Categorizing IT Innovation by Extent of Change and Location of Impact: A Contextual Approach

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This paper emphasizes the need to take the situational context into account when examining the success of IT innovation implementations. By combining Henderson and Clark's innovation extent of change continuum (incremental, architectural, and radical innovation) with a continuum based on the three organizational levels affected by the innovation (individual, work group and organizational level), important situational factors can be investigated. The Extent of Change/ Locus of Innovation Framework resulting from this combination can be used to characterize IT innovations in contextual terms and to assist in determining the causes for the success or failure of IT innovation implementations. This same framework can be used to analyze innovation contexts other than information technology innovations.

Researchers can use both the extent of change and the locus of impact of the innovation to characterize and study IT innovations. The use of the relationship between extent of change and locus may permit researchers to concentrate on fewer variables or on different variables in studying IT innovation implementation.

Introduction

Innovations occur more and more frequently, more and more rapidly in today's business environment (Adam 1990, Clark 1989, Peters 1989). Particularly in the field of information technology (IT), new developments are being created, refined, adopted and implemented at an astounding rate (Conard 1989). Cooper and Zmud (1990) define IT as: "Any artifact whose underlying technological base is comprised of computers or communication hardware and software." These IT innovations are having a tremendous impact on the organizations in which they are being implemented (Straub and Wetherbe 1989, Clark 1989). For good or bad, IT innovations greatly affect the progress and profit of implementing organizations. It is, therefore, important to understand the ways in which IT innovations influence organizations (Straub and Wetherbe 1989, Gerwin 1988, Barley 1986). We need to develop a better understanding of both the impact of IT innovations on organizations and how best to successfully implement IT innovations into organizations.

There have been many studies on the factors involved in organizational innovations. A number of these studies, from both the innovation literature (Moch and Morse 1977, Downs and Mohr 1976, Dewar and Dutton 1986) and the IT literature (Kwon and Zmud 1987) have produced conflicting results. Most of these studies have focused on too few variables (Tornatzky and Klein 1982) or have used "dissimilar variables and measures" (Ettlie et al, 1984). Many studies have limited their focus to attributes of individuals, managers, or organizations (Zmud 1982, Tornatzky and Klein 1982, Markus and Robey 1988). Several studies have focused instead on the characteristics of the technology, such as complexity and divisibility (Tornatzky and Klein 1982, Fliegel and Kivlin 1966). According to Stasz et al (1990), such studies must focus on 1) the characteristics of the technology, 2) the characteristics of the implementing organization, and 3) the implementa-

tion process itself. Even though such studies should focus on all three of these elements, most studies only focus on one of these elements. It is difficult to learn and to generalize from studies which have not considered all three of these three factors.

Downs and Mohr (1976) characterize an innovation by its primary attributes, on which it can be classified without regard to the implementing organization (the characteristics of the technology itself) and by its secondary attributes, those which are contextual in nature and which depend on the implementing organization. Secondary attributes are not characteristics of the technology itself but instead characterize the relationship between the technology and the organization.

> Variation of a characteristic of an innovation between one study and another, but not within the respective studies, is almost certainly an important source of instability in innovation research. Most, if not all, characteristics upon which one might consider basing a typology turn out to be secondary attributes of innovation" (Downs and Mohr 1976).

In other words, the same innovation may be classified "in different categories for different organizations" (Downs and Mohr 1976). This paper will focus on two of these secondary characteristics in studying IT innovation, the degree of change caused by the innovation and its locus of impact in the organization.

Downs and Mohr (1976) view the primary obstacles to innovation as contextual in nature, involving the interaction between the technology and the organization. This interaction is a result of the changes which the technology causes in the organization upon implementation, or changes in the technology caused by the organization's implementation. These changes may be minor or significant and may be found in interpersonal relationships, tasks, organizational structure and every other characteristic of organizations (Clark 1989). Poole and DeSanctis (1990) posit that it is the organizational and situational context which determines the way in which the IT is implemented, either as it was intended (faithfully) or in ways in which it was not intended (ironically).

Henderson and Clark (1990) focused on the incremental - radical innovation continuum (herein called the innovation extent of change continuum) and developed a new middle point on that continuum which they call "architectural innovation". Their model directs researchers to a new way of classifying IT innovations, leading to increased understanding of their impact and implementation.

Architectural innovation involves changing relationships among the parts (core concepts) rather than changing the parts (core concepts) themselves. The way parts are integrated into a system (or organization) reflects its architecture (Henderson and Clark 1990). Architectural innovations destroy the usefulness of the architectural knowledge of established firms (Henderson and Clark 1990). Where relationships are changed, there is increased uncertainty and an increased need for organizational learning and communication across organizational channels, such as departments or functions, to reduce the uncertainty (Henderson and Clark 1990, Galbraith 1977, Burkhardt and Brass 1990).

Because problems of uncertainty and need for organizational learning can take place at any level in the organization, the attention of researchers, and indeed of management, should be focused on the level in the organization in which these problems are located. Taking this perspective, the locus where learning and communication most need to take place can be determined by analyzing the locus of an innovation's impact; whether the innovation affects the individual, the work group or the organization will determine where the potential interventions for uncertainty and changing relationships need to be focused. When the locus of impact is located away from top management, it may be that the support of top management is less critical to the success of the innovation (Tornatzky and Klein, 1982). The failure of many previous studies to take the locus of the problem situation into account may explain some of the conflicting results on the importance of management support and intervention. Top management support may be important as well, but management support at the level where the innovation is having its greatest impact is the most critical and is the focus of this paper. Researchers and practitioners need to be sensitive to the needs of each locus of impact (individual, group and organizational) and focus primary attention on the most highly impacted locus.

This paper presents a research model combining Henderson and Clark's innovation extent of change continuum and a continuum based on the

locus of the impact. The implications of this classification for successful implementation strategies are presented in the form of managerial interventions which may be instituted at the locus of the innovation's impact. Finally, the implications of this paper for future research will be addressed.

Henderson and Clark framework

The literature on incremental vs. radical innovation has focused largely on the fundamental differences in these two ends of a continuum denoting the extent of change caused by the impact which technological innovation has on the organization (Dewar and Dutton 1986, Ettlie et al 1984). Henderson and Clark presented a framework (see Figure 1) for defining innovation that states well the need for further study on the middle range of the "innovation extent of change continuum" (Henderson and Clark 1990).

	Core Concepts	
Linkages between Core Concepts and Components	***Reinforced***	***Overturned***
Unchanged	Incremental Innovation	Modular Innovation
Changed	Architectural Innovation	Radical Innovation

Figure 1: Henderson and Clark framework for defining innovation

According to Henderson and Clark, incremental innovation "reinforces core design concepts" (parts) and does not change the "linkages between core concepts and components". Incremental innovation is comprised of competence-enhancing innovations which are unlikely to necessitate major changes in the work routine of the organization or in the way its technology and tasks are viewed (Tushman and Nelson 1990). Incremental innovations are characterized by their "lower level of novel technological process content or knowledge and (by) familiarity" (Nilikanta and Scamell 1990, p. 33). Incremental innovations happen slowly and involve isolated functions; they pose little if any risk to those involved (London and MacDuffie 1987). Modular innovation, wherein core concepts are overturned but relationships remain unchanged, will be subsumed under the category of incremental innovation. Because the relationships are unchanged, uncertainty and the need for expanded organizational learning are not increased; therefore, for purposes of this paper, modular innovation is incremental innovation.

Radical innovation changes both core concepts and the linkages between the core concepts. Radical innovation is characterized by the "revolutionary change in technological content or knowledge and (by) lack of familiarity" (Nilikanta and Scamell 1990, p. 33). The more radical a change is, the more difficult and time-consuming it is to implement (London and MacDuffie 1987). Because the changes produced by radical innovations are so pronounced (Dewar and Dutton 1986), management usually understands the need to pay attention to alleviating uncertainty and assisting with changing relationships as well as changing technology and tasks.

With architectural innovation, the core concepts remain unchanged but relationships between core concepts and components are changed. In the manufacturing idiom in which Henderson and Clark were writing, these relationships were between the design core concepts (how things work together) and components (parts). In the information technology idiom which is the focus of this paper, these relationships are between the individuals and work groups in the organization and the work (task) itself. Changes in relationships among individuals, among work groups or between individuals or work groups and the tasks they are to accomplish create uncertainty and require new ways of learning and interacting.

To illustrate the classification of innovations on the incremental-modular-architectural-radical continuum, we can consider an example from the modern workplace: the transition from manual typewriter to microcomputer-based wordprocessor (see Figure 2). If the established technology

	Core Concepts	
Linkages between Core Concepts and Components	***Reinforced***	***Overturned***
Unchanged	Electric Typewriter	Magnetic Card Typewriter
Changed	Dedicated Wordprocessor	PC-based Wordprocessor

Figure 2: Henderson and Clark framework for defining innovation applied to the wordprocessing environment

is that of the manual typewriter, the advent of the electric typewriter with electric return and other electrically run features, is an incremental in-

novation. The user components (keyboard, platen, etc.) are unchanged and the relationships between the user and his/her tasks, other individuals and the organization are also unchanged.

The transition to magnetic card typewriters from manual typewriters is a modular innovation, changing "core concepts" or parts but without changing the relationships between those parts (interpersonal relationships, work groups, etc.). In this case, the keyboard has changed and there is an additional magnetic card unit attached to the typewriter. Although these components are changed, the linkages or relationships between the user and his/her tasks, other individuals and the organization remain the same.

The implementation of dedicated wordprocessors (such as the IBM OS6 or the original Displaywriter) from the manual typewriter is architectural in nature. With the exception of the addition of a viewing screen and a disk drive and changes in the keyboard, the parts did not change. But much more clerical work could be centralized, mass mailings became much easier and were, therefore, used more often, and rapid changes to large documents became possible. This created wordprocessing work groups, creating "secretarial" pools where none had been feasible before. This changed the relationships of the user with his/her tasks, other individuals and the organization. From the managerial point of view, a magnetic disk and screen were simply added to the typewriter. Uncertainty about the nature of work and its locus in the organization was present, but the manifestations of the uncertainty and the need for organizational learning and change were subtle. While the parts -- from management's point of view -- did not change a great deal from the manual typewriter to the dedicated wordprocessor, relationships between tasks and people and between work groups and individuals changed. These are the characteristics of architectural innovation.

Finally, the implementation of the microcomputer-based wordprocessor from any of its wordprocessing predecessors has the potential to radically change the office. Managers can now draft (and produce) their own documents, networks can permit swapping of files and integration of material from various departments and both relationships among individuals and work groups and the parts themselves have changed. Both components and linkages between components and core concepts have been changed. PC-based wordprocessors are, therefore, a radical innovation.

Extent of change and uncertainty

The major difference in incremental and radical innovation is the degree of change anticipated by those affected by the innovation. As new technology is introduced into the organizational environment, changes in interaction patterns may occur due to increased complexity and uncertainty (James and Jones 1976). The uncertainty is caused by the perceived potential for changes in the relationship between the user and user tasks. People are uncomfortable with uncertainty and work to "structure, organize and interpret the world they experience" (James and Jones 1976) in order to reduce uncertainty.

Uncertainty is a critical factor in the organizational environment (Cooper and Zmud 1990) and is the extent to which future states of the environment cannot be anticipated or accurately predicted (Dess and Beard 1984). Innovation implies risk and uncertainty (Mohr 1969). Uncertainty is contextual in nature and poses an obstacle to the implementation of the innovation. According to Mohr, innovation is directly related to the motivation to innovate, inversely related to the strength of the obstacles to innovation and directly related to the availability of resources to overcome the obstacles. Therefore, the more uncertainty the IT innovation causes, the less likely the innovation is to be successfully implemented.

As discussed above, the changes in the relationships between the user and his/her tasks may be insignificant (incremental innovation), subtle but significant (architectural innovation) or profound (radical innovation). These changes cause uncertainty in proportion to the amount of change and so each cell in the framework presented above also represents a degree of uncertainty, increasing as the extent of change moves from incremental to radical. As workers attempt to restructure, reorganize and reinterpret their work and their relationships to reduce uncertainty, implementation may be seriously affected. A user may work to sabotage or slow down the innovation implementation or to change the innovation to fit

the world in which the user is comfortable. Poole and DeSanctis (1990) state that "actual behavior in the context of technology frequently differs from the impacts intended by designers." These unpredicted behaviors are often a result of attempts to reduce uncertainty or to maintain an existing level of certainty.

The capacity for the organization to integrate new learning and to unlearn its "out-dated" architectural knowledge are mechanisms to alleviate this uncertainty and its resulting consequences. According to Henderson and Clark, existing organizations tend to use their traditional information filters, communication channels and problem-solving techniques in implementing innovations. These traditional mechanisms have become embedded in the organization as part of the firm's architectural knowledge (Henderson and Clark 1990, Cohen and Levinthal 1990). Architectural innovations are both competence-enhancing and competence-destroying innovations which alter the way organizations view the technology and the task (Henderson and Clark 1990). In order to develop new ways of viewing technology and tasks, the organization needs to be able to adapt to the innovation by developing new information filters, communication channels and problem-solving techniques -- by organizational learning. "An architectural innovation's effect depends in a direct way on the nature of organizational learning" (Henderson and Clark 1990).

While the definition of architectural innovation seems straightforward, the changes in the relationships among workers and tasks may be so subtle that management may miss the transformations caused by implementation (Henderson and Clark 1990, Dewar and Dutton 1986). Some of the firm's pre-innovation architectural knowledge may "not only not be useful, it may be harmful" (Henderson and Clark 1990) or competence-destroying (Tushman and Anderson 1986). Thus management may not institute the interventions (organizational learning techniques) which could relieve the uncertainty and diminish reliance on old routines. Because architectural knowledge is embedded in the firm, explicit management attention may be needed to change organizational learning and architectural knowledge. Researchers who study IT innovation need to understand that each category of innovation -- incremental, architectural and radical -- may require different techniques for implementation. In fact, it may be that incremental innovation requires little management attention while architectural and radical innovation both require the same kind and amount of management attention to potential problems arising from uncertainty regarding architectural knowledge and relationships.

Locus of impact

Whether an innovation affects the individual or a work group or the entire organization indicates the level at which interventions should be instituted. The locus of the impact (individual, work group or organization) thus forms another continuum on which to categorize innovations. If an innovation affects only the individual, then that individual and perhaps his or her supervisor or manager should be involved in considering which interventions, if any, are needed. Architectural innovations often involve relationships between people, between departments, and even between organizations. Because of the changes in relationships brought about by architectural innovation, architectural innovations usually affect both individuals and work groups, and sometimes the entire organization. Radical innovations can affect any of the three locus categories, or all three, but the amount of the impact can vary. Depending on the organizational locus of the innovation implementation, the management of that level will need to focus its attention on the innovation and implement any needed interventions. While incremental innovations can affect all three of the loci, it may be that only minor attention is needed for incremental innovation at the locus of impact because the change is so small. Events at the organizational level may affect innovation at the group or individual level; researchers must take these events into account even while focusing on the innovation's impact at a different level. Previous studies have shown conflicting results when determining management's influence in imple-mentation (Tornatzky and Klein 1982; Leonard-Barton and DesChamps 1988); this is particularly true of top management. By looking at the level of implementation, researchers seeking to ascertain the determinants of successful implementation may discover that the influence of top manage-

ment is not necessary for successful implementation at any but the organizational level of the IT innovation implementation. For radical innovations having impact at only the individual or work group level, successful implementation may require only the support of the management level immediately above the involved individual or work group.

Categorizing it innovation using the framework

By combining the extent of change and locus continua into a framework, IT innovations can be categorized in a manner which will enhance the researcher's ability to understand and to predict situational requirements for successful IT implementation (see Figure 3). The Extent of Change/Locus of Innovation Framework presents nine categories or cells into which all IT innovations can be classified.

Locus/Extent of Change	*Individual*	*Work Group*	*Organization*
Radical			
Architectural			
Incremental			

Figure 3: Framework for analyzing IT innovation

In order to better understand the Extent of Change/Locus of Innovation Framework, we can consider the case of introducing WordPerfect 5.1 into an organization. Depending on the contextual nature of the implementation, the innovation could fit any cell in the framework. The major factor in determining which of these continuum classifications applies to the particular situation at the individual locus of impact is the change in the relationship between the secretary and her tasks. If the secretary already used another pc-based wordprocessor, the introduction of WordPerfect 5.1 probably would not alter her tasks or relationships very much and would not increase uncertainty by a significant amount; this is an incremental innovation. For the secretary accustomed to a dedicated wordprocessor, WordPerfect 5.1 offers new functions, which lead to new tasks, which lead to changes in the relationship between the user (secretary) and her tasks, increasing uncertainty by a much larger amount than an incremental innovation; this is an architectural innovation. Finally, for the secretary accustomed to using only a typewriter, the range of tasks which can be accomplished by a sophisticated wordprocessor such as WordPerfect 5.1 is so broad that the relationship between the user and the tasks is greatly altered and uncertainty is obviously increased by a large amount; this is easily recognized as a radical innovation. It is the changes in these relationships which mark the movement along the Extent of Change continuum.

Using the same example of the implementation of WordPerfect 5.1, but this time applied to the work group (or department), assume that the work group normally uses pc-based wordprocessors and that all the pc's are interconnected by a network. For that work group, the innovation would likely be incremental while for a work group which previously had relied on a different work group for wordprocessing and had no wordprocessing experience, the innovation would be radical. If, however, the work group had previous experience with pc-based wordprocessors but had never been interconnected by a network, the networked aspect of the innovation would allow the work group to share files, to redistribute work loads, and possibly to connect to other work groups directly. This would likely be an architectural innovation because of the increases in the amount of uncertainty caused by the changes in work group relationships and changes in relationships between the work group and its tasks caused by the sharing of files and redistribution of work loads and by direct connection to others outside the work group.

Finally, at the organizational level, if an organization were to implement WordPerfect 5.1 where before their standard had been Wordperfect 5.0, the innovation would be incremental at the organizational level; very little change of any kind would be necessitated. If the organization had never instituted pc-based wordprocessing, the changes caused by implementation would be radical in nature. For the organization which used WordPerfect 5.0 and implemented WordPerfect 5.1 at the same time as they instituted a network for all of their pc's, the innovation would be architectural in nature; the abilities mentioned above to redistribute work load, share files and communicate data directly with others outside the work group cause changes and uncertainty in

the organization which may be so subtle that management may underestimate the magnitude of these problems.

While it is changes in the nature of the task-technology relationship and the role of the individual or work group which determine the extent of change, there is a moderating variable of the individual or group's experience with such relationship and roles. The greater the experience of the individual or work group with similar relationships and roles, the less radical the change will appear. Previous experience with the technology involved is one of the prime considerations in each of these examples using WordPerfect. Previous experience is negatively correlated with uncertainty. An individual or work group with previous experience with a similar technology should not exhibit a large amount of uncertainty when faced with a new technology.

Thus previous experience is an indicator of the amount of "learning" which will need to be instituted for successful implementation and is an indicator of the amount of change caused by the innovation. In each of these word-processing examples, the amount and kind of changes and uncertainty created by the innovation in the context of the implementing organization determine the extent of change of the innovation. The number and site of employees affected by the implementation determines the locus of impact of the innovation. The contextual characteristics for each of these examples is shown in Figure 4.

As can be seen from the preceding example, in categorizing IT innovations using the framework, several possibilities arise in addition to the possibility of the "one innovation/one cell" assumption. A specific IT innovation episode may apply to a single cell or it may apply to more than one cell. For example, an innovation may be incremental for the organization but architectural for one or more work groups in the organization. Using the WordPerfect example above, if a work group upgrades from a much less sophisticated word-processor to WordPerfect 5.1, the innovation may cause architectural changes in the work group while the impact of this change on the organization would be incremental, such changes being due largely to the new types of output (e.g., equations, graphics) the organization can now receive. Management should examine any potential loci of impact to determine which locus is the most affected by the innovation. Management can then determine where to focus most of its attention on relieving uncertainty. It is possible for an innovation to have varying extents of change in different loci and to require different remedies for uncertainty at each locus. For example, an innovation could be incremental for the individual, radical for the workgroup, and architectural for the organization.

An innovation may have one level of extent of change but apply to several locus levels. Again using the WordPerfect example, the organization-wide implementation of an upgrade to WordPerfect 5.1 from WordPerfect 5.0 would be incremental at all levels, just as the organization-wide implementation of WordPerfect 5.1 as a replacement for manual typewriters would be radical. In such cases, attention should focus on the

Locus/Extent of Change	*Individual*	*Work Group*	*Organization*
Radical	No prior experience; pronounced changes	No prior experience as individuals or work group; networking causes pronounced changes in relationships in/out of work groups	No prior experience as work groups or organization-wide; networking causes pronounced changes in relationships organization-wide
Architectural	Some prior experience with a **similar** technology; changes are subtle and may be missed	Some prior experience with a **similar** technology; changes in relationships in/out of work groups through networking are subtle and may be missed	Some prior experience with a **similar** technology; changes in relationships organization-wide through networking are subtle and may be missed
Incremental	Prior experience with a similar technology; little changes or uncertainty	Prior experience with a similar technology; no new relationships in/out of work groups; little change or uncertainty	Prior experience with a similar technology; no new relationships organization-wide; little change or uncertainty

Figure 4: Framework For analyzing IT innovation examples from word processing implementation

broadest locus of impact, which would be the organization in the preceding example.

These considerations have serious implications for the researcher. By focusing attention on the appropriate cell or cells of the framework, the researcher may more readily be able to ascertain and/or explain the determinants of successful implementation (or the causes of failure). More consistent results in reviewing IT innovation implementation would lead researchers into new as well as refined areas of research.

Interventions to reduce uncertainty: Organizational learning and communication

The need for interventions to resolve uncertainty increases as the innovation moves along the innovation extent of change continuum from incremental to architectural and radical. One can look at the extent of change as increasing from incremental to architectural and radical in the same way; the most extensive level of change in the innovation, therefore, is radical, followed by architectural and finally the least extensive, incremental. In these cases, primary attention for organizational learning should focus on the most extensive level of innovation. Using the WordPerfect example in the previous section, primary attention for organizational learning should focus at the work group level; the organization as a whole only experienced incremental changes whereas the work group had the more extensive (architectural) innovation.

Uncertainty caused by the innovative changes is felt at different levels in the organization. If the change relates only to the individual user, the user may feel isolated by the uncertainty or feel that he/she should be able alone to handle the changes brought by the innovation even though he/she feels incapable of handling the changes. This may result in underutilization or sabotaging of the innovation. In the case of a work group, the uncertainty may manifest itself in uses of power within the work group, with the individual with the least uncertainty achieving a certain amount of power, at least regarding the use of the innovation (Burkhardt and Brass 1990). This may in itself cause changes in the work group. If the entire work group faces more than a small degree of uncertainty, it may work to maintain the status quo of relationships with other work groups and with its own tasks, or it may work to achieve technological power over other groups and to broaden its tasks beyond the scope of the innovation. Finally, like the other loci of impact, organization-wide uncertainty may cause a restructuring or reorganization of work and work relationships that was not intended to occur. This could have a strategic impact on the organization.

In order to promote a smooth implementation, an organization should work to reduce uncertainty at the loci of impact. It is in determining and implementing the best means to reduce this uncertainty that an organization can best enhance the implementation of the innovation and manage the impact of the IT on the organization. An organization which relies on traditional learning mechanisms will fail to see the changes in relationships and task interactions and will not be successful at implementing the new IT technology. Such an organization will not have sufficient absorptive capacity (Cohen and Levinthal 1990) or ability to integrate new knowledge from outside its group or boundaries. An organization will need to cross its traditional organizational/work group boundaries in order to develop and/or refine information filters, communication channels and problem-solving techniques. This is organizational learning. Huber (1991) discussed four constructs which "are integrally linked to organizational learning" (p. 88). These are knowledge acquisition, information distribution, information interpretation and organizational memory. By developing and refining its information filters, communication channels and problem-solving techniques, an organization is enhancing its use of all four of these constructs. The creation of boundary-spanning roles which can promote cross-channel communications among different parties in intraorganizational relationships can enhance the likelihood of successful implementation (Barnett 1990, Tushman 1977, Lucas 1981).

Management can take action to increase the organization's absorptive capacity, or its ability to learn organizationally, thereby enhancing the organization's ability to survive and prosper in an uncertain or volatile environment. The mechanisms for increasing absorptive capacity are similar to those interventions cited for relieving

uncertainty. Communication across organizational boundaries, seeking input from a variety of employees, developing experts who not only serve to inform and train employees involved in the innovation implementation but who also track external developments in the field -- all of these facilitate organizational learning and relieve uncertainty through improved communication and increased absorptive capacity. Training employees in problem-solving techniques so that they feel more able (are empowered) to handle change and uncertainty when it arises is another useful intervention. Improving problem-solving techniques is also another means to improve absorptive capacity.

As can be seen from this discussion, those organizations with higher levels of absorptive capacity should be better able to handle the changes and uncertainty caused by innovation. Organizations should invest consistently and continuously in their absorptive capacity in order to ensure that they are always ready to recognize and handle change and uncertainty (Cohen and Levinthal 1990). Such organizations will have greater abilities for organizational learning and will be better prepared for change.

Use of cross-channel (transorganizational) communication can permit employees to discover how architectural innovation will change their relationships with their fellow employees and to prepare for these changes. A further intervention might be the creation of project groups across the organization to develop cross-channel communication, thereby increasing organizational learning and communication across organizational channels (Henderson and Clark 1990, Galbraith 1977, Burkhardt and Brass 1990). Another intervention might be to ensure that affected employees have an expert on whom they can call at any time and that the employees are aware of this expert and feel comfortable in asking for advice. Another managerial intervention would be to meet with employees who will be affected by the change to inform them and to seek their input, permitting them to feel as though they have some control over the situation and reducing their uncertainty. Training of employees, beginning with the time the implementation decision is made and continuing until the implementation is successfully completed, is another form of both communication and organizational learning which can help to alleviate uncertainty.

Conclusion

This paper has emphasized the need to take the situational context into account when examining the success of IT innovation implementations. By combining Henderson and Clark's innovation extent of change continuum with a continuum based on the three organizational levels affected by the innovation, important situational factors can be investigated. The Extent of Change/ Locus of Innovation Framework resulting from this combination has been used to characterize IT innovations in contextual terms and to assist in determining the causes for the success or failure of IT innovation implementations. This same framework can be used to analyze innovation contexts other than information technology innovations.

Researchers can use both the extent of change and the locus of impact of the innovation to characterize and study IT innovations. Use of the relationship between extent of change and locus may permit researchers to concentrate on fewer variables or on different variables. For example, if a researcher is investigating the effects of top management support on implementation and the innovation being studied is an architectural innovation being implemented at the work group level, the researcher would understand that top management is probably not necessary for that particular innovation; if that particular innovation is used in such a study, the results might conflict with other results and might not be valid or reliable. The use of varying innovation contexts in studying innovation and implementation can result in unstable or conflicting results. By framing research to take place in organizational contexts involving one or a small set of cells in the Extent of Change/Locus of Impact framework, researchers may be able to produce more consistent and reliable results.

Future research should also investigate the presence of the interventions discussed herein, such as cross-channel communication, informing and training employees, seeking employee input and investing in absorptive capacity. The use of these contextual factors may help to control for differences between various studies. By considering

IT innovation implementation in its situational context, researchers may be better able to analyze this phenomenon.

Researchers are currently examining a number of issues in IT innovation which could benefit from incorporating the framework presented in this paper into their research designs. Two such issues are:

User Satisfaction: Melone (1990), Doll and Torkzadeh (1988), Moore and Benbasat (1991) and others have examined user satisfaction with IT innovations. The use of the framework presented here to analyze IT innovation implementation could resolve some of the questions remaining in this area by taking into account in the research design and confounding variables considered the extent of change caused by the innovation and its locus of impact in the organization. For example, in investigating user satisfaction, it is likely that the independent variables influencing user satisfaction for an incremental innovation at the individual level will differ from those influencing this construct for a radical innovation at the work group or organizational level. Researchers attempting to explain user satisfaction need to allow for the nature and locus of impact of the innovations in their research design.

Measuring the Potential Impact of IT on the Organization: Scott-Morton (1991), Mahmood and Soon (1991) and others have examined the potential for IT innovation implementations to influence a variety of organizational variables, such as structure, productivity, performance, profitability and centralization. The use of this paper's framework could add a degree of richness to such studies and could help researchers to understand the failure of many IT innovations to have the positive and significant impact which the implementing organizations intended. For example, in examining the influence of an IT innovation on productivity, it is likely that the extent of change and locus of impact will influence the innovation's effect on productivity differently based on the cell in which the innovation is located in the framework; an innovation which is incremental at the individual level should have little effect on organizational level productivity, whereas an IT innovation which is radical at the organizational level should have a significant effect on organizational level productivity.

These are only two of the issues currently being examined by IT innovation researchers for whom the Extent of Change/Locus of Impact Framework could prove useful. Managers can also discover how better to handle innovation, change and uncertainty. Implementation of at least some of the interventions mentioned in this paper, along with paying attention to the locus of innovation and its concurrent extent of change, should help management to alleviate uncertainty and to maximize the benefits of innovation.

Many of the findings of innovation research have had conflicting interpretations. By considering the situational context, the researcher may be better able to focus research and to understand the true nature of innovation without the conflicting results found earlier.

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