links between technologies and their providers	Intricate knowledge structures co-emerging with the technological system

Table 3. Domains of organizational phenomena.

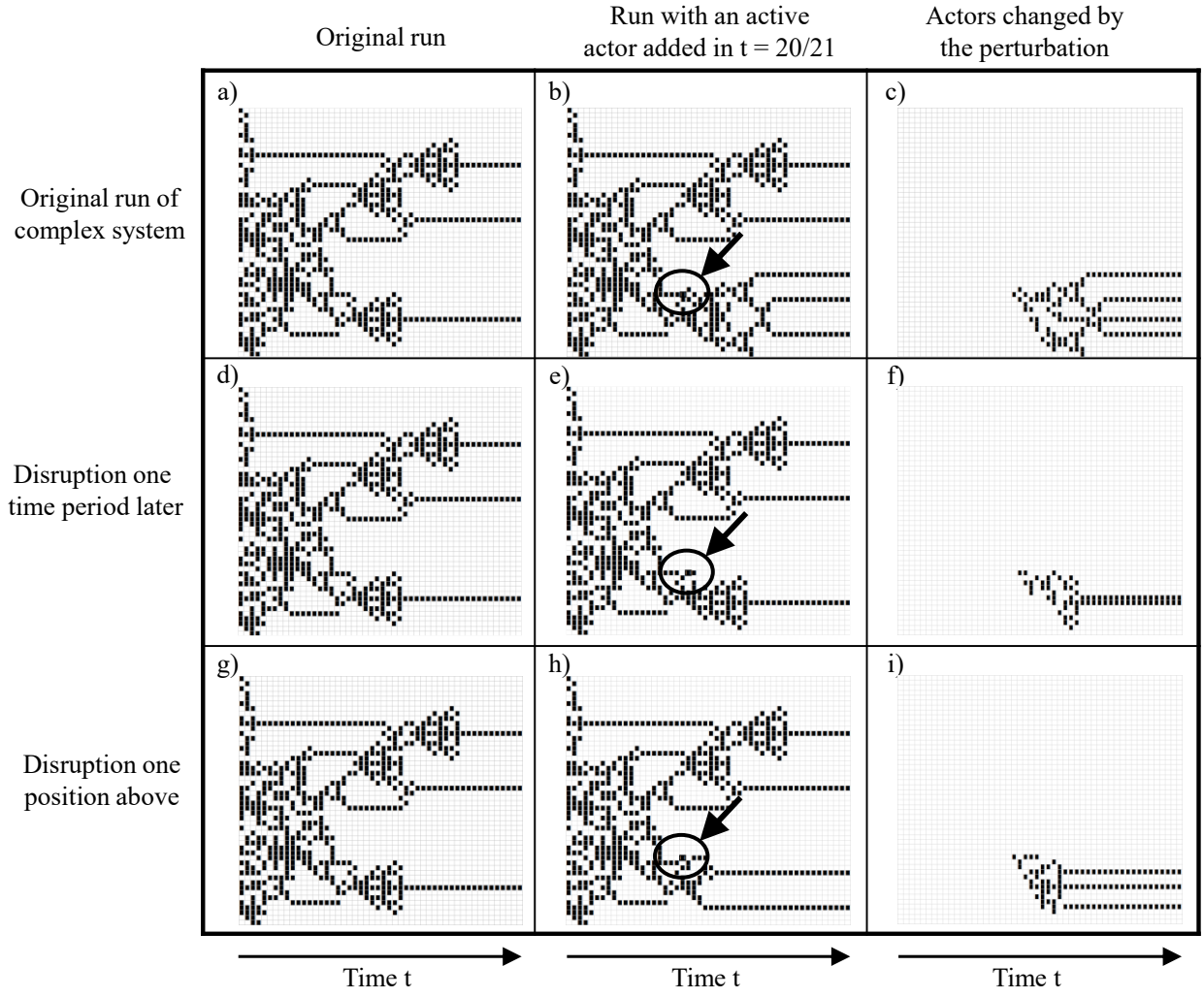
	Ordered	**Complex**	**Chaotic**
Example domains/ problems	Manufacturing, accounting	Organizational culture, innovation, HR management, strategic management	Socioeconomic transformations, crime, natural disasters
Nature of causality	Linear: It is possible to infer a direct relationship between a cause and an effect, or an action and its outcome.	Non-linear: There are rough patterns of cause and effect that can be inferred, but the exact relationships between actions and outcomes tend to escape our view.	Unknowable: From the organization's perspective, there is no apparent causal relationship between actions and their outcomes.
Nature of change	Equifinal: A given outcome can often be achieved from different starting points, and organizations converge toward "best practices."	Path dependent: The state of the organization determines the outcomes it can reach, and organizations tend to evolve along their own paths in context-specific ways.	Random: Neither the current state of the organization nor the preferred outcome gives any significant information on how the organization is likely to develop.
Organizational decision-making processes	Analytical: If sufficient information can be obtained, it can be analyzed to devise a course of action leading to the intended outcome.	Adaptive: The ultimate consequences of a course of action only become apparent over time. Experimentation, flexibility, and adaptation are vital to obtain favorable outcomes.	Reactive: The outcomes from chaotic processes are largely out of the decision-makers' control, but may require rapid organizational action.
Nature of capabilities	Stable routines	Simple rules and emergent and flexible routines	Little scope for capability building; boundary rules and sensing capabilities in some contexts
System design	Tight coupling: Elements exhibiting ordered system behavior can be linked tightly together for maximum efficiency.	Loose coupling: Elements generating complex behavior should be allowed to interact without constraining these interactions unnecessarily.	Decoupling: Interdependencies between elements exhibiting chaotic behavior and the other elements of the system should be avoided when possible.
Role of management	Manage: The manager can direct the process through the necessary steps to the desired outcome. Frequently the process is routinized, requiring only minimal intervention.	Facilitate: A specific outcome cannot be ascertained, but setting a proper context can increase the probability of favorable outcomes. The occasional intervention can be used to prod the process in the desired direction.	Prepare: From the management's point of view, outcomes are essentially random. The organization can hedge itself against negative outcomes while being prepared to take advantage of possible serendipitous occurrences.
Implications for research	The standard scientific method is viable. Qualitative research can uncover causal linkages and build theory, which can be tested through quantitative research.	Qualitative process research and agent-based modeling can uncover emergent patterns. Quantitative research can be used to test the predictions of complex theoretical models in terms of general patterns.	Qualitative research can describe phenomena but not predict causal relationships at the chaotic level of analysis. However, statistical analysis at higher levels of analysis is frequently possible.

Figure 1. A cellular automaton producing order, complexity, or chaos.



Note: Squares a) through i) show the behavior of 50 elementary actors over 50 time periods or rounds. An actor can be either inactive (white) or active (black). For the first round, actors are randomly selected to be inactive or active. Each actor has a maximum of four neighbors, the two actors above and below it. In each round, (shown along the horizontal axis), an active actor stays active if it has an even number of active neighbors (0, 2, or 4), otherwise it becomes inactive. An inactive actor stays inactive unless it has exactly m active neighbors. Changing the parameter m produces different systems: an ordered system shown at the top (m = 3), a complex ("edge of chaos") system in the middle (m = 2) and a chaotic system (m = 1) at the bottom row.

Figure 2. Impact of uncertainty on emergent order.



Note: The cellular automaton in the top row is as the middle row of Figure 1 (m = 2). The second row is the same automaton, but with the addition of the active actor delayed by one time period. The third row is the same as the first row but with the addition of the active actor shifted upwards by one row.

Author biographies

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Appendix 1. Definitions of complexity in the organizational literature.

The following table presents, in chronological order, definitions of complexity in the organizational literature. The focus is on definitions pertaining to complexity at the level of organizational systems rather than lower-level constructs, such as task complexity. The table is representative rather than exhaustive, with a focus on the most important contributions; for example, the various studies using the NK framework generally use a similar notion of complexity, and only a couple of the most notable examples are included.

Author	**Definition of complexity**	**Key properties of complex organizational systems**
Simon (1962)	A complex system is a system "made up of a large number of parts that interact in a nonsimple way," such that "given the properties of the parts and the laws of their interaction, it is not a trivial matter to infer the properties of the whole." (p. 468)	Interactions between parts Hierarchy Near decomposability
Thompson (1967)	The "complex organization is a set of interdependent parts which together make up a whole because each contributes something and receives something from the whole, which in turn is interdependent with some larger environment." (p. 6)	Interdependence between parts System-wide adaptation
Aiken & Hage (1968)	Complexity is defined as "the degree to which there is a high number of different types of occupational activities in the organization; and the degree to which these diverse occupations are anchored in professional societies." (p. 920)	Occupational diversity Professionalization
Dewar & Hage (1978)	Complexity can be "measured by the number of different occupations, level of training, and extent of professional activity." (p. 111)	Multiplicity of tasks Division of labor Structural differentiation

Roberts (1990)	”The elements of complexity are baffling interactions, subsystems called upon to serve multiple (and incompatible) functions, proximity, and indirect information sources.” (p. 163)	Interdependencies Unexpected sequences Indirect information sources
Kauffman (1993)	Complexity is defined as the number of interacting parts of a system. (p. 54)	Conflicting constraints Complexity catastrophe Self-organization and adaptation
Levy (1994)	In industries conceptualized as “complex, dynamic, nonlinear systems,” firms strategically “interact with each other and with other actors in their environment, such as consumers, labor, the government, and financial institutions” such that “decisions by one actor take into account anticipated reactions by others, and thus reflect a recognition of interdependence.” (p. 170)	Strategic interactions between actors Path-dependence and self-reinforcing feedback loops Self-organization and endogenous changes in industry structure
Johnson & Burton (1994)	Complexity theory is concerned with “the evolution of nonlinear systems over time”, having “relaxed some of the strict chaos theory restrictions.” (p. 321)	Nonlinearity Interdependence Evolution
Bettis & Prahalad (1995)	Complex systems are “systems in which a great many independent agents are interacting with each other in a great many ways.” (p. 10)	Interactions between agents Nonlinear behavior Emergent properties System-level adaptation to the environment
Browning (1995)	“The central message of complexity theory is that the self-organizing of complex ordered systems from apparent chaos does happen, all the time.” (p.139)	Interactions Self-reinforcing processes Self-organization and emergence Unintended consequences

Stacey (1995)	"The science of complexity is concerned with the fundamental logical properties of the behavior of nonlinear and network feedback systems." (p. 480)	Positive and negative feedback Disequilibrium Self-organization Unpredictability of outcomes
Damanpour (1996)	Structural complexity is "the extent to which an organization is divided into structural components or units" and "the variety of specialists that work in an organization." (p. 695)	Multiple differentiated actors Deep and diverse knowledge base Innovativeness
Brown & Eisenhardt (1997)	Complex systems "have large numbers of independent yet interacting actors." (p. 29)	Frequent and rapid change Operation at the edge of chaos Semistructures
Singh (1997)	A technologically complex (organizational) system is "an applied system whose components have multiple interactions and constitute a nondecomposable whole." (p. 340)	Hierachichal structure A network of interactions between components Nondecomposability
Kostova & Zaheer (1999)	Complex organizations "consist of multiple subunits with varying levels of interdependence and independence" (p. 67)	Fragmentation and integration Interdependencies and tensions
Anderson (1999)	"Complex adaptive system models" … "are characterized by four key elements: agents with schemata, self-organizing networks sustained by importing energy, coevolution to the edge of chaos, and system evolution based on recombination." (p. 216)	Agents with schemata Dissipative structures Coevolution to the edge of chaos Recombination and system evolution
McKelvey (1999)	Systems "in the critical complexity category" are "in a state far from equilibrium or at the edge of chaos" with "the possibility of emergent simple-rule deterministic structures." (p. 300)	Far-from-equilibrium behavior at the edge of chaos Multiple interacting elements Multiple local optima

MacIntosh & MacLean (1999)	Complexity theory is concerned with “the operation of nonlinear feedback on generative rules in densely interconnected, nonequilibrium systems. The dynamics and evolution of such a system are influenced by the operation of any number of positive and negative feedback loops within the system.” (p. 301)	Interconnected system Feedback loops Far-from-equilibrium behavior
Morel & Ramanujam (1999)	Complex systems “are difficult to define but easy to recognize” and “may be seen as exhibiting any of a set of basic characteristics” of which “two commonly observed characteristics” are a “large number of interacting elements and emergent properties.” (p. 279)	Many interacting elements Self-similarity Self-organized criticality Self-organization
Levinthal & Warglien (1999)	In complex landscapes, "a number of local peaks are present" because of "strong epistatic interactions in the payoff function." (p. 347)	Autonomous but interdependent actors Self-organization
Boisot & Child (1999)	Complexity is seen as ”arising out of the number of elements that go to make up a system—social or natural—and the nature of the interactions that take place between the elements.” (p. 238)	Cognitive diversity of agents Interactions and information flow between agents
Gavetti & Levinthal (2000)	Complexity is characterized by ”the intensity of interaction effects.” (p. 127)	Interdependencies among policy variables Multiple local peaks limiting the effectiveness of experiential search
Rivkin (2000)	Strategic complexity is defined by “the number of elements in a strategy and the interactions among those elements.” (p. 824)	Multiple elements Dense interactions between the elements Intractability of search for optimal strategy Inimitability

Rivkin (2001)	A "productive system is complex if (a) it consists of numerous elements and (b) those elements interact with one another richly." (p. 274)	Interdependencies between decisions Difficulty of knowledge transfer
Plsek and Greenhalgh (2001)	"A complex adaptive system is a collection of individual agents with freedom to act in ways that are not always totally predictable, and whose actions are interconnected so that one agent's actions changes the context for other agents." (p. 625)	Interconnected, independent agents Fuzzy system boundaries Unpredictability and unknowability Tension and paradox Nonlinearity, emergence, and self-organization
Pich et al. (2002)	"Project complexity means that many different actions and states of the world parameters interact ... so the effect of actions is difficult to assess." (p. 1013)	Interdependent actions Unforeseeable causal relationships
Carlile & Rebentisch (2003)	"Complexity can be defined as a whole that is made of interrelated parts." (p. 1182)	Interdependencies between actors Mutual adaptation
Ethiraj & Levinthal (2004b)	A complex system is "a set of interdependent decisions" in which "ostensibly localized adaptation can have serious consequences for overall system performance." (p. 161)	Interactions between parts of the system of often unknown nature and with often unknown performance implications Nonlinear responses to changes
Chiles et al. (2004)	Complexity theory is concerned with "the emergence of system-level order as an unintended consequence of the action and repeated interaction of lower level system components, without intervention by a central controller." (p. 502)	Fluctuation Positive feedback Stabilization Recombination

Colbert (2004)	"Complexity theory generally denotes a wide-ranging body of work built on such fields as chaos theory ..., cybernetics ..., and dynamic systems theory." In a complex system "the component agents operate with some measure of autonomy, as well as in relation to other system components—that is, independently and interdependently. That interaction gives rise to emergent properties that are irreducible—that exist only in relationship." (p. 349)	Many interacting agents System-level learning and adaptation Stable but unpredictable emergent properties
Sommer & Loch (2004)	Complexity is defined as a "large number of variables and interactions" which "leads to difficulty in assessing optimal actions beforehand." (p. 1334)	Multiple influencing factors Interdependencies between actions jointly determining performance Inability to determine globally optimal policies
Burnes (2005)	"Complexity theories are concerned with the emergence of order in dynamic non-linear systems operating at the edge of chaos: in other words, systems which are constantly changing and where the laws of cause and effect appear not to apply." (p. 77)	Simple order-generating rules Nonlinearity Self-organization Emergent patterns of behavior
Siggelkow & Rivkin (2005)	Complexity is operationalized as the "interdependence of tasks within organizations." (p. 101)	Interactions between choices Difficulty of finding optimal choice configurations Need for broad search

Maguire et al. (2006)	"A complex system is a whole comprised of a large number of parts, each of which behaves according to some rule or force that relates it interactively to other parts." (p. 166)	Large number of semi-autonomous elements Rich, dynamic, and non-linear interactions Open systems operating far from equilibrium Emergent phenomena
Amaral & Uzzi (2007)	Complex systems "have many components that can autonomously interact through emergent rules. … In management contexts … populations of interacting agents (persons, organizations, or communities) … act on their limited and local information." (p. 1033)	Multiple autonomous components Interactions between components Emergent rules Limited and local information
Fiss (2007)	Complexity theory sees "organizations as dynamic, nonlinear systems, explicitly focusing on connections and the interaction of variables in creating outcomes." (p. 1191)	Interactions between agents Nonlinear effects
Plowman et al. (2007)	"A complex system is comprised of numerous interacting agents, ... each of which acts on the basis of local knowledge or rules." (p. 519)	Nonlinearity Far-from-equilibrium dynamics Feedback loops Emergent self-organization
Snowden and Boone (2007)	A complex system "involves a large number of interacting elements" whose "interactions are nonlinear, and minor changes can produce disproportionately major consequences." (p. 71)	Interacting elements Nonlinear interactions Emergence Path dependence Constant change Unpredictability

Martin & Eisenhardt (2010)	A complex adaptive system is a system "composed of unique, relatively autonomous, partially connected actors." (p. 266)	Autonomous actors Connections between actors Emergence
Eisenhardt and Piezunka (2011)	A complex adaptive system is "comprised of partially connected agents whose interaction gives rise to the 'complex' behavior that is characteristic of these systems" (p. 508)	Autonomous agents Interactions between agents Emergent behavior that is neither completely structured nor random
Madden et al. (2012)	A complex adaptive system is "composed of highly interactive, interdependent agents who learn and adapt in order to produce behaviors that would not be predicted by observing the system's past" (p. 693)	Independent agents Coadaptation Emergence
Zhou (2013)	Complexity is "the extent of interdependence … among tasks." (p. 339)	Multiple interacting tasks Interdependencies and tradeoffs
Beck & Plowman (2014)	Complexity science conceptualizes organizations as "complex systems made up of interdependent agents that interact, learn from each other, and adapt their behaviors accordingly. These ongoing interactions lead to emergent outcomes, often unplanned and unexpected." (p. 1246)	Multiple agents Interdependent adaptation Self-organizing and emergence
Billinger et al. (2014)	In a complex organizational problem "decision variables interact in determining the value of an alternative combination." (p. 93)	Multiple interdependent tasks Difficulty of finding the optimal choice configuration
Schneider et al. (2017)	Complexity "refers to the number of elements that constitute a system or the environment of a system, and to the connections between these elements"	Large number of elements Large number of interactions between elements

Okwir et al. (2018)	In complex systems, "their associated members and their interaction with subsystems will determine their current and future [behavior] through a self-organizing set of order-generating rules" (p. 732)	Non-linear interactions Unpredictable consequences of small changes
Baumann et al. (2019)	Complex problems "require making a large number of highly interdependent choices." (p. 285)	Large number of choices Interactions between choices Difficulty of finding optimal choice configurations Need for broad search
Chen et al. (2019)	Complexity is "the extent of interdependence between different activities." (p. 1796)	Interactions between choices Difficulty of finding optimal choice configurations Rigidity due to getting stuck at local optima Need to draw search away from local optima
Rosenhead et al. (2019)	Complexity is "the study of phenomena which emerge from a collection of interacting objects" (p. 2, citing Johnson, 2009: 1)	Interactions Lack of a central controller Nonlinear feedback loops Unpredictable, emergent, and self-organizing system behavior Diverging system reactions from minor changes in initial conditions

Kreienkamp and Pegram (2021)	In complex problems, "elements constantly interact with each other and their environment, giving rise to emergent behavior that cannot be understood in terms of the properties of system elements but only in terms of the relationships between them" (p. 783)	Interactions Openness Nonlinear dynamics Emergent properties and self-organization Patterns that are identifiable but difficult to predict

Footnotes

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[1] In the NK framework, organizations search on a landscape with N decision elements, where the performance of each element depends on choices made regarding the focal element itself as well as on choices made regarding K other elements in the landscape.

[2] Cellular automata are computational models consisting of cells that change their state based on their neighboring cells, following a predefined set of rules.

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