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## Firms as Systems of Interdependent Choices

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ABSTRACT Managers within firms have to make choices along a large number of dimensions; for instance, how to configure activities involving manufacturing and marketing, and which organizational design to employ. Since these choices interact with each other, firms can be conceived of as systems of interdependent choices. In this article, I discuss research that addresses three questions that naturally arise in this context. First, how do such systems evolve over time? Second, what role does organizational design play in whether a firm will arrive at a consistent and high-performing set of choices? Third, what are the consequences of cognitive limitations by decision makers when faced with such complex systems? The article concludes by sketching out possible future directions of research in this domain.

### INTRODUCTION

Managers within firms have to make choices along a large number of dimensions – e.g. how to configure activities involving manufacturing, distribution, research, and marketing; how to organize and divide up tasks; and which organizational design to employ. It is one of strategy's longest-standing notions that these choices interact with each other and need to fit together for a firm to achieve high performance (Drazin and Van de Ven, 1985; Khandwalla, 1973; Learned et al., 1961; Miller and Friesen, 1984).

Consider the example of Vanguard, one of the world's largest mutual fund providers. Vanguard, guided by its founder Jack Bogle, focused on conservatively managed funds, such as index and money market funds, distributed these funds directly not using banks or brokers, stressed candid communication with fund shareholders, created high quality service for its fund shareholders, used an organizational structure in which fund shareholders were also the owners of the asset management company, and pursued low costs in all of its operations. A number of these choices were not only unique, but they also interacted with each other. For instance, the focus on low cost created high long-term returns, leading to increased fund inflows, which in turn created lower costs due to economies of scale. Yet this positive feedback loop was strengthened, and in part created in the first place, by Vanguard's other choices. For example, low costs only translated to

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Figure 1. Map of interactions among Vanguard's choices in 1997

perceivably higher long-term returns for the types of funds that Vanguard focused on (i.e. funds where costs are a main driver of differences in final returns for fund shareholders, such as index funds). Likewise, its organizational structure ensured that all cost savings would be passed on to fund shareholders. Vanguard's information and communication activities made the link between higher long-term returns and fund inflows stronger, while larger fund inflows led to lower costs especially for the types of funds that Vanguard focused on, i.e. easily scalable funds.

Figure 1 shows a sketch of Vanguard's set of choices, c. 1997, and the interactions among them (Siggelkow, 2002a). Underlying this figure is a definition of interaction that has been employed in the literature on complex interdependent systems (e.g. Levinthal, 1997; Rivkin, 2000). Two elements are said to interact if the value of one element depends on the presence of the other element. In particular, two elements are said to reinforce each other if the value of each element is increased by the presence of the other element, that is, if the two elements are complementary to each other (Milgrom and Roberts, 1990).

When looking at a complex system such as the one depicted in Figure 1, a number of questions naturally emerge. For instance:

- 1. How do such systems evolve over time, because it is quite unlikely that firms are founded with such full-fledged systems?
- 2. How does one manage such systems? If many decision makers are involved in running a firm, how does organizational design affect which choices get adopted within a firm?
- 3. What are the consequences of cognitive limitations by decision makers when faced with such complex systems?

In this article, I will outline some of the research that I have conducted together with a number of colleagues along these three questions. Thus, this article is intended to reflect a personal journey I have taken over the last decade. By design, it certainly is not a comprehensive overview. Relatedly, most of the research discussed has its intellectual heritage in the behavioural theory of the firm (Cyert and March, 1963), focusing often at an organizational level of analysis. Promising, and quite natural links to an even more micro-level analysis, at the level of managerial practices (Johnson et al., 2003; Whittington, 1996), exist, and are outlined in the last section of this article.

# 1. HOW DO SYSTEMS OF INTERDEPENDENT CHOICES EVOLVE OVER TIME?

While prior work has argued that systems of tightly interconnected activities play an important role in creating and sustaining competitive advantage (e.g. Milgrom and Roberts, 1995; Porter, 1996), existing research has been much more silent on the theoretically and managerially important question of how such systems become established and evolve over time (Miller, 1996). A number of related research strands are suggestive of some features that might arise in the evolution of such systems. For instance, Miller and Friesen (1982, 1984) argued that tight interdependencies will lead firms to change in 'quantum' leaps, i.e. that a firm's evolution will consist of 'long periods of maintenance of a given configuration, punctuated by brief periods of multifaceted and concerted transition to a new one' (Miller and Friesen, 1984, p. 23). Similar arguments concerning change following a 'punctuated equilibrium' path have been made by Tushman and Romanelli (1985) and Gersick (1991). At the same time, other scholars have argued that several transition paths from one configuration to another are possible (Greenwood and Hinings, 1988).

Using an inductive study of the developmental path of the Vanguard Group, one of the largest mutual fund provider in the USA (Siggelkow, 2002a), I tried to make some headway by developing tools and concepts that would allow a consistent description of the development of interdependent systems. Through an iterative process, involving the data of the case (generated through fieldwork and primary and secondary sources), existing literature, and broader conceptual reasoning about organizational evolution, it was possible to identify four developmental processes that were intimately related to the creation and further elaboration of organizational elements that had 'core' characteristics. While many scholars had previously argued that some organizational elements are more central or core to an organization than others (Hannan and Freeman, 1984; Singh et al., 1986), little progress had been made in distinguishing them systematically. To define more tightly developmental processes, I developed a characterization of organizational core elements that allowed a systematic identification of such elements. Building on a consensus in the literature concerning the properties of core elements, an organizational core element is defined as an element that interacts with many other current or future organizational elements (Baron et al., 1999; Hannan et al., 1996). Thus, the notion of *interactions* among the elements of an organizational system plays a key role in identifying core elements. More specifically, by representing a firm's system of interdependent choices as a network consisting of nodes (organizational elements) and connecting edges (interactions), core elements are identified as central nodes in this network, using network-theoretic measures, such as degree centrality (Freeman, 1979) and information centrality (Stephenson and Zelen, 1989). If such an analysis is performed for various intervals, e.g. on a yearly basis, the firm's core elements can be traced over time.

Once the core elements are pinpointed, different developmental processes can be found: *thickening*, the reinforcement of an existing core element by new elaborating elements; *patching*, the creation of a new core element and its reinforcement by new elaborating elements; *coasting*, no further elaboration of a new core element in a given period; and *trimming*, the deletion of a core element and its elaborating elements. These four developmental processes form a vocabulary that can be used to describe the development of systems of interdependent choices in a systematic way, allowing the comparison of how different organizations have evolved.

Besides the challenge of growth, many firms face the challenge to adapt their system of activity choices after their competitive environment has changed. In this context, the question arises of 'How does tight interdependency among a firm's choices affect this adaptation process?'. In the literature, two opposing positions have been taken. On the one hand, it has been argued that internal interdependency leads to increased inertia (Levinthal, 1997), making tight fit among choices a potential liability in dynamic environments. On the other hand, it has been argued that tight interdependency raises the sensitivity and incentive for management to optimally configure and adjust all of its choices (Weick, 1976).

In Siggelkow (2001), some light is shed on this debate by showing that the relationship between tight interdependency and inertia depends on the type of environmental change that a firm encounters. To clarify the issue, first the distinction is made between *internal fit* and *external fit*. A firm achieves internal fit when its activity choices are mutually reinforcing. A firm achieves external fit when its configuration of choices generates high performance given its current environmental conditions. Based on whether internal and/or external fit of a firm is affected by the environmental change, a new classification scheme for environmental changes can be derived. The two main classes of environmental change are *fit-conserving* changes, which keep a firm's internal fit among activities intact yet decrease the appropriateness of the set of activities as a whole, i.e. decrease external fit; and *fit-destroying* changes, which perturb both internal and external fit.

For firms encountering fit-conserving change, tight fit among its activities can lead to high inertia. Even though the firm's financial performance has declined, no obvious misfits can be detected because the internal fit of the old system remains intact. Moreover, since the internal consistency of the firm's system of choices is not affected, incremental changes are likely to lead to a further deterioration of performance, strengthening managers' beliefs that the old system is still appropriate – which at one level it is (it still has internal fit), yet at another level it is not (its external fit has declined). In contrast, following fit-destroying change, firms with tight fit may very well respond quickly, because both their financial performance has deteriorated and internal misfits can be identified. In this case, firms with tight fit have a high incentive to adapt and there might exist a range of clues concerning what should be done since various elements are misaligned.

## 2. THE ROLE OF ORGANIZATIONAL DESIGN IN MANAGING SYSTEMS OF INTERDEPENDENT CHOICES

My in-depth research on individual firms made me very much aware of the distributed nature of decision making within firms. While top management clearly had an effect on the broad contours of a firm's strategy, the eventual set of activities that a firm engaged in arose from the interplay of many decision makers distributed throughout the entire organization. I became intrigued by the role played by organizational design in this process. How does organizational design – which includes, among others, task and decision allocations, incentive systems, and communication channels – affect a firm's ability to coordinate its interdependent activity choices and hence its performance? Moreover, in the presence of distributed decision making, organizational design is one of the key levers available for top managers to affect how decisions are made within organizations, and thus an important means to shape the evolution of a firm (Burton and Obel, 1984; Galbraith, 1973; Khandwalla, 1977; Thompson, 1967).

When I embarked on my research on organizational design, the existing literature fell mainly into two categories: (a) a qualitative literature, offering rich descriptive accounts and informal arguments leading to various prescriptions and typologies (e.g. Gibson et al., 2000; Mintzberg, 1979); and (b) a formal organizational economics literature, analysing in depth and with closed-form mathematical approaches very stark, simplified organizational structures (e.g. Aghion and Tirole, 1997; Bolton and Dewatripont, 1994). While both approaches have their strengths, neither of them appeared to be well-suited to address the issue at hand. In the presence of interdependencies, intuition can easily be misguided, and as a result, informal arguments, even when based on detailed observations, can be misleading. At the same time, unless one significantly restricts the interactions among activity choices and focuses on only very simple organizational set-ups, closed-form mathematical solutions are difficult to obtain. The result was a massive gap between spartan models and the rich descriptions of actual organizations in the empirically-grounded literature. The advent of agent-based computer modelling techniques has allowed researchers to narrow this gap significantly (e.g. Anderson et al., 1999; Axelrod and Cohen, 1999; Carley and Lin, 1997; Carley and Svoboda, 1996; Gavetti and Levinthal, 2000; Levinthal, 1997; Macy and Willer, 2002). Consequently, a simulation approach, which allowed the inclusion of more organizational detail, yet also afforded a systematic analysis, seemed an attractive path to pursue. As a result, my colleague Jan Rivkin and I started to build a set of new models that allowed us to study the effects of organizational design on the ability of firms to find high-performing sets of choices.

We have used the simulation approach to achieve three main goals. First, the models help to unearth underlying mechanisms, i.e. common drivers that help explain relationships between organizational design features (such as the degree of decentralization, or the type of incentive system), environmental contexts (such as the degree of turbulence or complexity), and performance outcomes. Second, by being systematic, the models are able to show various boundary conditions on conventional wisdom that relates to how organizational design affects performance. Third, the results of the models have pointed towards more refined hypotheses for the various relationships between organizational design and performance.

More broadly, with our modelling approach we have striven to follow a tradition of creating simple yet insightful models (e.g. Burton and Obel, 1984; Cohen et al., 1972; March and Simon, 1958; Nelson and Winter, 1982). As Axelrod (1997, p. 5) emphasized, 'the goal of agent-based modeling is to enrich our understanding of fundamental processes . . . [I]f a simulation is used to train the crew of a supertanker . . . accuracy is important and simplicity of the model is not. But if the goal is to deepen our understanding of some fundamental process, then simplicity of the assumptions is important, and realistic representation of all the details of a particular setting is not.'

In this stream of work, we formally operationalize the concept of a firm as a system of interdependent choices, by requiring managers of firms to search for good combinations of N different activities that to varying degrees are interdependent of each other. Thus, managers have to find good solutions to a complex N-dimensional optimization problem. These decision problems can be interpreted as 'performance landscapes' – mappings of all possible sets of a firm's activity choices onto performance values – on which managers search to find high peaks, i.e. coherent sets of activity choices that generate high performance (Kauffman, 1993; Levinthal, 1997; Wright, 1931). We further add organizational elements such as incentive systems, hierarchical structures, and communication with managers.

The formal modelling of organizational designs required us to be very specific about each organizational design element we included. We saw this as an advantage. As Krackhardt (2000, p. 271) pointed out: 'Through the discipline of computational models, we are forced to explicate carefully the premises and microassumptions underlying our theory. We allow untold complexities to emerge and play out . . . [while enjoying the] benefit of logical accuracy . . . and generality. That is, computational theorizing is a step forward in completing the circle of theoretical development in the field of organizations.' Other simulation work that formalizes prior notions includes Lant and Mezias (1990), March (1991), Bruderer and Singh (1996), Sastry (1997), Gavetti and Levinthal (2000), Rudolph and Repenning (2002), and Zott (2003).

In Rivkin and Siggelkow (2003), we examine how and why elements of organizational design depend on one another. While prior studies have pinpointed specific interdependencies among various elements of design, they have not explained *why* interdependencies among design elements arise. A deeper understanding of these interdependencies is important, however, to create high-performing organizational designs. In this paper, we identify a general, underlying tension that gives rise to interdependencies among organizational design elements. Our results show that successful firms balance two opposing needs. On the one hand, to be effective, the managers of a firm must search broadly for

good combinations of decisions; they must not lock in prematurely on the first decent set of activities they discover. On the other hand, a successful firm must halt its search efforts and stabilize its decisions once it finds an outstanding set of activities. We identify specific elements of organizational design that drive a firm towards broad search and others that encourage stability. The need to balance search and stability creates interdependencies among the design elements.

The notion of a performance, or fitness, landscape was originally developed in the biological and physical sciences, which are concerned with agents that generally search using a local and random process (Kauffman, 1993, 1995). For instance, bacteria 'search' to find a good configuration of genes by random mutation. With random and local search, entities will migrate towards the local peaks of these landscapes. (A local peak is a vector of activity choices **d** with the property that no alternative that differs in only one element from **d** has higher performance than **d**.) Using this framework, scholars studying human organizations and adopting the notion of fitness landscapes had generally assumed that organizations would migrate towards the local peaks of performance landscapes as well. We show, however, that human organizations may very well come to rest at a 'sticking point' which is *not* a local peak on the performance landscape of the overall organization. In other words, in trying to find solutions to high-dimensional optimization problems, firms do not even get to local optima (let alone find the global optimum). At a broader level, our results illustrate that it is valuable to use tools developed to study one type of complex adaptive system in order to examine another type - but that researchers must adapt the tools with care as they attempt to do so (Rivkin and Siggelkow, 2002).

In Siggelkow and Rivkin (2005), we analyse which organizational structures are appropriate for turbulent vs. stable environments. While it has long been argued that an organization's internal design should reflect the nature of its external environment, researchers are far less unanimous concerning how optimal design is contingent on environmental features such as turbulence or complexity. In particular, attempts to construct simple contingency relationships, i.e. one-to-one mappings from environmental conditions to appropriate design elements, have met with limited success. For instance, prior research has argued that a turbulent environment is best handled with a rich lateral communication flow, while the opposite argument, that a turbulent environment requires centralization, has also been made. Our analysis sheds light on this debate by modelling firms that vary in their organizational structures. We find that the same organizational feature may have quite different effects on speed and search depending on what other design elements are deployed. A feature that accelerates improvement in a decentralized firm, for instance, may slow it down in a hierarchical firm. It is this subtlety that undermines simple contingency relationships. From our model we also derive a set of testable hypotheses concerning which types of formal design cope well with three different environments: turbulent settings, in which firms must improve their performance speedily; complex environments, in which firms must search broadly; and settings with both turbulence and complexity, in which firms must balance speed and search. The results shed new light on longstanding notions such as equifinality.

In Siggelkow and Rivkin (2006), we investigate another piece of conventional wisdom. An enduring belief is that unleashing low-level members of an organization to explore extensively will broaden the exploration conducted by the entire organization. In this

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paper, we show that in multilevel organizations, increased exploration at lower levels can backfire, *reducing* overall exploration and diminishing performance in environments that require broad search. This result arises when interdependencies cut across the domains of low-level managers. Our findings show that careful attention to information processing in multilevel organizations can shed light on whether, and when, decentralization encourages innovation.

Other surprising effects can arise when organizations are modelled that change their designs over time. The starting point of this research project with my colleague Daniel Levinthal was the general question of 'How should firms organize to explore and search a new space of possibilities?'. More concretely, we were fascinated by the variety of organizational responses to the emergence of the worldwide web. To many firms, the web constituted a significant environmental shock, creating an altered performance landscape that opened many new activity configurations and that required firms to readjust their existing activity systems. Which organizational structure to adopt in the search for an appropriate strategic response to the new competitive landscape was a non-trivial question for many firms, and a large variety of organizational responses ensued. Some firms, like The Gap, Vanguard, and Dell, pursued centralized change efforts in which the firm incorporated its e-commerce activities seamlessly into the existing organization. In contrast, other firms, such as Bank One and Disney, pursued more decentralized search efforts, while others, such as Charles Schwab, started decentralized but fairly quickly reverted to a centralized and integrated structure.

Using an agent-based simulation, we modelled these three organizational responses: centralized, decentralized, and reintegration (Siggelkow and Levinthal, 2003). Our main finding was that temporary decentralization with subsequent reintegration – an organizational response that had not found much attention in the literature – yielded the highest long-term performance. This sequence of organizational structures allows a firm to both initially explore possible solutions and to eventually coordinate across its divisions. We further showed that: (1) as the degree of environmental change increases, the performance advantage of the reintegrator over the centralized firm increases; (2) as the degree of interaction among the choices of the firm increases; and (3) as the degree of interaction among the choices of the firm increases; and (3) as the degree of interaction among the choices of the firm increases; and (3) as the degree of interaction among the choices of the firm increases; and (3) as the degree of interaction among the choices of the firm increases; and (3) as the degree of interaction among the choices of the firm increases; and (3) as the degree of interaction among the choices of the firm increases.

At a more fundamental level, our results showed important extensions to two of the most central tenets of the field of organizational design. First, it is commonly held that if a system contains many interdependencies, it should not be split apart since interaction effects would be ignored (Khandwalla, 1977; Thompson, 1967). Indeed, we found that if attention is restricted to organizational structures conforming to the pure forms of permanently centralized or decentralized structures, this belief is true. However, a third solution exists: a temporary decentralization followed by reintegration. Our results showed that this temporal sequencing of different organizational structures can lead to higher performance than either pure form. Thus, even if a system is not decomposable (i.e. cannot be split into independent subsystems), one still may usefully break it apart, if it is done temporarily.

A second central doctrine of organizational design states that tasks should be grouped so that the tasks with the most intensive interactions are grouped together (Simon, 1962). For instance, if tasks 1, 2, and 3 interact with each other, and likewise tasks 4, 5, and 6, yet none of 1, 2, and 3 interact with 4, 5, and 6, this design principle would state to create two groups,  $\{1, 2, 3\}$  and  $\{4, 5, 6\}$ . Our results showed a limitation of this dictum as well. If the subsystems, or modules, that decomposition creates are complex by themselves (i.e. contain many interdependencies), temporary cross-interdependence among modules can yield higher final performance than perfect decomposition from the start. In our case, creating temporarily, for instance, the groups  $\{1, 4, 5\}$  and  $\{2, 3, 6\}$ , and letting agents search for good solutions for a while, before changing the task groupings to  $\{1, 2,$  $3\}$  and  $\{4, 5, 6\}$ , yields higher performance than breaking up the system right away into the two independent groups  $\{1, 2, 3\}$  and  $\{4, 5, 6\}$ . Thus, even if a system could be split in a way such that the subsystems are independent of each other (i.e. a perfect decomposition), it may be beneficial not to do so right from the start.

The underlying driver for these results is similar in both cases: cross-interdependencies between divisions leads to increased exploration because divisions will not get stuck with the first set of consistent choices they chance upon. Subsequent centralization (in the case of a non-decomposable system) or decomposition (in the case of a fully decomposable system) allows the firm to further refine the solutions and to coordinate across the divisions.

Siggelkow and Rivkin (2009) builds on this work on changes of organizational design by allowing firms to endogenously change their designs. For instance, firms might be more likely to change their design when their performance is low. More abstractly, firms are engaged in a coupled search process: at low frequency, managers search for appropriate organizational designs. At higher frequency, managers use designs to search for high-performing operational choices. The two searches are coupled: organizational design moulds the choice among operational alternatives, and performance feedback from operational choices shapes design.

Coupled search processes like these are common: at a low frequency, a firm searches for partners and develops its position in a network of allied firms; at a faster cadence, the position influences the firm's ability to tap into knowledge and to search for innovation (Ahuja, 2000). At a slow pace, managers develop cognitive frames – images of their competitive environment and their place in it; more rapidly, these frames shape their search for a strategy (Gavetti and Levinthal, 2000). A firm's resource allocation process, evolving slowly, moulds the firm's deployment of its resources, which has a near-term impact on its behaviour and success in the marketplace (Bower, 1970). Gradually, a nation might develop and adapt its legal Constitution; the Constitution then guides the formation of policies and laws at a faster pace, and those policies and laws – not the Constitution – have the direct impact on the country's prosperity (North and Weingast, 1989).

An enduring goal of organizational research is to examine the low-frequency objects of search and to isolate their (indirect) impact on performance. How, for instance, do formal organizational design choices, a firm's position in an alliance network, managers' cognitive frames, characteristics of the resource allocation process affect organizational performance? How do Constitutional provisions influence national prosperity? Clearly, such questions are of first-order interest to students of organizations. In Siggelkow and Rivkin (2009), we show that to address these questions, researchers must grasp the consequences of the two-level, asynchronous search processes that stand between the low-frequency objects and performance. An understanding promises two related benefits. First, it can shed light on the mixed results that have plagued past research. For instance, empirical studies of the relationship between organizational design and performance have resulted in a vexingly large number of ambiguous findings despite strong theoretical arguments that such a relationship should exist (Donaldson, 2001). Why are clean results so hard to obtain? What forces dampen relationships that should, in theory, exist? Second, an understanding can guide empirical work by identifying research settings in which those dampening forces are particularly prevalent or muted.

In our paper, we identify research strategies for tackling the empirical difficulties created by coupled search processes; discuss population-level advantages of coupled search processes; and highlight implications for analogous coupled search processes that shape networks, cognition, and capabilities.

### 3. THE EFFECTS OF MANAGERIAL COGNITIVE LIMITS

My work on mapping the systems of interdependent activity choices of various firms made me appreciate how complex the interactions among a firm's choices often were. Not all interactions are complementary, and whether interactions have the character of complements or substitutes is frequently dependent on other activity choices that a firm has made, i.e. interactions are contextual. This richness has important managerial and theoretical implications.

In Porter and Siggelkow (2008), we develop the notion of 'contextual' interactions further. We document various ways in which interactions can be contextual and we discuss the strategic implications of contextual interactions, particularly with respect to sustainability of competitive advantage. In addition, we outline the implications of contextual interactions for future empirical and simulation research.

One of the implications of contextual interactions is that managers who imitate activities from other firms may misjudge the way the new activities interact with the existing activities of a firm. More broadly, if firms are complex systems of many interdependent activity choices, it is quite likely that decision makers may not take all interactions fully into account. Contextuality of interactions as well as incentive and accounting systems may lead managers to ignore or misperceive interactions.

I have studied the consequences of such misperceptions in two papers. Siggelkow (2002b) focuses on the different costs that arise from misperceiving interactions among complements vs. substitutes. Using closed-form mathematical analysis, the model shows that misperceptions with respect to complements are more costly than with respect to substitutes. Consequently, firms should optimally invest more to gather information about interactions among complementary activities, e.g. concerning network effects, than about interactions among substitute activities. Similarly, the use of division-based incentive schemes would be more advisable for divisions whose products are substitutes than for divisions that produce complements.

In Martignoni and Siggelkow (2010), we study contingency relationships more generally. The value of many activities that a firm is engaged in is affected by external

factors, such as the degree of environmental turbulence, and by internal factors, such as the configuration of other firm activities. Managers may, however, not always have the correct mental model that would reflect all present contingency relationships. Managers might have blind spots (Zajac and Bazerman, 1991), i.e. have mental models that miss interactions that are present, or they may be too neurotic, i.e. have mental models that contain interdependencies that are not present in the real world, perhaps created by prior superstitious learning (Levitt and March, 1988). Using a simulation model, we study the effects of misspecified mental models. We find circumstances in which misspecified mental models lead to higher performance than do correctly specified mental models. In particular, we find that for external contingencies it can pay to be slightly neurotic, while for internal contingencies it can be beneficial to have a few blind spots. In both cases, misspecification creates a benefit because it induces beneficial exploration.

### **FUTURE DIRECTIONS**

For each of the three research domains outlined above, a range of future research directions are wide open. Let us start with the dynamics of organizational growth and development, an overall fairly under-researched area. As a first step, it would be helpful to know what type of developmental trajectories we can observe in firms. A second step would be to analyse the conditions under which different trajectories arise. These conditions would include both external factors, such as industry conditions, and internal factors, including the (dynamic) capabilities of a firm (Teece et al., 1997). Moreover, particular fine-grained managerial practices may lead firms to develop in different ways. Thus, a deeper understanding of managerial practices as they relate to developmental activities (Johnson et al., 2003) could be an important building block for disentangling the causes that lead firms to follow different trajectories. Third, what are the performance implications of having developed along a certain trajectory? Answers to these questions would be of both theoretical and managerial interest. These answers would, however, also require an extensive data-gathering and analysis effort, as each data point would require the detailed history of one organization. Methodologically, set-theoretic methods like qualitative comparative analysis (Fiss, 2007), may become more suitable to this type of analysis than traditional regression analyses, especially if the dataset that a researcher is able to assemble is not very large.

In general, the approach of thinking of sequences of events could be a fruitful avenue to pursue (Abbott, 1995; Abbott and Tsay, 2000). Over the last few years, empirical research has moved to a large degree from cross-sectional studies to longitudinal studies. Most longitudinal models, however, exploit the longitudinal nature of the data only by using a one-year (or x-year) lag structure, together with a treatment for correlated errors. While this certainly helps with establishing causal relationships, it does not get very far for probing into path dependencies (Nelson and Winter, 1982). More methodological advances are needed, it seems, to push this line of research further. One complication, of course, is that treating an entire sequence of events as one 'data point' reduces radically the size of one's dataset and reduces the statistical power of any test.

Another related aspect of studying growth and development is the question of what drives strategy and what are the origins of strategy? The strategy field has many tools to evaluate strategy, but is fairly quiet on the topic of the origins of strategy (Gavetti and Rivkin, 2007). For instance, what comes first: a positioning insight, followed by the accumulation of necessary resources to implement this positioning; or an assessment of resources and capabilities, that is followed by an analysis of how to exploit these resources? It seems very much an open empirical question whether, or under what circumstances (e.g. age of firm), one or the other way of creating strategies is predominant.

The work on organizational design seems also rife for many further extensions. The work started out by stressing the formal elements of design, then was superseded by research stressing informal elements of design, and the recent resurgence of work using simulation models has again stressed the formal elements. The next step clearly would be the incorporation of informal elements of design into simulation models. As with any formal modelling, however, this will require to formalize the 'informal elements,' a difficult but worthwhile task.

A second gap is a lack of empirical studies at the organizational level of organization design. A few studies exist at a more macro level, documenting broad shifts, e.g. towards flatter organizational designs (Rajan and Wulf, 2006). At the same time, a number of studies exist at a more micro level, that look at pieces of design, e.g. incentive systems (Bandiera et al., 2009). In some sense, the formal models, and the simulation models in particular, have currently outpaced the empirical work in this field. Many revised hypotheses about how organizational design should affect performance have been created: now it would be helpful to see whether any of these hypotheses are actually empirically born out.

Lastly, the work on organization design will, I suspect, benefit in the future from a richer modelling of decision makers, thereby bridging this research with the work on managerial cognition and cognitive limits. While the notions of bounded rationality (Simon, 1957) and the effects of cognition on strategy (Porac et al., 1989) have been long-standing notions in the fields of organizational and strategy research, many further avenues of this research exist (see Kaplan, 2011, for a survey).

With respect to work on firms as interdependent systems of choices, current research is increasingly starting to tread a middle ground in the representation of the notion of bounded rationality as intendedly rational behaviour by agents with limited information processing power. First steps in this direction have been very encouraging (e.g. Gavetti and Levinthal, 2000; Gavetti et al., 2005). Moving further along these lines might include different aspects of forward-looking behaviour (besides cognitive maps or analogies) such as memory and the formation and adaptation of theories about the search space a decision maker is traversing (Nelson, 2008). In general, work on inductive and deductive reasoning could potentially yield a new set of insights in this arena (Cornelissen and Clarke, 2010; Regnér, 2003).

More broadly, I see a lot of potential for progress in the area of how managers can create processes to manage the growth and development of their organizations. This research would encompass the notions of interdependencies among the choices that need to be resolved, while taking into account organizational design as one lever, among others, to influences and guide the process, all in the context of acknowledging the cognitive boundaries of all decision makers involved.

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