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ORGANIZATIONAL INNOVATION AND ORGANIZATIONAL CHANGE

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ABSTRACT

Three ideas—a complex division of labor, an organic structure, and a high-risk strategy—provoke consistent findings relative to organizational innovation. Of these three ideas, the complexity of the division of labor is most important because it taps the organizational learning, problem-solving, and creativity capacities of the organization. The importance of a complex division of labor has been underappreciated because of the various ways in which it has been measured, which in turn reflect the macroinstitutional arrangements of the educational system within a society. These ideas can be extended to the study of interorganizational relationships and the theories of organizational change. Integrating these theories would provide a general organizational theory of evolution within the context of knowledge societies.

ORGANIZATIONAL INNOVATION AND CHANGE

Although many lament the absence of cumulative findings in sociology, the study of organizational innovation is one instance where consistent findings have accumulated across more than thirty years of research. This was demonstrated in two recent reviews (Damanpour 1991, Zammuto & O'Connor 1992) published in the management literature. This present review has as one of its objectives to acquaint sociologists with the generalizations that have emerged and, as another objective, to extend beyond these previous reviews in three

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distinctive ways: (*a*) by emphasizing the importance of the complexity of the division of labor; (*b*) by suggesting needed arenas of new research; and (*c*) by integrating organizational innovation with the more general topic of organizational change. This will broaden systemically the solid body of research already accumulated.

Innovation research, although previously not central to the concerns of many sociologists, now offers an opportunity to address a large number of important practical and theoretical issues. Here are a few examples. Practically, since a country's economic development depends largely on the continued launching of new products, governments have become concerned about innovation. Indeed, the new products and new services provide new employment opportunities and positive balances of trade, thus protecting the nation's standard of living. But innovation in products, services, technologies, and administrative practices is also relevant to other institutional sectors besides the economy; the study of organizational innovation, for instance, articulates with the study of significant breakthroughs in science, the development of superior military equipment, the creation of interdisciplinary programs in higher education (Blau 1973), the reform of welfare, etc. In other words, for anyone interested in some of the most basic problems of society, the subject of organizational innovation is relevant.

Theoretically, research on organizational innovation opens new perspectives on a number of interesting issues that have surfaced recently, including the issues of societal evolution and institutional change, the dynamics of knowledge societies (Bell 1973, Hage & Powers 1992), and the integration of macro and micro levels of analysis. Beyond sociology, organizational innovation can make important contributions to several important arenas of new research in economics. The most obvious one is research on national systems of innovation (Lundvall 1992, Nelson 1993), but it is equally relevant to endogenous theories of economic growth (Romer 1986, 1990, Solow 1992) more generally.

The first section of this review examines the general pattern of findings and emphasizes the importance of three critical variables: (*a*) the organic structure, (*b*) the organizational strategy; and (*c*) the complexity of the division of labor. In this section, we discuss the definition of innovation. The second section focuses on the new areas of potential research on organizational innovation. Here the emphasis is put on considering inputs and feedbacks as well as extending innovation studies to interorganizational relationships and the institutional level of analysis. Throughout this discussion, continued reference is made to linkages with several topics in the economics literature. The third section then shifts to the relationship between organizational innovation and the more general literature on organizational change. Four distinctive perspectives of change are considered and integrated.

AN OVERVIEW OF ORGANIZATIONAL INNOVATION RESEARCH

The Theoretical Relevance of Innovation Research in the Study of Organizations

Despite the attractiveness of the idea of creative and flexible organizations, the topic of organizational innovation has never been central in either organizational or management theory and research (see such textbooks as Hall 1991, Scott 1992, or any of the management textbooks in organizational theory such as Daft 1989 and Mintzberg 1979). Yet, innovations reflect a critical way in which organizations respond to either technological or market challenges (Brenner 1987, Gomes--Casseres 1994, 1996, Smith et al 1992, Hage 1988). In particular, technological advance is increasingly the basis of competition between nations (Kitson & Michie 1998, Porter 1990). As Zammuto & O'Connor (1992) demonstrate, most systems of flexible manufacturing adopted in the United States have had little impact on flexibility and only half have improved productivity, raising serious questions as to why, and about the long-term prospects for the United States (Jaikumar 1986).

Businesses have come to realize the importance of innovation for survival in a world of global competition. A recent report from the British Department of Trade and Industry (Sullivan 1998) indicates that the major companies, irrespective of country—France, Germany, Italy, Japan, Sweden, United Kingdom, and the United States—spend between 4% and 5% of sales on research in the automobile and the commercial aircraft industries, from 5% to 8% in the three sectors of semi-conductors and computers, electrical products, and chemical products and 10% to 15%% in the health products, pharmaceuticals, and software sectors. In the past year, the research and development (R&D) spending in the top 300 companies world-wide increased 12.8%, with the largest increases in some 100 American companies. While this may be an exceptional increase, it continues the long-term trend since 1975 (Hage & Powers 1992:32) of annual growth of 4% to 5% above inflation per annum in private expenditure, at least in the American firms.

The Definition of Organization Innovation and Styles of Research

Organizational innovation has been consistently defined as the adoption of an idea or behavior that is new to the organization (Damanpour 1988, 1991, Daft & Becker 1978, Hage 1980, Hage & Aiken 1970, Zaltman, Duncan & Holbek 1973, Oerlemans et al 1998, Wood 1998, Zummato & O'Connor 1992). The innovation can either be a new product, a new service, a new technology, or a new administrative practice. The research usually focuses on *rates* of innova-

tion and not on single innovations except in the instance of diffusion studies (e.g. Collins et al 1987, Ettlie et al 1984, Walton 1987) where the speed of adoption is an issue. The importance of studies of innovation rates rather than a case study of a single innovation must be stressed. In the metaanalysis of Damanpour (1991), he found that the greater the number of innovations considered in the research study, the more consistent the findings. *This is an important conclusion, namely, that the focus on rates of a phenomenon will produce more consistent results than the analysis of a single event.* Here lies one of the major methodological reasons why organizational sociologists have not always been able to observe an accumulation of findings.

Although the definition has remained consistent, the particular kinds of innovation examined have shifted across time as well as have the kinds of problems that have interested people. In the 1960s and 1970s the emphasis was on incremental change in public sector organizations (Allen & Cohen 1969, Daft & Becker 1978, Hage & Aiken 1967, Kaluzny et al 1972, Moch 1976), while in the 1980s and 1990s it has been on radical change in private sector organizations (Collins et al 1987, Cohn & Turyn 1980, Ettlie et al 1984, Gerwin 1988, Jaikumar 1986, Teece 1987, Walton 1987). Examples of the latter include flexible manufacturing (Collins et al 1987, Gerwin 1988, Teece 1987), retortable pouches (Ettlie et al 1984), robotics, automated handling of materials, or computer numerically controlled machines (Jaikumar 1986), and even ship automation (Walton 1987) and shoe production (Cohn & Turyn 1980). Furthermore, the measures for "radical" altered from subjective ones (Kaluzny et al 1972) to more objective ones (Cohn & Turyn 1980, Collins et al 1987, Ettlie et al 1984, Walton 1987).

As this shift in focus occurred, the nature of the problem being investigated also changed. Rather than simply count the number of adoptions within a particular time period, the analytical focus became differential implementation of radical innovations, most typically advanced manufacturing technologies (see Zammuto & O'Connor 1992).

What kinds of innovation have not been studied? This is always the more difficult but necessary question in any review. Essentially there are two kinds of organizational innovations that have not received much attention. The first lacuna is the examination of radical innovations in the components of assembled products such as cars, commercial airplanes, and trains. By and large the organizational innovation literature has focused on simple products or services rather than the assembled variety. But some of the most interesting radical innovations are occurring in the components of assembled products. To take cars as one example, there have been air bags, anti-lock disk brakes, geographical positioning systems, fuel efficient engines, etc. The second lacuna is radical innovations in what are called large-scale technical systems (Mayntz & Hughes 1988) such as electrical, railroad, and telephone systems. Some radical

innovations in these areas include nuclear energy, high-speed trains, and coaxial cables. And this is to say nothing about the emergence of new radical large scale technical systems such as satellite television and internet. We need a shift in focus to assembled products and large-scale technical systems because of their importance in the post-industrial economy.

Consistency of Findings

In the two management reviews (Damanpour 1991, Zammuto & O'Connor 1992), two important themes about the determinants of innovation have emerged, namely, the importance of an organic structure (Burns & Stalker 1961) and pro-change values or high-risk strategies. The organic structure has long been a feature of various reviews (see Burns & Stalker 1961, Hage 1965, Aiken & Hage 1971, Zaltman et al 1973) as has the pro-change strategy (Hage & Dewar 1973, Hage 1980). What has been missed is the central role of the complexity of the division of labor (Hage 1965). Before considering this latter idea, however, the general ideas of the two management reviews need to be summarized.

THE DAMANPOUR (1991) REVIEW This review contains a metaanalysis involving 23 studies in which four major contingencies—type of organization, type of innovation, stage of adoption, and scope of innovation—were controlled in the analysis of the impact of structure and strategy on innovation rates. In general, these contingencies did not eliminate most of the general findings although in certain instances they affected the size of the parameters.

For structural variables that in some way refer to the division of labor, Damanpour examined the impact of specialization (or number of occupations), departmentalization or functional differentiation (or number of departments), professionalism (education and/or involvement in professional activities), and a new one, the technical knowledge resources involved in the job. The first three had significant relationships with innovation. In the moderator analysis, however, it was specialization that had the most robust association across the four moderator variables. Technological knowledge resources represent a specific kind of human capital or expertise (Becker 1964, Schultz 1961). Again, there was a positive relationship with innovation, but only a few of the control variables could be considered because of the small number of studies involving this variable.

However, this positive relationship is consistent with a number of other findings in the literature on organizational innovation that are not generally known in the organizational literature. In several British and German plant comparisons (Daly et al 1985, Steedman & Wagner 1987, 1989), the researchers found that when managers did not have technical training relevant to their manufacturing they were slow to adopt new technologies.

The two other structural variables Damanpour (1991) examined in one way or another referred to characteristics of the organic organization—centralization and formalization. Centralization had a robust and negative relationship with innovation, whereas formalization had a weak and inconsistent one given various controls. The major strategy variable was managerial attitudes toward change, which in general had a positive relationship with innovation, though less robust than did centralization and specialization.

There is, however, an important qualification to be made about Damanpour's metaanalysis. Although the author has taken several dimensions of an organic structure (Burns & Stalker 1961), perhaps the most fundamental characteristics of this structure have not been examined in studies of innovation. Here are three examples: the idea of shifting leadership, the different mechanisms for facilitating communication, and the importance of technical progress as a goal.

THE ZAMMUTO AND O'CONNOR(1992) REVIEW This review focuses specifically on the problems of the adoption of flexible manufacturing, including those for Britain (Bessant 1985, Ingersoll Engineers 1984, Primrose 1988), Japan (Jaikumar 1986), Australia (Fleck 1984), and the United States (Jaikumar 1986, Voss 1988), and thus it deals directly with the issue of unemployment and national standards of living. However, this study poses a new problem, namely, differential implementation. Few American firms achieved flexibility, and only one half had improvements in productivity. Given the work of Piore & Sabel (1984), who have argued that flexible specialized manufacturing represents what they call "the second industrial divide," and that of Pine (1993) on mass customization, these findings are disquieting.

The thesis of the Zammuto & O'Connor review is that it is an organic organization and a pro-change or high-risk strategy that provide the best chance for a successful implementation of flexible manufacturing so that both productivity and flexibility are achieved. Unlike the Damanpour (1991) review, this review is qualitative, but it has the advantage of including a number of engineering studies that are not part of the previous review.

Within the review, the authors mention the importance of the complexity of the job (Zammuto & O' Connor 1992:708), another new characteristic of the division of labor. Their argument that more complex jobs at the operative level facilitated organizational learning is similar to the one made for professionalism in the literature cited above. The importance of complex jobs in facilitating the adoption of new technologies is again demonstrated in a number of matched plant comparisons not cited in Zammuto & O'Connor's (1992) review (Prais et al 1989, Prais & Steedman 1989, Steedman & Wagner 1987, 1989; Steedman et al 1991). For instance, the German foremen typically performed the activities associated with several distinct positions found in British plants,

including responsibility for quality control and production scheduling, activities regularly assigned to managers or engineers in American plants. More complex jobs at the bottom of the hierarchy were associated in the German plants with much greater flexibility in the work force and the ability of the German manufacturers to provide customization of their products. The German workers repaired their own machines, took responsibility for their maintenance, and exploited more effectively the range of capabilities in the machines, thus explaining how gains in both productivity and flexibility could be obtained from advanced manufacturing technologies. Admittedly, it is difficult to separate the unique effects of the German superior technical training from the complexity of the job because these two are related in the German instance.

A recent study (Collins et al 1988) on differential implementation of flexible manufacturing across a number of industries in the United States was not included in either of these two reviews, although it further substantiates the idea that flexible manufacturing systems were more likely to be adopted when there was complexity in the division of labor. This study used the diversity of occupational specialties as the measure of complexity and controlled for the prior level of automation, which almost none of the previous research studies reviewed did. The expected finding was the higher the level, the *less* the movement toward greater automation. *But the unexpected finding was that at higher levels of automation, complexity had a multiplier effect on further adoption of flexible manufacturing,* i.e. an interaction effect. Again, in quantitative terms this substantiates the qualitative comparisons of plants in Europe.

Zammuto & O'Connor (1992:717) also expanded the idea of decentralization by discussing the importance of participation of the workers during the implementation process, but they did not explain why this was successful. This provides another insight as to why the organic structure—decentralization, horizontal communication, and shifting leadership—facilitates the process of implementation. This allows for mobilizing the skills and knowledge that the employees have. In particular, Jaikumar's (1986) comparison of Japan and the United States across a number of industries and Walton's (1987) study of the adoption of innovations in the shipping industries of Britain, Germany, Japan, Norway, the Netherlands, and the United States both provide considerable evidence for this assertion. The continual gains in productivity—incremental process innovation—associated with quality work circles are also proof of this assertion (Lazonick 1998).

One of the weaknesses in the various studies of strategy relative to innovation is shifting definitions of the content of the strategy. In particular what has not been addressed is the degree of radicalness in the strategy itself. This is important because of Tushman &Andersen's work (1986), which indicates that dominant firms are more likely to adopt nonradical strategies, while new and weak firms are more likely to adopt radical ones.

Another issue not discussed in the Zammuto & O'Connor (1992) review but relevant to their analysis are the advantages for motivation of a high-risk strategy that is visionary. Resistance to radical changes, and especially when they involve the potential loss of jobs, as for example with automation, is a constant theme. But a high-risk strategy that contains a new vision about protecting employment is quite different. Beyond this, strategies that involve making the world better in some way have a considerable motivational impact on the employees as they are struggling with the implementation of the radical innovation (Hage & Aiken 1970). Economists have stressed the importance of incentives and especially the entrepreneurial rewards obtained from radical innovations (Baldwin & Scott 1987, Cayselle 1998) but have ignored the motivation of the employees or workers who may not directly benefit economically. In particular, the idea of public goods, that is gains for society, as a motivating factor is not part of their framework. Interestingly, items in the Hage & Dewar (1973) operationalization of change values stressed the gains for society rather than self-interest, whether for the organization or its members. The famous Kidder (1979) account of the development of a computer provides a dramatic illustration of how important making society better in some way is for the motivation of many people. In future research we need to more directly access whether or not the successful introduction of radical products or the implementation of radical process innovations involved some vision of a better society.

THE MISSING VARIABLE: THE COMPLEX DIVISION OF LABOR Although both reviews discussed various aspects of the division of labor in organizations as an important feature that facilitated innovation, they did not directly reference the complexity of the division of labor as the most critical variable for stimulating innovation. Four of the potential six indicators were in the Damanpour (1991) review: specialization, departmentalization, professionalization, and technical knowledge resources, and one of them, the complexity of the job, was in the Zammuto & O'Connor (1992) review. Neither considered the importance of the presence of a research department, which would appear to be the most obvious prior condition for innovation and which appeared in the Cohen & Levinthal (1990) discussion of absorbtive capacity and was relevant to the literature on organizational learning. The true significance of the complexity of the division of labor can only be appreciated when one adds across these various dimensions.

Why is the complexity of the division of labor so critical for organizational innovation? The original argument made by Hage (1965) was that the complexity of the division of labor would lead to much greater adaptiveness or flexibility relative to changes in the environment (for some evidence for this assertion, see Smith et al 1992). However, this occurred via several different

chains of reasoning: (*a*) the complexity reduced the amount of centralization and formalization, that is the bureaucracy; and (*b*) shifted the ends of the organization away from efficiency toward higher morale. These were further amplified in Hage & Aiken (1970) when they suggested that occupants of a diverse number of college-level trained occupations monitor the environment and learn about new ideas either as problems or as solutions. Given a diverse number of specialties, more aspects of the task environment are being monitored, generating a cross-fertilization of ideas. Coalitions of professionals form in differentiated units such as departments and struggle for scarce resources. Consistent with this idea but not separately analyzed is the finding about the relationship between the existence of a department and the number of new techniques associated with that occupational specialty (Moch & Morse 1977) or the presence of a research department (see Allen 1977), in part the idea of functional differentiation. In current work this is referred to as absorptive capacity (Cohen & Levinthal 1990). Damanpour (1991) reviews a number of these reasons under various indicators of complexity.

Given the current emphasis on the organic structure and pro-change strategies, why is the complexity of the division of labor more important? Neither concept—that is, neither the organic structure nor the pro-change or high-risk strategy—refer to the intellectual or problem-solving capacities or learning capacities (Cohen & Levinthal 1990) of the organization, to say nothing about the creative capacities. Diversity of knowledge is critical for creative, complex, and rapid problem solving (Smith et al 1992, Schoenberger 1994), which is increasingly required in the global market place (Hage & Powers 1992). Organic structures help mobilize this knowledge and strategies provide goals and motivation, but ultimately one has to have the knowledge base represented by complexity and its various indicators.

Given the considerable importance currently being attached to the management of knowledge and the learning organization in both the management and industrial economics literatures (Foss 1999, Nooteboom 1999), the concept of the degree of complexity needs to be stressed. Except for the advantages of a research department in improving the absorptive capacity (Cohen & Levinthal 1990), the other dimensions of complexity have not been considered in discussions of the learning organization. Nonaka & Takeuchi (1995) in their discussion of the knowledge organization have primarily stressed mechanisms of integration rather than the various measures of complexity. Perhaps most critically, most of this literature (Foss 1999) is not predictive because it does not ask, Why do some organizations learn more? Some have begun to suggest that the learning organization is the innovative organization (Nooteboom 1999), but again this begs the question as to what explains the higher rates of innovation and we are lead back to complexity.

THE VARIABLE TO BE IGNORED: ORGANIZATIONAL SIZE Ever since the thesis of Schumpeter (Baldwin & Scott 1987) about the advantages of large size and/or market power (concentration), a number of studies in economics have tried to demonstrate whether or not he was correct. Most reviews have found that the picture is quite mixed (see reviews of Baldwin & Scott 1987, Cayselle 1998, Cohen & Levin 1989). The reason for this is that the economists have not divided their industrial sectors or sample of large firms into those with high complexity such as chemicals, computers, commerical airplanes, electrical products, drugs, etc and those with low complexity such as rubber tires, steel, processed foods, cement, cigarettes, etc. When this is done there is much more order in the data. In the former instance, even with relatively high levels of concentration, firms spend a great deal on research and product development while in the latter case they do not (Hage 1980). The same assertion can be made about small firms (see Nooteboom 1994). Many do not spend much money on research and development but those that do spend a great deal. Again, the difference is the degree of complexity (see Hage 1980 for the explicit organizational typology generated by large versus small size and low versus high complexity).

Furthermore, another problem with the variable of organizational size is the issue of how does one measure innovation in firms of varying size. As I observed in the beginning the usual research design for innovation research in sociology is a single industrial sector where there is a modal size. But in comparing across sectors, which is of more interest to industrial economists, the problem becomes whether or not the rate of innovation should be standardized on the size of the organization. An additional problem is the weighting issue. Across sectors, the amount of money required for a radical product innovation is vastly different. Compare 70 million dollars for a radical new drug with one billion for a new model car that might have only incremental improvements in its various components.

NEW ARENAS OF RESEARCH FOR ORGANIZATIONAL INNOVATION

Several ways exist for specifying new arenas of research. If one takes a systems perspective, it becomes easier to observe several limitations in the literature (Hage 1980). In general, little attention has been paid to the problem of inputs as a necessary control. Only recently have feedbacks become part of the literature. They are a necessary next step, especially for those interested in building some theory about evolution and in particular the characteristics of knowledge societies. Finally, there are several logical extensions of this literature, specifically to the study of networks and to the macroinstitutional level of analysis.

Controlling for Inputs

THE INPUT OF RESEARCH EXPENDITURES *One of the major limitations of the large number of studies on organizational innovation is that there has not been any attempt to control for the amount of investment in research and development before testing whether the structure of the organization has a multiplier effect on the amount of innovation produced.* There is one exception (Hull 1988), and one not involved in either of the two management reviews. This study demonstrates that controlling for the investment in either research dollars or researchers, and controlling for size, the organic model provides a multiplier effect on the number of patents produced, while the opposite—the use of centralization and formalization—reduces their number. The sample includes a wide variety of research departments in major American companies, including most of the major pharmaceuticals. Unfortunately, this study is a rare exception to the typical ones in organizational sociology. Most organizational research has ignored the inputs of human capital and more critically the amount of money spent on research. Thus, one could always question whether or not innovation was a consequence of these inputs. By combining the economists' input-output modeling, in this instance the inputs of the number of researchers and the amount invested in research, and testing the impact of organizational characteristics such as complexity and the organic model to predict the amount of innovation, admittedly here only measured by patents (which has its own problems), one has both a much more convincing and a more powerful argument relative to the importance of structural variables in general and the complexity of the division of labor in particular.

Please observe that the multiplier is being provided not by technological progress but instead by the nature of the intervening organization. Likewise, the complexity of the organizational structure when it is integrated in an organic structure creates the innovation in products, services, and technologies by the same kind of logic. The basic thesis of a structural paradigm is that it augments what is invested, and it is this idea that should be tested. Following the logic of the economists, one would like to partition the amount of technological progress produced by innovation among the three components that have been suggested in this review. In other words how much is technological progress produced by the complexity of the division of labor, by an organic structure, or by a high-risk strategy? With answers to these questions, governments could more wisely select policies to facilitate one or another of these structural or strategic attributes.

The failure to study the impact of research departments and their organization on rates of innovation is all the more regrettable because, as was suggested at the beginning of this review, most of the major corporations in the world now allocate money for research expenditures, at minimum product develop-

ment. Similarly, nations recognize that their economic vitality is dependent upon the effectiveness of their research programs. Therefore, the study of how to organize research becomes a strategic arena for organizational sociologists if they want to make a contribution to the study of economic progress.

Paradoxically, very few studies of industrial research departments and their characteristics exist in the literature, the Hull (1988) study being a major exception. In contrast, the sociology of science has studied public sector research departments and been concerned with the local knowledge problem (Knorr 1981, Latour & Woolgar 1979), rather than with how the organization of the research team or department affects the ability to make major discoveries. Complexity is also relevant to studies of organizational learning for the same reason; the complexity of the division of labor overcomes the single-loop reasoning problem of managers (Argyris & Schoen 1978).

THE INPUT OF PRIOR INNOVATION A similar limitation of the research to date is that just as these studies generally do not control for the amount of inputs invested in producing organizational innovation, there is also little analysis of the prior history of innovation, what some might term the culture of the organization and others the prior strategy (presumably these ideas are in various ways related). Again, there is one major study (see Hage & Dewar 1973), which controlled for both the prior history of innovation, the attitudes of the power elite toward social change, and organizational structure, and it found that all three perspectives or paradigms—and with only three variables, one for each—explained some 70% of the variation in a three-year prediction study. Although Damanpour (1991) includes this study in his meta-analysis, the variable prior innovation is not, precisely because it is missing from most research studies. Future research on organizational innovation should control for the prior history of innovation as a critical explanation of the future behavior of the organization, even though it is not a particularly exciting idea that organizations repeat their behavior across time!

Another important reason for studying prior innovation is the problem of the product life-cycle. Abernathy & Utterbach (1978, Utterbach 1994) argue that, when a new industrial sector is created, the first phase involves a high rate of product innovation, the second phase a high rate of process innovation, and the third phase a relatively low rate of both. Except for Utterbach's work, no long-term historical studies of the evolution of industrial sectors across time have been conducted. There is a need for further work in this area.

THE INPUT OF A PERFORMANCE GAP Any review of a topic should be quite explicit about issues that were once important and have not necessarily been pursued. In the context of innovation research, probably the most critical omission is the process approach. In the early work (Hage & Aiken 1970, Zaltman

et al 1973), considerable attention was devoted to the problem of naming the stages in the process of change and sometimes to identifying the various problems associated with each stage (in particular, see Hage 1980). Much of this work has proved to be a dead end, perhaps in part because there have been few process studies.

However, one critical idea from this early work has remained and is worth emphasizing; that is the notion of a performance gap (Zaltman et al 1973) as the triggering mechanism for the introduction of innovation and particularly of radical change, including the transformation of the organizational form from one steady state such as mechanical to another such as mixed mechanical-organic. The Minnesota studies (Van de Ven Angle & Poole 1989), which are probably the single most important collective effort focusing on innovation today, have a large quantity of data demonstrating the role of crises in moving organizations to adopt radical innovations. Furthermore, this finding has also been substantiated in developing countries (Hage & Finsterbusch 1987).

The concept of a performance gap is especially interesting because it connects back to the ambiguities of the meaning of a high-risk strategy. The potential connection is clear: If individuals set very high standards, or high goals, they will perceive a large performance gap, which will lead them to adopt a high-risk strategy in order to close it.

Examining Feedbacks

Most of the literature on organizational innovation has concentrated on the causes of innovation but has not considered the feedbacks. Yet, we witness the beginning of some interesting work in this area, although it has not been connected closely to the study of innovation. A wide variety of potential feedbacks could be considered. Only three can be touched upon in this review: (*a*) the complexity of the division of labor and thus the organization; (*b*) the nature of competition; and (*c*) the survival of specific firms. Together they provide an evolutionary perspective, especially in knowledge societies.

ON THE COMPLEXITY OF THE DIVISION OF LABOR One crucial kind of feedback is the impact of innovation on the complexity of the division of labor. What little evidence exists suggest that, rather than deskilling, there has been a shift to upgrade the skills and training of the labor forces in which innovation occurs. Dewar & Hage (1978) found that across a six-year period innovation did lead to the hiring of new occupations in the rehabilitation sector. A more dramatic illustration, in a study (Collins 1997) of a number of manufacturing plants, is the consequence of adding flexible manufacturing. This study found that both radical process and radical product innovation resulted in a considerable change in the composition of the labor force. Although the employee numbers

remained about the same, the proportion of technical, professional, and managerial personnel increased. In other words, one critical feedback was the reduction in the number of unskilled and semi-skilled employees and their replacement with those who were more educated. Pianta (1998:82) found parallel results in a study of the impact of innovation on employment in Italian service sectors. More generally his research shows a decline in employment across many industrial sectors associated with improvements with productivity in Europe, the USA, and Japan, the implication being that this is because of radical new process technologies.

ON THE KIND OF COMPETITION Another important kind of feedback is on the nature of competition. Tushman & Andersen (1986) have made a distinction between technologies that enhance capacities and those that destroy capabilities—where destroy means primarily the elimination of a number of firms—a needed refinement when assessing radical technologies and their impact. The successful organizations are likely to do the former, while new organizations are likely to introduce radical process innovations that destroy capabilities. The authors also demonstrate that the number of organizations declines when these radical process innovations are introduced. The beauty of their work is that it calls attention to the problem of discontinuities, a perspective that I believe is particular relevant for understanding postindustrial society (Bell 1973, Hage & Powers 1992) or knowledge societies.

ON SURVIVAL Still a different way of posing the same question is to ask about the survival of particular companies. Given the argument in the introduction that firms must innovate to survive, one might ask two questions concerning this. Is it the case that plants and therefore firms that emphasize innovation are more likely to survive? And do those that survive have a complex division of labor and an organic structure as well as flexible manufacturing (characteristics suggested above as needed for success in competition for innovation)? In Hage et al (1993), 97 plants, including most of the major industrial sectors in the economy, were studied across 15 years, that is from 1973 to 1987. About 40% of the plants had closed during this period, indicating that many American businesses were unable to adjust to global competition.

An event history analysis demonstrated that the plants that survived longer were significantly more likely to have a diverse set of professional and scientific personnel (the number of managers did not make a difference) or a complex division of labor, to have invested more in flexible manufacturing, to be decentralized, to have fewer rules and procedures or be less bureaucratic, and to be located in industries that were research intensive. Controlling for industrial growth or market concentration ratio had no effect on these findings; in other words they were not a function of either product life cycle or monopoly

control. Perhaps the most interesting finding was that the amount of money spent on research *by the entire industry* also led to a higher survival rate net of other factors. This documents the importance of both spill-over effects, a hot topic in economics (Romer 1986, Solow 1992) and the importance of the research department for absorptive capacity (Cohen & Levinthal 1990). But it is making an additional point, namely the collective benefits of individual firm investments in research. This suggests a win-win game.

New Areas for Research

INTERORGANIZATIONAL RELATIONSHIPS All of the above research has focused on comparisons of organizations. Little research has occurred on whether or not the same ideas can be applied to joint ventures and interorganizational networks. Given the size of this expanding literature on joint ventures and interorganizational networks (for reviews see Alter & Hage 1993, Beamish & Killing 1997, Gomes-Casseres 1996, Jarillo 1993, Nohria & Eccles 1992, Powell 1990), it is surprising that few studies have been conducted on how successful these interorganization arrangements are for increasing innovation. Admittedly not all such arrangements are designed to maximize innovation, though most of them do involve at minimum the desire for access to new skills and areas of expertise, that is, concern for expanding the complexity of the division of labor (Badaracco 1991, Killing 1988). But in addition many joint ventures have set innovation as one of their objectives (Alter & Hage 1993, Contractor & Lorange 1988, Häkansson 1990, Hladik 1988, Laage-Hellman 1989).

Furthermore, more complex forms than joint ventures, such as consortia (Aldrich & Sasaki 1995) and strategic alliances (Gomes-Casseres 1996) are designed to generate innovations for an entire industry or to impose a new global standard. So far there has been only one study of the innovative effectiveness (for SEMATECH, Browning et al 1995) in a consortium. Yet, these new organizational forms represent ways of increasing the national competitiveness of the nation, and they deserve greater attention.

Kitson & Michie (1998) in a study of small businesses in the United Kingdom found that both fast growth firms and innovative firms were more likely to collaborate. The most typical reasons provided were gaining expertise of one kind or another. Both innovators and collaborators were more likely to have growth in profit margins than the non-innovative and non-collaborative firms. Unfortunately the fruits of collaboration relative to innovation were not directly measured, at least as reported in this study.

Another study (Oerlemans et al 1998), although not directly focused on joint ventures as such, was able to demonstrate that inter-organizational network variables contributed to the amount of innovation in a quite diverse sam-

ple of about 600 small firms in the Netherlands. The variables considered included interactions with trade organizations, national centers of applied research, consultants, important buyers and/or suppliers, chambers of commerce, and regional innovation centers. This study is important because it destroys the notion of the organization creating innovations on its own and has a much broader view of what they call the organization set than just joint ventures or collaborators along the supply chain.

These new forms can be easily incorporated within the basic framework of an organic structure, strategy of high risk, and a complex division of labor for stimulating innovation. Both Killing (1988) and Alter & Hage (1993) provide examples of how these concepts can be applied. However, neither of these studies actually examined comparatively the rates of innovation.

In research on the impact of the complexity of the division of labor, the organic nature of the interorganizational network, and the high-risk strategy, special attention should be paid to whether more radical innovations are developed in shorter periods of time. Actually, an argument made in the literature is that interorganizational networks appear to have these advantages (Gomes-Casseres 1996, Schoenberger 1994, Smith et al 1992, Stalk & Hout 1990), but this remains to be tested.

INTEGRATING THE MESO AND THE MACRO LEVELS OF ANALYSIS One major objective of this review is to begin to link the macro institutional levels in society (Maurice et al 1986, Whitley 1992) with the meso analysis of organizational innovation by stipulating that the way in which knowledge is channelled affects the relative importance of specific indicators (for one model, see Walton 1987). The six indicators of complexity—specialization, departmentalization, professionalization, the technical knowledge involved in the training or education, the complexity of the job, and the presence or absence of a research department—reflect the alternative ways in which knowledge is "packaged." Thus, in the United States specialization and professionalism among managers and professionals are important, whereas in Europe the level of technical training and the scope of the job are more likely to be critical. This idea has been suggested in the "societal effects" approach to organizational analysis (Maurice 1978, 1995, Maurice Sellier & Silvestre 1986, Maurice et al 1980, Sorge 1996), which has emphasized the impact of education and values on the way in which the division of labor is structured in firms.

The same logic can be used to examine how research is institutionally arranged, which is the point of another important and relevant literature in economics (Nelson 1993, Lundvall 1992). Both the United States and Germany had pioneering companies that had industrial research laboratories. The close connection between research and education in both countries facilitated the early development of industrial laboratories (Mowry & Rosenberg 1993), a

pattern largely absent in Japan. In contrast, the separation of research and higher education in France has slowed down certain forms of innovations.

The previous two perspectives stress the importance of the institutional embeddedness of the organization and how that shapes its internal characteristics. Another perspective, and one consistent with the previous arguments about examining the feedbacks of radical innovations, provides quite a different view. Two issues can be briefly considered: employment and institutional change.

The feedback of radical innovations on employment is quite mixed, as Pianta (1998) observes. On the one hand, radical process innovations reduce employment, as we have already observed. On the other hand, radical product innovations increase employment. Furthermore, these results are complicated by the relative speed of the introduction of the new products and processes. Countries which are the first to introduce even radical process innovations do not necessarily suffer losses in employment (Lazonick 1998). Some countries invest too late and reap few advantages from innovation (Valéry 1999). The reasons why are to be found in the nature of their institutional environment, which then relates back to the literature on the national systems of innovation (Lundvall 1992, Nelson 1993). This process is leading to specialization by nation in the areas in which they have comparative advantage (Porter 1990) but it is being driven by the innovation process and the relative speed with which it occurs.

Perhaps the most interesting and unexplored, at least in sociology, impact of radical innovations is their consequences for institutional change. The emergence of inter-organizational joint ventures and research consortia is perhaps the most dramatic illustration but it is not the only one. Consider the development of computer and softwear companies and how this has led to the creation of computer science departments, the resulting explosion in their enrollments, and the proliferation of new avenues of research. Furthermore, the computer and its software represents not only a whole new industrial sector in which there are many small firms but a considerable range of service companies—repair and maintenance, retailing, and training. One of the reasons as to why advanced industrial economies are really service economies is because of the proliferation of services relative to all of the various radical new products and processes being introduced. Any theory of organizational evolution should consider this feedback process on the institutional environment as part of its explanatory framework.

Finally, another promising direction for future research is to integrate organizational innovation with economic theories of growth, especially the new literature on endogenous patterns of economic growth (Romer 1986, Solow 1992). At several points, I have suggested how the theory of organizational innovation provides new insights into economic growth. Complexity as a measure of the diversity of human capital (Becker 1964, Schultz 1961) is a much

more accurate way of estimating the effects of education on economic growth (Hage & Garnier 1993). The Hull (1988) study indicates how the way in which research is organized partially explains the multiplier effect associated with technical progress. This suggests that the input-output form of thinking involved in Cobb-Douglass equations should include variables for complexity and the organic structure as a way of developing a more accurate explanation for economic growth. Finally, once one builds in feedbacks, especially the major parameters used in economic growth theory, a more complex socioeconomic theory of economic growth becomes possible (for one attempt to do so, see Hage 1998).

AN OVERVIEW OF ORGANIZATIONAL CHANGE

The third objective of this review is to unite the general organizational literature on change with the studies of organizational innovation. This is less obvious than it might appear because the major perspectives—structural contingency theory, political theory, organizational ecology theory, and meso institutional theory—generally have not focused on the problem of organizational innovation per se. Nevertheless, they can be related by recognizing that in various ways their focus on environmental change can force or influence the choice of organizational form, whether mechanical or organic (Burns & Stalker 1961), which in turn can be linked to the relative emphasis on innovation.

This connection between the choice of form and the theory of organizational change can be made because each paradigm or perspective (Astley & Van de Ven 1983, Hage 1980)—structural contingency (Blau 1973, Blau & Schoenherr 1971, Hage 1980, Lawrence & Lorsch 1967, Perrow 1967); political (Hickson et al 1971, Hinings et al 1974, Pfeffer 1981, Pfeffer & Salancik 1974); organizational ecology (Baum 1996, Carroll 1987, Hannan & Freeman 1989, Hannan & Carroll 1992, Singh et al 1986) and meso institutional theory (DiMaggio & Powell 1983, Meyer & Rowan 1977, Powell & DiMaggio 1991, Scott 1987, Zucker 1987)— rests on a more or less explicit view of the environment. Given changes in the environment one or another form becomes favored for selection. In other words, does environmental change lead to changes in the nature of organizational form and especially the movement toward (or away from) an organic form with an emphasis on organizational innovation? As these connections are made, implicitly a number of new areas of research on innovation are suggested.

Structural Contingency Theory

The original insight of Burns & Stalker (1961) was that a stable demand led to the mechanical organization, whereas a changing demand created the need for

an organic organization with its emphasis on innovation and flexibility. Hence the name structural contingency. Though not recognized for it, Lawrence & Lorsch (1967) were the ones who provided an evolutionary theory of increasing knowledge and its impact on these choices, suggesting that movement toward the organic form took place as departments of product development, applied research, and then basic research were being added to the structure of the organization. Building upon their work and that of Bell (1973) and others, Hage & Powers (1992) argue that more and more economic and political sectors must now emphasize either the organic model or interorganizational networks (Jarillo 1993, Nohria & Eccles 1992, Contractor & Lorange, 1988). The study of Hage et al (1993) provides empirical evidence for this set of ideas. These same ideas about evolution and knowledge societies can also be applied and tested with more complex forms such as interorganizational networks (Alter & Hage 1993, Contractor & Lorange 1988, Powell 1990) as discussed above. However, as yet, the contingencies that explain why one particular form of interorganizational network is better for which kind of innovation and in which institutional or societal context have not been developed.

In the previous section, it was suggested that it was worthwhile to examine the feedback effects on the complexity of the division of labor. As this increases, at some point the Lawrence & Lorsch (1967) solutions for integration break down. Firms (and government agencies) must split into either separate firms or "deconstruct" into profit centers, two processes occurring very frequently now (Hage & Powers 1992). How competencies, and more importantly their integration, impact on the boundaries of the organization (Foss 1999) lies at the heart of an evolutionary theory of the firm. Again, part of the answer to this problem lies in the institutional "packing" of knowledge that has already been discussed.

Political Theory

Political theory emerged in opposition to structural contingency theory and its implicit assumption that managers will also adjust to meet environment demands in ways that are appropriate for them. The central premise is that those departments or occupations (Hickson et al 1971, Hinings et al 1974) that handle the major contingency facing the organizations will become the dominant coalition. Pfeffer (1981) has indicated a number of ways in which the dominant coalition, once in power, can remain even if the basic contingencies for the organization change, thus offering an explanation for why some firms do not respond to environment change.

However, leaving aside which occurs first—changes in the major contingency or changes in the dominant coalition—shifts in the latter usually mean changes in strategy either toward or away from innovation. Therefore, the po-

litical model can be easily integrated with the findings on the importance of a high risk-strategy, usually a distinctive prerogative of this dominant coalition.

Another version is resource dependency theory (Pfeffer & Salancik 1974, 1978), which argues that the dominant coalition is beholden to those who control the purse strings of the organization. If they want innovation, it will occur. Again, changes in resource dependency generally have not been studied for their impact on innovation, though this has become a current concern with the shifting of welfare financing to state governments. Will this produce more reform, as has been argued?

Organizational Ecology Theory

An excellent review of the studies that have been done on organizational change within this perspective is to be found in Baum (1996). Baum's central insight is that the bulk of the organizational ecology approach has emphasized the selection of organizational form (for examples, see Hannan & Freeman 1984, 1989, Hannan & Carroll 1992, Singh et al 1986). The study of Hage et al (1993) provides a good example of how the mechanical form is being eliminated in the United States because of its inability to be flexible and its lack of innovation, while the organic form is being selected. In addition, there is now a renewed appreciation in this literature for trying to specificity the circumstances when adaptation occurs and when selection occurs. As yet, however, little attention has been paid to either the organic structure, the complexity of the division of labor, or innovation rates. In other words, in the debate about inertia versus adaptiveness (Hannan & Freeman 1984, Baum 1996), organizational ecologists have not considered whether a generic form such as a complex division of labor combined with an organic structure is adaptive.

But regardless of the relative absence of research on this topic, at the population level (Carroll 1987, Hannan & Freeman 1989, Baum 1996) adaptiveness can occur via the creation of a new specific form that allows for the population of organizations to adapt to new competitive circumstances such as globalization. Illustrations are research institutes in bio-medical research at the turn of the century, mini-mills in the steel industry, half-way homes in the rehabilitation service sector, the Italian network during the 1970s in textiles, luggage, and machine tools (Lazonick 1998, Piore & Sabel 1984), the commodity chain à la Nike in shoes, etc. These kinds of adaptation are especially interesting because they reflect radical innovations in the nature of the organization, a topic that has not been researched in the organizational literature on innovation. Furthermore, there is some indication in the literature that quite radical product and process innovations frequently have to have a new form. Again, we have another topic deserving of attention, not the least because of its implications for organizational evolution.

Although one would normally assume that organizational ecology would be primarily interested in the evolution of organizational forms across time, there has been surprisingly little research on this, with Aldrich & Mueller (1982) as a major exception. In their work the latter have focused on the evolution of the multidivisional form.

Institutional Theory

In the iron cage theory DiMaggio & Powell (1983) indicate the different ways in which organizational forms are adopted within a country. More recently, they (Powell & DiMaggio 1991) have stressed the importance of professional associations, foundations, and socialization agents as sources of change in organizational form. Again, none of this literature has been related to organic structure and the problem of rates of innovation. In a very different perspective, Ramirez & Boli (1987) demonstrated the role of military and societal failure as a motivation for adopting a similar form of primary school. Here lie the beginnings of a basic theory about institutional failure and change. Currently, a number of European countries are lamenting their lack of small high tech companies and are looking for institutional mechanisms to stimulate their growth.

The ideas about selection and adaptation can easily be combined with the political theory and with the structural contingency theory. Political theory would explain why some organizations do not adapt and thus are rejected. It can also explain how under certain circumstances, such as the emergence of a new elite, a new and more adaptive form might be created. Structural contingency theory offers insights as to which forms are most appropiate for what kinds of environments and the dynamics of competition. Structural contingency theory also makes clear how failures in evolution can occur when not all parts of the structure are compatible. Finally, institutional theory can explain how diffusion occurs within countries and even across them. It provides a different set of explanations for why countries may not respond to competitive pressures.

CONCLUSIONS

Across the last quarter century three basic ideas united much of the research (see list of studies in Hage 1980, Damanpour 1991, and Zammuto & O'Connor 1992). A complex division of labor, an organic structure, and a high-risk strategy together account for the varying rates of innovation across the organizations that have been studied. However, in this research there has been a tendency to neglect the inputs of research expenditures, feedback, and macro-institutional levels of analysis.

This literature can easily be extended in a number of directions. I have stressed three possibilities: the application of these ideas to the study of organizational relations, the integration with intitutional analysis, and the study of organizational change. Throughout the discussion two critical concepts can integrate a number of the ideas for future research that have been discussed—organizational evolution and feedbacks. There has been too much emphasis on the causes of organizational innovation and not enough attention to the consequences. We need to think "backwards!"If this were to be done, the different perspectives would then be integrated into a general theory of organizations.

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