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# The architecture and design of organizational capabilities

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This article considers how ideas from evolutionary theory in general, and Sidney Winter in particular, can be fruitfully combined with ideas from Herbert Simon and the Carnegie tradition on decomposability and cognitive limits. Rather than focusing on any one individual issue, this article outlines a research program on the architecture and design of organizational capabilities. Such a program can help us explain how labor is divided and organized within and between firms and can consider the implications of the division of labor for the process of capability development. Extensions to this emerging research program are proposed: The emergence and evolution of intra- and inter-organizational boundaries, the implications of such boundaries for different types of capabilities and for the knowledge accumulation process, and the design of firms' architecture to support adaptation and change are all briefly discussed.

## 1. From the Schumpeterian theory of production to the architecture of organizational capabilities

Sid Winter's article (this issue) gives an interesting perspective on the early roots of "evolutionary economics" and evolutionary ideas more broadly (Nelson & Winter, 1982) and also hints at the ambiguity of what it means to be "evolutionary." First, what is clear is that Winter cares about a set of issues which is relatively neglected by mainstream theory: that is, the way in which firms change their own "technologies," their capabilities in doing things, or the products and services they offer; as a result, how technologies evolve at the aggregate level. So being "evolutionary" is not an article of faith; it is not the a priori preference in one mode of explanation (rooted in routines) over another (rooted in rational choice) but rather an effort to understand what cannot be properly accounted for by existing toolkits and methods. Second, Winter's article, as well as the project he was undertaking, was titled "Neo-Schumpeterian," rather than "evolutionary" at first. I take this to indicate that we should think of the subsequent work as a very broad research program—one that does not limit itself to following Schumpeter or Nelson and Winter in a strict sense but rather building on the general spirit that is in those ideas (Dosi, 2004).<sup>1</sup>

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<sup>1</sup>As a personal aside, let me attest to the fact that Sid was never a proselytizer. As his doctoral student in Wharton, I would somewhat arrogantly state that I was not an evolutionary economist—defining myself as an institutional/organizational economist instead. Sid clearly did not mind; quite to the contrary.

We should, therefore, not be surprised that Winter's work led to important developments in far-flung areas, such as technological change, the economics of knowledge, industrial dynamics, organizational learning, and theories of organizational capabilities; ideas important not only to evolutionary studies but to a broader set of constituents, in economics, management, and beyond. Concepts such as evolution, technological change, competencies and capabilities, routines, tacit knowledge, central to the fields of strategy, organization theory, management, and technology studies owe much of their development to Sid's early and later work.

Yet, concepts alone are not enough, and for all the progress that has been made since Winter (and Nelson's) early papers, there still are issues we need to address. For one thing, developing new ideas and concepts—an understandable side effect of the incentive structure in academe—sometimes dominates our efforts to understand and integrate, thus resulting in what Dosi *et al.* (2000: 3) refer to as the “terminological flotilla and anarchy” that is sometimes present in our field(s). As they note “The term ‘capabilities’ floats in the literature like an iceberg in a foggy Arctic sea, one iceberg among many, not easily recognized as different from several icebergs near by”. Yet, concepts and ideas flourish when they work within a broader theoretical framework, where loosely discussed concepts such as “routines,” “competencies,” and “capabilities” could become more sharply defined, through linking them to new empirical observables we want to explain—such as firm boundaries, value chain structure, or organizational structure.

Extending the research program of evolutionary theory to explain *structure*, in terms of the structure of organizations and the structure of industries and considering the effects of that structure, has two major benefits: First, it allows us to consider some important empirical regularities, some new factors that we will be able to better explain (e.g., what affects the way in which firms set their internal boundaries and structure? What determines the boundaries of organizations? What shapes the nature of an industry's boundaries?). Second, it allows us to consider these new factors in explaining some of the core questions that the evolutionary tradition aspires to address (e.g., how does setting boundaries within a firm affect its ability to develop capabilities? How do inter-firm boundaries affect technology evolution within a sector?).

Such an organizing scheme might also afford us the opportunity of building more explicitly on what we now know about how decision-makers and organizational participants operate. Over the last decades, significant strides have been made in our understanding of individual and collective decision-making, and we now know much more about persistent, if counter-productive regularities relating to framing, biases, and the role of cognition and learning. These findings, though, have largely been presented as “interesting empirical deviations from the standard textbook model of

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He was interested in working in new areas, or uncovering new regularities, rather than building a reverential intellectual imperium!

decision-makers” (Allais, 1953; Kahneman and Tversky, 1972, 1996; Camerer, 2003).<sup>2</sup> And, surprisingly, in much of the evolutionary and management research, where bounded rationality is accepted as a premise, we have not made the effort to integrate research on the cognitive limitations of decision-makers and consider how this affects the patterns of organization and change.<sup>3</sup>

Building such a program would draw on and extend Winter’s work, as it considers the factors that determine how technology develops, but it would also build on another forefather of Winter’s own work—Herb Simon. First, it would draw on Simon’s (1997) admonition to study what he termed “empirically based micro economics,” that is, letting empirical regularities and observations of real organizations drive research, both in terms of explaining phenomena and causal mechanisms. Such emphasis on problem-driven research was not just Simon’s idea but was a feature of much of the early Carnegie work, on which Nelson and Winter’s work built.<sup>4</sup> Second, it would draw on Simon’s seminal work on adaptation, flexibility, evolution, and decomposability, articulated in the *Science of the Artificial*.

Based on both Simon and Winter and emerging research, then, we can define the outlines of a research program on the architecture and the design of organizations, which should be able to account for how the division of labor within and across organizations emerges and also explain the ways in which this division of labor affects both productive capabilities and dynamic capabilities, that is, the capabilities to change and adapt.

Such an endeavor, if successful, could add up to more than just theoretical sense making. It could help explain regularities that have not been fully accounted for to

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<sup>2</sup>This would clearly be insufficient from an evolutionary viewpoint seeking to incorporate such disequilibrium and “dynamic” phenomena. As Nelson and Winter early noted: “Evolutionary . . . theorizing must deal explicitly with dynamics, and not get drawn into spending undue time considering selection equilibrium as a counterpart to more orthodox economic equilibrium concepts. This is certainly so when the focus is on processes of long-range economic growth or on Schumpeterian competition” (1982: 162).

<sup>3</sup>It may be the case that Nelson and Winter’s (1982) remarkably successful achievement of showing how routines affect aggregate behavior or Allison’s (1971) analysis of how standard operating procedures, framing, and politics affect an organization are still at the forefront of our understanding. Yet, as emerging research on cognition, organizational structure, and strategy shows (Ocasio, 1997; Gavetti *et al.*, 2005), this is a fertile and under-explored field.

<sup>4</sup>For the Carnegie influence, see also Nelson’s article in this issue and Dosi (2004). Winter also was an early reviewer of Cyert and March in QJE, where he noted that “This book . . . delivers a major blow to that battered but hitherto unshaken intellectual construct, the theory of the profit-maximizing firm. . . . For the past several years, the research at Carnegie has been distinctive for the boldness of its departure from the accepted modes of economic thought on the subject. . . . Those who have not heard the distant rumblings of the ‘behavioral revolution’ will be surprised at the momentum it has achieved” (see the review by Winter, 1964a: 145, 147–148).

date—such as the tendency away from large hierarchical organizations toward more decentralized organizational structures and how this affects the capabilities of these organizations. It could also explain industrial dynamics, such as the shift from integration to disintegration and back to reintegration, as firms try to develop new products, services, or as they invent, incorporate, or cope with new technologies. It could also provide a rigorous analysis of what underlies the increasingly rapid shifts of value propositions and changes in business models.

Yet, before delving into the research program's outline, some brief background on the genesis of Sid's ideas, and how they have evolved over time, is called for.

## **2. The program in historical context: the evolution of evolution, capabilities, and Carnegie**

### *2.1 Winter and capability research in the evolutionary tradition*

Starting with the antecedents of Winter's article, it is worth pointing out that this was written at RAND, itself both a hotbed of related activity, focused on understanding "new problems" that had not been addressed by existing disciplines. Other related foundational works (Arrow, 1951; Simon, 1955) were also developed in this intellectually exciting environment, which in the 1950s and 1960s serve as the development of many hot ideas in the cold war, including game theory, linear and dynamic programming, Operations Research and artificial intelligence, and counted scholars such as Nash, Arrow, Simon, Newell, Alchian, Morgenstern, von Neumann, Coase, Schelling, Shubik, and, of course, Nelson and Winter.

The 1950s offered the right context for early evolutionary ideas to begin to flourish, but the evolutionary "revolution" was no silent coup, and it often involved quite heated debates. For instance, evolutionary ideas were present in the early debate around the idea of profit maximization in economics among Machlup, Friedman, Alchian, and Penrose in the early 1950s. While this debate led to the formal evolutionary work by Winter in the 1960s and 1970s (Winter, 1964b, 1971), a distinct evolutionary theory of the firm did not come until much later. And the collaboration between Nelson and Winter began in part as a result of these debates and Winter's involvement, combined with Nelson's work at RAND on, and interest in, technological change (see Nelson's contribution to this issue).

Consistent with Schumpeter's observation that the idea of bounded rationality is necessary for a theory of dynamics (Schumpeter, 1934: 80), Nelson and Winter built on Carnegie—and others such as Hayek—providing a view of the firm as bundle of routines and competencies, recurrent patterns of action which may change through learning and search (Cyert and March, 1963). This provided a much needed platform for subsequent work on issues such as technological

change, strategy, organizational learning, capabilities, and also an alternative to the more neoclassical theories of the firm drawing mainly on transaction cost reasoning (Dosi, 2004).<sup>5</sup>

More recently, Winter has added another chapter to this on learning and competencies (Winter, 1994, 1995, 2000, 2003) and also to contributions to the strategy literature around (dynamic) capabilities, helping pave the way to a distinct “strategic theory of the firm” (Rumelt, 1984). In particular, he has the question, when does learning stop? The answer, Winter finds, is an application of the satisficing principle in capability learning: “The initial learning phase ends or fades away when performance that is deemed satisfactory is achieved. . . . It is entirely possible that attractive opportunities for further improvement lie just around the corner when the search for them is abandoned” (Winter, 1995).

## 2.2 *More roots: from Winter to the Carnegie tradition*

The ideas that I suggest incorporating into the future development of evolutionary/capabilities ideas come from Simon’s simple, yet powerful observations on the architecture of complex systems and of hierarchies (and competencies) as problem solving entities. As he noted “[t]he distinction between the world as sensed and the world as acted upon defines the basic condition for the survival of adaptive organisms. The organism must develop correlations between goals in the sensed world and actions in the world of process. And because many complex systems have a nearly decomposable, hierarchical structure, we can often understand . . . describe and even . . . see such systems and their parts” (Simon, 1969: 17–18). Yet, this applies to much more than multi-cell organisms. Even the most casual empiricism would suggest that organizations also decompose their problems in tasks, assigning them to units and subunits that specialize in dealing with particular parts of the value-added process; that, within economies, industries afford a decomposition and, within industries, firms support such decomposition and specialization.

Why is this the case? The answer lies in the benefits of decomposability (Simon, 1962).<sup>6</sup> Decomposition, as Simon noted, ensures that a system can be more robust

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<sup>5</sup>Part of this work has found its way into the recent Jacobides and Winter ventures, where we consider the role of firm (and industry) boundaries—an issue that had been conspicuously absent from evolutionary and neo-Schumpeterian research until most recently (Winter, 2005: 541). Our approach (2005) explains how capabilities affects scope and how scope shapes capabilities in an evolutionary pattern. More recently (Jacobides and Winter, 2006), we argued that the scope of entrepreneurial ventures would not be primarily driven by transactional considerations (Teece, 1986); considering, e.g., the role of “cash leverage” and asset appreciation in the determination of firm boundaries.

<sup>6</sup>Key to the decomposability argument is that most complex systems are hierarchical in structure. This does not refer power relations but to the fact that the components are divided; at each level, they are not independent of each other, but there is much denser and more rapid interaction within the components at any level than between components at that level. Such systems are said to be nearly decomposable (Simon, 1962).

to environmental permutations; it can adapt better to a changing environment. His comparison of the two blind watchmakers, Hora and Tempus, eloquently makes the point: In a watch made by 10,000 components, Hora's modular effort of putting together 100 subsystems of 100 components is much more robust to interruptions than the Tempus's integral effort of putting together the whole 10,000 at one go. If something goes wrong, Tempus will have to start all over again, while Hora will be able to just modify one subsystem (Simon, 1962). This insight has been recently extended by modularity research (Baldwin and Clark, 2000) that has pointed out that the creation of separable modules allows each separate module to improve its own performance independently, without putting excessive strains on the system. Yet, there is more to decomposition than the creation of evolutionary benefits from increased stability at the system level or the possibility of undertaking parallel searches of the solution space. The other benefits of the division of labor, first (and famously) noted by Smith (1776/1874), rest not only in the economies of scale that accrue from specializing in particular subtasks but also on the ability to build a focused body of knowledge pertaining to the more specialized subtasks.<sup>7</sup>

Moving beyond Simon, but in the spirit of other seminal Carnegie research (March and Simon, 1958; Cyert and March, 1963), it is also clear that dividing labor and specializing tasks has the advantage of creating a clearer set of objectives, which affects individual and then aggregate behavior in two ways: First, it limits the strain on individual cognition, as it helps direct activities by creating a comprehensible set of expectations to organizational participants, as students of organizational design have argued (Daft, 1999). Second, it facilitates the provision of incentives that can motivate and, more important, align economic behavior – whether this happens through specialization and asset allocation through the market, or whether it occurs within the province of an organization (Lange, 1936; Hayek, 1945; Milgrom and Roberts, 1992; Holmstrom, 1999).

Clearly, the way that labor is divided both between and within institutions will affect the capability of individuals, of the organizations where individuals invest their productive efforts, and of the industries and economies where these organizations belong. What is less clear, or what has not been well-articulated to date, is the way in which this division of labor relates to the capabilities of organizations and to the ways in which these capabilities change and evolve.

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<sup>7</sup>It is interesting to note that, in much contemporary analysis, the benefits of scale have received much more attention than the benefits of specialized knowledge accumulation. Ironically, the idea of how the division of labor increases productivity came to Smith as he was studying the evolution of human knowledge on astronomy and on how the division of knowledge between different types of scientists facilitated faster aggregate knowledge accumulation.

### 3. The architecture and design of organizational capabilities: a new chapter in the evolutionary/neo-Schumpeterian tradition?

While we may now be in the pre-paradigmatic phase, a program is starting to emerge that can extend the path marked by Sid Winter's work. The objective of this section is to bring this emerging program into perspective and consolidate some recent advances.<sup>8</sup>

More concretely, what would such a program consist of? In this brief discussion, I start with the behavioral foundations; show how these explain the division of labor within organizations; then move into the implications of this division of labor (within firms) and the role of management within firms to countervail them. I then consider the division of labor between organizations and conclude with its implications for capability structure and development. This could help us understand why structure emerges, in the sense that some organizational architectures emerge or dominate as a result of their abilities to develop and utilize new knowledge. It could also help appreciate the advantages and limitations of any given organizational architecture on the nature of capabilities, as they drive the shift from the "known" to the "unknown."

In a Winterian spirit, let us start by positing individuals who are cognitively bounded. Yet, they are not only bounded in the sense of not knowing how to contract or how to protect themselves from future contingencies (Williamson, 1985), but are bounded because there is only so much that they can understand, react to, and do. Sure enough, they participate in routines. But, over and above that, there is a limited number of stimuli that can be understood and evaluated, and there is a constraint in terms of the complexities decision-makers can cope with at any point in time (Ocasio, 1997; Gavetti *et al.*, 2005). This can help us understand why divisionalization exists, both within and between organizations: It results from individual cognitive limitations. But such divisionalization may become counterproductive.

Incentives exacerbate the problem. Since incentives often are provided within divisions, parochial, narrow attitudes tend to be reinforced, and only amplify excessive compartmentalization, leading to goal displacement (Merton, 1957) when the organization is left to its own devices. Also, the division of labor, and the resulting incentives work their way through the creation of narrow cognitive frames (Kaplan and Henderson, 2005).<sup>9</sup> The way in which these dynamics operate cross-sectionally and over time becomes, then, an important area for future work.

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<sup>8</sup>As Schumpeter (1947: 9) would have put it, "the time may have come . . . to co-ordinate and to organize [different past theoretical traditions] work by means of comprehensive 'programs' and to provide, for the use of the individual research worker, orderly schemata of possible problems. It is here, and in its instrumental capacity, not as a master, but as a servant of historical research, that theory may prove useful."

<sup>9</sup>Divisionalization and the excessive fragmentation of a problem may also become self-reinforcing: As decision-makers develop deeper bases of expertise, they both comprehend their world better within their own (narrow) purview and also dynamically limit the aspects of the environment that they "let in." In other words, experience often shapes, reinforces, and sustains frames and analogies (Gavetti *et al.*, 2005), which turn into rigidities over time (Leonard-Barton, 1992; Markides, 1999).

Yet, positing that organizations (have to) have divisions and pointing out that divisionalization and intra-organizational boundaries create the bootstraps that hinder the development of new productive techniques (as a result of an excessive fragmentation of how the environment is perceived) is only half the story (Dougherty, 1992). Management and the use of hierarchical interventions can help redress the limits of excessive compartmentalization: For instance, management can identify that a manufacturing problem is really a customer proposition problem in disguise; and that an accounts receivable problem is a customer relationship problem in disguise. This way, rather than allowing the manufacturing division to address its manufacturing “issue”, it can address the real issue, which is the underlying value proposition. Likewise, rather than letting its accounting team enforce the collection of the account receivable, it may want to address the underlying customer relationship problem. In both these examples, management can intervene, “hold off” on the respective routines, and reframe the problem, bypassing the “organizational autopilot” that emerges from the way labour is divided within the firm (Jacobides, 2006). Simply put, divisionalization canalizes behaviour; yet management can (in principle) intervene, and partly redress these inherent limitations imposed by structure. This suggests that understanding how the division of labor shapes capabilities and how management works to contravene the inherent limits imposed by the division of labor could yield much insight in the near future.

Moving from the intra-organizational to the inter-organizational division of labor, we observe that unified governance and the role of authority may similarly have some benefits. So hierarchical governance might be more appropriate under conditions of rapid change, when the ability to reconfigure on the basis of fiat becomes more important (Ethiraj and Levinthal, 2004): Since fiat is easy to achieve within the bounds of one organization and much more difficult when decision-making is independent, uncoordinated, and performed by different firms, tight coordination does call for greater integration: Whereas senior management in one organization can mandate or dictate the concerted approach of all of the divisions that report to it, it is near to impossibility to achieve the same coordinated response through a set of independent, yet interdependent organizations. Free-riding problems, incentive design, and transfer pricing issues become so complex so quickly that it can become virtually impossible to organize a consistent set of responses. This suggests that, to develop the capabilities to adapt to change, integration may be more important (Langlois and Robertson, 1995; Jacobides and Winter, 2005).

More broadly, understanding why different constituent parts of an industry are found within one firm or in multiple firms holds promise and is likely to point to more than the ability of hierarchy to ensure convergence to coordination games (Schelling, 1960; Camerer and Knez, 1996). This strand of research may help shed some more light on what Winter and I called “institutional packages”; that is, the sets of activities that tend to be lumped together within the boundaries of one division (within an organization) or one firm (within an industry/economy). It can also

explain the dynamics of industry/value chain boundaries. Our expectation is that, over and above the benefits of integration in achieving a coordinated response, the similarity of knowledge bases may determine the nature and structure of firm and industry boundaries.<sup>10</sup>

This approach, then, provides a high-level template to explain structure (i.e., the division of labor within and between organizations). So the next question becomes “how does this affect performance”—and in particular, “how does it affect capability development,” that is, the ability to break new ground? Put it in Winter’s (1968, 2006) terminology, how does the inter- or intra-organizational architecture affect our ability to “find new recipes,” go into “the great unknown” (or respond to unknowable environmental permutations)? Or, in more common parlance, how does it determine “dynamic capabilities” (Teece *et al.*, 1997; Helfat, 2003)? Some answers are starting to emerge to this question. For instance, in a study of the UK construction sector, Cacciatori and Jacobides (2005) suggest that the division of labor between the different types of organizational participants sets in motion a trajectory of capability development. The way in which labor was divided in the sector among architects, engineers, quantity surveyors, and contractors sets the path that shaped the knowledge bases in that sector, and these knowledge bases solidified and became increasingly focused. So much as the “building system” produced substantial advances in terms of its constituent parts (as modularity fans would expect), areas that fell between them were increasingly being neglected. Architects become increasingly focused on “art”; engineers on the engineering efficiency; quantity surveyors on effective auditing; and so on. Areas such as “buildability” and “time-to-completion” become increasingly neglected, and the building system started falling apart, until a new, reintegrated set of solutions came about despite the resistance of entrenched incumbents. This new structure was not the response to any exogenous change in transactional conditions; it was rather a response to the need to find a structure that supports knowledge accumulation in a more efficient way. That is, the nature of the “architecture” of the sector had defined not only the capabilities but also the *paths along which capabilities would develop—the*

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<sup>10</sup>The argument here is that advances in one area (part of a value chain or product-market activity) may correlate with or help the knowledge base in another. Thus, keeping different activities within the same “institutional bundle” may make sense, as in the case of a textile firm, where knowledge gleaned by the fabric division can help generate innovative ideas in the design division (Jacobides and Billinger, 2006). The question of how and when such benefits emerge and why these benefits are higher under some forms of organization (or governance) than others is still an open empirical issue, and even the theory is tentative (Conner and Prahalad, 1996; Foss, 1996; Kogut and Zander, 1996). For instance, it may be that physical proximity is a substitute for common ownership, as in the Silicon Valley (Saxenian, 1999), and it also may be the case that within firms some types of knowledge transfer are harder than across firms (Almeida *et al.*, 2002). Research on when different institutional packages make sense and when they do not is thus still in its infancy, but it could have substantial implication, not least for our understanding of corporate strategy and the scope of the enterprise. And it will help us address Winter’s (1968, 2004) main question—that is, how do different structures condition the ability of firms to identify new solutions, products, or processes?

*dynamic capabilities in terms of responding to change or the direction of innovation* (Dosi, 1982, on trajectories; Henderson and Clark, 1990, on architectures).

In conclusion, a behaviorally plausible structure, which combines Winter's attention on the nature and evolution of technology, to Simon's ideas of decomposability and, ultimately, to Coase's question of what shapes the "institutional structure of production" could help form a consistent body of research—perhaps even a research program. I would call this a program on the "architecture and design of organizational capabilities," since it considers how architecture (of organizational components within a firm or of different types of firms within a sector) shapes capabilities; it also considers how different types of capabilities fit together, to shape firm-level and aggregate technological and strategic advances. At the same time, it can yield fresh insights into how capabilities define the structure of firms and industries alike. It also has the advantage of using the same toolkit to examine intra- and inter-organizational boundaries, as well as their implications. Finally, such a program would also encompass design, since it emphasizes the ability of decision-makers to affect the capabilities of organization through shaping nature and scope of their organizations.

#### **4. From past to present to future: where can this research program take us?**

Of course, much of what is discussed above requires further elaboration.<sup>11</sup> Also, the boundary conditions of what can and what cannot be explained through this program should be more clearly spelled out. Still, even so, I hope that the basic principles of this research program will help coalesce-related research under way. Many of the ideas mentioned above are just now being developed or integrated into the heart of evolutionary capability theory. Important work by Gavetti (forthcoming), Knudsen and Levinthal (2005), Marengo and Dosi (2005), Marengo *et al.* (2000), and others highlights the links among problem-solving, decision-making, and aggregate outcomes. Also, microfoundations of capabilities and evolutionary reasoning are being developed (Feldman and Pentland, 2003), and the link between the microfoundations of capabilities and profitability has also attracted attention (Lippman and Rumelt, 2003). So work in the spirit of this research program is clearly already under way, and space precludes a full discussion of contribution or contributors to the debate. However, in the spirit of moving forward, some applications of this emerging program are worth mentioning.

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<sup>11</sup>For instance, the concept of "organizational architecture" includes both the division of labor within a firm and the mechanisms of resource allocation and interdepartmental coordination. Yet the provision of a more precise definition would require a solid empirical foundation and scope for theoretical or analytical development, which would be beyond the scope of this article. For an edifying discussion of the nature or role of "architectures", see Crawley *et al.*, (2004); a related discussion of designs can be found in Baldwin and Clark (2005).

#### 4.1 *Explaining firm and industry boundaries, their dynamics, and their implications*

The first application is to explain industry dynamics, with a special emphasis on firm and industry boundaries, focusing on the “architecture” of entire sectors and what drives it can do much to expand our understanding. Thus, we can study how and why industries shift from integration and disintegration and back and how that affects industry-level dynamics (Fine, 1998; Jacobides, 2005; Jacobides and Winter, 2005). This approach can both answer new questions (How do new markets emerge? How do firms manipulate their institutional environment? What drives changes in transaction costs? How do “all-in-one” bundles appear?) and redress the division of academic labor between institutional economists (mostly of the Transaction Cost Economics variety), on the one hand, and of those interested in technology, evolution, or competitive advantage, on the other.

On the basis of these insights, we could even revisit concepts such as “technological regimes” (Winter, 1984). The analysis of regimes has been applied at the level of the industry, which itself may be integrated *or* disintegrated or shifting from one pole to the other. Thus, a more careful analysis of the sector’s architecture could reveal that the industry may either consist of many different vertical segments, each with a “regime” of its own; it would also suggest that changes in architecture or aggregate scope can substantially affect the industry’s regime. In terms of methods, this also points to the potential shortcomings of Standard Industry Classifications (which mask such changes) and underscores the promise of industry histories as a basis of empirical evidence.

Relatedly, in addition to understanding how industry boundaries emerge, and why they come about, we can think of their implications for capabilities and profitability at the level of the industry. As their evolution shapes the nature of the capabilities, or the knowledge trajectories at the sector level, we can start looking at how knowledge bases evolve, and why. This could explain the direction and trajectory of technological and strategic progress (Dosi, 1984). And, in addition to helping explain the efficiency of any one industrial system, this approach can be leveraged to explain empirical regularities in related areas—such as international business (Jacobides, 2006).<sup>12</sup>

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<sup>12</sup>The argument there is simple: Given that each country has its own ways of dividing labor, it will develop a set of companies, with competencies that will be tailored to that industry structure. So a firm that seeks to expand abroad not only has to address the challenge of a potentially hostile host environment (the “liability of foreignness”), but it also has to ensure that its capabilities “fit” the vertical structure of the target country. An architect firm in France, the UK, Italy, and Germany is not at all the same actor: It occupies a subtly different part of the value chain and has different skills: this makes foreign expansion difficult (Winch, 2000). Since services can be deconstructed in more arbitrary ways than products, this is much more of an issue there. Relatedly, off-shoring can be seen as an effort to standardize global value chain structures by the firms that expect to profit from moulding a vertical ecosystem so as to match and fit their skills.

#### 4.2 *Designing the architecture of organizations: bringing management back in*

In addition to explaining industry-level dynamics, such a research program could help us understand the drivers and implications of the architecture of organizations (be they business firms, parts of the public sector, non-profits, or even the military). The key question here becomes the way in which the structure of an organization (and its internal or external boundaries) affect its efficiency, and the way in which it can discover and generate new knowledge and develop new productive capabilities. A number of questions pertain: How do firms use their boundary design to improve on their capability? Over and above transactional alignment, how does boundary design affect the organization as a whole (Jacobides and Billinger, 2006)? Or, how do managers use the boundaries of influence and control to shape the industry environment to their advantage (Santos and Eisenhardt, 2005)? Asking such questions can help us bypass the potentially sterile conceptual debate that juxtaposes “the firm” with “the market.” It also forces us to abandon simple, but perhaps simplistic conceptions developed in the realm of theory, and pushes us to consider how firms *really* operate and what the functions of their boundaries are (Eccles and White, 1988).

In addition to looking at the function and design of an organizations’ multiple boundaries, issues of the division of labor, and of organizational design, that have been neglected ever since Chandler’s (1962, 1977) seminal work became relegated to a locus for discussing safeguards of opportunism, to the chagrin of Chandler himself (1992). Issues of firm structure, of mechanisms of resource allocation, and of different types of organizing can come to the fore, through an examination of how architecture within an organization affects structure and the evolution of firm-level prospects (Bower and Gilbert, 2005). Yet another extension of the analysis of firm architecture could focus on the strategic dimension and the structured analysis of an organizations’ business and functional model. We need to approach the question of business model as a question of capability architecture—the means to achieve not only the day-to-day goals (i.e., identifying the structures which allow the organization to successfully carry out its tasks) but also as the means to create new knowledge and action—to develop the capability to adapt and change.<sup>13</sup>

Organizations and their design, then, can be seen as different “shots,” different “bets” as for how to deconstruct complex tasks which, interdependent as they might be, cannot ever be carried out by a fully integral, entirely interdependent organization, due to the cognitive strain this would impose (Dosi and Grazzi, this issue). Each of these “bets” finds a different way to breakup the problem, which may turn out to be more or less effective at any point in time. Also, by finding different ways to break it

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<sup>13</sup>This might allow us to reconsider the role of fit, much discussed in teaching auditoria and board-rooms, but more seldom analyzed in research. It would also highlight the dynamic elements of fit—that is, consider not only how different activities can interact at any one point in time (Porter, 1994; Siggelkow, 2003) but also how their interaction affects the trajectories of the capability development overall.

up, an organization creates divisions that construct their own “reference points,” their own ways to “satisfice” in terms of looking for new solutions to existing problems or scouting the world for new opportunities. Thus, the way organizations are structured will *both* shape the nature of the possible solutions that might be encountered *and* the extent of effort that each division could put in. So structure and, more broadly, the way in which labor is divided and organized within an organization (as well as the ways in which an organization links to final and intermediate markets) affects productive and dynamic capabilities alike; it will shape the immediate and long-term prospects of the organization. Finally, given that changing the structure is a difficult, expensive undertaking, with uncertain outcomes (Levinthal, 1997), we should expect to see multiple solutions coexist, some more effective than others, which should not necessarily be expected to converge, whether in absolute or relative terms (Dosi and Grazzi, this issue).

Research on how exactly these dynamics operate can help us understand the root causes of productive and dynamic capability heterogeneity. It can highlight the opportunities, but also the responsibilities of organizational designers in affecting the way in which their organizations can evolve. It also brings a useful link between description and prescription, allowing us to put our evolutionary apparatus to good use.

#### 4.3 *Helping us distinguish between different kinds of capabilities and consider their implications*

The preceding discussion suggests that this research program could help us understand the nature and function of capabilities in a non-tautological way. It helps consider what a firm “does” as the normal course of action—possibly as a result of its architecture—and what are its mechanisms to do “extraordinary things” in terms of adapting to change.

This opens up a wide field to consider the capabilities of the constituent parts of an organization; the ways in which an organization can draw on and coordinate between these parts; and the means and mechanisms used in such coordination. More broadly, it allows us to consider how different types of capabilities combine, and how they dynamically interact. For instance, we could examine how the capabilities to learn or be entrepreneurial combine with specialized competencies needed to achieve better overall performance, in areas such as marketing, management, leadership, strategy, and investment. The overarching objective would be to see how the *architecture of the organization*, including its divisional structure, transfer pricing, incentive policies, and socialization process relates to the *architecture of its capabilities*, in terms of both productive capabilities (how well it works a whole) and dynamic capabilities (how effectively it can change).

The ability to respond to change, for instance, might be embedded in the mechanisms of decision-making—as Zollo and Winter (2002) put it “through ‘learned and stable pattern[s]’ that the firm uses to modify its routines.” Alternatively, it could

consist of the operation of ad hoc procedures, instigated by managers. As Frank Knight pointed out, the existence of (entrepreneurial) judgement is essential to the existence of firms (Langlois and Cosgel, 1993; Jacobides and Winter, 2006). Such entrepreneurial qualities may be important in both the creation of new capabilities and the recombination of existing ones and also in the creation, design, and effectuation of new “strategic architectures” or business models for the firm.

Through the detailed analysis of capabilities, their architecture, and their interactions, we can examine how the firms’ structure allows it to canalize its expertise and develop new knowledge, products, or markets (Galunic and Eisenhardt, 2001; Helfat and Eisenhardt, 2004; Williams and Mitchell, 2004). This can help us better understand how firms adapt to change and also consider how the mechanisms at the architectural level compare and contrast with the operation of a firm’s senior management. Is structure more or less effective in responding to change than the interventions of senior management (Burgelman, 1991)? What is the role of architecture in terms of instigating change or adapting, and how does this coevolve with the substantive deliberations of firm strategy at the senior level (Gavetti *et al.*, 2005) and the imposition of top-down strategic change?

#### *4.4 Broaden up the motivational basis for the theory of organization via identification and cognition*

Another promising avenue for future work based in integrating Winter and Simon’s ideas comes from considering the motivational and cognitive assumptions laid out in the previous section and considers new rationales that can account for organizational architectures. Traditionally, organizational economics has, at least since Alchian and Demsetz and Williamson, tended to rest on a rather strong assumption of opportunism or desire to maximize total surplus; it is because of basic self-interested action that firms or other structures become the efficient way of organizing.

Organizational identification, and the way in which frames are shaped by individual’s (temporary) positions, affecting motivation and cognition alike, may, however, offer complementary or competing predictions in explain organization—not least because it provides a strong psychological mechanism for people to stay within organizations (or groups or nations), and also both enables and constraints their action. As Simon remarked, “identification . . . has a firm basis in the limitations of human psychology in coping with the problem of rational choice . . . identification is an important mechanism for constructing the environment of decision [since] it permits human rationality to transcend the limitations imposed upon it by the narrow span of attention” (1947: 167). While this does not negate the role of incentives or the familiar transaction cost economics (TCE) elements, it does suggest another mechanism, which may be crucial in determining how decision-makers react to their environment.

This point becomes all the more relevant when we consider that a major part of the gross domestic product in even the most developed countries relates to the public

sector and that much human activity is canalized through non-for-profits, whose structure looks conspicuously similar to firms, even though many of the familiar arguments in terms of incentives and opportunism are not at play. From sailing boats to religious and voluntary organizations to self-help groups, division of labor, hierarchical coordination, and the challenges imposed by excessive compartmentalization are pervasive—and cannot be explained by recourse to challenges of surplus division. Thus, elaborating ideas on organizational identification and cognitive limitations may provide a better motivational background for evolutionary-based capability reasoning and enable it to accommodate elements of organizational culture, learning, cognitive biases that are not present in TCE-based theories.

#### *4.5 Coda: extending Sid Winter's legacy*

Sketchy as this exposition might be, I hope that it might help mobilize more research to these interesting dynamics and point to the promise of studying new empirical regularities: Industries and their vertical/value chain structures over time; firms and their overall boundaries (and resulting capabilities) over time; trajectories of capability development, at the firm and industry level; organizational architecture, and the architecture of capabilities, or the related business models (and their re-configurability). These new empirical foci should be complemented with research drawing on Winter (and Simon) which can shed new light as for the causes and consequences of the division and the organization and division of labor within and between firms. We could thus make headway in a number of directions, not least is to respond to Winter's (1968, 2006) call for research that explains issues such as the nature, direction, and depth of new knowledge and processes.

### **5. Give the man a fish, and you have fed him for a day. Teach him how to fish, and you have fed him for life**

Let us now return full circle to where we started: Sid Winter's impact, and the way in which his 1968 and forthcoming contribution, as well as his other work, can be extended to shed yet more light to questions old and new. In this article, I tried to articulate a research program that draws on his ideas (combined with Simon's), and extends them, bringing in some recent research. What I have not done so far is recognize his crucial role in shaping this research program. And, in doing so, I could think of no quote more appropriate than this Chinese proverb (attributed to Lao Tzu): I think that it sets the right tone in terms of identifying Sid's contribution.

Sid's work is not only important as for the content, but is also important in terms of approach. Sid has not only shown us how to better understand the content and contribution of economic models, but he has also shown us how to ask more interesting questions through models, or how to sort out what lies behind the façade of a prima facie plausible argument, which quickly collapses if one asks the right question.

So, as part of this tribute to Sid, I think it is appropriate to point out that he has advanced the field not only through the introduction of new ideas, but also through the introduction of a mode of research that departs from existing research, as it tackles a new set of phenomena, and focuses on the unanswered, juicy questions. For this, my own personal indebtedness should be on the record—and I trust that I am speaking of a good many students and colleagues.

Back from retrospect to prospect, I hope that this article will incite some more research that will tackle such interesting phenomena and that it will help coalesce the emerging group of researchers interested in the architecture and design of organizational capabilities. In so doing, I hope we can ensure that evolutionary approach will not remain content of holding the “high moral ground” of being more behaviorally plausible but rather head on to new questions, new, unanswered empirical puzzles and regularities, new and concrete predictions. Finally, focusing on the architecture and design of organizational capabilities could provide an organizing template for future research. For, as Joseph Schumpeter said “we should first have to visualize a distinct set of coherent phenomena a worth-while object of our analytic efforts. In other words, analytic effort is of necessity preceded by a pre-analytic cognitive act that supplies the raw material for the analytic effort . . . this pre-analytic cognitive act will be called Vision” (1954: 41). Sid Winter’s work has been paramount in driving this vision; for this, his academic progeny is grateful.

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