Leadership as Process:

A Theory of Formal and Informal Organizing in Complex Adaptive Systems

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Abstract

Organization theorists have increasingly recognized the need to incorporate dynamic processes that include individual intentionality into theories of organizing. In particular, the leadership and human interaction aspects of organizing and their role in the development of organizational and managerial capabilities have been identified as an under researched area. This paper addresses this gap. Using complexity-informed theories of human interaction dynamics (HID), the paper defines leadership as the process that evolves organizational capabilities. More specifically, it describes three leadership processes that serve three system survival functions, and it identifies three mechanisms that operate locally to enable organizing through local interactions within a complex adaptive system. In sum, leadership evolves the ways in which individuals interact with one another to survive and prosper as collectives. It thus shapes the particular expression of dynamic, operating and managerial capabilities that emerge from these interactions within the ecosystem. Eleven propositions are averred.

Keywords: Complexity, Dynamic Capabilities, Leadership

Introduction

This paper contributes to the growing area of research seeking to open the "black box" of individual potency in the face of complex causality. To do so, it draws on complexity leadership research to unpack the complex, interdependent causality that characterizes the link between individual interactions ─ what are called fine-grained interactions in complexity science ─ and the dynamic capabilities within firms that are important to organizational adaptability ─ called coarse-grained properties in complexity. It presents a unified theory of how managerial capabilities in

organizations are established through leadership and how both managerial and leadership capabilities evolve to deal with this complex causality.

Leadership itself is described as an organizational capability rather than as an individual attribute or behavior. In particular, leadership is a process that organizes all of the organization's properties - like innovation or operating processes, but also sales growth or product profitability - that are emerging at the coarse-grained level. As such, leadership considered in this way is at once a bottom-up process of individual influence and a process that enables persistent system regularities that apply social pressure which entrains the individual interactions that form them.

Rationale, Definitions and Approach

It is axiomatic that operating, dynamic, and managerial capabilities can only be operationalized through the interpersonal influence of individuals upon one another, either directly through interpersonal interactions such as in a motivational, coercive, or creative exchange (Salvato, 2009), or indirectly, through changing the context or altering constraints on action, for example, by adjusting the incentive programs (Helfat, et al., 2007). As the distinction between levels of analysis is critical to the argument contained herein, we use Gell-Mann's (2002) fine- versus coarse-grained classification of complex phenomena throughout.

In particular, the term "fine-grained interactions" describes local interactions among individuals, or more generally, any semi-autonomous decision making unit. These day-to-day interactions occur locally governed by local rules like policies or norms. Even in the executive suite, interactions are fine-grained and are locally enacted. These are to be distinguished from the "coarse-grained properties" that emerge from these interdependent interactions. Emergent coarse-grained properties form system elements such as organizational routines or capabilities and these reflect facets of the organization's functioning as a system.

Complex causality results since fine-grained interactions are interdependent and also have upward influence on the coarse-grained system properties ─ like a budgeting process ─ that emerge. Thus, they ultimately impact the system's functioning. At the same time, these emergent routines and capabilities are also interdependent and impose downward influence on the rules governing the local enactment of fine-grained interactions ─ as a budgeting process certainly does. This cross-level mutual causality is what Haken (2006) calls "circular causality". Because human interaction dynamics (HID) within organizations also include interdependence and time-dependence (Rahmandad, 2008), the term "complex causality" includes the distinctly human challenges associated with leadership as well as the idea of circular causality.

This paper argues that individual-to-individual interactions rather than individual behaviors, or traits are the "primitive events" that enable organizational capabilities to be expressed. The coarse-grained properties that emerge, for example *managerial capabilities* in organizations like incentive systems and budgetary processes, exert downward influence on day-to-day fine-grained interactions. By doing so, they influence organizational outcomes. However, these capabilities can only be changed from the bottom up, that is, through the local interactions affecting their emergence. The effectiveness of these interventions is, of course, the issue.

However, it is upward influence (from fine- to coarse-grained, as distinct from low to high management level) that has the potency to make change happen (Salvato, 2009). This flows from fine-grained interactions through dynamic, managerial and operating capabilities to outcomes (see Figure 1). It is only by thoughtfully changing to what is happening at the fine-grained level that intentional change to coarse-grained properties can result. If one desires to reinforce, evolve, or abandon the emergent managerial (and other) capabilities upon which one depends one must change what is happening locally every day during fine-grained interactions. This consequential flow from fine-grained individual interactions up through coarse-grained system performance and

adaptation is more properly called "leadership" than management. It is fundamentally about influencing changes to how people interact with one another than being about enforcing policies or directly establishing managerial capabilities by fiat.

A Paradigm Shift in Thinking about Leadership and Management

In the traditional mode of thinking ─ as exemplified by House (1977), Bass (1985), Conger (1989), and Bennis and Nanus (1985) ─ leaders align and motivate the troops to follow the top-down plan that has been "designed" in some way. In this way of thinking, leaders devise and implement the plan and do so through effective relationships and human interaction. This widely-shared perspective implies that "leadership" in organizations involves something akin to "fitting the organization with its new design." Further, tradition thinking is that this was done by overcoming resistance to change, developing new policies and processes to enforce the new way of doing things, working out the kinks, overcoming objections, and persisting and cajoling until the new design was implemented in order to meet the expectations of the grand designers. Using the managerial tool-kit of incentive plans, work rules, budgetary policies, and implemented by personal influence strategies, power relationships, and effective communications, the "leader" is assumed, using Aristotelian terms, to be the efficient cause of "leadership," the exogenous influence on the system, the direct cause that makes the right things happen.

Causality in organizations is endogenous

The only problem with this approach is that this is not how organizations work. At least it is not how they work anymore. The organizational reality of complex causality means that the efficient cause can arise endogenously and that the system is in fact closed to efficient cause (Rosen, 1991). Change is not imposed by "leaders", it arises through leadership, and "leadership" is contained within the system. In short, it is a type of dynamic capability that acts on the system itself; leadership is a meta-capability. It emerges through individual interactions as a way to

organize dynamic and organizational capabilities (as well as the individual interactions from which they emerge) to enable performance and adaptation.

Of course, differences in status and power imply differences in the relative levels of individual influence during interactions, and these are readily apparent to the observer. Thus their relative impact on the operating and dynamic capabilities that emerge is often imputed either correctly or incorrectly to be "caused" by the actions of certain individuals. In short, in human organizations the relative impact of interactions is decidedly heterogeneous. High status and power can translate into greater influence, but this is not the same as cause. Complex causality during human organizing greatly complicates the causal pathway that links individual actions and influence to complex organizational outcomes.

Complex causality and adaptation

At the same time, complex causality does not imply that organizing forms arise spontaneously appearing from nothing as if by "magic." Organizing forms arise from within, discovered by those inside the system as "…day-to-day activities carried out by individuals within and around the organization with the aim of improving streaming core processes can allow organizations to renew their core capabilities" (Salvato, 2009). Individuals with heterogeneous status and power try out experiments with each other to discover regularities in the local environment. The organizing approaches that emerge from these experiments become the raw material from which the collective will build its future (Goldstein, Hazy & Lichtenstein, 2010).

By learning from both success and failure, through the actions of their members organizations grow those capabilities that work and extinguish the experiments that fail (Surie & Hazy, 2006). In this way, individuals with various levels of status and power guide the unfolding future, forming as they do the future within which they will live and which will to some degree apply social pressure to constrain their own actions going forward. In essence, they build the cages

that will constrain them. The future being discovered includes the local rules that determine how fine-grained interactions will be governed as well as the nature of the coarse-grained properties that will guide their own interactions.

The Rise of Dynamic Organizing Theory

The dynamic capabilities approach to organization theory literature (Teece, Pissano & Schoen, 1997) can be traced back to the resource-based view (RBV) of the firm (Penrose, 1959). Other elements owe their origins to the evolutionary theory of the firm (Nelson & Winter, 1982). And still other aspects owe their origins to Simon (1945), March (1988, 1991) and the behavioral theory of the firm (Cyert & March, 1963). All of these approaches have the noteworthy similarity that they each identify the focus of an organization's survival and fitness on its people and on their continuing access to resources and knowledge. That is, the focus is on discovering the particulars of organizing that are successful and their relation to knowledge accumulation and use.

Within this tradition, managerial capabilities are a key element of the broader theory of operating and dynamic capabilities, but this area is widely acknowledged as being largely under researched (Augier & Teece, 2009; Helfat et al. 2007). Managerial capabilities are processes like incentive programs, budgetary procedures, succession planning, strategic planning, and the like, that focus on organizing human activity so as to remain effective as an organization. How these properties are enacted at the fine-grained level, either directly, during person-to-person interactions or indirectly as necessitated through boundary constraints levied on certain individuals is poorly understood. The present study addresses this gap by going after this cross-level linkage directly using ideas from complexity science.

Complex adaptive systems are characterized by interdependent, autonomous agents who interact over time under a set of local rules (referred to as occurring at the fine-grained level) that are constrained by external conditions as well as internal limitations (Holland, 1975). The

definition does not stop there, however, because the complex systems that are of interest also exhibit the dual characteristics of i) "emergence" (Goldstein, 2007), where predictable properties emerge at a coarse-grained scale and ii) "entrainment" (Haken, 2006, who calls this feature of complex systems "enslavement"), such that coarse-grained properties place downward influence on the fine-grained interaction rules, changing them to make the system more predictable.

The causal-circularity in the relationships linking fine-grained interactions, through emergence, to coarse-grained-properties, and then through the further entrainment of fine-grained interactions, and so forth is shown in Figure 1. But even this is not enough when defining the complexity paradigm that has been forming in organization science. The complex systems that are instructive for organization theorists are those that adapt to a changing environment, not simply because the individual agents adapt, but because emerging coarse-grained properties themselves ─ the operating, managerial, and dynamic capabilities of the firm ─ also change and adapt. This is no small feat when one realizes that the capabilities exist as a consequence of what is happening at the fine-grained level, and this is guided by changing sets of local interaction rules that can greatly vary at different places across the system and over time.

In human interaction dynamics (HID), complex, information gathering and use processes operate at multiple levels producing feedback that crosses levels both downward and upward. As coarse-grained properties interact within a changing environment, events influence individual interactions at the fine-grained level. In turn, as individuals observe outcomes during local interactions local events can impact the coarse-grained properties that emerge. Interpersonal conflicts can impact organizational outcomes, for example. In complex systems, leadership is defined as "changing the rules" in local interaction (Hazy, Goldstein, & Lichtenstein, 2007; Hazy & Uhl-Bien, in press). Through emergence, changing rules locally can translate into changing coarse-grained properties, and these properties may provide collective benefit that may ultimately

accrue to certain individuals. Examples of outcomes from this process would be public goods such as highways or the rule of law which are created through individual interaction but which have influence on individuals beyond those who were personally involved in their construction. All of this adaptation occurs in the context of complex causality and time delays.

The implication of a complexity-informed model of organizing is that leadership within organizations is largely related to information processing (Hazy, 2004). Organizing forms within organizations and firms change moment-to-moment as events unfold and these may enhance (or inhibit) performance or enable (or inhibit) adaptation. These dynamics are shown in Figure 1. Fine grained interactions shown at the bottom of the figure reflect the fact that individuals are gathering and using information from their experiences and that these activities lead to the emergence of persistent coarse-grained properties such as operating, managerial and dynamic capabilities.

Because regularities are observed and modeled by individuals, their presence ─ like managerial capabilities with respect to budgeting procedures ─ place downward pressure on individual actions, thus guiding fine-grained individual interactions through a morass of complex causality. Leadership involves organizing across levels of analysis, recognizing coarse-grained patterns but intervening only at the fine-grained level (Salvato, 2009). Information that is relevant to an organization can be recognized from events that occur at multiple levels: at the fine-grained level during individual choice and action, at the coarse-grained level through firm performance and adaptation, and at intermediate levels between. In all cases, information from these events only causes change in operating or dynamic capabilities if the information is embedded in the system as different "rules of interaction" at the fine-grained level. These changes can occur either directly by person-to-person influence to change the unfolding interactions themselves, or indirectly by adding or modifying the constraints on interactions as a means to change how they unfold. The latter could happen, for example, by changing a managerial practice or policy or by

allocating resources differently. This changes the solution to the problem the interactions are solving. When modeled with appropriate effective complexity, the outcomes from fine-grained interactions in interaction with coarse-grained capabilities become more predictable. This line of thinking implies to a proposition:

PROPOSITION 1: Change to dynamic and/or operating capabilities occurs *only if* locally enacted *rules of interaction* among individuals change in a significant and patterned way.

The proposition above can be tested by cataloging events that impact an organization (stimuli), identifying actions that result (responses), and then incorporating information about success or failure back into the system, a process that can be complicated by time delays (Rahmandah, 2008). The proposition would imply that any "new" response would be conditioned on a change to how local fine-grained interactions occur locally, that is to the rules that constrain how people interaction with one another, or with technology or resources. The results of the response would then either reinforce success, or change the rules in the event of failure. Exactly how this happens and what approaches lead to success, of course, are the real areas of interest.

For completeness, we note here that a self-similar process is likely to be observable at levels above the individuals wherein firms are interacting with one another. In this even more coarse-grained case, firms themselves interact and these interactions can lead to emergent coarse-grained regularities at the institutional level. Again, (by the self-similar analogy) one would hypothesize that higher-level institutional change could only be affected through direct or indirect change at the fine-grained interaction level. By recursion, these changes can only occur through intervention at the human interaction level. Although potentially a useful area for future research, this reinterpretation of institutional theory and leadership in this context as framed in complexity terms is beyond the scope of this paper. It seems clear, however, that the way that leadership is conceived is turned on its head under this way of thinking.

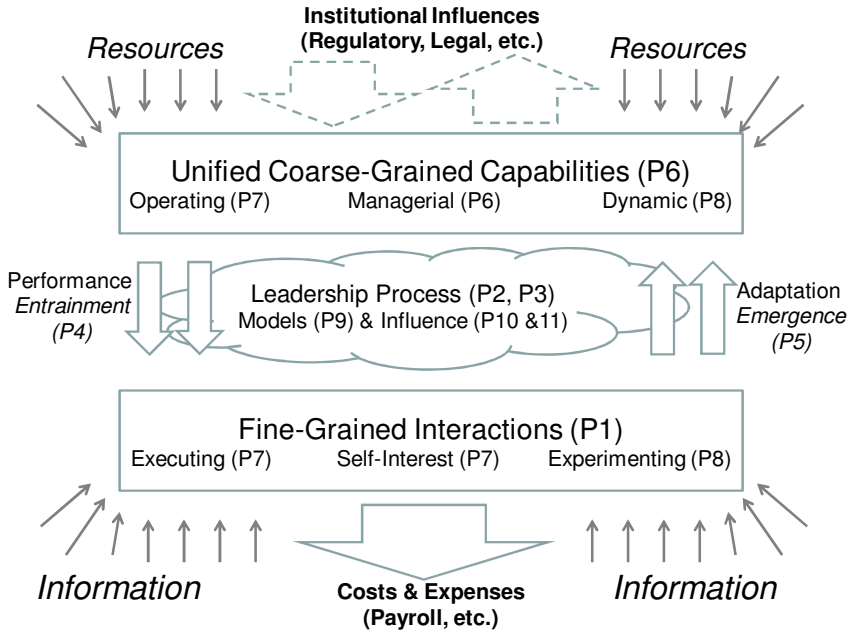

Figure 1. A dynamic organizing model that includes the Leadership Process and the loci of the propositions presented herein (denoted P1 to P11). Fine-grained interactions enable emergent coarse-grained dynamic capabilities (shown of the right side) which in turn engender operating capabilities (shown on the left side) and these exert downward influence on individual interactions. Leadership processes shown in the center organize individual activity with the help of managerial capabilities in support of collective objectives in the face of self-interest.

A New Conceptualization of Leadership

In 2001, Marion and Uhl-Bien called for rethinking the leadership paradigm based upon the findings from complexity science. Rather than limiting the domain of leadership to interpersonal influence, they described it as somehow enabling complexity phenomena such as "emergent structures" within and among organizations in a manner directly analogous to observed complexity phenomena in the natural sciences (Schneider & Somers, 2006). In a subsequent study Uhl-Bien, Marion and McKelvey (2007) linked the new leadership model to the emerging knowledge economy. The emergent coarse-grained structures in Figure 1 were linked to operating and dynamic capabilities as described in the business strategy literature by Hazy (2006, 2011).

Of course, as described in Figure 1, the challenge was, and to a large extent remains, to specify precisely how operating and dynamic capabilities are constructed, maintained, and evolved

in firms and other organizations, and to clarify exactly what leadership and/or "managerial capabilities" have to do with this process. If leadership is not limited to person-to-person influence, that is, to leader-follower alignment, then what exactly is it?

At the macro-leadership level (e.g., leadership *of* the organization; Boal & Hooijberg, 2001), this might mean that the focus of leadership should be on how to foster and speed up the emergence of new organizational approaches and capabilities (Dosi, Nelson & Winter, 2000; Helfat et al., 2007). At the micro-level (e.g., leadership *in* the organization, Boal & Hooijberg, 2001), this might mean determining local programs of action, or creating the conditions that might enable the emergence of potentially productive, but largely unspecified future. In complex systems, all of this must be done by changing the local rules of interactions (Hazy et al., 2007).

The Leadership Process in Legacy Organizations

Uhl-Bien et al. (2007) proposed a leadership theory based upon complexity ideas to bridge between prior views of organizations as bureaucracy to the emerging dynamic organizational paradigm that embraces complex interdependent causality (Eisenhardt & Tabrizi, 1995) as well as operating and dynamic capabilities (Helfat et al., 2007). In doing so, complexity leadership approaches take the notion of leadership-as-person from the Industrial Age metaphor of organization as machine and replaces this with leadership-as–meta-capability in the modern Knowledge Era. But legacy management practices have lagged behind.

Organizations, as often implemented today, are *not* treated and managed as complex adaptive systems with living, adaptive dynamics that continually respond to rapid change in the environment. Instead they are built and managed as bureaucracies (Hales, 2002) with boxes on organization charts each with clearly defined roles, responsibilities and deliverables. They are in effect "built" to operate like machines. A bureaucracy is not designed to be adaptive (Heckscher, 1994). It is designed to be efficient. In practice, effective leadership does not limit itself in this

way, however, and never has actually. Leadership enables interaction and embraces the complex adaptive dynamics that can move the organization forward in spite of the bureaucracy (Hazy, 2006; Marion & Uhl-Bien, 2001; Uhl-Bien et al., 2007).

Using the complexity paradigm, Uhl-Bien et al. (2007) offer a different perspective on leadership in traditional bureaucratic organizations by identifying: administrative leadership, adaptive leadership, and a third type of enabling leadership that engages complex causality within the CAS framework. The first, administrative leadership is what might be called typical managerial leadership, imparted to the individual by virtue of position and mostly associated with the bureaucratic aspects of organizational functioning. It involves traditional management processes that drive business results: setting strategic direction and maintaining alignment, budgeting, allocating resources, regulating, scheduling, and so forth. It aligns the organization's members with the needs of the business, and as such comprises the *administrative function* of the legacy bureaucratic organizations, integrating them into a CAS framework, keeping what works and discarding what does not, acting as if it were running a machine that is not really a machine.

The Uhl-Bien et al. (2007) notion of adaptive leadership is described as emerging in and from interactions among heterogeneous agents as they work interdependently in organizations rather than emanating from an individual in a formal position of authority. Adaptive leadership focuses particularly on the adaptive work (cf. Heifetz, 1994) of organizations and is defined by Uhl-Bien and Marion (2009) as an informal leadership process occurring as interdependent human agents (individuals or collectives) interact and recognize the need to adapt to changing markets. Adaptive leadership emerges to generate and advance novel solutions in the face of adaptive needs of the organization (cf. Heifetz & Laurie, 2001; Johannessen & Aasen, 2007), countering the tendency of the bureaucracy to force machine-like compliance.

The tension between top-down and bottom-up processes was identified by Osborn and Marion (2009). They found that, in alliances, administrative leadership as enacted through transformational leadership did return profit to the mother institution, but was at the same time endemic to innovation within the alliance itself. Martin and Eisenhardt (2010) found similar results. Clarifying this adaptive tension and the role of leadership within it is a key to developing any useful process model of leadership. Hazy (2008b) showed how these tensions enabled a bottom-up transformation at Intel where a new business model came to dominate the firm eventually even supplanting prior management and the strategy that they were implementing. But there is more to leadership than these two roles.

Individuals in traditional organizations perform leadership activities that simultaneously sustain the bureaucracy as appropriate (Administrative Leadership) and seek to challenge the bureaucracy when it is perceived to be necessary to respond to changes in the environment (Adaptive Leadership). This *adaptive tension* creates leadership challenges in the organization, what are collectively called "complexity leadership", that are manifested as nonlinear, potentially scale-free mechanisms that have not previously been explored in management or leadership research. This discussion leads to a proposition:

PROPOSITION 2: The Leadership Process operates to change the fine-grained local interaction rules in patterned ways, and these are reflected as predictable changes to coarse-grained operating, managerial, and dynamic capabilities within the organization.

One should note that given the complexity inherent in HID, the leadership process *necessarily* exploits complex causal relationships and scale-crossing mechanisms that are not explained in previous leadership or management research. The particulars of these dynamics must be explored, of course. This is the subject of the next section.

Leadership and Human Interaction Dynamics (HID)

If an organizing form is considered to be a complex system, then one can assume that changes to its internal state over time can be modeled as a dynamical system. Further, if one defines "leadership" to be an operation that iterates on the internal state of the system, as represented by the rules of interaction among agents, then this operation can be studied as the process that enables organizing within the system in ways that express effective outcomes through the organization's emergent properties. To complete the picture, a theory is needed that links fine-grained individual interactions ─ heterogeneous in their information, status and influence ─ to the coarse-grained emergent organizing forms such as operating, managerial, and dynamic capabilities within organizations that determine system outcomes (Hazy & Ashley, 2011). As Figure 1 makes clear the theory must also relate the influences of these coarse-grained emergent forms back to the fine-grained interactions that are occurring among individuals as events unfold. Each individual makes what appear to be autonomous choices, but these are in fact guided by a continuous stream of experiences as coarse-grained properties are enacted and reinforced. The simultaneous and continuous unfolding of upward and downward causality makes the study of leadership and emergent organizational capabilities uniquely challenging. This complexity is explored through the study of HID.

Interactions, Models and Organizing Forms

Hazy and Ashley (2011) use mathematical results from complexity science to describe a dynamic process whereby patterns of human interactions are focused into persistent organizing forms which in turn influence how human interactions unfold. Unlike the non-sentient agents in traditional complex adaptive systems (CAS) framings, for these authors human agents proactively construct and share mental-models of their ecosystem including the complex organizing forms in which they interact. The agents use the changing models to predict or at least anticipate events. Because the models are believed to predict events, they prescribe choices and behaviors for the

agents. In this way, the models people share with one another influence the choices and actions that connected people take, a process closely related to organizational knowledge creation (for a recent review see: von Krogh, Nonaka, & Rechsteiner, 2012).

The coarse-grained properties that are modeled in this way include emergent routines and organizational capabilities (Dosi, Nelson & Winter, 2000). Some of these operate primarily within the social sphere, enacted as cultural norms, policies, or practices. Beyond the purely social, some properties use technologies to organize material activities in the physical world. For example, a merchandizing capability within a supermarket might operate to routinely supply the fresh fruits and vegetables at the local grocery. Operating and dynamic capabilities with firms ─ like quality management or new product development ─ require both social and technological aspects of organizing and apply them to specific applications. Individuals use and communicate models to dynamically organize their activity.

Capabilities guide individual action. In the grocery store example, an individual might create and then use a "model" of the supermarket's operating capability to predict what might happen if one attempted to negotiate a better price. The model might predict that the outcome of this negotiation would be positive and worth the effort, or negative and not worth it. Thus the particulars of the model frames the individual's choice whether to bother engaging in the negotiation. In another situation, the availability and quality of fresh produce might be the concern. In this case, one might create and use a model that predicts the supermarket's operating capability. In particular, the model would be used to predict the relative freshness of the produce depending upon the day of the week or the season of the year. In both these cases, the model helps the individual predict events before they occur and guides his or her choices. The presence of regularities in an otherwise uncertain world ─ arising through the emergence of coarse-grained properties ─ is why events are predictable in the first place.

Without regularities, events would not be predictable, and thus there would be no benefit to making choices. Thus, rather than residing within the individual, a *set of choices* is presented by the environment to the individual based upon the emergent properties the individual encounters. Each individual then takes action on their individual choices according to what the models lead them to believe is likely to result from the choice.

For a given regularity, like the daily commute for millions, the simplest choice is whether to go along with the regularity or to opt out, to "cooperate" or "defect" as one would say in game theory. After this initial choice, a cascade of other choices follows each dependent upon prior choices. Operating and dynamic capabilities within organizations are regularities, and they present a series of choices to individuals in this way. Tightly honed capabilities present few choices; once the decision to cooperate is taken, most action is prescribed and most events can be ignored. Ill-formed capabilities involve a much larger set of choices and require greater vigilance about events in the surroundings.

The degree to which individual actions are "autonomous" depends upon the regularities in the environment and the models being used by agents to predict them and guide their actions. When certain models are shared among many people, individuals can be observed to act in concert by habit (Dewey, 1922; Giddens, 1984; Hazy, in press). For example, the behaviors of individuals might share a model that predicts that Tuesday is the best day to buy produce at the corner grocer, and the relevant activities of many autonomous individuals would be correlated with one another.

The models used by the individuals could be developed independently, or they could be shared with one another through symbolic communication (Hazy & Ashley, 2011) or even using social media. This distinction is ambiguous, however. Although initially one person might independently predict Tuesday's as being the best day to shop for produce, when a second person, particularly one with good reputation, is observed to be regularly shopping for produce on

Tuesdays, the first person's model might be reinforced as imitation of the other's model. When the models include cooperative activities as with operating or dynamic capabilities and are enabled by real-time exchange of information ─ specialization of tasks, or individual work efforts that are applied in a common direction ─ an *organizing form* is said to have emerged.

To the extent the information within this real-time flow is absorbed by one or more individuals such that the rules governing how individuals interact with one another are changed, leadership is observed to be operating within the system. The models of organizing forms that are guiding choices and behaviors reside in each individual, but these disparate models can be synchronized through communication. The models-in-use can change randomly in response to events, or they can be coherently changed intentionally across more than one individual. This is leadership (Hazy & Silberstang, 2009b) since changing models will also change the rules of interaction being enacted (Hazy, Goldstein, & Lichtenstein, 2007). This implies a proposition:

PROPOSITION 3: Under conditions of complex causality, leadership interventions can impact coarse-grained properties as predicted by the conceptual models shared among individuals IF AND ONLY IF the interventions occur at the fine-grained level such that:

i) Individuals identify with and can describe elements of a common model of an emergent organizing form (e.g. "the group", "the firm", or an organizational capability such as "product development") that approximates the coarse-grained property, that are constraining their choices and within which success can be defined (that is, the vision that indicates "leadership of what"), AND

ii) Individuals feel that what is expected of them has changed, i.e., the choices available to them and the "local rules" that govern interactions have been changed going forward in a way that resonates as consistent with the model used in i).

Leadership and Its Sub-Processes

Leadership process interventions that change the rules of interaction are not random. According to Hazy (2011), these occur to perform one of three distinct system functions that are critical to sustaining a CAS. Reflecting back on the Katz & Kahn (1978) discussion of organizational leadership within the open systems model, Hazy argues that organizing a complex adaptive system (CAS) of human agents places certain functional demands on leadership if the

organization is to persist as an entity and also adapt to changing circumstances. In particular, the Leadership Process enables predictability and resource exploitation through the *convergence process*; it engenders internal variety and information gathering incorporating complexity into its structure through the *generative process*; and it sustains its identity as a distinct entity in the ecosystem through the *unifying process*. These processes span levels of analysis. The relationships among them and their enabling mechanisms are shown in Figure 2.

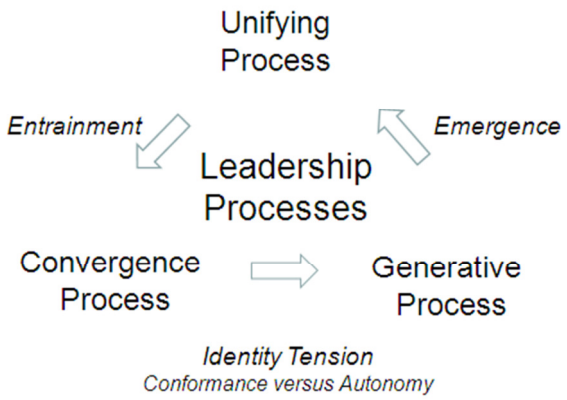

Figure 2. The leadership process dynamically manages three mechanisms of human organizing: *Entrainment* of individuals into alignment, a mechanism associated with command and control; *identity tension* that arises as individuals are presented with choices to conform or act with autonomy, a mechanism associated with forming into groups and organizations; and *emergence*, a mechanism associated with innovation, creativity and change. As this diagram illustrates, each mechanism has a sending and receiving leadership process to facilitate its effectiveness, but also must counter a leadership process that opposes its affects.

Convergent Function Performed by Leadership

The convergent function of leadership maintains stability in emergent coarse-grained properties such as organizational capabilities (Dosi, Nelsen & Winter, 2000; Helfat et al., 2007) in the face of a changing environment. It does this through dynamic processes that present to individuals a set of choices and also frames these choices in conceptual models that predict organizational outcomes (Hazy & Ashley, 2011). In this way, leadership processes exert downward influence on individual interactions effectively pressuring them to conform to a

common model of effective coordinated action. In dynamical systems terms, these processes act as dynamic attractor limiting degrees of freedom by dampening destructive deviations or fluctuations and guiding compliance. This top-down dynamic mechanism is called *entrainment.*

The model of the organizing process that entrains action reflects the constraints on action that are recognized by the members. Examples include market conditions, managerial polices or external deadlines and timelines as well as the social roles and the organizational responsibilities of the members. As Katz and Khan (1978) point out, leadership must deal with changing boundaries, weaknesses in design, and the rights and responsibilities of membership in the context of performance. This implies that leadership must channel *convergence* to a predictable, dynamically stable organizing form within a CAS. Thus leadership ensures that its semi-autonomous members know what to do, as well as how and when to do it.

The most obvious way that individuals would realize that rules governing their interactions are changing is when the organizing form is becoming more predictable and thus presents fewer choices to the individual. Budgets are cut limiting options or schedules are more rigorously enforced. For example, one can count on a weekly status meeting and that it will begin promptly at 9:00AM. In this way people know what will happen and whom they will encounter. For this predictability to happen, however, "rules" and conventions must be reinforced; this is the convergent function of leadership. Crisp agendas, and timelines can enhance efficiency, but the protocols that enable them need to be continuously reinforced in order to maintain order as a buttress against the disordering forces of individual self-interest. At the same time, because stability and compliance are the norm, information about surprising events may be ignored or lost.

The rules are enacted by the choices presented, of course, and there must be a context wherein the rules are relevant. This context is the organizing form and its concomitant organizational capabilities. For organizing to be effective, each individual must know the choices

that are required and how to carry these out. To do this each person has to carry a model of that organizing form, what it is about, and how it should be working in order to know how to participate by making the appropriate choices. Since the individual models may be quite different, some reflecting the organizing form fairly accurately, others being simplistic or even delusional, synchronizing the models that are used by disparate individuals ─ publishing a meeting schedule and agenda ─ is one mechanism to promote convergence, albeit, an indirect one. By proposition 3, one would expect actions that promote convergence to be perceived as leadership. This discussion implies a proposition:

PROPOSITION 4: Operating, dynamic and managerial capabilities and other coarse-grained properties promote individual conformance through the mechanism of "entrainment" which acts to constrain degrees of freedom or limits choices (for example, fixing a budget or restricting travel) during fine-grained interactions. The degree to which individuals identify with the model and find it compelling is positively related to their level of conformance.

The convergence leadership process enacts the entrainment of fine-grained interactions toward dynamic, managerial, and operating capabilities. It does this through actions that constrain relevant choices and reduce degrees of freedom in fine-grained interactions by establishing or enforcing local rules that promote convergence toward more predictable coarse-grained outcomes. The enforcement of quality management policies are an example of this process.

Generative Function Performed by Leadership

Due to inherent uncertainly in the environment and the coevolution of an organization within its ecosystem, the predictability of organizing forms and their organizational capabilities is always qualified by changing circumstances. Markets might change, technology might be invented, social or demographic trends might overwhelm, political or economic conditions might change, or competitors might take surprising action. As such, convergence alone in a CAS is inadequate for securing survival in a changing ecosystem. This is due to the Queen of Hearts

Effect, a reference to Lewis Carroll's *Alice's Adventures in Wonderland* wherein the queen runs and runs but never gets anywhere (Kauffman, 1993). This means that organizations cannot just get better at what they do. They must also adapt and change in anticipation of events. They do this through the generative function of leadership (Hazy, 2010).

According to the CAS perspective, what happens in organizations is akin to variation, selection and retention in an evolutionary context (Nelsen & Winter, 1982). First, for variation to occur a *generative* function is required to create new possibilities for the firm. Famously, Ross Ashby (1956) argued that a system, like a firm, that seeks to control its environment, must have internal variety that matches that in the external ecosystem. This principle of *requisite variety* implies that convergence to organizational capabilities is not enough when the environment includes variety or variance. To control the environment, the firm must absorb into its internal structure the variations and informational differences that are apparent in the ecosystem. One way they can do this is by increasing the number of possible states that the system can assume, and this can be done by increasing the possible variables or *degrees of freedom* of the system. This thinking implies that firms that seek to minimize internal variety are doomed to fail in complex environments. As these firms become more and more orderly and coherent and internal degrees of freedom are reduced, and individuals become blind to what is required within the ecosystem. Thus a mechanism that generates requisite variety inside the system is required (Hazy, 2006).

Katz and Kahn (1978) described the need for leadership because of the ever present need to correct for design flaws and for changing internal and external circumstances. Hazy (2011) linked these organizational needs to a requisite generative functional demand on leadership in a CAS wherein internal variety is created through exploration, incorporating information differences and experimenting with connections and alternative approaches to organizing. These experiments then become the raw material from which new ways to organize can be constructed by those in the

system. The generative function thus supports Ashby's (1956) principle of requisite variety while enabling internal renewal and adaptation. This leads to a proposition:

PROPOSITION 5: Fine-grained interactions that relax locally enacted constraints (e.g., by allowing exceptions to the budget), expanding individual autonomy (e.g., by empowerment or funding external conferences), and generally increasing degrees of freedom while maintaining average resource levels, are necessary but not sufficient conditions to enable the mechanism of "emergence." Levels of exploration and experimentation and thus the potential for emergence are positively related to:

i) the degree to which individuals continue to find the global model with which they identify compelling, but also find the local situation incongruous to it, AND

ii) they have the resources to maintain their level of individual satisfaction during experimentation.

The generative leadership process enacts emergence through actions and communications that broaden degrees of freedom during fine-grained interactions by encouraging exploration, the sharing and interpretation of informational differences, and experimentation. These activities serve the system purpose to generate internal variety that matches that of the ecosystem.

The Unifying Function Performed by Leadership

A generative process that celebrates informational differences and experimentation creates internal tension within individuals as their local identities come into conflict with more global ones as coarse-grained properties exert downward influence on individuals to promote convergence (Hazy, in press). As Katz and Kahn (1978) describe, internal tensions like this *identity tension*, changing boundaries, and an evolving ecosystem present another demand on leadership that Hazy (2011) calls the *unifying function.* This function organizes an entity that succeeds of fails as an unified system of fine-grained interactions distinct from its environment.

Synthesizing the tensions between bottom-up emergence processes that begin locally and top-down entrainment processes that reflect external constraining pressures on the global system requires a mechanism that crosses scale from fine-grained interaction to coarse-grained capabilities and back to the fine-grained interactions. This implies a proposition:

PROPOSITION 6: The tension between conformance and autonomy experienced by individuals during fine-grained interactions, called "identity tension," is positively related to informational differences among individuals and negatively related to the congruence between the models of coarse-grained properties used by the individuals and the perceived performance of those properties when compared to what is expected from the models with which they identity, that is, the tension is negatively related to how good the models are.

The unifying leadership process performs the unifying function by enacting global models of "unity" across interdependent coarse-grained capabilities and creating a global "entity" with which the individuals involved can identify, and within which they can see a benefit to them from their active participation. To do this the entity must be both distinct within the environment (to compete effectively for resources) and congruous with its changing ecosystem (to acquire necessary resources) with regards both performance and adaptation. These processes are described next.

The Leadership Process Model

The previous analysis and propositions are summarized in Figure 3 as elements of a Leadership Process Model (LPM). Using a complexity framing of human interaction dynamics, and a dynamic capabilities framework from business strategy and economics (Augier & Teece, 2009), the model describes how individuals interact at the fine-grained level within coarse-grained organizational processes and managerial capabilities. They do this by enacting the leadership meta-capability through the organizing models that they use, share, and change to determine the choice events present and the rules that govern how interactions occur. By doing so, individuals can also change the managerial and other dynamic and operating capabilities that emerge. The LPM offers insight into how traditional bureaucratic approaches to organizing can and must be changed in the fast-paced, knowledge-based organizations of the 21st century.

On the left side of Figure 3, the legacy-inspired roles such as Administration & Adaptive Leadership are shown. These were described in a prior section. On the right side of the Figure, the insights from complexity-informed HID thinking are summarized as the three functional demands

on leadership within a CAS framework. The center of the Figure brings these together to propose a complexity-informed theory of a leadership meta-capability that evolves managerial and other capabilities within the dynamic and operating capabilities strategic and economic framework.

Operating Capabilities and Their Execution

The top of the middle section of Figure 3 shows the emergent Operating Capabilities (Nelsen & Winter, 1982; Dosi, Nelson & Winter, 2000; Helfat, et al., 2007) reinterpreting them in the context of complex adaptive system organizing theory within HID. In bureaucratic organizations, individuals might engage in Administrative Leadership as implemented in traditional managerial roles wherein the processes that make the bureaucracy function are continuously reinforced and enforced to maintain operating capabilities such a customer care, manufacturing, product develop, and so forth.

When human organizing dynamics are considered in the CAS context, these activities can be seen to be enablers of ongoing convergence to predictable coarse-grained properties, in this case these are the operating capabilities (Dosi, Nelson & Winter, 2000), but they are seen to be evolving structures that both result from fine-grained interactions, and at the same time exert downward governing influence, often through bureaucratic structures, constraining individual action to more efficiently produced coarse-grained outcomes. This implies a proposition:

PROPOSITION 7: *Operating capabilities* may develop bureaucratic processes to enact managerial capabilities supporting convergence toward predictable models of stable and effective operations independent of actual performance; these coarse-grained properties are reinforced in fine-grained interactions in proportion to the levels of Administrative Leadership observed.

This process of entrainment enforces alignment in local rules decreasing individual *degrees-of-freedom* during interactions to counter self-interest and dampen destructive deviations. This means that relevant information from events may be lost or ignored by the organization in the name of efficient conformance to the model being used by the collective.

Dynamic Capabilities and Enabling Innovation and Adaptation

The bottom box in the middle of Figure 3 represents the process challenges associated with leadership that supports exploration, innovation, adaptation. As Rothaermel and Hess (2007) found in their multi-level empirical study of innovation in pharmaceutical firms, "the antecedents to innovation clearly lie *across* levels of analysis" (p.916), and this model reflects this reality.

Under the promise of benefits from collective organizing, fine-grained interactions and exploratory activities unleash creativity, experimentation, and innovation which engender adaptability. These activities acknowledge uncertainty and weakness in bureaucratic processes (Weber, 1947) when balanced against evolving needs of the organization and its people. To satisfy this end, information about unanticipated events in the environment as well as in the system must be brought within the firms boundaries to be explicated and interpreted; the tension here is between recognizing and exploring "surprises" whose relevance and potential benefits are unknowable ad hoc, and the effective "leadership" of exploration (March, 1991) and the adaptive imperative of organizational renewal that this implies (Hazy, 2009). Wasting resources is risky, but how does one know in advance if they are being wasted or is they are being used wisely to support resilience and change?

Performance and adaptation operate in dynamic tension with one another (Houchin & MacLean, 2005). This tension is reflected in pressures from administrators to bureaucratize and enforce organizational processes (a process of entrainment) and pressures from organizational members to explore the environment and to adapt more informally and flexibly to the evolving ecosystem. For example, Christiansen and Varnes (2007) described how many "micro-decisions" and individual negotiations occurring in day-to-day activities tend to preempt the formal decision-making of managers. This proactive work effectively relegates "decision" meetings to the role of approval or non-approval on an already formed program-of-action (Hazy & Silberstang, 2009a).

Failing to perform proactively can also have the opposite effect: Eisenhardt and Tabrizi (1995) describe how an overly controlling administrative function can suppress an effective adaptive process: “The results also show that planning and rewarding for schedule attainment are ineffective ways of accelerating pace” (p. 84).

Koch and Leitner (2008) identified emergent bottom-up innovative processes. Without explicit orders, employees took the initiative to experiment in ways that deliberately bypassed or ignored formal processes (e.g., financial incentive systems, suggestion schemes, patent rules). They sometimes even kept these activities secret until they were developed enough to be presented to management. Burgelman (1994) found similar results at Intel, and Hazy (2008) used systems dynamics modeling to show how such “skunk works” can eventually lead to strategic changes in organizations absent top down strategic alignment. This implies a proposition:

PROPOSITION 8: *Dynamic Capabilities* that support adaptation and innovation are the emergent result of Adaptive Leadership and are positively related to fine-grained interactions which increase the *set of choices* (*degrees of freedom)* and thus information that is available to individuals as events unfold. This effect is mediated by the level to which average resource levels are maintained as degrees of freedom are increased.

This means that for emergence to occur, incremental resources must be allocated to encourage experiments in response to uncertainty in the environment. For example, doing experiments “on your own time” is less effective than granting permission to explore one’s own projects during normal hours as is done by Google and 3M. By incorporating internal complexity into the system’s structure, uncertainty can be reduced thus increasing the predictability of coarse-grained properties that are modeled.

Innovation only impacts coarse-grained properties in human organizing when its affects scale from local events to global structures. More particularly, scale-free mechanisms must be identified that recombines local experiments and new inventions into new globally active internal structures. In the next section we look at the importance of network topology and relative

heterogeneity in enabling the leadership meta-capability to have potency, often through managerial capabilities, across levels of scale.

Management Capabilities and Leadership across Fine- and Coarse-Grained Levels

In Figure 3, the center box addresses the cross-level challenges of leadership associated with complex causality and evolving managerial capabilities. Because the leadership process amplifies the potency of individuals during fine-grained interactions, it enables system outcomes. It does this by influencing emergent coarse-grained dynamic, operating, and managerial capabilities. Since leadership itself reflects organizational capability acting upon other capabilities, it is called a meta-capability. It has two distinct complementary aspects.

First, it facilitates information and knowledge flows stimulating the creation, communication and sharing of models of relevant properties in the organization and in the ecosystem including those that actualize operating, dynamic, and managerial of the properties are internalized by individuals and serve to identify choices and guide fine-grained interactions (Hazy, in press-a). To be effective as predictors these models must match the effective complexity of the phenomenon that is being modeled (Hazy & Ashley, 2011).

Second, the leadership meta-capability regulates the relative status and reputation of various individuals (with heterogeneous skills, experiences and cognitive capacity) within an information and influence network as a means to cross scale and to enable the system to act as an entity. Through this network, system mechanisms that are operating locally can cross scale. On the input side, they can parse information about coarse-grained events, identify what is relevant for individuals, and change rules of interaction locally in response to them. On the output side, these mechanisms operate to implement programs that synchronize choice and action locally. Through information and influence networks, this synchronization can also have affect globally by being enacted as changes to local rules governing fine-grained interactions across the entire organization

or some part of it. When such change is enacted in the context of a model of the system's coarse-grained properties, outputs from operating, dynamic, or managerial capabilities can be changed.

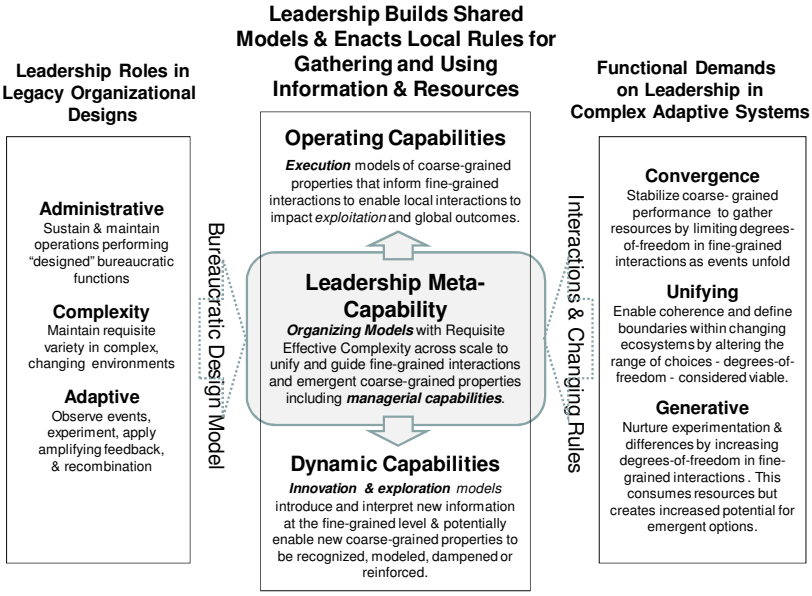

Figure 3. This Leadership Process Model shows how leadership in traditional bureaucratic organizations (left side) performs the requisite functions of an organizational complex adaptive system (CAS) (right). The center box shows how organizing across scale engages leadership to construct models that reflect the effective complexity of the organization's ecosystem. These models facilitate convergence of individual interactions at the fine-grained level toward effective *operating capabilities* at the coarse-grained level (top-middle) and are generative of sufficient variety to allow *dynamic capabilities* to enable newly formed coarse-grained properties to emerge to further influence individual interactions (bottom-middle). The highlighted center box shows that tensions among these processes are resolved through fine-grained organizing models and coarse-grained *managerial capabilities* which cross scale to unify the organization's member-identities while maintaining requisite variety within the organization with respect to the changing variety in the environment.

Together, the above describe the organization's leadership meta-capability. On the input or stimulus side, it represents the organization's capacity to absorb and interpret information from a variety of events in the environment and to include this information into the conceptual models that are shared across the organization, plans, programs, and beliefs, for example. On the output or response side, local interaction rules are changed in response to these changing models as a means

to evolve the operating and dynamic capabilities of the organization so that they function with the requisite variety implied by the environment (Ashby, 1956). Each of these is discussed next.

Processing Inputs Using Models of Effective Complexity. Today's organizations and their ecosystems are causally complex, rapidly changing multi-level systems of HID. Successful organizing projects are those that can engage this complexity rather than denying it, identifying and reacting to predictable coarse-grained events as they arise from interdependent dynamic and operating capabilities. At the same time, these outcomes are operationalized indirectly arising from heterogeneous fine-grained interactions that are continuously unfolding among heterogeneous individuals with varying backgrounds, skills, status and influence. For all of this to work, the organizing models being used to guide and enable local interactions must be reflective of the effective complexity of the systems being modeled.

The notion of the "effective complexity" of the system originally comes from Murray Gell-Mann (2002), but was described by Hazy and Ashley (2011) who say that modeling effective complexity: "means that a model can predict the statistical behavior of unfolding events at the coarse-grained or aggregate level" (p.60). Doing this, of course, means that the model would need to reflect the complexity of the environmental ecosystem and also the internal interdependence and causal complexity of the firm's operating and dynamic capabilities. This is consistent with Elliot Jaques (1989) conceptualization of the requisite organization and that of Boal and others (Boal & Hooijberg, 2001; Boal & Schultz, 2007) who conceptualize strategic leadership in complexity terms. One important element of the leadership meta-capability, therefore, is facilitating the building, evolving and sharing of organizing models which reflect the effective complexity of the firm within its ecosystem, a process closely related to organizational knowledge creation (for a review see: von Krogh, Nonaka, Rechsteiner, L., 2012).

This assertion is supported empirically. For example, Hass (2006) found that project teams with high levels of prior work experience in the organization had better quality outcomes than those who did not know how the organization functioned. Further, teams with prior organization experience made better use of information gathering activities, and took better advantage of decision autonomy than those who did not have knowledge of how their firm functioned. Whereas lower organization experience was found to sometimes interact negatively with each of these factors with the ultimate effect of lower overall results. One can infer from this that high levels of organization experience enables team members to possess models of the internal workings of their organization and how it interacts with its environment which better represent the effective complexity of their group within its ecosystem (Hazy & Ashley, 2011).

Presumably, additional information, and additional perspectives from those outside the organization would serve to further enhance their models to make the even more closely approximate that effective complexity. On the other hand, absent an existing, relatively complex model of the situation, new information might simply overwhelm the group's understanding of what is possible given their own internal situation. These effects could account for improved project performance found by the researchers. These ideas imply a proposition:

PROPOSITION 9: The coarse-grained leadership meta-capability organizes the activities of simultaneous performance where information is lost (through operating capabilities) and adaptation where information is gained (through dynamic capabilities). Its effectiveness is positively related to the degree to which this capability:

- **i) creates, evolves, and shares models of the organization and the ecosystem that are found to be useful because they allow some information and events to be ignored as irrelevant and with which individuals identify (performance through entrainment), AND**
- **ii) such that the models used are continually changing to reflect (rather than denying, ignoring, or attempting to artificially simplify) the effective complexity (and thus the requisite variety) of their reality (adaptation through emergence).**

These models and the identities they imply are used by individuals to enact changes to local rules governing fine-grained interactions in response to change in various local contexts.

The above must be done while avoiding overwhelming individuals' cognitive capabilities which might result in what Kauffman (1993) calls complexity catastrophe. Complex causality within an organization and organizing models of the firm's capabilities creates inherent difficulties in managing fine-grained interactions. Multiple influences converging on individuals can lead to complexity catastrophes. Hazy (2008) described the leadership challenge:

> This situation has been modeled (Solow & Leenawong, 2003; Solow, Piderit, Burnetas, & Leenawong, 2005) to identify the impact of leadership on outcomes in complex environments. A key inference from these studies is that one of the functions of leadership is to decrease the counterproductive aspects of overload; that is, to defer the possibility of interaction catastrophe. When the collective is engaged in highly complex functioning (Schreiber & Carley 2006) ... confusion and coordination difficulty can result. Leadership navigates this complexity to mitigate the risk of interaction catastrophe. For example, leadership among agents might serve to put additional weight on individual contributions according to expertise (Solow et al., 2005). Endorsement by an agent of another agent's right to veto a decision, for example, would be a leadership event. By transferring reputation and thus influence to expert members, the first agent effectively reduces the number of opinions to consider (Jiang & Burton, 2002) and thus limits the potential for complexity catastrophe (p. 292).

The risks of complexity catastrophe can be reduced by placing individuals with greater cognitive capacity into high-traffic hub-nodes in the network. Due to their unique experience or training, some individuals are better equipped to handle a particular instance of complex causality than others are, and it serves the system to put them into these positions so as not to overload information processing within the system. Identifying these individuals and placing them into the particular critical positions that match their unique capacities is one of the difficult challenges of leadership, a core aspect of the leadership process. If one assumes that individuals who are likely to succeed going forward, are more likely to have succeeded in the past, then acquiring and processing feedback on success or failure becomes an important prerequisite for assignment into these high load nodes in organizing networks.

This leads to a further manifestation of the leadership meta-capability which involves the emersion of human beings within the system of HID and surrounded by complex causality. The

information processing system across the enterprise must be structured to maximize flows while minimizing bottlenecks (Goldstein et al., 2010). The leadership process therefore involves constructing and evolving the network of information, influence and resource flows so as to limit the cognitive, emotional and resource processing overload on individuals in critical roles (Schreiber & Carley, 2006). This is done in part by developing a network topology overall that avoids interaction catastrophe (Solow et al. 2005) at the fine-grained level, but also that places the highest capacity individuals into critical roles. The system itself must reflect the effective complexity of the organization as a component of its ecosystem to the greatest degree possible.

Responding with Outputs with a Dynamic Scale-Free Structure. In addition to enabling the formation and evolution of organizing models reflecting requisite effective complexity, the leadership meta-capability also crosses levels of scale to respond with outputs. As information is gathered and processed, resource allocation decisions are taken, and fine-grained interaction rules are supported or changed enabling the expression of adaptive emergent organizational capabilities.

Hazy (2008a; in press) argues that the challenge of coarse-grained response by individuals limited to fine-grained interactions is met through the operation of a leadership meta-capability. To enable coarse-grained response, this process situates certain fine-grained interactions within network positions that can be amplified and repeated throughout the system in a signaling network that crosses scale (Hazy, 2008) and thus enables coarse-grained action. This network is constructed through the assignment of differential status and reputations (and thus power and influence) to certain individuals. Cumulative advantage that stems from this influence results in highly centralized and influential nodes which, when properly placed, ensure that the system is tuned to dampen destructive deviations and amplify constructive ones. This structure enables a coherent response in the entire organization that even crosses scale (Hazy, in press-a).

Under some conditions, this structure can be institutionalized as management hierarchy (Hazy, in press). However, the design/machine metaphor that often seems to accompany this natural result is a false interpretation of the forces at work within the underlying HID. Given the velocity of information flows, the structure must necessarily be much more dynamic and less directive in a knowledge-economy.

The leadership meta-capability is the emergent internal system property that builds, tunes, and evolves this network by elevating the status of those who have been successful at identifying and executing similar programs in the past, and by diminishing those who have failed in similar cases. This is why feedback regarding success or failure is so critical. The tension between convergent and divergent signaling implies that the network is likely to exhibit a scale-free structure (McKelvey & Boisot, 2010). Goldstein, Hazy & Lichtenstein (2010) suggest that the best topology is that of a Smart Network like the human brain with tightly connected cluster of highly centralized nodes, each at the center of its own scale-free cluster. Hazy (2008, in press-b) argues that the "learning network" that results from this structure has properties analogous to neural network feed-forward learning in the human brain. These ideas imply a proposition.

PROPOSITION 10: The leadership meta-capability emerges endogenously as scale-crossing network structures that transport information to enact the performance and adaptation mechanisms of entrainment, emergence and identity tension and has a scale free topology.

Differential Status and Reputation in the Network Structure

There is considerable evidence that cognitive capacity of individuals varies considerably, both at birth and across the lifespan. Elliot Jaques (1989) described levels of capacity which correspond to acting with attention to various time spans, and thus implicitly to gradations of complexity. These differences would be expected to manifest themselves within influences networks, and there is evidence that this is so. Nerkar and Paruchuri (2005) studied the recombination of inventions within Dupont over a 27 year period and uncovered the impact of

social networks on the eventual development of new technologies and innovation more broadly. They found, in effect that "... the network of inventors in a firm influence the way the R&D capability of a firm evolves" (p. 782). In particular the centrality of certain inventors and the efficiency of their network with regards structural holes were important predictors of which technologies were used in future innovation projects, and thus that the evolution of the R&D capability is subject to path dependence.

Presumably, in successful organizations there would be a relationship between those individuals with high cognitive capacity and their position as hubs within organization's social network (Hazy, in press-b). This would apply in the context of application specific knowledge in addition to technology platform knowledge (Sosa, 2009). Although raw information about success and failure is stored in human and artificial memory across the organization and beyond, its relative value to the organization and thus how it is shared and used is determined by the particulars of the network structure. Who is where in the network; who is connected to whom; and the relative power, status, and reputation characteristics among individuals, all make a difference. This implies a final proposition:

PROPOSITION 11: Differential characteristics among individuals with regards to status, power, and reputation, and their relative centrality in various networks determine relative influence within the leadership meta-capability. Thus the leadership meta-capability embodies a type of supra-individual memory for the organization with regards to its priorities, and further:

i) **Organizational effectiveness is positively related to how well individuals in more centralized network positions are correlated with their relative contributions, and**
ii) **Organizational effectiveness is positively related to the presence of scale-free topologies with regards the above characteristics: status, power, and reputation.**

This last point is because the networks operate to enable information transit across scale. The leadership meta-capability network infrastructure with a scale-free topology may provide an additional benefit. A recent study of network structures indicate that such an organization provides individuals who are responsible for decision or implementation an efficient means to access the

requisite information to perform given the effective complexity of their reality (see Proposition 9). The network described in Propositions 10 and 11 also affords the most efficient access to those individuals with the best information and the best models (Baek, Bernhardsson, & Minnhagen, 2011). Thus decisions are taken with the most informed expertise and this is ranked such that the most influence is afforded to those who have been the most successful in the past. Note that this proposition offers an additional theoretical rationale for organizational structures that roughly resemble a hierarchy (See Simon, 1962).

Conclusion

Leadership and organization scholars are in the midst of a paradigm shift. Although a growing number of empirical studies support of the emerging complexity paradigm (for a review see Hazy & Uhl-Bien, in press), to date most scholarly work has focused on conceptual interpretations of results from complexity science in the context of human interactions and emergent organizing forms. The time has come to engage in programmatic empirical research. Towards that end, this paper has framed the linkage between human interactions and organizational outcomes into a research agenda. The intent of the proposed agenda is to uncover the ways in which individuals exercise influence on organizational outcomes when organizations are taken to be complex adaptive systems.

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