Towards a new theory of innovation management: A case study comparing Canon, Inc. and Apple Computer, Inc.

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Abstract

This paper argues that innovation can be best understood as an information process which is then concretized as a product that meets demand. Two very different firms, Canon Inc. and Apple Computer Inc., are used as case study illustrations. Innovation does not proceed through logical deduction, but rather is furthered by the use of metaphors and analogies. The bureaucratic and staid structures of the firm can be challenged and broken up to provide the space for innovations to emerge. The leader’s role in the innovating firm is as a catalyst and facilitator, not as an all-knowing despot. The importance of innovations is not merely in the new product, but also the “ripple” effects of innovations which can propel the firm into a self-renewal process.

Keywords: Innovation management, High-technology, Case study.

1. Introduction

Increasingly, corporate competitive success is hinging upon the effective management of innovation. Innovation has been the object of considerable academic study from a variety of perspectives. However, innovations are usually considered as objects. We choose to look at innovation differently. For us, innovation is a process by which new information is created, and it is this information that is embodied in the product. To understand this process we conceptualize human beings not merely as information processors (Galbraith, 1973), but more importantly as information creators. Inherently, innovation is the process by which new information emerges and is concretized in a product that meets human needs\(^1\). The healthy firm is a negative-entropy system

\(^1\)For one of the most interesting treatments of the process by which the inventor or innovator imagines the new development, see Usher (1954).
which constantly creates new order and structure in its struggle to survive and grow.

2. Approaches to innovation

We break with the model posited by Simon (1969) and elaborated by Abernathy (1978) of innovation as problem-solving. In fact, most important in the innovation process is the problem creation moment. That is, the positing of the correct problem, which allows the solution to be discovered (information to be created). The key to the creation process is information. Information can be divided into two categories: syntactic and semantic (Machlup and Mansfield, 1983; Nonaka, 1987). Syntactic information can be reduced to a digital form which has no inherent meaning. This is exemplified by the discrete type of information used in computers and which can be manipulated through logical operation. The process of interpreting the results gives this type of information value and meaning. Semantic information is qualitative; what is important here is the meaning or content of the information. Semantic information is more holistic and capable of evolving and transforming. It is not created in the traditional deductive model hypothesized as the way Western science operates, but rather through insights which allow the creation of new models. The tools in this creation process are often metaphors and analogies (i.e., devices to help in rethinking or even discarding old ways of thinking).

Throughout this paper “information” refers to semantic rather than syntactic information. Thus, information creation is used synonymously with meaning creation. Product innovation can be considered as a restricted subset of this creation process. However, it would be a mistake to think that the meaning creation process either can be or should be restricted to product development; in a larger sense, the “culture” of the firm is semantic information. Informa-

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2This analogy, however, is not that of the Parsonian structural functionalism. See, for example, Parsons (1951). Rather, we are using chaos models, or what one might term “emergence” models, more in keeping with Prigogine (1980). See also Prigogine and Stengers (1984). For further discussion, see Nonaka (1988a).

3Artificial intelligence is the technique being applied to make the more routine aspects of interpretation amenable to machine control. See Daft and Weick (1984) for a discussion of organizations as interpretation systems.

4This type of information is in sharp contrast to that manipulated by traditional academic economists which is assumed to be based on so-called “hard” data. The real world of business is more often predicated on hunches, “gut” feelings and inarticulable experience.

5There is an increasing literature in the sociology and history of science which argues that the traditional deductive model of science does not describe the way science is actually done. See, for example, Latour and Woolgar (1979), and Rose and Rose (1976).
tion creation can and must go on at every level and in every part of the firm. For example, the development of new process innovations within quality control circles is an aspect of information creation. To remain competitive any firm must constantly be creating new strategies, new products, and new ways of manufacturing, distributing and selling. Constant reexamination, reconceptualization and reorganization are necessary—and this entails and requires the constant creation of new meanings.

The newly created information must then be diffused throughout the firm setting off further innovations. This diffusion within the firm is important because it allows the firm to reap more of the benefits of its newly created information. As Schumpeter observed, new innovations trigger other innovations in an effect that resembles the dropping of a stone in a still pond. If the company can internalize some of the resulting “ripples”, then it can secure greater economic benefits. It should also be noted that often the “ripple” effects that emerge cannot be predicted, but result in major economic advantage. Thus, the innovation process becomes a moment in the constant evolution and transformation of the firm.

Though different from that of Schoonhoven and Jelinek (1990, p. 107), we provide a model for conceptualizing the “output” of the “quasi-formal structure” of the firm. It is from this quasi-structure of teams, task forces and/or committees that new meaning (semantic information) emerges. The formal structure is devoted to transmitting syntactic information, necessary for operating the firm, but unable to create the new meanings necessary for growth and development. Hence, we find ourselves in agreement with Schoonhoven and Jelinek, but believe that the “ad hocracy” proposed by Burns and Stalker (1961) provides valuable insight into the operation of the quasi-formal structure.

In this paper we compare the product development process in two firms that have reputations for innovation. We will show how the information creation process operated and how that assisted in the self-renewal of the firms. The Japanese case study is the development of the Mini Copier by Canon. The U.S. case study is the development of the Macintosh Computer by Apple Computers. For each company these were crucial product developments. The discussion following the presentation of the cases will reflect upon the dynamics of the information creation process in both companies and the lessons for management. Further, we will discuss the advantages and disadvantages of the Canon and Apple methods of organizing and encouraging the creation process.

^In many American firms information creation is limited to the top executives and perhaps their strategic management group. They then transmit the new information down through middle-level managers who are seen as information channels and not information creators. This perspective of middle-level managers is critiqued in Nonaka (1988b). For another critique of this style of management, see Peters (1988).
3. Case study 1: The Canon Mini Copier—New product development and information creation

Canon was founded in 1933 with the aim of developing and manufacturing a 35 mm camera. After World War II the company once again began to manufacture cameras. Throughout the 1950s the company grew rapidly, developing a series of new single reflex cameras. By the early 1960s, however, it became evident that Canon would have to diversify into new areas to maintain its growth. Thus, in the 1960s Canon began to diversify into office machinery through the development of electronic calculators and copying machines. In the mid-1970s, though, Canon ran into severe difficulties as demand for existing products declined precipitously and Canon was forced to retreat from the low-priced calculator market. In 1975 Canon had to suspend its dividend payments—a radical step of a Japanese firm. In the words of the Canon Handbook (1987):

“Canon was experiencing a managerial crisis. Top management lacked coherence and direction; the company's inflexible corporate structure made it impossible to deal effectively with diversification, and insufficient attention had been paid to the rationalization of production. Or, as the new President, Ryusaburo Kaku has put it, ‘Canon was like a ship that constantly changes course and goes nowhere’.”

After a wrenching organizational restructuring Canon once again prospered, with an average annual growth rate of over 20% from 1975 to 1985. Canon was well-equipped to undertake difficult product development projects as it had accumulated a large and diverse technical staff of over 3,000 engineers, consisting of mechanical engineers (30%), electronics engineers (30%), physicists (17%), chemists (10%), and computer-related and other fields (13%). The electronics engineers had been hired in earlier relatively unsuccessful efforts to enter the synchro-reader and electronic calculator fields. The accumulation and interaction of personnel with these diverse technical capabilities provided an environment that induced the creative tension which is necessary to lead to synthesis and new information creation. To further

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7 The bulk of this section is based on intensive interviews by Ikujiro Nonaka with Canon Inc. personnel. Some of the information is available in the Canon Handbook (1987). For another discussion of the Canon case study, see Nonaka and Yamanouchi (1989).

8 An evidence of its successful technology development is the fact that in 1988 Canon filed more patents in the U.S. than any other company, Japanese or American.

9 On the seriousness of such a move, see Aoki (1989).

10 Canon does not separate technical personnel into departments according to discipline so there is much greater mixing of research personnel (for the importance of this method of organizing the innovation process, see Florida and Kenney (1990). This heightens the possibility of new concepts and ideas emerging serendipitously. For further discussion of Japanese strength in hybrid technologies, see, for example, Kodama (1988).
accelerate information creation Canon has had a policy of hiring mid-career personnel from other firms to create “counter-cultures” or diversity within Canon to increase the potential for new information creation.

In Fall 1970 Canon began internal development of a plain paper copier (PPC) technology. In the early days diversification into PPCs was opposed by many in the company, some going so far as to advocate discontinuation of the entire effort, recommending instead that Canon concentrate on its camera industry. But in 1969 Canon introduced a PPC that used completely original technology and did not violate any of Xerox’s over 600 patents. By 1982, however, demand for PPC was leveling off and office market saturation appeared to be complete. Rather than view the market as mature, though, Canon began a process of reconceptualizing the entire PPC market. Canon came to think of the copier market not in terms of firms (i.e., does the firm have a copier), but rather in terms of individual offices. With this new perspective the market appeared for larger. If small offices could use a copier, so might small businesses, and perhaps even home use would become prevalent. Further, large firms which had already purchased a PPC might also be interested in purchasing a desk-side model. Apparently, there would be an enormous market for a small copier.

A small copier (Mini Copier or MC) would require very different characteristics from traditional PPCs. Obviously, the copier must produce clear copies, and be lightweight and compact (less than 50 pounds). More problematic was that the MC might be used only rarely and thus the cost of regular servicing would be exorbitant on a per copy basis. Because of this, the MC must require either extremely simple maintenance or none at all. Moreover, the initial price must be no more than 200,000 yen (approximately $1,000 at that time). These constraints imposed a heavy burden on the design team.

Initially, a feasibility study team was formed to examine what would be necessary to actualize an MC. This team would form the core of the entire project and had an average age of 28. The 14-member team consisted of eight people from R&D, three from production, two from marketing, and one from product design. The fundamental contradiction the team faced was managing the inverse relationship between reliability and cost. That is, when reliability was improved the costs of production increased, but when costs were reduced service requirements increased. Managing Director Mitarai named this objective “Cost-Reliability Improvement”. To resolve this contradiction the development staff would have to create a new concept of how a copier operated. This objective was so challenging that internally it was referred to as aiming a “Canon Revolution”. To achieve this objective, joint efforts by Design and Production Engineering were indispensable.

The crux of the problem was clearly outlined by research on the causes of copy machine troubles. The researchers discovered that 90 percent of the problems occurred around the drum. The conventional method of addressing this problem was to seek methods of improving the durability of the drums and
cleaners. As long as this was the goal, however, it was impossible to escape the contradiction between major cost savings and reliability improvement. Thus, what was necessary was a major concept change, that is, a synthesis of the contradiction through the creation of a new concept.

To solve the problem the members of the feasibility team engaged in heated arguments at several spontaneously organized "camp" sessions. Camp sessions are gatherings of project teams outside the workplace to brainstorm new solutions. They are frequently used by Japanese corporations during product development efforts. In this case the camp session provided an opportunity for the feasibility team to invite people from other parts of Canon to discuss how to overcome the contradiction.

The new concept that emerged from the camp session was that the entire drum should be a module that could be discarded after making a certain number of copies. With this the copier would be essentially maintenance-free. Whereas in conventional copiers the drum was a component with open-ended operating life which would certainly fail and then need to be repaired, the team created an entirely new way of thinking about the drum. It was reconceptualized as a cartridge with a limited but known life-expectancy. This made it necessary to develop a disposable photo receptor, disposable development apparatus, and an instant toner-fuser—all within the target cost. When many task force members said it was impossible to produce the drum inexpensively, the feasibility team leader, Hiroshi Tanaka, had some disposable cans of beer purchased and told them to drink the beer. Then he engaged the members in an argument about how much the beer can cost and what made it so inexpensive. The disposable beer can resembled the copier drum because it would be disposable. The conceptual linking of the drum and beer can provided the taskforce members many insights into methods of manufacturing the drum at a lower cost.

This opening up of new understandings revolutionized product development and added substantially to the firm's capability. Hiroshi Nitanda, manager of First Design Department of Reprographic Products, explains it this way (Nitanda, 1984):

"The idea of packaging the drum and surrounding components as a cartridge revealed to us a great number of things. First of all, as everything is brought together, the structure can be simplified and only a very small number of essential parts are needed. So, high precision design becomes possible by combination in design. The product becomes less messy. Also, the key module becomes quite compact as the release mechanisms between units are no longer needed. So, low cost as well as high reliability will be achieved at the same time. Moreover, with a cartridge, the toner seal is opened only after reaching the customer. This meant the plant is required to develop a production process without imaging inspection. This led to better efficiency."

The big breakthrough on the cartridge then led to a cascade of other improve-
meets in the chain reaction-style well described by Usher (1954). After this the design conception and a feasibility model was advanced by another early stage design team. When these were completed the corporation decided to develop the MC.

It was clear from the beginning that the development of the MC would require all of the talents in the firm, so a task force was formed to actualize the MC. At Canon task forces are independent organizations whose team members are appointed by the company president. With the exception of the tremendously successful AE-1 camera task force, this task force would be the second largest horizontal development organization Canon had ever formed (approximately 300 persons). It was also the first such massive effort by the Reprographic Products Group. Tanaka, director of Reprographic Products Development Center, was appointed as the chief of the task force. Its advisor was Keizo Yamaji, Managing Director of Reprographic Products Division.

A system also was organized for constant communication with the leaders of related internal organizations such as Hajime Mitarai, managing director for Research and Development; Teruo Yamanouchi, director of Corporate Technical Planning and Operations Center; and Kazuo Naito, director of Production Engineering Research Center. The importance attached to this effort was indicated by the symbolic assignment of chiefs of related departments to the MC task force and the appointment of active key corporate personnel as leaders. This appointment made these personnel responsible for the project's success and thus also project champions. Further, the project slogan became the "development" of the AE-1 of copiers. This helped create a commitment among corporate personnel and was a powerful rallying point because Canon's employees considered the AE-1 the company's greatest product development success.

From the planning stage the task force included Quality Assessment and Cost Assessment groups. Because of the projected usage pattern for the MC, the Quality Assessment group decided the repair frequency of television sets was the relevant goal and proceeded to collect exhaustive information related to television sets. With this information as a target, the group began the task of setting all quality standards for charging, exposure, development, cleaning and fusing. Similarly, the Cost Assessment group was working on cost and quality allocation for achieving a sales price of 200,000 yen. This was the first time in Canon's history that a task force had ever gone so far in the planning process. A Market Task group was also created, consisting of copier sales representatives from around the world to study marketing ideas. Finally, the Soft Task group was to examine the "software" aspects such as color copying and other possible uses.

As a rule, teams of representatives from development-related groups and production engineering-related groups held a managing committee meeting once a week to decide all issues. This task-force system greatly contributed to
a reduction of the time from development planning to completion of the product. Kei Saito (1984), deputy general manager of the Advanced Technology Development Department of the Reprographic Products Development Center, recalled:

“In any company good products are created when production engineering and design become fused for their development. I believe there were tangible and intangible cost reductions. By becoming one with Production Engineering, one can propose uniform parts design, or assembly in one direction, how something should be assembled and in what sequence, or that one should do this or that if possible, when attempting to automate production, for example. If we (in product design) are by ourselves, it is easy to prepare drawings, and do what we like without thinking that far ahead. So, our discussions with Production Engineering people and working to accommodate their various requests in our own ways resulted in both tangible and intangible cost reductions.”

Of course, such fusions are not simple, and Design and Production Engineering often participated in outspoken arguments. These led to major synergistic effects, however, reducing costs and speeding product development11.

The new technologies that were developed for the cartridge then became a part of the corporation’s knowledge base and later would be applied to other products, such as laser printers and facsimile machines. In this sense the MC innovation process became continuous and spread throughout Canon. The knowledge generated in the development of the MC became part of the Canon’s competitive strength.

To lower price, new design technologies were invented which facilitated miniaturization, weight reduction, adjustment-less assembly, and automated assembly. The assembly line was automated by the installation of automated inspection machinery and the actual production process was designed in coordination with parts and material suppliers. Thus, further skills were created that carried over to other office automation products such as microfilm readers, laser printers, word processors and typewriters. The development of the MC taught the product development and manufacturing technology sections how to better cooperate. Further, the manufacturing technology section which had previously concentrated only on cameras began to focus on the rationalization of copier manufacturing.

The total contribution of the MC in Canon’s sales increased from 24% in 1979 to over 35% in 1987, underlining the importance of this line. By 1987, 74% of Canon’s revenues would come from its Business Machines Division, whereas 15 years earlier nearly all of Canon’s revenues were from cameras. The project was an important force in Canon’s efforts to diversify out of the stagnating camera industry and into the high-growth office automation areas.

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11 For further discussion of the integration of design and production engineering in Japanese firms, see Takeuchi and Nonaka (1986), and Imai et al. (1995).
4. Case study 2: Apple Computer and the development of the Macintosh

Apple Computer, Inc. differs from Canon in many ways, yet there are important similarities in their respective product development processes. Apple is located in Silicon Valley and is a quintessential venture-capital-financed high-technology firm. Apple had begun selling personal computers produced in the garage of one of the corporate founders in 1976, and was incorporated in 1977. Apple’s first important product, the Apple II personal computer, was released in 1977, and by 1982 Apple's sales had increased to over $750 million. The early 1980s were a difficult period for Apple as it released the Apple III and the Lisa, both failures in the marketplace.

The earlier Apple II success meant that there was a constant stream of cash flowing into the company. Management was still largely in the hands of the founding team and within this environment there was little financial or bureaucratic discipline. Apple was in a constant state of confusion, with many different R&D projects going on simultaneously. Within this turmoil the Macintosh group was formed in 1979 to examine the feasibility of developing an extremely low-cost computer for the public. At that time the Mac project was limited to three people.

In late 1979 Steven Jobs, one of the Apple’s founders, was removed from the Lisa project. This led Jobs to look for another project, and he was attracted to the small Macintosh group. By early 1981 Jobs had replaced the original leader of the project and had begun to build up the project team. Jobs was going to be the “product champion” and was prepared to battle within Apple for the resources necessary to bring the product to market. He was determined to build a computer that was, in his words, “insanely great”.

The Mac was not a completely revolutionary machine in the sense that it drew technology that had been developed at Xerox Parc in the 1970s and implemented in two earlier, but much higher-priced machines, the Xerox Star and Apple Lisa. However, the Mac would adopt many of the features of these machines in a computer that was smaller, faster and much less expensive. To facilitate this, many members of the Mac team were recruited from Xerox Parc and the Apple Lisa teams. They were thus able to benefit from the knowledge that was developed in these earlier projects.

In the early days the Mac team did not even have a precise idea of what the computer would be like. In fact, there was not even a development schedule. One of the most important engineers in the project has said that “Steve [Jobs] allowed us to crystallize the problem and the solution simultaneously” (Guterl, 1984:34-43; and Walton, 1985: 13-28). For a more general treatment of Silicon Valley’s innovation atmosphere see Florida and Kenney (1990).

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1985, p. 35). Jobs and the earlier leader of the group had set out only basic principles; it was the personnel of the team who would concretize these. In effect, the Mac team was self-organizing.

By early 1982 the Mac team had grown to 25 members, yet the group remained closely knit. Their average age was 28, and for many this was their first experience working on a major project. Because of the small size of teams, each member was responsible for a fairly large portion of the total design and was free to consult with other team members when considering alternatives. The team included trained engineers as well as self-taught “hackers” and even an industrial artist. The small size of the team allowed intense interaction between hardware and software people; thus the Mac was able to optimize both.

The Mac team occupied a building physically separate from the rest of the corporation, and the environment was one of intense and constant interaction. This separation, however, created conflict with the rest of the corporation, and there was a lack of technology transfer and coordination between the Mac group and other divisions of Apple. Thus, the important innovations made by the Mac team would not reverberate throughout the company.

The constant interaction between the members of the Mac team led to the emergence of new features and ideas. The project team held numerous informal design meetings that covered minute details of the computer they were creating and there would often be heated discussions. At one such discussion nontechnical personnel remarked “how much fun it would be if the Macintosh could sound four distinct voices at once so the user could program it to play music”. This prompted the hardware engineer and software programmer to spend extra hours to design a sound generator with four voices. Marketing staff, finance specialists and even secretaries often joined these impromptu discussions. This created what one of the key members of the development group called “group mania”, which tried to expand the limits of what was thought possible. In effect, the team created new problems and this stimulated other team members to create solutions, that is, to create information (Guterl, 1985, p. 41).

Interaction was further intensified by organized team retreats away from the office. For two days up to 25 team members would discuss the project. Each group in the project presented the work accomplished and outlined their goals. This provided the project team an opportunity to reflect on what had been accomplished and set future goals. The retreats also increased team spirit and motivated the engineers to continue working the long hours necessary to complete the project.

As at Canon, the manufacturing managers were an integral component of the Mac project team. From early on manufacturing engineers participated in the design decisions. This was necessary because Apple would build a highly automated factory to be able to produce the Mac inexpensively, because a low target price had been set.

The Mac project was managed quite differently from the Canon PC project.
Steven Jobs always made the final decision. This autocratic system meant that many good ideas were ignored because of Job’s preconceptions. For example, in the decision regarding the use of the 5.25 inch or 3.5 inch floppy disk, Jobs wanted the slower, lower-capacity 5.25 inch floppy disk, even though the engineers insisted that the 3.5 inch would be better. The engineers prevailed, but only because the maker of the 5.25 disks could not deliver on schedule.

The role of Jobs as product champion was critical, but he also introduced major complications into the development process. Michael Moritz (1984, p. 129) observed that:

“Some at Apple thought the entire Mac project reflected a parade of personal idiosyncrasies rather than any grand design. There was no plan of Napoleonic proportions. False starts, diversions, mistakes, experiments, rebellion, and competition formed the stuff of the machine.”

The completed Mac introduced a series of features to personal computing that by 1988 had become necessary for all personal computers. The role of Jobs as not only the leader, but also the final arbiter of decisions had the positive aspect because he was clearly a product visionary. The negative aspect was that at time he made decisions on the basis of personal bias. For example, Jobs decided against providing expansion slots on the original Mac which would allow third-party vendors to produce add-on equipment. All successful personal computers, though, such as the IBM PC, Apple II, and NEC 9800 series, included this add-on capability. The third-party vendors provide value-added to the computer and develop new functions and designs. In effect, they make the computer more useful. Jobs remained adamantly opposed to them.

Jobs set some difficult challenges for the project team that demanded a complete rethinking of the personal computers features. For example, as Jobs began to contemplate the role of computers in society he reconceptualized them as having the same transformative role as telephones had in an earlier period. He spent time studying telephones in houses and offices and noticed that they often sat on telephone books. On the basis of this observation he became convinced that the new computer should have a base the dimensions of a telephone book. This was much more difficult because it made it necessary to lay out the interior of the computer in a vertical rather than horizontal manner. It also gave the Mac a distinctive design and made it much more compact (Young, 1988, p. 226-228).

As in the case of Canon slogans were used as motivators for the Mac group. Two important slogans were “the journey is the reward” and “It’s better to be a pirate than to join the Navy. Let’s be pirates”. Through these slogans the team spirit of the group was enhanced and they were persuaded to great exertion. There was a less beneficial effect of the pirate slogan in that it served to separate the Mac group from the rest of the company. In effect, a company
within a company developed, and this adversely affected morale throughout the company.

The Macintosh was a major leap forward in personal computers and created new information for Apple. However, it did not transform Apple in the same way as in the case of Canon, even though it became the basis for building Apple Computer into a $4 billion company. An important reason that it did not have the same effect on Apple is that many leaders of the Mac development project left the company when it was completed because of disagreements with management, burnout, or other economic opportunities. Thus, the embodiment of the newly created information—veterans of the Mac team—was lost from Apple.

5. Innovation as an organizational information creation process

The Apple and Canon case studies indicated that innovation is an information creation process that arises out of social interaction. In effect, the firm provides a structure within which the creative process is located. These highly interactive project development teams were composed of personnel drawn from varying backgrounds and operated in an atmosphere of intense daily communication.

The actual products being developed were rather different in these two cases. Canon took an established product and redesigned it for a larger market. On the other hand, the Mac proved to be a fundamental step forward in personal computing. Similarly, the relationship of the product development team to the host firm differed greatly. At Canon, top management was far more united in support of the development of the MC.

Management at Apple was initially ambivalent toward the Mac project. It was only later that management became completely supportive. As mentioned earlier the Mac was developed in isolation and in destructive relation to the rest of the company. Thus, the information created in the Mac design process was not transmitted to other parts of the company.

The MC team at Canon stood in a very different relationship with the corporation than did the Mac team at Apple. The leaders were much more a part of a homogeneous structure with a clear hierarchy and a definitive ability to coordinate different parts of the corporation. In addition, goals were agreed upon and the task force was able to call upon the assistance of the rest of the corporation.

The activities of the product champions were quite different, too. Steven Jobs, as chair of Apple Computer, commanded that resources be funneled into the Mac project. His most important role, however, was to create the vision of an “insanely great” computer and the ability of the Mac team to "make a dent in the world", the Mac team was left to translate these general visions into a real product—that is, to create a reality that would satisfy the vision. In the
process incredible goals for product introduction were created and slipped, but these encouraged extreme efforts from the team.

Product champion Hiroshi Tanaka (1984) of Canon described his role very differently:

“I never allow individual play. Whenever we submit a patent we do it as a team.... To create new technology everyone must have commitment. Even though we put a very capable man in the team, if he becomes selfish the project has never succeeded. So the role of the leader is how to make other participants committed. Innovations cannot be made by giving commands.”

The Japanese system is designed in such a way as to provide a sense of commitment and purpose on the part of project participants without creating the "star" system that became so disruptive in the Mac development project.

It is interesting to note that in the Canon case, as is typical for Japanese firms, the information developed in a product development project is created and accumulated inside the firm. Conversely, because of the long-term employment system most Japanese firms must draw largely on internally accumulated information when undertaking a project.

In contrast, the Mac team, situated in Silicon Valley, had the advantage of being able to recruit outside talent. Steven Jobs repeatedly raided Xerox PARC and Hewlett-Packard. The negative aspect of this ease of recruitment, though, is that employees are also far more willing to leave the company. In fact, nearly all the employees responsible for developing the Mac have now left, including Steven Jobs. The information and experience these employees represent thus had been lost to the company. This knowledge is often available to other entrepreneurial firms, and so helps to fertilize the entire Silicon Valley (Florida and Kenney, 1990).

The use of metaphors and analogies in both case studies was important for helping conceptualize difficult parts of the project. For example, at various times the Mac was conceived of as the bicycle of personal computers, the telephone of the 1980s, the crankless Volkswagen for the quality conscious, and the Cuisinart. The ideas was to inspire the team to develop a product that would become pervasive and impact everyone's life. At Canon the goal of “creating the AK-1 of copiers” was used to rally the corporation around the MC project. It is interesting to note the difference between the slogans. The Canon slogans appealed to an internal goal; reproducing its success in cameras in a new field. Apple slogans, by contrast, had a more universal goal aiming at furthering the PC revolution.

6. Conclusion: Towards a new theory of innovation management

There are some fundamental differences between the Silicon Valley model of innovation that Apple Computer represents and the type of innovation that
Canon represents. First, the chaos of Silicon Valley and the small startup firms that have grown so rapidly is quite different from that of a product development group inside a large Japanese company. Thus, while the Mac project was underway, Apple was improving the Apple II line and completing the Apple III and the Lisa. There were few formal mechanisms for transferring information between these various projects. In effect, each project became self-contained, drawing on the income from the Apple II. In a larger sense, the constant combination and recombination of Silicon Valley is a high-velocity chaotic system created by venture capital and a constant flow of new entrepreneurs. Silicon Valley is a constantly evolving system of corporate formation, growth and decline (Florida and Kenney, 1990).

In contrast, Japanese firms such as Canon have a relatively stable workforce having a long-term employment practice and income from existing product lines. In the highly competitive Japanese marketplace a constant flow of innovations is necessary to ensure growth. In this rapidly changing economy all firms must create an environment in which new ideas and meanings are created and transmitted throughout the firm. The MC project performed this function by its induction of chaos into Canon's R&D division.

The key, then, is not simply to create chaos, but rather to create an environment in which new information can emerge from chaos (Quinn, 1985; Baumol and Benhabib, 1989). This requires a careful and involved management. The chaos cannot be so overwhelming as to overload the company's integrative capabilities (the ability of personnel to create new meanings). One type of chaos can be introduced into the firm through merger and acquisition activity, but this can be detrimental to the firm. For example, the addition of a wholly unrelated subsidiary may provide a discontinuity that cannot be integrated into the firm. In this sense, no meaning would be created and there would be no synergy.

A system that cannot create new meanings is best characterized as a stagnant bureaucracy. These organizations are managed on the basis of syntactic information such as ROI and profit center analysis. Emergence or meaning creation is neither sought nor desired, because it will disrupt the formal information channels. In fact, channels created for the communication of syntactic information are not suited for the transmission of semantic information. In a syntactic channel, semantic information is interpreted as merely “fluff” without pragmatic use. Further, in the highly divisionalized structure of a bureaucratic firm the transmission or flow of new meaning throughout the firm is stifled and hindered by the boundaries between different parts of the corporation.

Strategy in such companies is usually confined to being “Number One (or Two) in every business we are in” or “keeping ROI above some arbitrary number”. With this method of doing business those parts of the company that do not meet these tests are spun-off with little regard for the lost personnel and
information. These synthetic rules are mistaken for vision and the employees in
the corporation are motivated not as much by leadership as by fear. In such
situations the short-term fix and risk minimization strategies will prevail among
the rank and file and at the middle levels. This may lower the breakeven point,
but will rarely create the new information which will lead to corporate selfrenewal
and growth.

The role of the leader in a corporation attempting to maximize information
creation is not that of a military-style commander, but rather of a catalyst. Thus,
the leader may initiate the chaos generation and create a context for selecting the
relevant people, sometimes arguing with them, but also helping them to overcome
barriers and accelerate the realization of their vision.

Despite the great differences between these two companies and the products
being developed there are some important underlying similarities. The first is the
comparatively small core group that participated in intense interaction and
exhibited extremely high commitment. The second is the use of analogies and
metaphors to create new understandings and conceptualizationst. In both cases
the innovation process was not deductive, but rather emergent. The third is that
although Steven Jobs was the clear leader and had a top-down management style,
the Mac group was in many ways self-organizing. Similarly, even though
members of the product development group at Canon were appointed by senior
management, the group was self-organizing.

The similarities drawn from these two case studies provide a fertile field for
further empirical research and theory-building on innovation. Little attention has
been given to the striking similarities in the organization of innovation in Silicon
Valley high-tech firms and their larger Japanese counterparts (Kenney, 1986; and

The case studies used to illustrate the process by which innovation arises
provide the raw material for a theoretical project aimed at reconceptualizing the
innovation process as human activity based not on deduction or induction.
Rather, it is a process of information creation. The emphasis must be placed on
emergence and synthesis. In this process, metaphors and analogies are often more
useful than syllogisms and proofs.

If this is true, then the task of the company is to provide an environment in
which innovation or information creation can occur, then facilitate its
transmission throughout the firm. The burst of energy or transformative
capability is a powerful stimulus to propelling the company forward. Thus, the
spinoffs of creating the MC revitalized a number of other product lines in Canon,
and the Mac became the base upon which Apple rests. The innovating firm must
create an environment which will lead to information creation and must structure
institutions to amplify and transmit the newly-created information.

13The current president of Apple, John Sculley, pointed out the importance of metaphors for motivating
product development teams (Sculley, 1984).
Finally, all institutions and procedures created must continually be re-evaluated, revised and reconstructed to create a permanent self-renewal process.

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References


