ORGANIZATIONAL RIGIDITY, INCENTIVES AND TECHNOLOGICAL CHANGE: INSIGHTS FROM ORGANIZATIONAL ECONOMICS?

Sarah Kaplan
University of Pennsylvania, Wharton School
3620 Locust Walk, Suite 2019
Philadelphia, PA 19104
215-898-6377
slkaplan@wharton.upenn.edu

Rebecca Henderson
MIT Sloan School of Management and NBER
50 Memorial Dr., E52-543
Cambridge, MA 02142
617-253-6618
rhenders@mit.edu

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Abstract

While there is widespread evidence that large, well established firms have significant difficulty in responding to radical or discontinuous technological change, we lack a comprehensive theory of exactly why this is the case. This is not because of any shortage of explanations. On the contrary, the literature is full of plausible (though often conflicting) hypotheses, including the fear of cannibalization, founding conditions leading to organizational inertia, cognitive problems in the senior team, the role of current customers in shaping resource allocation, the rigidity of micro level procedures and routines, the challenge of cultural change and the difficulty of search across rugged landscapes characterized by extensive interdependencies.

This paper proposes a more unified theory by drawing on recent developments in organizational economics to explore the difficulty established firms encounter in attempting to create new incentive regimes for entrepreneurial divisions charged with exploiting radical technological change. A close analysis of the problems firms encounter in attempting to create these new incentive regimes suggests that the distinction between cognitive problems and agency or incentive problems may be analytically convenient but reflects a fundamental misapprehension of the roots of action in a modern firm, which in fact co-evolve through an intensely path-dependent, reciprocal process. We take this perspective to an analysis of the existing literature, and suggest that it may prove to offer important insights toward the development of a more integrated theory of the micro-dynamics of organizational inertia in the face of radical technological change.

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Popular accounts of how an established firm should react to radical technological change suggest that the firm should set up an isolated organizational unit – a new team, new division or new company – and then manage the new unit using processes that are significantly different from those employed in the existing business (Christensen 1997; Utterback 1994; Wheelwright and Clark 1992). A particularly common recommendation is that the people employed by the new unit be managed using different incentive structures (Block and MacMillan 1993).

This would seem to be sensible advice. It is unlikely that the ways one can most effectively motivate and reward the employees of a stable, slow-growing business focused on operational excellence would be identical to the ways one would most effectively motivate and reward the employees of a fast-moving, entrepreneurial unit designed to generate growth. Despite this, a surprisingly large number of older, more established firms impose the same incentive structure on their new units as on their existing, more mature businesses. While many managers recognize that a different incentive structure might encourage their employees to pursue these high-risk, more radical technologies, they are often flummoxed by the prospect of implementing such a system.

This paper draws on recent work in organizational economics to attempt to understand this puzzle. We believe that it presents a particularly appealing object of study both because it is important in its own right – creating appropriate incentive regimes is widely understood to be a critical part of facilitating organizational response to radical technological change – and because

a careful unpacking of this problem has the potential to lay the foundation for an integrated understanding of the full set of problems facing established firms as they respond to change.[1]

We take advantage of recent research in incentive theory to begin to build an explanation for why firms might find it difficult to design appropriate incentive systems for people and units charged with new ventures and why it might be the case that when firms do design new systems they don't work very well. We use some simple analytic formalizations to delve more deeply into the micro-dynamics of why incentives are so difficult to change. We first suggest that the key to understanding this puzzle is the recognition that, in practice, incentives always function in relation to the cognitive frames of the firm's employees. In an established firm, incentives are likely to be embodied in relational contracts around measures that are subject to interpretation. We call these measures "subjective" because the behaviors that will be rewarded are not written down or enforceable in court, but rather evolve gradually over time as managers and employees build an understanding of what effective behavior looks like. As Coriat and Dosi (1998) have suggested, the local knowledge of a firm that is embedded in routines is thus not just about how to get the work done but also about what work *should* be done.

Second, we argue that the firm is likely to have developed a relational contract with its employees to reward behavior that conforms to these subjective measures. The plumber believes that she will get paid because as a last resort she has a contract and can sue the homeowner – but

[1] The answer that we reach in these explorations is a product of two very different views of the problem, one "top down" and theoretical and the other "bottom up" and empirical. First, while it seems natural to explore incentive theory to explain these innovation incentives challenges, we have been frustrated by the lack of theorizing about change within the models by organizational economists. For economists, there is, in effect, no problem of change. The new equilibrium is always instantaneously achieved. Yet empirical evidence of change as a less-than-instantaneous process abound. Second, empirical evidence from one of the authors' longitudinal, ethnographic study of a firm's response to a radical technological change (Kaplan 2004) suggests that strategic choices about investment in new technologies are not simply shaped by the incentives in the organization but also by the interpretive processes that ultimately shape those incentives. We use these two perspectives on the problem to inform and amplify incentive theory in the context of radical, technological change.

the engineer who works nights and weekends on a new project because managers say, "If you do the right thing we'll take care of you" depends on the managers' long history of recognizing what "the right thing" is and of rewarding people who do it. Therefore, if the incentive system is a relational contract based on subjective measures, the observation that it must be modified in the face of radical technological change becomes much less puzzling. While the definition of "radical" or "discontinuous" technological change is highly contentious, nearly all current definitions share the belief that it is accompanied by a qualitative increase in uncertainty.[2] Under such conditions firms simply do not know on what measures to base a new incentive system. Moreover even if the firm can develop new measures, it has no history of rewarding people who behave in the new ways, leaving managers and their employees without a familiar – and hence effective – relational contract. Worst of all, moving to the use of new measures and establishing a new relational contract may be viewed as a violation of the *existing* relational contract, making it very difficult to manage the current enterprise.

The paper begins by briefly reviewing recent research in modern incentive theory as a framework for the discussion of why changes in incentive regimes are so difficult to implement. A critical component of this discussion is the translation of ideas and terms that are relatively unproblematic from an economics perspective into the messy reality of a complex organization faced with the uncertainties of radical technological change. This analysis highlights the fact that the cognitive and incentive mechanisms of an organization are intimately linked at the most

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[2] Radical technological change (and, more broadly, any discontinuity) creates uncertainties for managers. Managers have to contend with changes in the environment (relevance of various competitors, technologies, market boundaries), changes in performance dimensions (technical choices, economic formulae) and changes in internal dynamics (salience of different capabilities). As Knight (1921/1965) suggested, it is not these changes *per se* that make discontinuities so difficult for firms to manage, but rather the inability to anticipate the future, even probabilistically. In periods of relatively slow change, firms can develop quasi-stable sets of heuristics that help guide strategic choices about investment and direction. Discontinuities, on the other hand, place firms in a setting of particularly intense Knightian uncertainty in which these routines break down.

detailed level: cognitive beliefs and codified knowledge not only serve as a means of capturing and sharing information but also shape individual interests and the effectiveness of incentives employed by the firm. In this sense, the distinction between "cognitive" problems and "agency" or "incentive" problems may be analytically convenient but reflects a fundamental misapprehension of the roots of action in a modern firm, which in fact co-evolve through an intensely path-dependent, reciprocal process.

The next section of the paper extends this analysis by looking not just at the specific problem of getting incentives right in an independent division, but more broadly at the problem of established firm failure in the face of radical technological change. Despite many years of work in the area, and the existence of a large and lively literature, the theoretical explanations for firm failure remain remarkably disjointed. Broadly, the literature offers three classes of explanations: established firms fail to respond to radical technological innovation because they do not recognize the implications of the new technology; because they recognize the importance of the change but make a rational choice not to act; or because they recognize the opportunity but, despite significant investment, are unable to match the capabilities of entrepreneurial firms in the new market. In analyzing these explanations with regard to incentives, we show that the hypothesis that incentives and cognition co-evolve in a path-dependent, locally efficient way may provide a unifying perspective on what has been hitherto a deeply disparate literature.

We close by suggesting that the recognition that incentives and cognition are tightly intertwined helps bridge organization economics and organization theory and suggests some intriguing directions for further research.

One caveat for this discussion is in order. Although this paper draws from modern organizational economics, and particularly from the work of those who study incentive systems,

it is not – nor does it aim to be – a comprehensive statement of the current beliefs of those economists who use these tools. Instead, this paper attempts to sketch out the contribution organizational economists might make to our understanding of organizational theory if they were to take the problem of change seriously. As such this paper can be read as much as a manifesto to organizational economists as one that is written for organizational theorists.

Organizational economics and organizational rigidities

The idea that it may be difficult to sustain radically different incentive regimes within the same organization is not a new one. One long-standing perspective on this problem focuses on the problem of equity, suggesting that internal norms make it difficult to offer the employees of a new unit incentives that are significantly more "high powered" than those offered to employees in the existing firm (Adams 1963; Block and MacMillan 1993; Block and Ornati 1987; Chesborough 1999; Lind and Tyler 1988).[3]

Closer in spirit to our core argument here, Foss (2003) notes that the difficulties managers encounter in what he calls "selective intervention" are likely to be even more extreme in turbulent industries, suggesting that an inability to commit to a new incentive regime may lie behind the difficulties in creating entrepreneurial ventures. Makadok (2003) argues that where agency problems are the most severe (in cases of risky bets), managers will tend to underinvest in the opportunity. Similarly Nelson and Winter (1982) assert that one of the reasons

[3] Managers have attempted to correct for incentives problems by splitting out the development of the new technology into a new unit in the organization, often in a location geographically remote from headquarters. Block and MacMillan (1993: 137-138) lay out the tensions associated with this approach. For a new venture to be successful, it must have the support of the parent organization. But, a sure way to undermine that support is to provide incentives that are perceived as unfair by employees in the parent. Yet it is precisely these kinds of incentives that are required to get the new venture off the ground. Corporate managers then decide to create a separate unit and move it far away from the rest of the company precisely so that they can mask the inequity in incentives structures. The net result is that the new venture can no longer benefit from the knowledge or complementary assets within the parent organization that could make the venture a success. Thus, in their attempt to fix the incentives problem, corporate managers may actually hamper the success of the new business.

organizational routines evolve only incrementally is that they sustain an "organizational truce" between the members of the firm and, Hannan and Freeman's (1984) focus on the importance of accountability – not only to external stakeholders but also to employees – suggests to us that stability in structure and process serves to reassure employees that their commitment to the organization will continue to be valued. More recently, Coriat and Dosi (1998) argue that routines can be interpreted as "a locus of conflict, governance and a way of codifying micro-economic incentives and constraints" (p. 104).

Here we expand on these ideas by drawing on recent work in organizational economics to focus in detail on the dynamics that make incentive regimes so difficult to change in the face of radical technological shifts. We believe that by reinterpreting the formalizations introduced by this literature in the light of organizational theory and in relation to the uncertainties introduced by radical technological change we can extend the existing theory in exciting and unexpected ways. In particular, we provide a very specific language for understanding why incentive regimes cannot be understood separately from the cognitive frames and interests of both employees and employers in any complex organization and how these factors interact to produce the inertial effects we observe in example after example of companies facing change.

A brief excursion into algebra serves to clarify ideas.[4]

Assume, first, that employees can take two kinds of actions, a_1 and a_2. These actions, in turn, generate two kinds of output: Q, which is valuable to the employee, and P, which is valuable to the employer, according to the equations:

[4] The discussion that follows draws extensively on Baker, Gibbons and Murphy (2002; 1999; 1994), on Robert Gibbon's forthcoming book, and on numerous conversations with him. Any errors that it may contain are, however, entirely our responsibility.

$$Q_i(a) = q_1 a_1 + q_2 a_2 \quad (1)$$

and

$$P_i(a) = p_1 a_1 + p_2 a_2 \quad (2)$$

Where i indexes employees, a_1 is the kind of directed effort that the firm is likely to find extremely valuable, and a_2 is the kind of effort that employees might benefit from but that is likely to be much less useful to the firm. One should think of Q_i as including the full set of benefits that employees might find valuable, including reputation in the external labor market, status in the organization, intrinsic satisfaction and so on, and P_i as being either a tangible product of some kind, or, more plausibly, an observable set of signals of employee actions that correlate with the value of the firm according to an equation along the following lines:

$$\Pi_j = f\{\Sigma P_i\} + \varepsilon_j \quad (3)$$

Where j indexes the firm and ε_j is a random shock. Then $q_1 = p_1$ and $q_2 = p_2$ corresponds to a world in which there is no divergence between the interests of employer and employee (although there may still be a lively discussion about the division of rents which we will discuss more below), and $q_1 = 0$ and $p_2 = 0$ to a world in which there is complete divergence. In general it is useful to think of more intermediate (and plausible) cases, in which $q_1 \neq p_1 \neq 0$ and $q_2 \neq p_2 \neq 0$.

If managers cannot directly observe the set of actions, a, and thus cannot make an incentive regime contingent on them, they can instead offer incentives of the following form:

$$W_{it} = w_o + b_{it}(P_{it}) \quad (4)$$

Where w_o is the fixed component of total compensation (W_{it}) and b_{it} is the bonus paid by the firm for each useful output, or signal of such output, P_{it}. Note that W_{it} is not simply monetary compensation, but the full value of all the ways a firm rewards an employee, including promotions, corner offices and other perks. Note that equations (2) and (3) describe the benefits to the firm and equations (1) and (4) describe what motivates employees.

Baker, Gibbons and Murphy (henceforth "BGM") use these kinds of formalizations to suggest that to the degree that the set of objects Q_i and P_i can be observed by managers and employees but are *noncontractible* (i.e., the firm cannot write a legally enforceable contract around them) the incentive regime expressed in equation (4) becomes embedded in a set of relational contracts between employee and employers, or in other words, a contract that employers honor because the long-term benefits of enforcing it are greater than the short-term benefits of reneging on it. They then go on to derive a number of interesting conclusions regarding (among other things) the relationship between the divergence between Q and P and the feasible boundaries of the firm.

One can use this framework to advance a number of hypotheses about why firms may find it difficult to create suitable incentives for entrepreneurial ventures that remain within the boundaries of the firm. The most straightforward is a formalization of one of Williamson's (1981) insights, which is modeled in BGM (2002). If $P_i \leq Q_i$ for any given set of actions a_1, a_2, i.e., if the value of the output of the employee's labor in the open market is greater than the value of their output when produced in the context of the firm, then there is no feasible contract that the firm can enter into to persuade the employees to remain as employees. Intuitively, if the entrepreneurial venture doesn't need any of the existing assets of the established firm and can sell (or otherwise realize the value of) its output in the open market, the venture is more

effectively organized as a freestanding entity in which the employees have residual rights of control and can sell Q themselves rather than rely on a promise from the firm that they will be adequately compensated.

The more interesting case – and our focus here – is when $P_i \geq Q_i$, i.e., when the value of the employees' effort is likely to be greater when the work is carried out in the context of the firm. Intuitively, these are the cases in which the firm has extensive complementary assets (Teece 1986) that enhance the effort of the entrepreneurial venture.

BGM cannot help us understand why, in this scenario, it would be difficult to construct a suitable incentive regime for the entrepreneurial venture. If both employer and employees know the structure of equations (1-3) and can observe Pi and Qi, then the employer can simply announce a new regime – a new equation (4), signified by a new relational contract. If a new equation (4) creates value for both employees and employers and represents a new equilibrium, there should be no barriers to putting it in place. BGM assume that even if employee effort itself (a_1, a_2) is not observable, P, Q and Π can be readily observed, and that the structure of all four equations is known to both employees and to the firm. However, a more plausible view of the complexity of the nature of information within the firm serves to highlight how problematic these assumptions may be.

Consider first the assumption that the mappings inherent in equations (2) and (3) are common knowledge. These equations describe the benefits to the firm and embody the notion that managers can straightforwardly assess whether the actions of a particular employee provide long-term value to the firm. It may be the case that, for some very simple tasks, such a representation captures what actually happens in firms (c.f., Lazear 2000). However, we assert that for any task of even moderate complexity inside a modern firm, managerial knowledge of

these mappings is, at best, a partial and incomplete model that has evolved through many years of individual and organizational experience and, at worst, effectively nonexistent.

Of course, managers use intermediate measures of employee effort all the time – measures such as the operating result of a division, the morale of a factory's employees, the number of new products introduced last year or the number of lines of codes generated by a group of software engineers. But we know that these measures nearly always suffer from two fundamental limitations. First, they are rarely measures of *individual* effort. Work in a modern organization is a team effort of enormous complexity in which the output of any single employee is often diffused over long periods of time and across many different projects. Second, anything that can be easily measured probably does not adequately represent the desired behavior (Kerr 1975). For example, a manager wants the research organization to be productive – to generate new products that delight customers and lead to profitable sales – and such productivity is not well accounted for by intermediate measures such as "number of patents generated" or "number of compounds released into the clinic." Managers thus come to use more subjective measures of performance. BGM make this idea a critical part of their argument for the importance of relational (that is, not court-enforceable) contracts. For our purposes the key issue is that, in practice, establishing these incentives is likely to be a path-dependent process characterized by extensive local learning that is heavily shaped by managers' cognitive frames and their behavioral assumptions in deducing the nature of equation (2).

The mapping embodied in equation (3) – from intermediate outcomes to the long term profitability of the firm – is similarly problematic. The profitability of the firm is driven by a huge variety of factors besides the actions of its employees, and, even within the firm, it is difficult to disentangle the relative roles of various functions such as manufacturing, marketing

and distribution, in driving success, or of actions taken this year from actions taken last year and the year before. To the extent that employers and employees do have some understanding of this mapping, it is an understanding that develops over time as they learn about the nature of the environment, the firm's goals and how these relate to their own interests.

Consider next the question of the motivation of the employee as represented by the mapping of equations (1) and (4). The organizational economics notion of interests is that all individuals are essentially the same and that, beyond some basic requirements for material subsistence, their major interest is in maximizing income. BGM thus have the employee maximizing the discounted present value of Q and W over time, on the assumption that both employer and employee understand the structure of both equations.

But identifying exactly what an employee is actually trying to maximize – what his or her true "interests" are – is, in practice, a complicated task even for the individual employee. Putting to one side the important but thorny question of intrinsic motivation (Dyer and Parker 1975), as the field work reported on in Kaplan (2004) suggests, interests can run from the tangibly beneficial (preserving one's job, getting a promotion, commanding a larger number of resources) to the more intangibly beneficial (being seen as an expert or truth teller). Moreover, individuals' interests may evolve over time as they gain experience, move into new positions, belong to different organizational groups and respond to changed incentive structures. As such, individuals may have multiple interests that can be differentially salient in different contexts, depending in part on the incentives in that setting. In any given context, individuals will seek to maximize some subset of these interests, which might include monetary compensation, but they may not have a full knowledge of the mapping from actions to private benefits (equation 1) and may react in unanticipated ways to the bonuses that they are offered by an employer (equation 4).

As situations become more dynamic and more ambiguous, it is even less clear what the employees' interests are and – this is critical for our argument – it is increasingly unlikely that an employer can easily gain this knowledge. Designing the ideal incentive contract – equation (4) – is thus a difficult task that typically takes place under conditions of severely limited information. To design a truly effective regime, an employer must determine not only which kinds of compensation are likely to be valuable to which kinds of employees (who values status? who control? who money?), but also the true form of equations (1-3). Then the employer must begin to build a relational contract with its employees that will persuade them that it will actually follow through and reward them according to the new formula.

Looking at the entire system of relationships represented by equations (1) through (4), to the extent that any measure of output p is an imperfect measure of true output, employees are likely to change behavior so as to generate a measurable result ("p") rather than the best outcome for the company (increasing "Π"). This further complication is created by the kinds of distortionary behavior first noted by Kerr (1975) and subsequently modeled by BGM. BGM present this distortion as a problem of moral hazard, but this perspective underestimates the ways in which people come to believe that what is "good for me" may also be "good for the company." Here again, the cognitive framing of the problem is likely to become intertwined with the incentive problem in subtle ways that are hard to disentangle.

In designing an incentive system the managers of a firm must therefore make assumptions both about individuals' interests (equations 1 and 4) and about the mapping from effort to firm benefit (equations 2 and 3). We suggest that these assumptions become gradually refined over time, as managers learn about both their employees and the task facing the organization. Similarly employees learn about the relationship between effort and what is likely

to be rewarded. Task learning (embodied in cognitive frames about what should be done and how) therefore cannot be separated from incentive learning. Thus, we believe that one cannot understand the "political" dimensions of behavior (the pursuit of interests and incentives by both employees and employers) independent of the cognitive frames possessed by employees and employers. (Recall, after all, that we have proceeded as though there is a clear distinction between "employees" and "employers" but that in reality there is only a complex cascade in which everyone working for the firm is ultimately an "employee," including the CEO.)

It is in this sense that an organizational routine is likely to have both a cognitive dimension – "This is how we go about hiring sales managers," "Here's what you should do when quality in the plant starts to slide" – and an incentive dimension – "Fred looks as though he's doing well in his new assignment" "The big guys say many things, but, take it from me, all you really need to do is pay attention to your day-to-day operating numbers and make nice to the boss." In fact we suspect that it may well be harder to learn how to evaluate and reward people than to learn how to do the work itself, since there is nearly always a distance between effort and outcome, and the relationship between them is often clouded by random shocks.

In a well-established business, it is likely to be the case that senior managers have developed intuitions over years of experience that lead them to be able to evaluate their subordinates ("Did you see what Chris has been doing in Asia? A hellish situation, but it's clear that she knows what she's doing"). Indeed the most senior managers are perhaps as likely to have been promoted on the basis of this ability as on the basis of task knowledge, since their primary task is to evaluate and reward the people that report to them.

Moreover, building on BGM's insight about the importance of relational contracts in sustaining incentive regimes, an established firm is likely to be characterized both by a shared

understanding of "what it takes to get ahead around here" and by a well established history of rewarding those employees who display the appropriate behaviors. Despite the fact that equation (4) cannot be contractually enforced, employees have learned that employers will enforce it because it is in the firm's best interests.

This line of argument gives us entrée into the question of why firms may find it extremely difficult to create appropriate incentive schemes for entrepreneurial ventures created within the firm's boundaries. In trying to create a new incentive scheme, the employers face two problems. The first is that they do not know what the scheme should look like. It took many years for employers to learn what equations (1-3) look like in the current business, and for the knowledge to become embedded both in the cognitive frames of the employees and employers, and in the routines and procedures of the firm. As employers are faced with entirely new markets and technologies, or with the need to evaluate a manager who's running a highly risky, rapidly growing unit rather than a more mature, operationally focused one, their old intuitions as to what constitutes good effort are unlikely to be correct. Both employees and employers will need to relearn what constitutes good effort and identify appropriate measures of this effort under changed circumstances.

The second problem is that creating a relational contract around a new version of (4) is not straightforward. As we noted above, if employees and managers were fully rational and everyone had complete information, creating a new relational contract would be easy. One could, in principle, simply post an explanation of the new regime on the company web site, noting that while the firm might be tempted to fire people who take jobs with the new division when they fail to perform according to the new incentive scheme, the company knows that if it acts this way it will not get anyone to take these new kinds of jobs in the future.

But, in a world of uncertainty created by radical technological change, the transition is likely to be far more difficult. First of all, neither firm nor employee knows what "p" now looks like. Second, it is difficult to build the mutual understanding that the firm will pay according to the new implicit contract *even when it is in the firm's short term interest not to.* Such instances are much more likely to arise during volatile periods (given that managers do not know what to reward, they are likely to choose the wrong set of "p"s), and managers may not have a clear sense of the long-term benefits of holding to the new contract either. Worst of all, employees and employers may develop different senses of what the new incentive regime is – so that for any given action, employees may feel betrayed while managers believe that they are following through. Third, it may be simple for managers to recognize that they know little about the new technology but less obvious to them that their understanding of what makes for a good general manager is no longer appropriate. Alternatively, given the many complications outlined above, they may believe that they cannot create an effective new incentive scheme. Any of these circumstances may lead employers to impose an existing incentive scheme on the entrepreneurial venture.

In summary, the need to use subjective measures and implicit contracts to motivate the organization to do one thing may make it very difficult to do another. If, as Nelson and Winter (1982) argue, routines are "truces" in the organization, and if these truces embody certain cognitive frames about the business and a set of incentives for acting on that understanding, then any changes in either the frames or the incentives will result in a breakdown of the truce. The lack of a truce raises the potential for conflict and misdirected effort. Thus, many managers will be loath to change organizational routines. If a new technology requires a new understanding (frame) in order to implement it successfully, it is less likely to be pursued by those in power

positions who are invested in the existing system. Or, if it is pursued, managers may attempt to do so without disturbing that system, therefore assuring failure. Thus, inertial effects can be attributed to the degree of embeddedness of incentives with cognitive frames. This notion of incentives radically departs from principal agent models and allows us to formalize the insight from Coriat and Dosi that we need to consider "'what the agents believe to be their interests,' the ways they pursue them and the knowledge that they possess to be the evolutionary outcome of search, conflict and mutual adjustment sanctioned thereafter by rather inertial rules and organizational structures…" (Coriat and Dosi 1998: 124).

Implications for understanding firm response to radical technological change

We opened the paper by suggesting that one of the reasons established firms have difficulty duplicating the performance of new entrants is that they are unable to create new incentive regimes. Drawing on recent work in organizational economics we suggested that the common dichotomy between cognitive frames and the political pursuit of interests may be analytically convenient but empirically dangerous. The fact that the firm must base incentives on measures that are both subject to interpretation and embedded in relational contracts means that incentives cannot be disentangled from the cognitive frames of both employees and employers, and that the two evolve together in a mutually reciprocal pattern of causation that makes any significant shift in regime extraordinarily difficult. We have come to believe that this insight is fundamental, in that it may provide a unifying perspective from which to understand the otherwise exceedingly disparate literature that seeks to explain the difficulties established firms face in responding effectively to radical innovation.

In this section we briefly review this literature, and in doing so attempt to show how the perspective developed above might provide this more unifying theory. With this approach, we

hope to elaborate upon the bare bones agency model of the earlier literature, laying the groundwork for an approach to the problem of organizational failure that is rooted simultaneously in problems of cognition and incentives.

The hypothesis that larger, older, more established firms[5] find it more difficult to respond effectively to radical technological change has deep roots in the management of technology and economics of technical change literatures. Several detailed studies have shown that in many industries established firms have been significantly less likely than newly founded firms or firms entering from other industries to introduce discontinuous, competence-destroying or radical technological innovations (see, for example, a review by Chesbrough 2001, and further work by Christensen 1997; Tushman and Rosenkopf 1992; Tushman and Smith 2001).[6]

A large and lively literature has emerged to explain these results. Broadly, the literature outlines three classes of explanations: established firms fail to respond to radical technological innovation because, one, they do not recognize or understand the implications of the new technology; two, they recognize the importance of the change but make a rational choice not to act; or, three, they recognize the opportunity but, despite significant investment, are unable to match the capabilities of entrepreneurial firms in the new space. (The difficulties that we explored above, when firms encounter problems in creating appropriate incentives for a separate

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[5] The question of whether this kind of inertia is a function of age, size, or simply presence in the market has spawned an extensive literature that is less salient to the discussion here. See Barnett and Carroll (1995) for an introduction, and also Sorensen and Stewart (2000) and the references therein. For our purposes, we consider "established" firms the best representation because it suggests the presence of ingrained organizational routines. This is in contrast to young, startup, small firms that are often considered to be more agile.

[6] In a vast array of industries, including watches (Landes 1969), disk drives (Christensen and Rosenbloom 1995), photolithography (Henderson and Clark 1990), calculators (Majumdar 1982), pens, semiconductors and locomotives (Cooper and Schendel 1976), new entrants displaced incumbents as market leaders when radically new technology invaded the market, though selected work has shown that incumbents can often survive these events and even thrive (Christensen, Suarez and Utterback 1998; Tripsas 1997).

division, would fall into this latter category.) Some of the proffered explanations for these failures focus on the dynamics of the senior team, while others focus at the working level of the organization. Some are primarily economic, others more behavioral in flavor, while yet others focus on organizational rigidity. Much of the research picks a single explanation and attempts to demonstrate its importance in a particular context, giving this literature an air of discord.

Explanation 1: failures of recognition

The business press is rife with stories of firms that fail to exploit radical technological change because they fail to recognize its importance. IBM's top managers notoriously disregarded the personal computer, variously treating it as a toy, a hobbyist machine or simply a peripheral to their core mainframe business. Bill Gates of Microsoft belittled the browser until 1994 when he famously reversed himself and refocused company efforts on building one to beat Netscape. Large pharmaceutical firms as a class (perhaps with the exception of Eli Lilly) ignored the potential for biotechnology and large-molecule drugs and only later spent billions of dollars catching up through acquisitions of new biotech firms.

Scholarly research has primarily attributed this failure to the notion of local search. In this view, firms are constrained by existing organizational routines (Nelson and Winter 1982) that can change only incrementally since learning is based on local search processes (Levinthal and March 1993; Levitt and March 1988/1996; March and Simon 1958). Existing information-processing routines and communication patterns limit the range of exploration in which firms engage (March 1994). When looking at new technologies in particular, firms do not stray too far from what is familiar (Podolny and Stuart 1995). Gavetti and Levinthal (2000) point out that this experience-based search is inextricably linked to more deliberate cognitive framing.

Within the management of technology field, despite early scholarship noting that "response presumes the ability to recognize and assess the threatening innovation," (Cooper and Schendel 1976: 66), there has been little research that has focused squarely on the issue of failed recognition. Some exceptions include studies by Tripsas and Gavetti (2000) attributing Polaroid's failure in the digital camera market to top managers' inability to recognize the importance of the new economic model that would be required to make the business a success; by Kaplan, Murray and Henderson (2003) showing that those pharmaceutical firm top management teams that interpreted the biotechnology revolution as important to their core pharmaceutical business were more likely to make significant technical investments; and by Tyler and Steensma (1995) finding that when executives perceived their firm to have a greater emphasis on technology, they placed greater value on opportunities related to potential technology alliances and less on the alliances' associated risks.

These findings are consistent with research on managerial cognition that has suggested that cognitive views shape the degree to which firms respond to changes in the environment, including radical technological change. For example, some research has shown that response is influenced by whether a given technology is perceived as a threat or an opportunity (Dutton and Jackson 1987; Gilbert 2002).[7]

We suspect that these kinds of failures in recognition may also have links to the structure of interests and incentives within the firm. As Ocasio argued in the development of his attention-

[7] In his study of newspapers' response to the Internet, Gilbert found that if newspaper firms perceived the Internet as an opportunity, they were less likely to invest than if they perceived it is a threat. However, investments made in response to perceived threats were "rigid," and based on existing models of the industry. As a result, newspapers missed out on many of the potential new categories of revenue on the Internet, instead replicating their hard-copy business models in an on-line environment. It was only when they created separate organizations who framed the Internet as an opportunity that they met with any success.

based view of the firm, one of the contextual factors shaping the allocation of attention in the organization are what he calls the "rules of the game" – the incentive systems that structure the process by which interpretations are made. Since these incentives "regulate the attention of the organizational decision-makers so as to recognize and resolve those issues and activities most highly valued by the firm" (Ocasio 1997: 199), a seemingly "cognitive" failure may well reflect a failure of the incentive regime.

One could easily interpret Christensen and Bower's (Christensen and Bower 1996; Christensen 1997) story about the failure of incumbent firms in the disk drive industry in this light. Using resource dependence theory (Pfeffer and Salancik 1978), they argue that when a firm is dependent upon a dominant set of customers for its current profits, those customers exert undue influence on firm action. If a new technology is perceived to be of value to these customers, then a firm will invest heavily in it. If, however, as in the case of disk drives, existing customers do not value the capabilities of a new technology, then established firms are less likely to invest, bypassing potentially attractive opportunities. The incentives associated with serving important customers direct the attention of management away from emerging customer segments with different needs that could be met by new technologies. New entrants, unencumbered by these incentives, have different frames and are likely to be more open to new customers. Similarly, Burgelman's (1994) account of Intel's (too) slow move away from DRAMs includes both cognitive and incentive-based elements. He suggests that Intel's action was dramatically slowed by top managers' lack of attention to new processor technologies and that the firm's move into microprocessors was only enabled by managers at lower levels of the organization operating under a set of incentives that drove their attention to higher margin, new technology-based businesses.

This research suggests two possible mechanisms by which interests, incentives and cognitive frames may interrelate to cause failures in recognition. The first is one suggested directly by organizational economics. It could be that that incentive structure of lower level employees is such that senior managers are not getting the information they need – that the failure of recognition stems from a failure to transfer information within the organization. Thus, if it is not in the interest of lower level employees that the firm make a significant investment in a radical technology, and if the prevalent incentive regime does not specifically reward the transmission of information about technology threats, then the acquisition and communication of the necessary information to make a decision is hampered (Aghion and Tirole 1997; Osterloh and Frey 2000).

A second, more evolutionarily-based possibility is that for both senior and junior managers, interests, cognitive frames and incentives co-evolve, so that in any mature firm, they are intimately intertwined and deeply embedded in the way things are done. As such, the fact that managers might see things in a particular way is a product of their past and current incentives. Reciprocally, their perceptions of their own interests are shaped by their cognitive frames of the environment, the firm and the technology. This will be particularly true for very successful managers who have been promoted on the basis of their subtle understanding of what should be done. If, over time, managers have developed the kinds of local, focused cognitive frames that are likely to get them promoted, then they may plausibly reject information alerting them to radical shifts in the environment as unimportant.

Explanation 2: recognize but fail to invest.

The second explanation of incumbent firm failure (or delay) in response to radical technological change is not that they fail to recognize its importance but rather that they choose

not to act. The simplest version of this explanation comes from neoclassical economics: in some circumstances investment in the new opportunity may not be economically rational for the established firm. Arrow (1962) was one of the first to suggest that established firms might rationally choose not to introduce radical innovation because it might cannibalize their existing market, and while Arrow's formulation of the problem has been challenged, his original intuition has been successfully embodied in several formal models (see, for example, Gilbert and Newbery 1982; Reinganum 1983). These scholars have made important distinctions between the incentives of entrants and incumbents, pointing out that under some conditions, incumbents will invest less than entrants due to a fear of cannibalizing their existing products.[8] Scholars in the management of technology field have similarly suggested that firms may rationally respond to radical technological change not by adopting the new technology, but rather by focusing on improving the existing technology at a faster rate (Cooper and Schendel 1976; Utterback 1994).

Our reading of Hannan and Freeman's work, and population ecology arguments more broadly, is that they make a logically similar argument although the underlying causal mechanisms are significantly different. Given the advantages of structural stability and replicability in enhancing survival in stable markets, firms that may have the capability to explore new markets are likely to be selected out because this capability degrades their performance in the existing market, where firms that seek to change risk losing legitimacy. This liability of newness gives managers no incentive to act (Hannan and Freeman 1977). Firms will be particular inert if they have high variance in competitive relationships (a situation that is

[8] Note that not all arguments about the incentives to invest suggest that incumbents will lag. For example, Klepper and Simons (2000) found that the largest firms in the market (likely the incumbents) do the most R&D because their costs can be amortized over a larger base, and Gans and Stern (2000) argue that incumbents have strategic incentives to invest in R&D because it increases their bargaining power in licensing technology from entrants, though they agree that incumbents are likely to invest less in research than entrants.

highly likely during a period of radical technological change), since they cannot co-evolve with any one group (Barnett and Hansen 1996).

This class of explanation, of course, models the firm as a single-minded, rational entity. But the same result – recognition but no investment – can also be explained by simple agency models of misaligned incentives within the senior team or among employees. Consider first the problem of the interests of the senior team. The classical agency problem is to align these interests with the interests of the firm's shareholders, but, as is well known, this is rarely completely possible (Gibbons 1998; Holmstrom 1982/1999; Jensen and Meckling 1976). To the degree that the senior team possesses human capital that is specialized to the existing business (Lazear 2003) – a common scenario, given that knowledgeable senior managers are likely to add considerable value to a firm (Stein 2002) – the senior team may have very real economic incentives to avoid moving the firm into radically different areas that might make their knowledge base obsolete. A similar argument could be made for employees of the firm.

Although this explanation of firm failure to act appears to be one of pure incentives, we believe that what these agency models miss is an understanding of the mechanism that connects the (more or less accurate) incentives to action. Managers do not say to themselves (and certainly do not say to others) that the reason they are choosing not to invest is because they fear making their own human capital obsolete. Rather, their incentives interact with the cognitive frames that they have developed over time. A particular set of incentives makes a particular cognitive frame – a particular view of the technology, the environment – more salient than alternative views, so that at moments of radical change the passionate objections of senior management to change may well be aligned with their own interests, but are also likely to reflect deeply held views about the nature of the environment and what is good for the firm.

Most intriguingly, for those interested in the dynamics of senior management teams, a number of economists have started to build models in which it is rational for a firm to employ a CEO whose cognitive framing makes it likely that he or she will fund only a single type of project. Stein and colleagues model this idea as a simple consequence of informational overload. If, Stein argues, it is rational for stockholders or venture capitalists to hire a CEO to make investment decisions, it can only be because he or she has better information about some particular subset of investment opportunities. By definition, there will be opportunities that he or she is less equipped to evaluate (Gertner, Scharfstein and Stein 1994; Stein 2002). Rotemberg and Saloner (1994; 2000) build two models that produce similar conclusions through a slightly different mechanism. They model the central problem as one in which employees will work harder only if they can be sure that the CEO is likely to fund their ideas. The CEO can then persuade the employees to do the extra work required to find really good projects only if he or she credibly precommits not to fund other possible projects. In their 1994 paper, Rotemberg and Saloner propose that this dynamic may lead the firm to credibly commit to a narrow business strategy. In their 2000 paper, the authors find that another solution is to hire a CEO who has a strong "vision" and who can be trusted to fund only particular kinds of projects. Van den Steen (forthcoming) offers yet another solution: hiring only employees with similar beliefs. In Van den Steen's view, if I know that my colleagues share my beliefs, I am much more likely to support their decisions, and they are much more likely to support mine.

Notice that these models start from an incentive problem and generate a cognitive outcome, suggesting that limited cognition – whether knowledge of only a single area or a precommitment not to explore new directions – may be a rational response to the problem of appropriately motivating an established organization. This suggests that incentives, interests and

cognitive frames interact in shaping managers' interpretations of situations and therefore of what the rational choice might be. Different incentives might elicit different interpretations of the nature of the technological change, just as different cognitive frames might produce different responses to incentives or make different interests salient when making an investment choice. To the extent that interests, incentives and cognitive frames are tightly intertwined, a change in strategic direction (such as that required to respond to a radical technology change) would require a wholesale change in this interlocking system. This insight is consistent with the findings of Tushman and colleagues (Tushman and Rosenkopf 1996; Virany and Tushman 1986) that where environmental change is discontinuous, replacement of the entire senior team is often associated with better firm performance. Even despite the dislocation associated with a major change in the top team, this appears to be an easier way to realign frames and incentives than to make the change with existing personnel.

Explanation 3: recognize, invest and yet still have difficulties

The third class of explanations of established firm failure in the face of radical technological change is one of unsuccessful or unduly costly implementation. In this view, firms do not have trouble recognizing the challenge of radical innovation or deciding to act on it, but the actions they do take are misdirected or inadequate. Some of Kodak's critics believe that this may be true of the firm's response to digital imaging, for example. Indeed, research in the management of technology has suggested that a majority of established firms facing a radical technology change do attempt to invest, often at fairly substantial levels, but that in general these investments do not pay off or are significantly less productive than those made by new entrants (Cooper and Schendel 1976; Henderson 1993).

The most common explanation for this outcome is that firms whose activities have been well-suited to one technology regime will not do well once there has been an important shift in the industry. The most basic form of this explanation has to do with initial conditions (Hannan and Freeman 1984; Stinchcombe 1965). If differences in founding conditions mean that firms are fundamentally different from each other, those firms that survive to become dominant in a particular industry do so because they possess assets and capabilities that are better suited to the characteristics of that industry. Thus a major shift, such as a radical technological change, will make these differences a source of liability rather than an advantage, while newly founded firms, or those entering from other industries whose unique blueprint is better suited to the new conditions, will survive. This explanation is logically compelling, but it leaves unanswered the precise question of the source and nature of these differences and of the conditions under which they can be manipulated or changed.

Nelson and Winter's (1982) work on the importance of routines and procedures in shaping the behavior of the firm provides us with one mechanism for explaining this phenomenon. They suggest that historically derived routines and procedures make it difficult for the firm to do anything but search locally – and hence doubly difficult to do anything entirely new. Routines inherited from experience with the previous generation of technology cannot be easily translated to the new setting.[9] Tushman and Anderson (1986) have suggested that firms are more or less vulnerable to technological change depending on whether the change will enhance or destroy these existing routines (which they call "competencies").

[9] Yet another stream of work in this tradition focuses on the constraints imposed by particular organizational structures. This idea dates back at least to Burns and Stalker (1961), whose distinction between "organic" and "mechanistic" organizations continues to echo in the popular literature. Viewed from this perspective, established firms fail because they are too rule-bound, lacking in creativity, and too slow to respond effectively to significant change.

Cognitive frames have been proposed as an alternative mechanism that constrains commercialization choices. Over time, top management teams develop a set of shared beliefs about how a firm makes money. In implementing a new technology, managers base their expectations of commercial success on these shared frames. Even if these frames are inappropriate in a new environment, managers may find it difficult to change them. In a longitudinal comparison of two railway companies, for instance, Barr, Stimpert and Huff (1992) found that while management teams in both firms were cognizant of new environmental conditions, the more successful firm was able to link those changes in the environment to corporate strategy. Similarly, Tripsas and Gavetti (2000) found that the Polaroid top management team experienced difficulty overcoming their belief in the efficacy of a particular business model for commercializing digital imaging technologies. In these stories, firms do not get their response right because they do not think about the nature of the problem right.

Henderson and Clark's (1990) analysis of firms' responses to radical changes in the photolithography business integrates these two mechanisms by suggesting that some routines may have a very significant cognitive component. They argue that some firms' inability to respond to what they call "architectural" innovation is a function of a continued reliance on knowledge (information filters, mental models and problem-solving strategies) that reflects the architecture of the previous generation of products. While the authors do not expand on these concepts, we interpret "information filters" and "mental models" perhaps even "problem-solving strategies" as particular aspects of the cognitive frames that becomes embedded in the organization.

Indeed their argument foreshadows the arguments we developed in our discussion of the interplay between incentives and cognition in shaping established firm response to radical

technological change. They focus on disruptions in the architectural knowledge (cognitive frames) of the firm. These frames become embedded as they are enacted over time in the firm and implicated in the incentive system and the mutual understanding of "how we do things around here." Architectural innovations thus require new cognitive frames. Since these new frames would disrupt the tight links between existing frames and incentives that characterize established firms, they are resisted.

This review of the variety of explanations of firm response to radical technical change offers an explanation for the underlying dynamics that might unify the rather disparate perspectives extant in scholarship in this arena. The inertial effects can be attributed to the depth of embeddedness of frames. Deeply embedded cognitive frames are tightly intertwined with incentives, and this linkage proves difficult to change. Product architecture, customer demands and dominant designs are all areas where cognitive frames and incentives are linked. This line of reasoning lays the groundwork for an approach to the problem of organizational failure that is rooted simultaneously in problems of cognition and incentives.

Discussion and conclusion

What can we conclude from this discussion? First, as several authors have suggested, local routines – whether tacit knowledge, codes or procedures – are the product of not only a cognitive process, whereby individuals learn about how things are done, but also an incentive-related process, whereby individuals learn what kinds of behaviors are likely to be rewarded. The effects of an incentive regime – "I act like this because this is in my best interests" – cannot be cleanly separated from cognition – "I act like this because this is what I believe to be the case." Rather, as we have suggested in this paper, cognition and incentives evolve simultaneously in a complex, reciprocal process. Second, with regard to the adoption of a radical new technology

within an organization, we suggest that the barriers are both cognitive – "We know that this won't work and we doubt that it will ever make money even if it does" – and incentive-related – "You won't pay me for trying to learn." Moreover, because cognitive frames and incentives are tightly intertwined in an organization, any attempt to change one must be accompanied by a change in the other. The central problem, we suggest, is not that of cognition *versus* incentives, leadership versus structure, inertia versus conscious action and so on, but rather how to develop a richer understanding of the ways in which these various elements interact – endogenously and dynamically – to shape the choices and behavior of the modern firm in the face of significant change.

An incentives-only story about firm response to radical technological change does not explain why it is so difficult to construct new regimes in response that change. Designing the ideal incentive contract is particularly difficult under the uncertain conditions and limited information of a discontinuity. Managers do not know what the scheme should look like, and, even if they do, they find it hard to put a new relational contract in place that employees will find credible. A cognition-only story is also inadequate. Much work in managerial cognition has tended to push the political pursuit of interests to the background and thus fails to address conflicting views or the politicized processes for producing collective meaning. Instead, managerial cognition research attributes firm inertia to individual cognitive inertia – an entirely psychological perspective. Our approach suggests that people can change their minds but this potential is shaped in a social context. The stickiness of frames is due not only to individual cognitive inertia but also to linkages with incentives.

This discussion highlights three broad themes in which future research might yield high returns. The first is the relationship between the economic perspectives that we have briefly

outlined above and the sociological or behavioral perspectives that dominate the current organizational literature. Our belief is that it is fruitless to debate whether a firm is really a complex social system or a collection of self-interested individuals. It would be surprising if it were not the case that all firms can be usefully viewed through both lenses, as a number of scholars have compellingly argued (see, for example, Ancona et al., 1999). A more fruitful direction for research may be to explore the ways in which the economic dynamics of self-interest and competition *interact* with the social and behavioral dynamics of the firm. Such a research program could explore such questions as the degree to which the cognitive frames (and social structures more broadly) of a firm affect the motivation of its employees, whether certain kinds of formal structures and incentive systems are more likely to create certain kinds of social structures, and vice versa.

The second set of implications for research is both theoretical and methodological. By suggesting that cognitive frames, interests and incentives interact and co-evolve, we are arguing that we cannot treat the firm as a macro-level whole. Rather, just as organization economics insists that we need to understand the incentives of different parties inside the organization so, we believe, must we consider their cognitive frames. We must not reify the firm as a "cognizer," but rather must think of the firm as a collective of people, each with different interests and cognitive frames. Understanding firm response to radical technological change, or firm strategic action more broadly, requires that we show how a collective cognitive frame and ultimately a collective decision might emerge through the interactions of individuals (Spender 1998; Weick and Roberts 1993), in particular under conditions of uncertainty. This view is consistent with recent calls to "bring work back in" to the study of organizations (Barley and Kunda 2001)and to focus on the micro-processes within the organization (Johnson, Smith and Codling 2000). Such

an approach should shed light on more proximal reasons for the heterogeneity of firm performance (in particular in the face of radical technological change) by linking micro processes to macro changes.

The third set of implications for future research that this discussion opens up is practical and phenomenological. Much of the practitioner literature focused on the problem of firms' response to radical change has a very strong normative overtone. Firms that cannot change are "dinosaurs" or "elephants" and "teaching them to dance" is not only possible but essential (c.f., Gerstner 2002; Kanter 1989). Much of this work suggests that the failure of established firms reflects failings of the senior management team, and that better management, in the form of "double loop learning" (Argyris 1990), "ambidextrous organizations" (Tushman and O'Reilly 1997), superior strategic processes (Eisenhardt 1989), or appropriately visionary and forward-thinking senior leaders (Burgelman 2002; Finkelstein 2003), can enable a firm to manage major transitions effectively. Implicit in this perspective is the view that large firms can be made significantly more flexible and responsive, and that movement in this direction generates unambiguously high private and social returns.

The model we develop in this paper opens up both hopeful and discouraging possibilities. The empirical literature suggests that established firms faced with radical technological change sometimes respond effectively. In some cases, this success occurs because the threat facing the organization is so profound that it disrupts the tight connection between cognitive frames, interests and incentives in the organization. But as the social movements literature on framing (Benford 1997; Benford and Snow 2000) has demonstrated, actors can purposefully break and remake the connection between frames and incentives by mobilizing a powerful enough group around an alternative viewpoint. This perspective is consistent with an emerging stream of

research on the evolution of technology trajectories (Garud and Karnoe 2001; Garud and Karnoe 2003; Van de Ven and Hargrave 2003)[10] that demonstrates that purposeful action is an essential part of how industries respond to technological change. The findings from a field study on strategy-making in one firm during a period of radical technological change (Kaplan 2003) confirm this dynamic at an intra- rather than interfirm level, suggesting that sophisticated managers who understand the tight linkages between cognitive frames, interests and incentives can intervene to create effective coalitions for radical action.

On the other hand, the organizational economics literature that we have outlined above suggests that this model may need to be tempered with the awareness that in some circumstances a firm's inability to change may be an adaptive response to its current environment, and that forcing the firm to change significantly – to do two things at once – may not only be risky and expensive but may also wreak havoc on the firm's ability to perform well in its current business. This notion of the problem of transition complements the work of Leonard-Barton (1992) who suggested that core competencies can become "competency traps" and of those sociologists who have suggested that firms attempting major changes run significant risks (Barnett and Carroll 1995).

Research that attempted to assess the relative weight of these two alternatives in explaining the history of well-established firms faced with significant change would, we believe, be very productive. Potential research questions include: What types of cognitive frame-

[10] Garud and Karnoe (2001; 2003) contrast the notions of path dependence and path creation. They argue that actors purposively manipulate circumstances, either to reproduce existing structures or to disengage from these structures and pursue different trajectories. While these authors bring agency back into the technology evolution story, they neglect power. For them, all options are open and the outcomes are just a matter of path creation. Van de Ven and Hargrave (2003) as well as others who are bringing social movements theory into analyses of technical change (Wade, Swaminathan and Dowell 2003) focus explicitly on how politics both constrain and enable agency.

incentives links contribute to inertial responses to technical change? What contributes to the embeddedness of frames? Under what conditions is purposeful action that disrupts ingrained cognitive frames more likely? What characteristics might a non-inertial firm possess?

Is it the case, for example, that it is the best performing firms in one generation who are most likely to experience difficulty in the next? Such a finding would suggest that the second view based on the problem of transition is more correct. Or is it the case that "well managed" firms are better both at managing their current businesses and in transitioning to new ones? Such a finding would suggest that the first view based on the potential for change provides more insight into the problem. Our own suspicion is that both effects are important: that some firms are behind the production possibility frontier and for them a general upgrading of managerial capability by improving flexibility and responsiveness is unambiguously positive, others are so well tuned to their existing operations that any attempt to change them significantly is likely to degrade performance. As the pace of change in the economy increases, learning more about which effect will dominate under which conditions is likely to become increasingly important. Given the potential for dislocation in the lives of hundreds or even thousands of people as the major institutions of our economy are faced with change, knowing when it makes sense to attempt to change them and when it's better to start from scratch should be a shared goal for organizational research.

This paper highlights the importance of the degree of embeddedness of cognitive frames and incentives in dealing with change. The less embedded they are, the more likely that alternative views of the world (views that could better accommodate radical technological change) can emerge. Yet, a deeply embedded system has its advantages – being better able to smooth the decision-making process and the implementation of strategic actions. This is, of

course, the “essential tension” of which Kuhn (1977) wrote: “Very often the successful scientist must simultaneously display the characteristics of the traditionalist and of the iconoclast.” A model that views incentives and cognitive frames as intertwined in an organization recognizes that both are possible. Forces for tradition exist when cognitive frames and incentives are deeply embedded. Yet the iconoclastic effort to change is only possible when managers can reshape the links between cognitive frames and incentives.

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