IV. INNOVATION

A. Management Theory on Improving Organizations' Capacity to Innovate

Tim Craig, Achieving Innovation Through Bureaucracy: Lessons from the Japanese Brewing Industry, 38 California Management Review 8 (Fall 1995)

In case study of Japanese brewing industry, author argues that, when shifts in the market altered the structure of demand for beer, firms adapted not by eliminating the bureaucratic methods that had left them out of touch with the market, but by adapting bureaucracy to foster innovation. He points out that the development of new products required inputs such as technical know-how, consumer information, and creative ideas, as well as systems for combining them into a launchable product. Bureaucratic controls were effective in these firms for overcoming deep-rooted organizational conditions and inertia that hindered product development. On the input generation side, firms implemented systematic customer surveys and monitoring systems, a cross-functional "market watching" group, regular meetings between product developers and salespeople, and increased staffing diversity. To combine inputs more effectively, they set more specific rules and guidelines to systematize the product development process, fostered cross-functional product development teams, and introduced a new evaluation system, of which a hallmark was that people were rewarded for success but not penalized for taking risks that led to failure. Author notes that many researchers call for flexible process in order to free creativity, that discipline in transforming ideas into a marketable product may be as important as novelty. Innovation cannot be standardized, but there is a place for a standardized framework that ensures that product development is not haphazard, or at least that the firm takes advantage of haphazard events purposefully.

Deborah Dougherty & Cynthia Hardy, Sustained Product Innovation in Large, Mature Organizations: Overcoming Innovation-to-Organization Problems, 39 Academy of Management Journal 1120 (October 1996)

Qualitative interview study of innovators of new products at large, well-established firms sought to explain obstacles to sustained innovation at mature organizations. Existing literature suggests that mature organizations must make three types of innovation-to-organization connections: (1) making resources available for new products; (2) providing collaborative structures and processes to solve problems creatively and connect the innovations to existing businesses; and (3) incorporate innovation into the organization's strategy. Authors argue that innovation in mature organizations tends to suffer as resources are not made available systematically—innovators had to call on acquaintances or use their positions to "beg, borrow, or steal" materials to innovate. Structures and processes tended not to provide for collaborative processes across departments, or at different levels of hierarchy—decision making did not flow upwards or sideways, and did not relate evaluation criteria to innovation. Furthermore, firm strategic planners generally did not see innovation as a legitimate part of individuals' responsibilities—at best, interest in innovation did not survive changes in senior management; moreover, lower-level innovators did not have access to strategic planning sessions. In short, innovation occurred in spite of organization's structures, not because of them. Innovators worked their networks, using personal connections and the

authority of their positions to access the resources they needed; moreover, newcomers with few established connections had very limited access to these opportunities.

Philipp Genschel, The Dynamics of Inertia: Institutional Persistence and Change in Telecommunications and Health Care, 10 Governance 43 (January 1997)

Author uses case studies of international telecommunications and German health care to develop a theory about the potential of institutions for adapting to change. First, he identifies three causes of institutional persistence: sunk costs—institutions have karge set-up costs in terms of teaching actors rules, codes, skills, etc.; uncertainty—institutions are known by experience, so it is often difficult even to conceive of alternatives; and political conflict—institutions frequently have a distributive bias, so that actors who want change must overpower or buy off the beneficiaries of the status quo. He argues first that creative destruction—the decision to abandon the institution and replace it with an alternative structure—is extremely costly for the reasons described above.

However, he uses the case studies to illustrate two other types of change that are more feasible in institutions. As the telecommunications system became more international, and proved too complex for the existing institution to manage, the international regime adapted not by changing the mode of operation but by setting up a new structure to relieve part of the burden. Genschel calls this <u>patching up</u>—supplementing institutions with new organizations which cover up their weak spots. Patching up avoids disrupting internal structures in which there are sunk costs, reduces uncertainty by keeping most of the original institution's accomplishments safely within the old structure, and reduces political conflict, both by circumventing those who benefit from the status quo, and by avoiding a direct challenge to the original institution's political foundations.

The German health care case illustrates the value of <u>transpositions</u> in institutional change making. The Central Committee, an institution initially created to resolve disputes related to physicians' collective bargaining agreement, but in successive guises, it wrote regulations for resolving other conflicts, and gave technical guidance on the expansion of health care benefits. This process of transposition was characterized by backward looking and improvisation, as people identified ways in which an existing institution could be used to tackle a new problem. Authority was given by analogy—the institution was seen as capable of giving technical guidance on one issue because the task could be likened to another task it was already performing. Transposition can exist despite the three problems described above because it reuses sunk costs for a new purpose, allows people to face uncertainty over whether a problem is tractable without also having to worry about the quality and reliability of the institution, and tends to depoliticize new problems by placing them in the hands of an institution that has already achieved legitimacy.

Nile W. Hatch & David C. Mowery, Process Innovation and Learning by Doing in Semiconductor Manufacturing, 44 Management Science 1461 (November 1988, Part 1)

Authors offer a theory of the relationship between process innovation and learning by doing within the semiconductor industry. They consider two main issues: the factors affecting superior performance in the introduction of new manufacturing processes, and the factors that influence the rate of improvement. They show that the

learning curve is associated with deliberate activities intended to improve yield and reduce costs—i.e., engineering analysis of production volume. Learning, then is subject to managerial discretion over resources. Therefore, new processes, once in manufacturing, slow learning on existing processes because they draw away engineering resources to debug the new processes.

Rebecca Henderson, Managing Innovation in the Information Age, Harvard Business Review 100 (January-February 1994)

Three-year study of drug discovery in pharmaceutical company sought to identify characteristics of companies that were the most productive innovators. Author identifies three factors critical to the successful management of technological innovation. First, successful innovators keep connected to the scientific and medical community. These companies encourage their employees to publish in scientific journals and attend conferences. Author cautions that successful companies also ensure balance between reaching out for scientific knowledge and linking the knowledge to the firm's goals—the production of useful drugs. Second, successful companies allocate resources effectively, either placing the allocation in the hands of a widely read and scientifically knowledgeable individual who can think across department boundaries, or using a high-conflict committee process in which scientists confront one another over research needs, so that departments understand one another's research and exchange information freely. One key to resource allocation is ensuring that enough information flows to allow the firm to benefit from cross-fertilization of ideas. Third, successful companies manage tension between organizing by product and organizing function. These companies recognized that they could not simply focus on functional expertise at the expense of understanding the customer experience, but at the same time they could not afford to lose the functional expertise while trying to comprehend the whole product. These companies seem to try not to be satisfied with a single answer, and expend organizational energy to ensure that neither the functional nor the product focus becomes too dominant.

Marco Iansiti, Shooting the Rapids: Managing Product Development in Turbulent Environments, 38 California Management Review 37 (Fall 1995)

Four-year study of technology development in mainframes and supercomputers leads author to observe that this industry is defined by enormous levels of technical and market uncertainty, and to identify some of the drivers of product development in turbulent environments. Empirical analysis of 27 projects supports the hypothesis that firms develop products faster in a turbulent environment if their development process is "flexible." Flexible product development processes are characterized by overlapping concept development and implementation phases, rapid reaction to newly discovered information rather than rapid completion of development phases, and emphasis of the concept development stage. During concept development, firms define a road map for the project, identifying key technical problems and areas of likely technical change, and partitioning the tasks so that there are tight problem-solving loops around the most critical interactions between design choice and system performance. Author argues that traditional product development models are problematic in turbulent environments because firms that complete concept development and then move on to a distinct

implementation phase are unable to adapt that concept when technological change or new information leads it to identify fundamental flaws in the product as planned.

Andrew C. Inkpen, Creating Knowledge through Collaboration, 39 California Management Review 123 (Fall 1996)

Sample of 40 American-Japanese joint ventures, combined with five detailed case studies, seeks to determine whether alliance parents recognize and exploit alliance learning opportunities, and to discover what organizational conditions facilitate effective learning. Author identifies four knowledge management processes used to access and transform knowledge. First, firms put in place mechanisms for technology sharing; these include meetings between joint venture and parent managers, parent firms visiting one another's facilities, and formal technology agreements. Second, firms relied on joint venture/parent interactions, with visits to joint venture facilities, and development of "communities of practice"—groups of individuals who crossed organizational boundaries and who became insiders to the joint venture through their interest in the strategic benefits of the collaboration. Third, personnel rotate between the alliance and the parent in order to mobilize their personal knowledge. Fourth, when parent firms view the alliance as central to their strategy, they devote resources to managing the collaboration, making the alliance something closer to a fully integrated division of the parent. Author also identifies the most important predictors that firms will indeed seek to leverage alliance knowledge. These include willingness to treat learning objectives flexibly if the alliances does not lead to expected knowledge, top management commitment to extracting and managing knowledge, a sufficient climate of trust between the alliance and the parent to permit the free exchange of information, tolerance for the redundancy that must come with complex dialogue, management's adeptness at invoking or manipulate chaos towards creative ends, and avoidance of the "performance myopia" – the narrow focus on the bottom line that prevents firms from learning from poor performance.

William Q. Judge, Gerald E. Fryxell & Robert S. Dooley, The New Task of R&D Management: Creating Goal-Directed Communities for Innovation, 39 California Management Review 72 (Spring 1997)

Semi-structured interview study of eight biotech firms seeks to explain what kind of workplace culture is conducive to creativity and how managers can create and maintain an innovative culture. Authors find, first, that balance between operational autonomy of researchers and strategic autonomy of managers—in other words, managers set goals but researchers decide how to achieve them—is key to innovation. Second, R&D units are more innovative when the firm emphasizes personalized, intrinsic rewards (those that were related to the work and elicited feelings of accomplishment, such as peer and supervisor recognition, meaningful work opportunities) as opposed to extrinsic (bonuses, stock options). Third, innovative units have managers who integrate the sociotechnical system—focusing both on recruiting and managing cohesiveness and on the group's progress towards scientific innovation. Fourth, innovative units avoid discontinuities in slack—scientists in less innovative organizations complained that they were not sure whether they would be able to count on enough resources for their work.

Linsu Kim, The Dynamics of Samsung's Technological Learning in Semiconductors, 39 California Management Review 86 (Spring 1997)

Study of Samsung's rapid development as a major player in the semiconductor market seeks to understand how the firm could acquire technological capability rapidly and what role institutions have played in its technological learning. Author draws a series of implications from the Samsung case. First, informal mechanisms can facilitate technology transfer; Samsung did rely on formal licensing agreements, but also learned from informal mechanisms such as literature, observation tours, sample products, and mobile personnel. Second, it is difficult for firms to restrict technology's outflow; when one source would not cooperate, Samsung was generally able to find alternative sources with similar technologies. Third, effective technology transfer depends on the transferee's tacit knowledge; Samsung was able to assimilate new technologies quickly with the help of scientists whose tacit knowledge base enabled them to see how to adapt the technologies quickly. Fourth, mastery of technology at one stage is a platform for mastery at the next; tacit knowledge at earlier stages enabled Samsung scientists to make sense of new technologies as they arrived. Finally, author highlights prior knowledge base and intensity of effort as the two most important elements in absorptive capacity. Samsung relied on crisis creation to intensify its efforts, though author warns that crisis creation may be more useful for companies playing catch-up than pioneers; pioneers must work with strategic ambiguity and few sources of external knowledge, so that it is unclear that crisis mentality will lead to expeditious learning.

Charlan Jeanne Nemeth, Managing Innovation: When Less is More, 40 California Management Review 59 (Fall 1997)

Article points to research showing the formidable pressures employees of firms face towards conformity, and argues that firms must welcome dissent if they hope to encourage innovation. She argues that firms tend to try to promote strong cohesion and "ingroup" tendencies, but that psychological research suggest that falling into patterns of problem solving and adopting premises unreflectively is detrimental to the creative process. She notes that firms have attempted to overcome some of the inhibitions that make employees reluctant to engage in creative dissent by putting in place mechanisms such as placing an R&D department overseas (limiting the extent to which its processes receive oversight from top management), consciously recruiting teams for heterogeneity, and recognizing employees for "stealing" others' ideas and using them in a new context. Research on creativity suggests that creative people need independence and opportunities for play, and prefer complexity to simplicity, attributes. These attributes suggest that creative people are unlikely to be drawn to corporate environments that do not protect their ability to dissent and view problems differently from other workers.

Anurag Sharma, Central Dilemmas of Managing Innovation in Large Firms, 41 California Management Review 146 (Spring 1999)

Article argues that large firms face special dilemmas in transforming ideas into viable businesses, in navigating creative ideas through the bureaucratic maze. While many researchers have argued that large firms should learn from small entrepreneurial firms, author questions the extent to which they can imitate a work environment a fraction of their size, and notes that most entrepreneurial start-ups collapse under internal

chaos or external pressure. More specifically, author presents illustrations from field research of five key dilemmas that large firms face at different stages of innovation. First, the "Seeds versus Weeds" dilemma—large firms tend to have an overabundance of innovative ideas, so that they struggle to find mechanisms to sort out the ideas with real potential and avoid draining core resources on risky projects. The dilemma is heightened by the fact that significant initial investment may be necessary simply to build proposals to the point at which the can be evaluated. Second, the "Experience versus Initiative" dilemma—when they decide to take on a new venture, firms must often choose between enthusiastic but inexperienced innovators, and credible but risk-averse senior executives. Third, in the "Internal versus External Staffing" dilemma, transferred internal personnel are likely to bring ongoing social relationships and knowledge of organizational culture, but are also more likely than external hires to be comfortable with existing routines and unable to think outside the box. Fourth, in "Building Capabilities versus Collaborating," firms must choose whether to collaborate with someone outside the firm—the collaborator can share costs, bring immediate relevant expertise, and send a market signal about the project's worth, but collaboration also brings struggles over allocating contributions and benefits, and may create dependencies on the other firm for critical inputs. Fifth, the "Incremental versus Pre-emptive Launch (or Entry)" dilemma—a small-scale launch reduces risk to capital, but also limits the volume available for multi-year contracts, may undermine the product's credibility, and opens the door to competition.

Author offers three concepts to guide large firms addressing innovation dilemmas. First, firms can set up the overall context with a strategic envelope—defining the range of acceptable projects gives direction o initiatives and enables even failed projects to contribute to the firm's base of knowledge. Second, strategic pacing of innovations allows managers to separate dilemmas temporally so they are easier to manage. Finally, strategic partnering—forging links with important departments within the firm and forming partnerships with outside parties that span several projects—allows managers to leverage important capabilities.

Eric von Hippel, "Sticky Information" and the Locus of Problem Solving: Implications for Innovation, 40 Management Science 429 (April 1994)

Author discusses the implications for innovation of "sticky information"—technical information that is costly to acquire, transfer, and use in a new location. Specific designs and practices, as opposed to generic knowledge, tends to be costly to transfer because generic knowledge is generally associated with a body of professionals who know it systematically. Information may be sticky because a large amount of information is called for—e.g., a new type of laser. Stickiness can be high if organizations must acquire related information or skills in order to use the new information. Finally, stickiness can vary by traits of the transmitters and receivers—technological gatekeepers or an organized structure such as a transfer group can alter costs, as can the pricing decisions of the proprietor.

Citing existing research, author identifies four implication of the sticky information problem. First, innovation-related problem solving activities will tend to move to the locus of sticky information. Second, when there is more than one locus of sticky information, the locus of problem solving will tend to iterate among the sticky

information sites. Because problem solving is a trial and error process, people will tend to move back and forth searching for the site with the closest information fit. Third, when costs of iteration are high, problem-solving will be "task partitioned" into subproblems that draw from one site. Fourth, high iteration costs may also lead to investment in reducing the stickiness of the information.

B. Empirical Studies: Who Innovates? Who sustains innovations?

Marlene E. Burkhardt, Social Interaction Effects Following a Technological Change: A Longitudinal Investigation, 37 Academy of Management Journal 869 (August 1994)

Longitudinal study of local area computer network installation at a federal agency seeks to explain the role of social relationships in shaping attitudes and behaviors regarding new technology. Author tests, first, the social interaction hypothesis that variation in attitudes and behavior towards technology (e.g., sense of efficacy, frequency of use) would decrease over time, as people worked together to reduce uncertainty. Second, they predict that workers are influenced most by those with whom they interact most frequently—that the smaller the number of communication steps between two individuals, the greater the similarity in attitudes and behaviors towards technology. Third, because people in equivalent positions tend to interact with others in a similar way, authors expect that structurally equivalent individuals will develop similar technology attitudes and behaviors. Fourth, they distinguish between "high self-monitors" and "low self-monitors"—those who are more and less likely to adjust behaviors to situational cues. They expect that the first three hypotheses will hold true for the first group, but not the second.

Study relies on F-tests on ANOVA and QAP correlation of matrices representing the independent and dependent variables. They find mixed support for all four of the hypotheses. Variance in attitude towards computers and in self-efficacy does decrease significantly, though variation in hours of use does not. Does interaction over time does create significant similarity in computer self-efficacy, but not the other two measures. The structural equivalence hypothesis is supported for computer attitudes, and likewise the high self-monitor/low self-monitor distinction holds true for some of the measures. Changes in correlation over time suggest that individuals with similar attitudes may begin interacting with one another after the technology is adopted—discussions with agency staff also indicated that those who understood the computers became an informal leadership group after implementation.

Yingyi Qian & Chenggang Xu, Innovation and Bureaucracy Under Soft and Hard Budget Constraints, 65 Review of Economic Studies 151 (1998)

Economic analysis of the effect of soft and hard budget constraints on innovation in a bureaucracy is designed to explain differences in innovation between centralized and decentralized economies. Authors argue that, in centralized economies, where all projects are funded through the state, projects are subject to soft budget constraints—high-cost projects will not be terminated ex post. By contrast, in a decentralized economy, where projects are funded through many institutions, projects face hard budget constraints under which high-cost projects may be terminated ex post. Authors argue that

while the ex-post screening mechanism is valuable, the bureaucratic pre-screening mechanism can potentially screen out high-cost projects ex ante.

Authors then attempt to identify the conditions for effectiveness of bureaucratic pre-screening. They show that bureaucracy can work well where prior knowledge is good, but not when prior knowledge is bad. This is because both types of mechanisms can rely on high-quality signals from pre-screening when knowledge is good. Thus the aerospace industry, based on well understood physics principles, has done no worse in centralized economies, while the computer industry has suffered. Furthermore, the impact of the soft budget constraint is small when the start-up investment is relatively high, but very serious when the research-stage investment is low (again, aerospace vs. computers). This happens because the research-stage investment will often be too high even under a hard budget constraint.

This model also has implications for how different types of organizations deal with different kinds of innovations. Because large corporations have softer budget constraints than small firms, the theory suggests that large firms may rely more on bureaucratic pre-screening, and may do better in projects with fewer uncertainties. Small firms financed with venture capital may have a particular advantage for uncertain projects with poor prior knowledge.

Nitin Nohria & Ranjay Gulati, Is Slack Good or Bad for Innovation? 39 Academy of Management Journal 1245 (October 1996)

Study of subsidiaries of two major multinational corporations supports hypothesis of a curvilinear relationship between organizational slack and innovative accomplishments in policy, structure, method, product, or market opportunity (as perceived by the organization's managers). Authors argue that some slack promotes experimentation and pursuit of new projects, but that too much slack generates lax discipline in selection, support, and termination of projects.

Walter W. Powell, Kenneth Koput, & Laurel Smith-Doerr, Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology, 41 Administrative Science Quarterly 116 (March 1996)

Panel regression analysis of data from the biotechnology industry begins with the theory that when an industry faces a complex and expanding knowledge base and widely dispersed sources of expertise, the locus of innovation is found in "networks of learning," rather than in individual firms. Authors offer, and find support for several hypotheses about the behavior of firms in such industry. First, because firms learn from R&D experience how to recognize and structure synergies, authors predict that the greater the firm's number of R&D alliances and the greater its experience at managing R&D and other collaborations, the greater the number of non-R&D collaborations it subsequently pursues, and the more diverse its portfolio of ties becomes. Second, greater R&D alliance participation and collaboration management experience is associated with greater network centrality. Third, firms with greater centrality and more experience at managing ties grow more rapidly. Fourth, firms with greater centrality have a greater number of subsequent R&D collaborations. Authors explain that growth is a process that requires time, but growth of organizations is not programmed by age, but initiated by

collaboration, with centrality as an additional stimulus. Network position and collaboration have reciprocal influences on one another.

Susanne G. Scott & Reginald A. Bruce, Determinants of Innovative Behavior: A Path Model of Individual Innovation in the Workplace, 37 Academy of Management Journal 580 (June 1994)

Using survey data from a research and development subunit, authors test a path model of individual innovative behavior as the outcome of four interacting systems: the individual, the work group, the group leader, and the climate for innovation. Results generally supported hypotheses about supervisor and environment effects on innovation—both perception of a climate supportive to innovation and a leader who expects innovation are positively related to the subordinate's innovative behavior. The subordinate's perception of the quality of leader-member exchange (how positively group members perceived the relationship with their leaders) is positively related to both individual's innovative behavior and the degree to which she perceives the climate as supportive of innovation.

Authors did not find support for hypotheses that the quality of exchange between team members is positively associated with innovative behavior or perception of a climate that supports innovation. They also considered the effects of individual problem-solving style on innovation. They expected that an intuitive style would be positively related to innovative behavior because intuitive thinkers process information from different paradigms simultaneously, while systematic style would be negatively associated with innovation, because systematic thinkers tend to work within established methods, and so generate conventional solutions. They found support for the negative association with systematic thinking, but not the positive association with intuitive. They suggest that the study highlights the importance of the quality of the supervisor/subordinate relationship to innovation. They also speculate that perhaps task interdependence may be a mediating factor between team relations and innovation—i.e., that in this organization, member interaction was low, so the quality of the relationship wasn't a significant predictor of innovation.

James Wade, A Community-Level Analysis of Sources and Rates of Technological Variation in the Microprocessor Market, 39 Academy of Management Journal 1218 (October 1996)

Difference-in-means/event count study of merchant producers of microprocessors seeks to explain sources of technological variations in design within an industry. Author first considers the proliferation of new designs, arguing that new designs are more likely to be introduced by new entrants than by firms that have previously created an original design, because previous innovators will be reluctant to alienate customers, suppliers, and second sources (those who copy an existing design), and to deviate from designs that are technologically compatible with their current product. Difference in means analysis supports this hypothesis. Noting that the entry of a sponsor with a new design signals the birth of a new technological community, author next hypothesizes about the entry rate of sponsors. He predicts a curvilinear relationship between sponsor entry and the density of technological communities—when few alternatives exist, potential sponsors will initially be fearful to invest in an unproven technology; as the density gains legitimacy, potential

sponsors gain confidence, but as density rises still higher, gains from legitimizing the market are overwhelmed by competitors and the entry rate falls. He also hypothesizes that the greater the density of secondary sources supporting the existing communities, the lower the entry rate of new sponsors, because a large number of second sources implies that many customers are "locked in" to existing designs. Both of these hypotheses receive some support from his regression analyses.

A third set of hypotheses concerns dominant design. Dominant design theorists have argued that the emergence of one dominant design generates economies of scale and reduces uncertainty so that new sponsors are less likely to want to enter the market. However, author suggests a "resource partitioning" extension of this theory: that the emergence of economies of scale means that the dominant community will not want to cater to specialized interests, so that we might expect a dominant design to increase the entry of sponsors serving specialized niches. In fact, regression results do reveal a significant increase in entry of sponsors of specialized processors, and they do not support the dominant design theory.