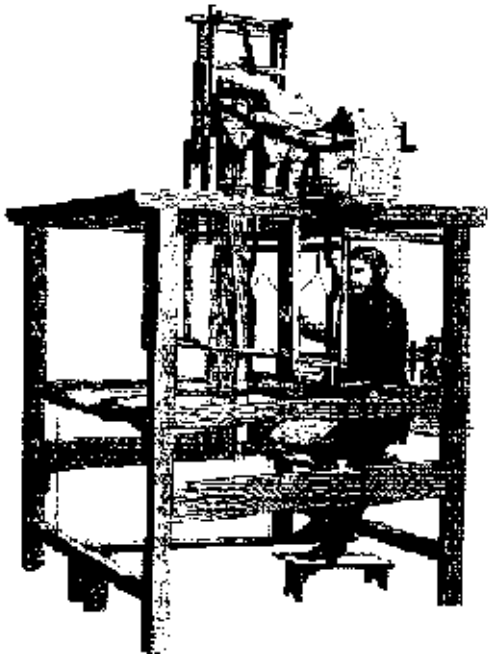
EMERGING TECHNOLOGIES MANAGEMENT



Prepared by: Glen Cooper

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INTRODUCTION

The world is in the midst of epochal shifts. Changes include: 1. the economic rise of the Pacific Basin 2. the search by Europe for a new world role, 3. the fall of the military based Soviet block governments, and 4. the decline of the economic and political predominance of the US. In these times the power to create and manage change is essential. Electronic technology is helping to fuel and speed change. Electronic technology's ability to integrate all forms of communication and to disseminate information globally in a matter of seconds should cause every corporation to rethink their corporate strategy, culture, organization, and management techniques.

The term "information management" originated with the US federal government's need to manage paper flow. Now, like the changes in the world today, information management has become complex and confusing. The gap between promise and performance illustrates how difficult it is to forecast if a new technology will exceed the cost/benefit threshold. Successfully predicting the impact of an emerging technology can be of great importances. As was indicated in a poll of Computerworld Premier's 100 winners, judged to be the US' most effective users of information technology, nearly 3/4 of these top information managers considered emerging technologies to be critical or very important to their competitive success[1] . The challenge is to determine the strategic opportunity or threat that a new technologies presents. To meet this challenge technological change must be understood and continuously monitored. Technology management must also be woven into all levels of strategic planning. Failure to do so could result in the erosion of a company's key businesses. Success will belong to those who provide the best solutions and service to their customers.

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[1] LaPlante, Alice, "Evaluating Advanced Technologies: The Needing Edge," Computerworld Vol: 25 Iss: 11 Mar 18, 1991 pp: 65,67

PHASES OF TECHNOLOGY

In order to manage technological change it must first be understood. As Roger Penrose, a noted mathematician, and many others have pointed out, scientific innovation rarely progresses in a smooth and orderly fashion. There are times of great upheaval when fundamental paradigms change. After such upheavals the new paradigms are "fleshed out." The great upheavals typically represent philosophic changes in our world view and occur relatively seldom. If these great upheavals occur relatively seldom, why have we seen so many changes over the past century? The answer is that knowledge has an exponential property. That is, the more knowledge that is accumulated the faster additional knowledge and innovation will come. Thus the invention stage to an innovation process life cycle can be expected to be ever accelerating.

Bruce D. Merrifield, describes a general four stage innovation process life cycle represented by an S curve. The S curve is used to reflect the obsolescence of a given technology by next-generation developments. Stages in the S curve are: 1. invention, 2. proliferation of variations on the original invention leading to a dominant design, 3. improvement in processes, and 4. product maturity. At the maturity stage, the technology is vulnerable to new technologies emerging to start new life cycles.[2]

From an industrywide view the four stage model can be divided into emerging, pace, key and base technologies. An emerging technology is one which is still in the laboratories or experimental stages. Pace technologies are pilot systems while key technologies are used by market leaders to gain a competitive advantage. Finally, base technologies are used by most firms as essential business tools.

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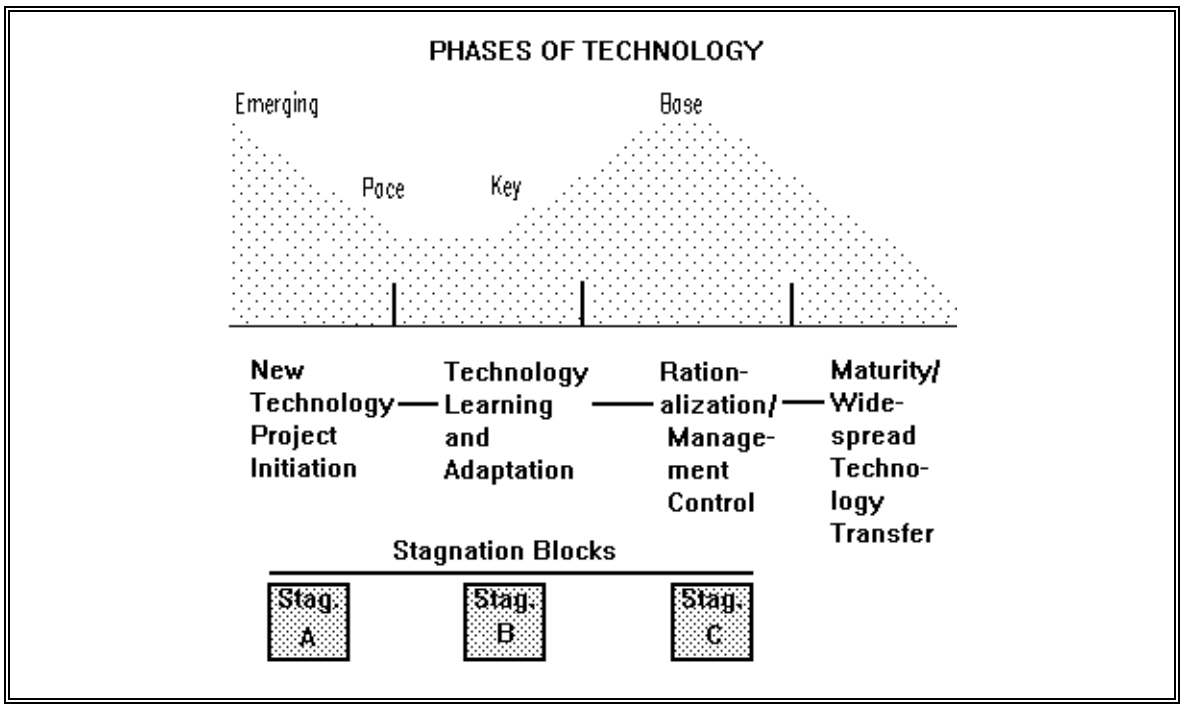
[2] Merrifield, D. Bruce, "Industrial Survival via Management Technology," Jrnl of Business Venturing , Vol: 3 Iss: 3 Summer 1988 pp: 171-185

The four stage innovation process has also been analyzed at the individual firm assimilation level by Cash, McFarlan, McKenney, and Vitale (building on earlier work of Cyrus Gibson, Richard Nolan, and Edgar Schein) in their book Corporate Information Systems Management: Text and Cases, 2nd Edition 1988, published by Richard D. Irwin, Inc. A graphical representation of this model with an innovation process life cycle S curve overlay and approximate locations of industrywide technology groupings is presented below.



As can be seen Gibson's, et al, model divides emerging technology assimilation into new technology project initiation, technology learning and adaptation, rationalization/management control, and maturity/widespread technology transfer. Associated with each of the first three stages are stagnation blocks. These stagnation blocks are failure or technology abandonment points. The first stage of this model has as its main trait impreciseness of both technological cost and benefit.

Its associated stagnation block A typically results from vendor failure, discovery that the technology is inappropriate for the business, or poor user involvement. Studies have shown that failure at this stage can result in significant cost overruns and will typically generate a two year lag before a new investment in the given technology is tried again. The second stage, namely technology learning and adaptation, is characterized by the overcoming of technical problems and the more clearly defining of the costs and benefits of the technology. It should be noted that as learning takes place the actual benefits are often quite different from the originally anticipated benefits. Failure at this stage is stagnation block B. Here because of the company's failure to learn from the first application of the technology and to disseminate that learning, the company will use the technology only for its initial applications. The rationalization/management control stage results in continued evolution and use of the technology in areas not originally considered and, more importantly, controls and guiding designs and implementation procedures are established to make further technology use more efficient and cost effective. At this stage, when excessive controls are developed that inhibit legitimate and profitable use of the technology, the stagnation block C is encountered. In the final maturity/widespread technology transfer stage the experience gained in one or more operating departments using the technology is expanded and used throughout the organization.

CORPORATE STRATEGY AND CULTURE

There appears to be a paucity of seriously focused management of the emerging technology issue. A study of 20 banks surveyed between October 1987 and March 1988 revealed 3/4 of those banks lacked a formal technology evaluation procedure[3] . Most organizations focus all or most of their energies on tactical priorities, such as next week's advertisement or next month's budget. This preoccupation with the present generally leaves information systems management, which are involved in tactical priorities of their own, with the burden of anticipating future requirements. This lack of focus and managements trepidation in the face of emerging technologies has evolved a bread of adventurous individuals call technology "champions." These innovative people force senior management to explore advancing technologies by persistently campaigning for there use. As a recent study of implemented decision support systems revealed almost all such systems had an organizational champion[4] . Executive information and artificial intelligence systems also represent examples of the efforts of technology champions. Other symptoms of this lack of focus are the strict use of the cost component in evaluating new technologies rather than its strategic component and the decentralization of computer technology purchasing decisions.

New technologies have resulted in astounding increases in quality, productivity, and customer satisfaction. Emerging technologies should, therefore, become a strategic focus of upper management. According to Robert O. Knorr, et al, three major strategic changes are needed in order for new technologies to succeed. These are: 1. the adoption of an enterprise viewpoint that includes customers,

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[3] Geisler, Eliezer; Rubenstein, Albert H., "How Do Banks Evaluate Their Information Technology?," Bank Administration , Vol: 64 Iss: 11 Nov 1988 pp: 30,32

[4] Carr, Houston H.; Hogue, Jack T., "It Takes a Champion," Jrnl of Systems Mgmt , Vol: 40 Iss: 8 Aug 1989 pp: 15-17

suppliers, distributors, and makers of complementary goods and services, 2. an emphasis on marketing and production as the hub of the enterprise, and 3. the structuring of the enterprise to respond quickly to the full spectrum of customer demands at ever higher levels of performance.[5]

It should be realized that not every new technology is going to be useful to every organization and that every organization may not see emerging technologies as strategically important. However, in most cases failure to change information managements traditional reactive role to a proactive one and failure to view competitive strategy as something that should be challenged and perhaps modified in the light of an emerging technology could result in the erosion of a company's competitive edge. The 1990's will belong to the customer. The organization that can service that customer best whether it be through some emerging technology or not will be the organization that survives.

Corporate culture should also be evaluated. The next century will be full of innovations and advancements. If a company's employees have not been encouraged to accept change and to experiment then management can expect the introduction of an emerging technology to incur relatively greater resistance.

A cardinal rule in introducing a new technology is making certain the system fits the strategic plan. Accommodating an organization's culture is the key to locating, implementing, and benefiting from strategic systems. Companies must first determine how they want to approach technology as a strategy, then they can decide how to organize for the development and implementation process.

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[5] Knorr, Robert O.; Thiede, Edward F., Jr., "Making New Technologies Work," Jrnl of Business Strategy , Vol: 12 Iss: 1 Jan/Feb 1991 pp: 46-49

ORGANIZATION

As was mentioned above the traditional role of information management has been reactive with the control of system resources as its top priority. The information systems management has not been in the main strategic planning processes of the organization. This separation from the strategic planning process has resulted in emerging technology development only when a champion is present or decentralized technology purchases are approved.

If guidance is to become a larger part of the information management's role. The control of systems resources by information management can no longer be the only priority. Strategic planning and coordinating the work of others must become an increasingly important role of information management. To make the shift to more advising and coordinating, information executives need to either reorganize or establish new types of groups as symbols of change and make it apparent to others in the firm that the information department is taking on a new role.

One approach to organizing for this new role is the establishment of liaisons between the user group and information management. This approach has the advantage of providing better communication of the user needs but does little in the way of evaluating new technologies and their strategic importance. Another organizing approach is the establishment of task forces. These groups are established after an emerging technology has been identified. The task force may be comprised of information system, marketing, production, and general management experts from within the organization and customer and vendor representatives from outside the organization.. This approach has the advantage of bring many experts together in the formulation of a plan to explore an emerging technology.

This task force approach may be well suited to those firms where active exploration of emerging technologies is not deemed strategically critical.

When the exploration of an emerging technologies is not perceived to give the organization a potent competitive advantage a strategic alliance may be sufficient in the development of emerging technologies. A strategic alliance is formed by contracting with a small firm which will pioneer the technology's commercialization, and the larger firm will participate in the venture and be able to capitalize on benefits that occur. Strategic alliances allow the firm to exploit new technologies with a minimum of internal diversity. They offer speedy access to technology, with a minimum of risk and financial exposure.

In those company's where active exploration of new technologies is strategically important then the establishment of what the 3M Co. calls the emerging technologies group (ETG) is appropriate. The function of the ETG is to: 1. understand new technologies, 2. evaluate them, 3. influence the course of their development, and 4. when feasible, decide when to redesign the technology to suit the company's needs. This group could be under the direction of the information management or it could report directly to senior management. As an adjunct to the ETG, an additional emerging technology nucleus made up of the chief technology officer, the ETG, and representatives of the business units can be set up as a decision support vehicle for all major technology purchases by the corporation. This nucleus is referred to by Shearson, Lehman & Hutton as the decision-impact group.

MANAGEMENT

Given that a firm has decided to explore the emerging technology issue and no matter what organizational form the firm employs, certain key management issues will remain. These key issues are staffing, planning, controlling and directing. Companies learned in the 1980s that information technology brings the greatest benefits when firms use it to create new and more effective business procedures rather than to automate old ones. In all new system development plans senior management should provide grand visions that strive to achieve such goals such as lowering costs, eliminating unnecessary work, improving service, and increasing speed to market.

Staffing

The first issue management will face after it has established its strategic plans and organization design will be staffing. Here management should be looking for the innovator. A research firm has found that these innovators come in three forms: "Witch Doctors", "Magicians", and "Wizards.". "Witch Doctors" are able to redesign business processes, create new paths of information, and are able to sell these new processes. "Magicians" are able to build large systems and get them moving even when they are not completely designed. "Wizards" have expert knowledge of advanced technologies and are able to bring these technologies into the firm and integrate them with others[6] . Innovative people also tend to tap into a widening network of expertise as they shape an idea. They are not only willing to listen, they also seek out people with the know-how they need.

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[6] Champy, James A.; Hammer, Michael, "Help Wanted: Heroes and Visionaries Preferred," Computerworld Vol: 23 Iss: 12 Mar 20, 1989 pp: 69,72-78

Communication skills will also be key in the staffing selection. Not only should the selected individual be able to communicate with the information management personnel but they must also be able to effectively communicate with the user and customer groups. A study by T. Burns and G.M. Stalker, described in The Management of Innovation (London: Tavistock Publishing 1979), found significant cultural differences between the R&D laboratories and the production workshops. These differences caused difficulties during the integration and deployment of new technologies. The study suggested that linguistic differences accounted for much of the cultural incompatibility between the two types of departments. There are many similar linguistic differences between the information systems departments and the other functional areas (accounting, marketing, production, etc.). Therefore, it is important that the emerging technology staff be able to bridge this communication gap.

Planning

Planning will be critical in the management of emerging technologies. Rod F. Monger suggests that management can plan by following a six-stage analysis model: 1. Determine the commercial potential of the emerging technologies. 2. Determine the impact of the technology on the industry. 3. Analyze specific ways the company could use the technology to create competitive advantage. 4. Develop a strategy for technology to contribute to cost leadership, differentiation of products and services, and concentration of a particular market. 5. Evaluate the firm's ability to develop the technology and determine if outside resources would be necessary. 6. Decide whether or not to use the technology[7] .

[7] Monger, Rod F., "AI Applications: What's Their Competitive Potential?," Jrnl of Information Systems Mgmt , Vol: 5 Iss: 3 Summer 1988

If the decision is made to move forward with a new technology the company should develop methods for handling all facets of unsuccessful introductions, including cost minimization, organizational restructuring, and corporate image maintenance. Additionally, if the determination is made to implement then plans should be made as how best to sell/market the new technology to the rest of the organization.

Controlling

Almost all information systems (IS) projects being undertaken today involve some degree of uncertainty, particularly those that deal with emerging technologies. The risk of failure is significant with the major uncertainty coming from the financial side. As was stated in a recent article, both government and industry perceive a lack of cost data and estimating methodologies to handle new and emerging technologies and acquisition strategies[8]

Methods for evaluating success and accurate cost accounting systems must be developed. New success/failure forecasting models will also be required. These systems should remain flexible. Standards of efficiency must also be greatly reduced during testing and funds must be made available if first attempts are not successful. But in all cases the organization must be able to assure itself that it is not spending too much money on hardware or software without getting the productivity or competitive tools desired.

[8] Laughlin, Edward P., "Roles and Trends: Cost Estimating of New Technologies," AACE Transactions , 1989 pp: K.2.1-K.2.6

Directing

The main leadership style to be applied to emerging technology professionals should resemble what Hersey et al referred to as "participating." Under this style there is little distinction between leaders and subordinates. Attention is given more to relationships. These professionals should be given the authority and accountability to reach decisions regarding all aspects of the development effort. And they should be responsible for preparing marketing people and customers, identifying strategic opportunities, organizing and getting researchers, developers and customers communicating and for minimizing redundancy.

However, any new project must always be subject to what the Cambridge, Mass.-based BBN Communications company calls the "Phase Zero" review, which means that the proposed product has to get the approval of senior management.