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SOCIAL NETWORKING FOR SUCCESSFUL ADOPTION OF TECHNOLOGY

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Abstract

This study investigates the impact that managerial networking knowledge has on the successful adoption of advanced technologies in firms. A survey primarily of CEOs and VPs of 30 small manufacturing companies in a tri-state region of the Midwest was conducted to determine the role that managerial networking knowledge has on 1) the overall number of technologies that a firm introduces and 2) the success rate of technology introduction as measured through usage and overall satisfaction. A mathematical model is constructed and used to analyze the effect of networking knowledge on successful technology adoption. The results of both the survey and the analysis show that managerial competence defined as networking knowledge is a critical component in the number of technologies introduced and successfully implemented. Some new concepts are introduced and used to develop a rigorous scientific foundation for the study of the successful introduction of technologies in organizations.

1. Introduction

The introduction of advanced technology into an organization may sometimes decrease rather than increase productivity or competitive advantage. Why? At the beginning of organizational learning, both managers and those assigned to use the technology are unfamiliar with it. They fear misusing it, and they may avoid using it. Even later, when they use it, they may use it without understanding how to use it to advantage. Yet, certain technologies can at critical times be adopted in ways that make a positive strategic difference to certain adopting organizations. In some cases, it is a matter of the organization's survival.

An important reason for failure to realize the benefits of a technology, such as several computerized information systems that were developed or administered independently, is the lack of integration of these technological fragments with one another and into the structure, culture and planning of the organization. The key issues to be addressed are organizational and procedural rather than technical problems of hardware, software, databases or model bases, though these are also important (Kochen, 1988a). Resolving these issues requires managerial competence and newer means for supporting managerial performance.

In what follows, we argue that a special managerial competence is very helpful, if not necessary, for successful adoption. That special competence is know-how of social networking. To make the case for this, we first describe networking in the context of advanced technology in small firms. Second, we report the results of a survey of small firms in the Midwest to find relations between the sucessful adoption of technologies and the practice of social networking. We conclude with an argument using a formal model to prove our claim from plausible assumptions. This study contributes a useful, empirically supported theoretical perspective for the integration of technology into the strategic, organizational and cultural aspects of successful adoption. The perspective is that of organizational networking, which builds and uses the social fabric of an organization. We believe that networking is a critical success factor for strategic planning and for integration. The study of social networking and its application has in recent years become an active area of high-level research (Kochen, 1988b). It holds promises for providing a rigorous and relevant scientific foundation for the study of the successful introduction of technologies in organizations (Chin, 1988).

2. What Is Organizational Networking?

To clarify this concept, consider the example of a small manufacturing firm in the U. S. Midwest which has begun to sense threats to its future. Its owner or CEO may have heard that the U. S. machine tool industry slipped from where it supplied 75% of the U. S. market in 1982, it only supplied 50% of that market in 1987. He[1] may have read this in Industrial Automation or heard that Congressional hearings were being held (by the subcommittee of the Senate's Small Business Committee, on Productivity, Innovation and Technology) that addressed the concern about erosion of the U. S. industrial base and which explored the role of the Federal government in trying to reverse it. Recalling the increased cost of compliance with past Federal regulations may cause him to view the prospects of a further Federal role with apprehension. But foreign competitors offering a rich variety

[1] For convenience we will adopt a masculine convention while it may pertain to either gender.

high-quality goods and services at lower prices, with faster, more reliable delivery schedules may cause him even greater concern.

The firm's leader realizes the need for strategic planning. As head of a small firm, he cannot readily find the time to plan in the face of daily crises. He may also have little inclination in light of the traditional mboxshort-term survival attitude of small firms and he may have little or no experience or training in strategic planning. But he may also sense opportunities in the use of advanced technologies. He may realize that many of his competitors - and perhaps he as well - have already adopted CNC (computerized numerical control) machines and robots. Some of his staff may have heard of flexible manufacturing systems, computer integrated engineering, computer integrated manufacturing, simultaneous engineering, etc.

If the sense of urgency for strategic action, together with a sense of enterprise to take advantage of these opportunities, as well as justified confidence in the firm's strengths, outweigh fears of the risks, uncertainties and perceived weaknesses, then a vision about the firm's future may emerge. This may give rise to an intention for realizing specific goals toward that vision and the attempt to mobilize resources. To have reached this preliminary stage will already have required organizational networking. He will have contacted persons outside the organization for stimulation and to increase his confidence that his vision is sound. The "visionary", strategic planner or senior manager, will have talked to key people in the organization to obtain inputs and support for the vision while forming it. He will try to generate enthusiasm and build consensus. If he encounters criticism or resistance, he may try to overcome it or to modify his vision. From most of those he contacts, he is likely to encounter indifference or lack of knowledge. But some of these may refer him to others who have more to contribute. Such referrals are the essence of networking. Through them, he is likely to reach all the key stakeholders and also those whose consensus is required for a vision to take hold.

As soon as the intention is firmly adopted and resource mobilization begins, barriers become evident. Banks may be reluctant to extend credit to small manufacturers, especially for advanced technology. Technology suppliers may not spend time with small firms. Where should the firm turn for leaders about the technology options available, how to choose among the options, how to obtain financing for the selected option, how to ensure that right after delivery it will be effectively used? Which people should comprise a core team to make the technology effective, and what incentives and modes of organizing them will bring them on board and into concert? Most likely, to minimize the risks associated with uncertain and incomplete replies to such questions, the firm will adopt technologies very incrementally. As a result, modest systems are likely to be introduced at different times and to be developed and administered independently. Only in rare cases will there be a great deal of coherence or compatibility among systems and across organizational borders. While the department or individual who acquired or uses a small system by and for himself or itself may feel that it got its money's worth, the feeling may not be shared by the higher-level manager from the perspective of the firm as a whole.

Clearly, management needs to get better answers to the above key questions involved in the mobilization of resources. How can it get such answers? It can search for persons with answers within the organization. It can engage outside consultants. But how to find them, how to recognize them? It can join technology users' groups, participate in trade or professional association activities, engage in continuing education by taking seminars, reading, etc. It boils down to the wise use of options–which is basically what technology offers.

Organizational networking is a means of supporting the wise use of options. It involves:

1. Thinking of someone likely to answer one of the key questions in a useful way and contacting that person to either obtain the answer <u>or a referral</u> to someone likely to provide an answer, or a better answer, or a complementary answers, etc.

2. Contacting the person referred to in the same way, recursively.

3. Terminating this process when useful answers have been obtained, or when the network or networking resources have been exhausted, whichever occurs first.

Having mobilized resources, the firm must <u>commit itself</u> to a course of action, and execute that course in an effective but adaptive way, learning and continually improving as it proceeds (Goldratt and Cox, 1984). Among very small closely held firms, the networks of the owners, VPs, directors, managers, and other employees are often intimate, patriarchical. As the size of the firm increases, the personal networks tend to get lost. Of the approximately 14 million businesses in the U. S. , only 2 million are corporations, about 11 million proprietorships, and 1 million partnerships (Mueller, 1986). Of the 2 million corporations, 98 percent are privately owned, many family held. These partnerships and proprietorships are held together by social network forces.

The strategic importance of networking was brought forth in a 1983 cross-sectional survey of 947 senior executives in the U. S. Western Europe, and Japan conducted by Arthur D. Little. In that study eleven important innovation practices or opinions regarding the management of innovation were explored. Six of those eleven findings revealed the importance of networking (or the potential of networking) in effecting an innovative management practice (Arthur D. Little, 1985, cf. Mueller). This concern is further highlighted in a recent Science article (Cohen and Zysman, 1988) which highlighted the erosion of manufacturing capacticies in the U. S. as a major contributor to America's trade problems. Rather than focusing on particular machines or U. S. technologies, the article considered the strategies for automation and the goals which American firms seek as paramount. Although mass production and administrative hierarchies created the basis for the U. S. industry dominance immediately after World War II, the authors claim that firms currently are unable to adopt or adapt to the production innovations emerging abroad. They concluded by stating that "our international competitveness is based on how effectively we develop and diffuse technology and product and production know-how to our firms and how effectively we use those technologies."

A specific example of a large firm's approach towards internal networking is Tandem Corporation's international E-mail/Conferencing capability. Individuals with specific technological problems can either send messages requesting aid from particular individuals that come to mind or place a request for solutions in a specific item of a conference. Its been reported that when such requests are placed, within a 1 to 2 day period many responses will have resulted from various geographic locations (Sproull, 1988). Many replies indicate they have similar questions and possibly form a new network of individuals of similar interests, but invariably one or two provide excellent solutions. Similarly, for small firms without the luxury of internal resources that a Tandem offers, the purchase of a personal computer, modem, and access to electronic bulletin boards such as Boston's BUSINESSnet can provide such a role. With slight enhancements in hardware and software, a small firm can just as easily create their own central bulletin board to the benefit of its own employees.

Thus, networking capacity and performance should always be continually improved. Moreover, it should be supported by technologies appropriate for that function.

3. Survey Methodology and Results.

To gain a better understanding and confirm the impact of managerial networking on successful adoption of advanced technologies in organizations, a survey was distributed among small manufacturing firms in a tri-state region ofthe Midwest. 30 firms replied representing a response rate of over 15 percent. Because of the nature of the target respondent (CEOs/owners, directors, top management personnel), proprietorship (primarily privately held), and size (median of 48.5 employees), this response rate was considered appropriate. We view this as more of a lower limit of the actual rate since we suspect a larger percent-age of these firms to have gone out of business contrasted to typical studies of larger sized corporations.

The survey consisted of both open ended and closed form questions. The open ended questions focussed on the nature of the technologies the firms were currently using, have considered using, as well as those which they acknowledged as essential for their problems or tasks. Space was provided for the respondent to give examples of each case and in certain parts asked to provide an overall assessment with an outline of the reasons for their ratings. In situations where technologies were rated as not beneficial to the firm, further elaboration was requested in the form of whether this condition was due to lack of usage, usage with no apparent benefits, or usage with negative results. The closed form questions, beyond individual and company demographics , included the overall number of technologies introduced into the firm over the past 5 years with an overall satisfaction rating in the form of a Likert scale in terms of "whether they got their money's worth" (with similar assesment for those that failed), an assessment of how well integrated their various technologies or systems were if originally developed or administered independently, the respondents' self-reported expertise concerning advanced technologies, and three specific social networking items.

The three social networking items were targeted at distinct aspects of individual networking. The first consists of the respondent's within firm network. It asked the respondent to report the number of contacts within the firm he would seek for useful advice or help when considering the introduction and use of advanced technology. The second item, analogous to the first, elicited the respondent's outside firm network. The final item is the respondent's expert acquaintance level. In this item, the individual was asked to assume that a genuine expert in the effective use of advanced technologies in his industry exists. Given such an expert, the respondent was to determine whether he would know such a person. If this were not the case, the respondent was then asked whether he felt he would know someone who would know such an expert. If the respondent knew such a person who knew the expert, the respondent would be considered one person removed from the expert. Thus, the final item was intended to determine how many persons removed the respondent was from this expert, and thus to determine his expert acquaintance level.

Other surrogate measures of the respondents' social networking can be assessed from the survey's questions regarding the various numbers of conferences, trade associations, seminars, technology user groups, etc that he attends each year. In addition, the level of media usage such as number of trade journal subscriptions, books, as well as vendor/supplier meetings was determined.

The average size of the firms surveyed, measured in number of employees, consisted of a median of 48.5 ranging from a low of 10 to a high of 415. The annual firm revenues ranged from $200,000 to $4.5 million with a median of $3 million. 86.7 percent of the firms were privately held. Firms involved in manufacturing fabricated metal, industrial machinery, and electronics accounted for over 60 percent of those surveyed. The other 40 percent consisted of primary metal, furniture, transportation equipment, stone/glass/clay, and others (which contributed 13 percent).

As targeted, over 80 percent of the respondents were either the CEO/owner or a top level strategic planner/VP/treasurer. 60 percent of those surveyed had an engineering background with the other 40 percent composed primarily of either financial or human resource training. Marketing backgrounds accounted for only 3.3 percent of those surveyed. The average age ranged ranged between 45 and 55 years and the average educational level was a completed 4 year college course. The average respondent considered himself somewhat better than moderate when questioned about their knowledge of advanced technology. As such, it was clear that social networking know-how would come into play for the average respondent. Over 50 percent of the respondents attend trade association meetings and industrial conference annually, both with a median number of 2. 60 percent who continued their education through seminars/courses did so with a median of 2.5 each year. Only 16 percent of the respondents attended technology user groups. The median number of trade journals they subscribe to was reported at 4, with a range of 2 to 12. 76 percent have regular meetings with vendors/suppliers totaling an average median of 5 per year with a range of 2 to 45.

A note of interest is that 72.4 percent of those responding said that they have not encountered problems or tasks that were essentially dependent on advanced technology. Those who did indicate the essential need for technology gave examples of competitive and strategic advantage. Synergy between man and machine were stressed, indicating the importance of information processing throughout the firm. One respondent said that they were losing potential business and competitive advantage through their inability to access the "latest information on cutting tool technology." This same individual also indicated the firm's lack of in-house expertise in computer application development and maintanence. Another individual related the desire for "real time capabilities", both on the shop floor and in customer interaction.

Statistical analysis of the relationships between the survey variable on networking know-how and advanced technology items were performed through non-parametric measures of association and corresponding tests of significance. Because of the non-normality of some of the variable measures and potential bias in assuming interval level measurement, Spearman's r_s, Kendall's tau-b, and chi-square contingency analysis were performed. For the first two analyses, an assumption of either monotonic increasing or monotonic decreasing relationship among two variables measured on the ordinal level was assumed. In both instances, when $N \geq 10$, the sampling distribution statistics can be assumed to be approximately normal and appropriate Z score test of significance can be computed. For the last analysis, the variables are assumed measured at a nominal level.

The results of the analysis[2] show that an individual's within firm network level was positively related to the the number of technologies introduced into the firm and their knowledge of technologies. It was also found that within firm level was correlated with expert acquaintance level suggesting that within firm networks aid as an avenue toward expertise contact. The outside firm measure was also positively related to the individual's knowledge of technology as well as the level of integration of firm's current technologies or systems. The expert acquaintance measure was also shown to be associated with level of integration. At first

[2]All at a minimum significance level of .05 with many below .001

glance, this seems to suggest the the further removed a firm's leader is from a genuine expert in his industry, the greater the chances that the techonologies are not integrated. Upon a closer look at the contigency tables, it was found that this was the case for individual's 2 persons or greater removed. But for respondents who were 1 person removed or said they knew such an expert, the chance of low technology integration was 50 percent. Thus it suggests that while other factors do come into play concerning integration of a firm's technologies or systems, the further removed its leaders are from expert advice the greater the chances of inappropriate fits.

In examining the effects of firm size, it was found that the larger the number of employees in the firm , the greater the probability of knowing a genuine expert. Firm size was also not surprisingly associated with the within firm network. Finally, the firm size was inversely related to ratings of failed technologies. This implies that the larger the firm, the more critical its leaders are towards technologies that failed to be adopted. This may be construed as a tendency towards complacency among smaller firms, possibly due to a lack of awareness of its position relative to competitors.

A composite index was formed, grouping those firms that have had incidents of technologies that were not being used, used and not helping, or used and making things worse for comparision with those successful firms. It was found that a difference between the two groups can be attributed to the level of outside firm networking. It was also not surprising to find the groups correlated with the level of technological integration. The lack of expert advice and appropriate outside firm networking is exemplified by one firm's leader who stated

"We were not aware of specific maintainence required of CNC equipment. Early obsolescence . . .long learning curve. Low programmer loyalty." The same individual in discussing computer usage said that it "has cost us a ridiculous amount of money due to the criminals selling them to the novice purchaser (us)". Another respondent discussing a powder coating machine stated that the "savings as represented by the equipment manufacturers was not there." The same individual discussing reasons why their computer system was not being used enough suggested that a primary reason was the lack of knowledge and ability to learn and adopt quickly.

Thus, while we found a relationship between the level of knowledge of technology a firm's leader has with the level of technology integration in the firm, we also found that social networking in the form of access to expert and outside firm level also aids in technology integration. Within firm networks seems to aid in the number of technologies introduced and in level of expert acquaintance.

4. A Formal Model of Networking Effects On Technology Adoption

Why should social networking contribute to the effective use of technology? If so, how much? An informal answer is that it accelerates organizational learning. If we can formally combine both the networking process and the process of accelerated learning into a model, we may be able to answer the above question, explain our empirical results, make useful predictions, and perhaps systematically design and analyze accelerators based on enhancing social networking. To fix the above concepts, we begin by modeling the simplest situation, consisting of a key person U, who makes decisions about adopting technologies, who also uses it himself, and who is responsible for strategic planning for his firm. In a more realistic model, these three roles would be played by at least three different actors. But that would complicate the analysis while the simplest case still produces useful insights. In addition, among small firms, these three roles often are played by a single individual.

Let the bottom-line variable be P, the probability that U chooses an appropriate technology and uses it effectively to increase the value of his firm as much as possible. P is a function of time, t, measured from, say, $t = 0$ pertaining to when the firm was founded. If U is not technologically, strategically, or managerially sophisticated at $t = 0, P(0)$ would be quite low. But, unles $P(0)$ is too low, $P(t)$ is likely to increase as U learns. It is mathematically convenient and not objectionable on empirical grounds to assume $P(t)$ to be continuous and twice differentiable. Further, it is plausible to assume that the faster U learns, the larger $P(t)$ becomes, since the greater his technological sophistication, the more quickly he can recognize appropriate technological items and ways of using them purposefully and effectively. But this is self- limiting. The rate of learning, $\frac{dP}{dt}$, is also proportional to $P_m - P(t), P_m < 1$, which reflects how much U has yet to learn. Thus, as $P(t)$ approaches P_m, a bound on $U's$ ultimate performance, $\frac{dP}{dt}$ becomes small again.

$$\frac{dP}{dt} = kP(P_m - P), \qquad P(0) = P_o, P(\infty) = P_m \tag{0.1}$$

An interesting, though controversial hypothesis, is the additional condition:

$$\text{If} \quad P_o < P_c \quad \text{then} \quad P_m < P_o$$

$$\text{and if } P_o \geq P_c \text{ then } P_m > P_o$$

This asserts the existence of a critical threshold on U's know-X and talent (X = "how", "who", "what", "where", "why", "when", "how much"), such that if U starts at a level of competence below this threshold, the "learning curve" decreases: it is his error rate that increases overtime and his use of of technology accelerates the rate at which he steers his firms into ruin. Such a U is better off not starting or managing a business. It is, of course, possible that this initial know-X and talent could improve if U initiates another firm, or that some technology could help him compensate for his deficiency. But that is a little like looking for miracles or technological fixes unless specific causes are found that explain the conditions where $P_o < P_c$ would transfer to other situations. Alternatively, this concept of a threshold may not correspond to reality, and thus is subject to empirical test.

The solution to this nonlinear differential equation (1) is the well-known logistic curve or S-shaped learning curve shown (see also fig 1.)

$$P = \frac{P_m}{1 + \frac{P_m - P_o}{P_o} e^{-kP_m t}} \tag{0.2}$$

Five parameters characterize the geometry of this curve (fig 1): P_m, P_o, the coordinates of the inflection point, t_i and P_i, and the slope of the surve at the inflection point, P_i'.

Setting $\frac{d^2P}{dt^2} = 0$, it is easy to see that $P_i = \frac{P_m}{2}$, and $P_i' = k\frac{P_m^2}{4}$ and $t_i = \frac{1}{kP_m} ln \frac{P_m - P_o}{P_o}$.

The following relations among these parameters are evident: Increasing the value of k increases P_i' and decreases t_i. We will see that k is the variable that reflects social networking, while P_i' indicates the greatest speed of learning curve, and t_i indicates how soon that maximum learning is attained. Thus, increasing k accelerates learning. On the other hand, substituting Eqn(2) into Eqn(1) gives

$$\frac{dP}{dt} = k\frac{P_m^2}{(1+\frac{P_m-P_o}{P_o}e^{-kP_mt})^2}\frac{P_m-P_o}{P_o}e^{-kP_mt} \tag{0.3}$$

which increases with k and then decrease to 0 as $k \rightarrow \infty$. Thus, k cannot be increased without bound. An ideal enhancer would also increase P_m, but P_m in this formulation is independent of k unless the threshold P_c is related to k.

Note that Eqn(1) also describes the rate at which the number of infectives in a simple fixed population of size P_m increases. Here k can be interpreted as the number of susceptibiles that an infective infects per unit time. $P(t)$ is the number of infectives at any time. $P_m - P(t)$ is the number of susceptibles.[3]

From what sources does U learn? At least three important sources are available to U after $t = 0$, when presumably his formal education is over. The first source comprises experts in his firm who can serve to stimulate, influence, help, serve as a mentor, and possibly infect him with their enthusiasm as well as biases. The second source consists of counterparts of the above, but outside the firm. The third source includes trade magazines, mass media presentations, advertisements, etc.

Consider first n experts internal to the firm. Each one is analogous to an infective. Let

[3]Deaths, births, immunes, migrants, etc are assumed not to occur in the simplest model. The population consists of only infectives and susceptibles, and initially they are all susceptibles with one person somehow infected from the outside.

$c\,dt$ be the probability that during any time interval, $(t, t+dt)$, U knows such an expert and thinks of asking his advice about selecting and/or using appropriate technologies and/or that such an expert contacts U. Then the probability of a contact with at least one of the n experts during $(t, t+dt)$, assuming independence, is $C\,dt$ where

$$\begin{aligned} C &= (1-(1-c)^n) \\ &\doteq (1-e^{-nc}) \end{aligned} \tag{0.4}$$

The approximation is quite good, with less than 2% error, if $nc > 1$.

At the rate of one encounter per unit time, the probability of at least one encounter with at least one of the n experts, by time t, is

$$\begin{aligned} C(t) &= (1-(1-c)^{nt}) \\ &\doteq 1-e^{nct} \end{aligned} \tag{0.5}$$

Let b be the conditional probability that the advice given by an expert is sound, and will help U choose and use the technology to increase the value of the firm, given a productive contact between U and the expert. Let a be the conditional probability that U will heed the expert's advice and effectively act on it, given that the expert's advice is sound and was contacted; and a' be the conditional probability that U will act as effectively without the expert's advice. Then

$$\begin{aligned} k &= abC + a'(1-b)C \\ &\doteq (1-e^{-nct})(ab + a'(1-b)) \end{aligned} \tag{0.6}$$

Rearranging Eqn(1) and substitution of Eqn(6) for k produces

$$\frac{dp}{P(P_m - P)} = [ab + a'(1-b)](1 - e^{-nct})dt \tag{0.7}$$

The solution of which becomes

$$P = \frac{P_m P_o}{(P_m - P_o)[e^{[a+b+a'(1-b)][\frac{1}{nc}(1-e^{-nct})-1]} + \frac{P_o}{P_m - P_o}]} \tag{0.8}$$

Clearly, k increases with n as well as with c. As mentioned earlier, this accelerates learning. A large n, the number of experts, can compensate for small c, which measures U's awareness and readiness to contact an expert. If n is fixed, then a large c, the social networking parameter, is necessary for accelerated learning.

Suppose that U is not aware that there are n experts in his firm, but he does think of m colleagues in the firm who are not themselves experts, but who are likely to think of one of the n expert. In place of c, consider $c'dt$ to be the probability that U thinks of asking a colleague to refer him to an expert given that U does not know or think of an expert, with cdt being the probability of that colleague naming an expert. With but one expert and one colleague, c is replaced by $c'c$. With one colleague, replace c by $1-(1-c)^n \doteq 1-e^{-nc}$ assuming independence. With m colleagues, $C \doteq 1-(1-c'(1-e^{-nc}))^m \doteq 1-e^{-mc'(1-e^{-nc})}$, again assuming independence. To a second approximation, this is $1-e^{-mc'nc}$. If $mc' > 1$, then $mc'nc > nc$ and $1-e^{-mc'nc} > 1-e^{-nc}$, significantly increasing the probability of a useful contact.

5. Discussion and Conclusions.

How does social networking relate to strategic, organizational, and cultural aspects of successful adoption of technology? First, social networking can be regarded as part of general managerial competence that is independent of the technology. For a given value of c, which in turn specifies k, the organizational learning curve for a particular technology reaches as plateau characterized by P_m. This may be a constant for that firm or for the industry. For example, in the 1950's, propeller-based aircraft technology had attained limits to speed, payload, etc that set bounds on P_m relative to what was possible with jet propulsion-based technologies. The latter technology started its logistic curve before the former reached its plateau and its P_m, or an equivalent parameter, exceeded that of the P_m for the plateau of propeller-based technology. Generally, the advance of technologies can be characterized by such a cascade of logistic curves, though the probabilities, P, will have to be renormalized. Social networking is an aid in adapting from one technology to another, and the organziation which can adapt more quickly and more effectively has a strategic advantage.

In small firms, experts and persons like U are likely to know one another, and no special effort at social networking inside the organization is necessary. As firm size increases, such orgnizational properties as centralization or decentralization become more important. In a decentralized organization, there is at least as much lateral as vertical communication (Kochen and Deutsch, 1980), and social networking is both more possible and necessary for successful adoption of technology. It allows the firm to augment and extend beyond abilities and capacities that its normal hierarchical structure provides by tapping into a system of skills and relationships that always occur, albeit informally.

Corporate culture, such as the operational incentives for employees at all levels to participate, generate a climate that affects successful adoption. Social networking mediates the transmission of such incentives, and of culture more generally. If employees know that when they have a problem, there are others who are both knowledgeable and willing to help them, they will feel more confident of the usage support and will engage more readily in innovative activities.

Where social networking is important and used to advantage, it can be supported, and its value amplified, by sociotechnological aids. Examples of such possible aids are: computerized address database systems designed to automatically remind users of potentially useful contacts at the right time; the use of electronic mail or computer conferencing; automated versions of the "Yellow Pages" or similar directories, programs for tracking trails in the social networking process and for recording accumulated experience.

In stressing the successful adoption of technology, we did not mean to imply that this guarantees a firm's survival. It is conceivable that successful adoption of technology to manage inventories might accelerate the demise of a firm which is competing against others that use just-in-time methods whose goal is to eliminate inventories. Perhaps even worse, the use of such technologies could prolong the agony of the firm's demise. An equal if not even more important function of social networking is to apprise such a firm that the maintenance of large inventories relative to just-in-time strategies could be very decisive in competition.

Our findings suggest that the more a firm relies on within-firm contacts the less they tend to attend to outside-of-firm contacts which is often detrimental. An ostrich-like or complacent attitude can account for lack of awarness of change at critical times. It follows that incentives for, and training in social networking, especially with contacts outside the firm, could be of great value for small and midsized firms in a changing or turbulent environment.

In conclusion, we have presented both an empirical and mathematical argument for the need and active role that social networking gives toward a firm's sucessful adoption of advanced technologies. The results show that managerial competance in the form of networking knowledge is a critical component in the number of technologies introduced and successfully implemented. While within-firm networking was shown to be associated with the number of technologies introduced, it was outside-of-firm and expert acquaintance level that correlated with the successful level of technology integration. Thus, we can speculate that internal networking is vital to manage social and political relationships for technology installation, but access to outside expertise is critical for the *appropriate* adoption and adaptation of technologies.

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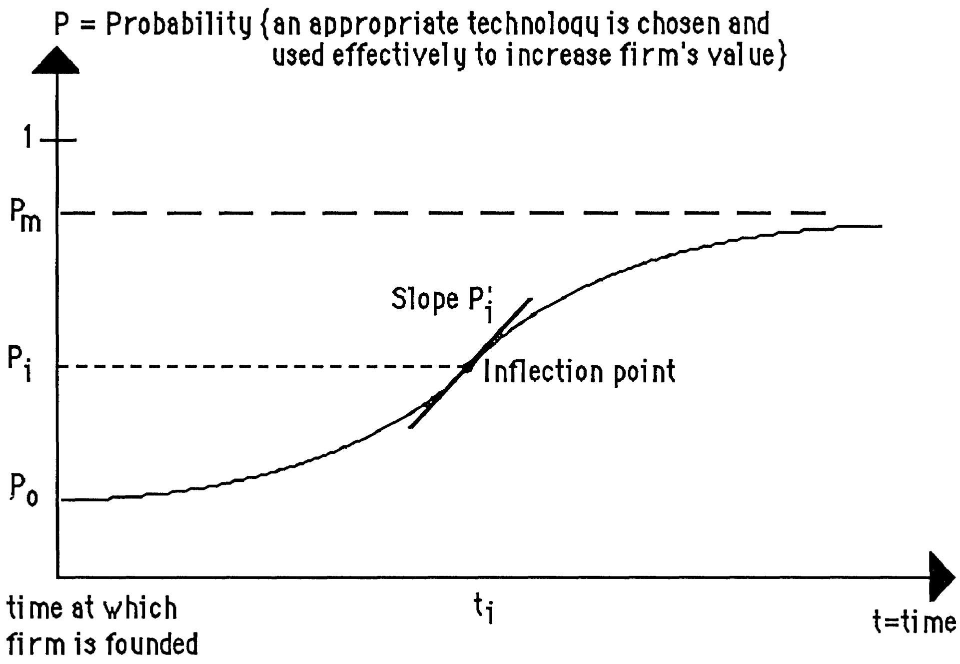

$$P_i = \frac{P_m}{2} \qquad P_i' = k\frac{P_m}{4} \qquad t_i = \frac{1}{kP_m}\ln\frac{P_m - P_0}{P_0}$$

An organizational learning curve

Figure 1