Developing Effective Knowledge-Based Systems: Overcoming Organizational and Individual Behavioral Barriers

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This article deals with the situational theory of management and develops situational guidelines for managers planning knowledge-based system development and introduction within their organizations. It includes a discussion of two specific company situations and the different ways in which the general approaches to implementing knowledge-based systems are applied to meet the unique situational requirements of each company.

Considerable work has been, and continues to be done in an effort to provide a theoretical basis for the structuring and implementation of knowledge-based system development projects, particularly during the expert knowledge acquisition and definition phases. These efforts draw upon several disciplines, including the cognitive, organizational, and individual behavioral areas.

Cognitive studies have, for example, attempted to define conceptual modeling differences between an expert's thinking patterns and the formal thinking pattern representations used in computer inferential reasoning (e.g., Gruber & Cohen, 1987). Other studies have examined different modeling and interviewing approaches helpful in the definition of expert thought processes, translating those thought processes into computer compatible models, and extracting expertise from the expert (e.g., Delgrande, 1987; Evanson, 1988; Garber, 1987; LaFrance, 1987; Mitchell, 1987; Mockler, 1989a, 1989b). Yet other studies, several of which are described below, focus on the factors of organizational and individual human behavior that can affect computer system development projects.

Building on these studies and work done by the authors, this article defines and develops methods to overcome some of the organizational and individual behavioral barriers frequently encountered in developing and introducing knowledge-based systems within a business environment.

Beginning with a discussion of knowledge-based systems and how they are developed, some of the organizational and individual human behavior problems encountered in implementing the system development process are considered. The difficulties in obtaining the expert/user involvement essential to successful knowledge acquisition and system use are afforded special consideration. In conclusion, appropriate methods for two companies, each with unique requirements, are developed to suggest situationally appropriate organizational and management mechanisms to assist in overcoming each organization's particular potential problems.

Expert Knowledge-based Systems and How They Are Developed

Knowledge-based systems are one branch of artificial intelligence (Charniack & McDermott, 1985; Harmon & King, 1985: Hart, 1986; Keller, 1987; Mockler, 1989a; Rauch-Hindin, 1985, 1986), designed to replicate the functions performed by a human expert. For example, DuPont has developed knowledge-based systems to perform such tasks as selecting the right grade and kind of rubber for customers, diagnosing equipment failures, and scheduling machines on the factory floor. Similar systems exist at other companies and offer expert advice in such areas of management planning and decision making in sales management, media and new product selection, financial services, capital budgeting, inventory and distribution management, and configuring computer systems.

Typically, knowledge-based systems enable a user to consult a computer system as they would an expert advisor in order to diagnose what might be the source of a problem, or to determine how to solve a problem, do a task, or make a particular decision. Like a human expert, such a computer system can extract additional information from a user during a consultation by asking questions related to the problem. It can also answer questions generated by a user as to why certain information is required. The computer system is then able to make recommendations regarding the problem or decision at the end of the consultation, and, when asked by a user, will explain the reasoning steps applied in reaching its conclusions.

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These systems are termed "knowledge-based" because they are largely based upon expert knowledge and reasoning processes (called heuristics). Their distinguishing characteristics are that they:

- contain symbolic programming and reasoning capabilities;
- contain a knowledge base about a specific decision domain or situation, which is in large measure distinct from the inferencing mechanism;
- contain an inference engine, or inferential reasoning capability, which is in large measure distinct from the knowledge base.

The term "expert" is applied here only in a relative sense. It refers to persons who perform their jobs well or in a professional manner. The actual job can range from an order entry clerk, to a troubleshooting repair person, to a product planner, to an inventory manager, to a strategy developer. The absolute importance of the decision, problem, or task is not what makes the individual an expert. Rather, the manner in which the particular task is performed is determinative.

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General guidelines for the development of knowledge-based systems have been presented in the works cited at the beginning of this section. As an example of these generally applicable approaches, the following summary suggests one approach often used to acquire knowledge and expertise and to refine situation and system models.

- **Expert observation:** Watch the expert solve real problems in the workplace.
- **Problem analysis:** Explore the kinds of data, knowledge, and procedures needed to solve problems in the expert's area.
- **Problem refinement:** Present the expert with a series of realistic problems to solve, probing for the rationale behind the reasoning steps.
- **System development and refinement:** Once a description of how the expert works has been developed, the expert provides a series of problems to solve using the rules acquired from the interviews.
- **System testing:** The expert examines and critiques a prototype system's rules and structure, as well as the results of a prototype system consultation.
- **System validation:** The cases solved by both the expert and the prototype system are presented to other outside experts.

Each of these general approaches includes a warning such as, "it is clear that it is necessary to adapt these guidelines to the reader's individual company situation." This type of comment is intended to indicate how difficult it is to implement such general approaches in the context of specific company situations.

Organizational and Individual Behavior Factors Affecting Knowledge-based System Development

As other studies suggest (Benjamin & Scott Morton, 1986; Cupello & Mishelevick, 1988; DeLong & Rockart, 1986; Evanson, 1988; Hart, 1986; Hoffman, 1987; Keller, 1987; Leonard-Barton, 1987; Mockler, 1989a; Prerau, 1987), the concept of knowledge-based system development appears to involve straightforward, methodical processes, yet many organizational problems can be encountered in their implementation. These problems arise particularly because expert/user involvement in the development process can be much greater in knowledge-based system development than that typically found in conventional computer system development. This heavy involvement of experts/users has several organizational and individual behavior implications, particularly during the early phases of knowledge-based system development. For example:

- Where managers are developing their own system, these managers need specific analysis and conceptual modeling skills, as well as computer skills, which they might not possess. Insufficient skills can leave in question the manager's job performance capabilities.

- Where a knowledge engineer is involved in working with an expert, skillful management of the interaction with the individual expert, and not just the technical computer knowledge of the engineer is necessary. Very often, knowledge engineers lack sufficient training in both interpersonal relations and conceptual thinking, both of which are required to formulate management decision situation models.

- Where the system under development is large and complex, people within an organization may resist change; new organization patterns may have to be developed to enable the successful development and introduction of a knowledge-based system.
- Except where managers are developing their own systems, expert knowledge-based systems development and use can have a major impact on many functional areas of an organization, creating additional problems and requiring additional management and planning initiatives.

While the focus of this article is on specific individual human problems encountered by a business expert and/or a knowledge engineer when developing a knowledge-based system, the solution to circumventing actual barriers is often found in the organizational and individual behavioral context within which the system is developed.

The introduction of knowledge-based systems into an organization, as the introduction of any new computer technology, can have a dramatic impact on an organization and the individuals within that organization (Dyer, 1984; Hoffman, 1987; Kirkpatrick, 1985; Munson, 1984; Prerau, 1987; Twiss, 1986). For that reason, the successful development and implementation of knowledge-based systems has as much to do with *managing the change process* as it can have to do with advanced computer-based technology. As a result, when introducing new technology, managers must consider such factors as:

- The nature of the technology to be used;
- The kind of decision under study;
- The individuals involved; and
- The organization involved.

Individuals can be apprehensive when confronted with technological change. Change itself, as well as the new technology, can be threatening. Experience also shows that the technology is often not an improvement, may not work, and can have a negative impact on an individual's position in an organization (Buchanan & Boddy, 1982). These types of negative results are particularly common with the introduction of new and advanced technologies such as Artificial Intelligence and knowledge-based systems.

Many factors can affect an individual's reaction to the introduction of new technology. Different individuals interpret change differently and, clearly, not all individuals resist change. Personality variables may also be related to one's propensity to resist change (Stone & Kemmerer, 1984). The adaptation process can, accordingly, vary from individual to individual, as well as from organization to organization. Some will embrace the change quickly, some will never fully accept the changes, and yet others will fall somewhere between the two extremes.

Managing the change process when introducing knowledge-based systems, therefore, involves balancing many factors, including:

- The selection and structure of the management decisions to be computerized;
- The existing company character, organization, and people affected by the new technology;
- The management style used in dealing with individuals involved when introducing the change;
- The selection of technology used to develop and deliver the system; and

- The kind of organizations created to develop and use such systems.

Some of the individual problems encountered in the introduction of knowledge-based systems are discussed in the following section.

Individual Psychological and Emotional Barriers and How They May Be Overcome

One of the most troublesome problems encountered, and the one that most often leads to the failure of system development efforts, first arises during the knowledge or expertise acquisition phase and, later, in the implementation phase. Because knowledge or expertise acquisition involves individual experts and, at times, knowledge engineers, and because successful implementation involves getting individuals to use a system, a major factor affecting success is planning for and managing the impact of the new technology on individuals' attitudes and perceptions (Dyer, 1984; Kirkpatrick, 1985; Parsons, 1985).

The following are some of the common individual psychological and emotional problems (and their solutions) encountered by the authors in their development of over 100 knowledge-based systems, when assisting business managers in their efforts to translate their expertise into usable, reformulated statements or scenarios and diagrams.

1. It is difficult to write succinctly and accurately when relating how a job is done or a decision made. The better a manager is at his or her job, the more difficult this task. A highly competent manager sees all the nuances, exceptions, and ramificiations of various aspects of the problem, decision, or task. These perceptions can make writing a simple scenario model or diagram for problem solving or decision making (the heuristics) very difficult. For this reason, it is often preferable to involve a third party, such as a knowledge engineer, to assist in or complete, this task.

Solution: Focus on a typical specific situation, ignoring exceptions until a later stage. Settle at first for a diagram and written scenario which cover only the most typical situations. This procedure is suggested whether an expert is developing a system on his own, or a knowledge engineer is working with the expert to develop a system (Garber, Johnson, & Zualkernan, 1987; LaFrance, 1987).

As part of this focusing process, it is helpful to compile a list of the expert's potential specific recommendations, given the possible circumstances in the type of decision, problem, or task situation under study. Such simplifications enable a quicker identification of what Evanson and others refer to as an expert's basic "information processing strategy" (Evanson, 1988, p. 40). Such a focused approach also enables a knowledge engineer, where one is involved, to become familiar with the vocabulary or language of an expert in a shorter period ot time. Language barriers have been identified as stumbling blocks in many studies (e.g., Buchanan et al., 1983).

2. Describing one's job is a bothersome job which seems pointless. A competent expert knows how to do his or her job. So, initially an expert has difficulty perceiving the necessity of writing down how they do it. For most people, writing this description is a difficult, nasty, dumb job. This sentiment is particularly true for managers who are "doers" -that is, managers who are successful at getting things done in a pressured work environment. Making a list also takes a lot of time, something which busy people lack. The job can also appear to be an intellectual exercise with no point.

The problem is that without extensive and active participation by experts, the system probably will not be particularly effective. **Solution:** Emphasize the benefits, while acknowledging the negative aspects, of this approach as described in the following paragraphs. If the expert will not sufficiently participate, the project should not proceed because there is a high probability that the project will ultimately fail. In fact, the authors conclude that unless the expert, and sometimes, the user, are willing to actually develop (or participate in the development of) at least a small initial prototype of their own, using an expert system development shell, with the knowledge engineer's assistance where needed, it is not worthwhile to proceed with the development project (Edwards, 1987).

3. There appears to be no payoff. Initially, this lack of reward very often appears to be true to the expert involved. The solution is to review the actual benefits, including:

-functioning as an effective training tool for others;

- enabling more consistent performance; and

- providing a quick reference point or reminder guide for any manager who has multiple jobs to perform under time constraints.

The major payoff, then, can be one of self-interest: many managers find that it helps them to better understand and perform their jobs.

4. Even when recognized, the benefits rarely seem to justify the effort and costs. The costs can be enormous because they involve potential damage to one's ego. The potential consequences include:

- Once the expert has written down how the task, problem, or decision is handled, the magic is gone, and with it the ego satisfaction. Part of the power and satisfaction in a job is the magic that "nobody can do it like ol' George." In reality many jobs in the business world are not that complicated and do not require any true superior competence. Further, when a task is written, it can seem even less complex than it actually is, because only the most typical situations are normally replicated in the system.

Solution: Emphasize the fact that the professional expert will still be needed to handle the tough, exceptional problems, and will likely find more satisfaction when not required to perform the routine tasks.

- A problem related to the fear of automation is the feeling that one will no longer be needed. If an individual helps to create the system, then that individual may naturally assume that his/her services will no longer be required. This fear may likely be true, and accordingly, well-founded, in a general sense because fewer people may be needed in the wake of automation and the least competent workers may be discharged. While truly competent professionals will always be needed and will likely be led to more secure positions, there may be fewer of them in the end.

Solution: Only the better, stronger professionals should be involved in the development of a knowledge-based system. Fearful, insecure, less competent experts are highly likely to sabotage the system development effort.

5. Even for the seasoned professionals, it will be difficult to resolve the conflict between professional instincts. On the one hand, if an individual expert refuses to participate in a knowledge-based system development effort, their professionalism may be called into question. It could be assumed that the individual cannot do his or her job and is therefore not really competent. On the other hand, if the individual expert does participate, enormous time is involved and the end result may be to create a system which replaces or renders obsolete the

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expert. Enormous costs and risks are apparent.

The first step toward a resolution of the conflict is to appreciate the conflict, the dilemma, and how emotionally charged this conflict actually is. If a particular expert is to develop a knowledge-based system and the business needs that expert over the long run, then the expert must be offered sufficient rewards and satisfactions, both real and psychic. It is suggested that this award-based system is the only long term, effective way to motivate professionals who might otherwise fear that their participation in the development of the system may ultimately jeopardize the longevity of their job.

The most effective organizational way to resolve the conflict facing the expert is to involve the expert and, where necessary the user, in the system development and use of the system in a way that offers the expert and user a proprietary interest in the system. Many companies today folllow this example, yet the methods to reach this end can differ markedly in recognition of the individual situational requirements of a company, as is suggested by the following two company studies.

Creating an Organization, Selecting Decisions or Tasks, Developing a Management Style, and Choosing an Appropriate Technology: One Company's Experiences

This section describes one company's experiences in balancing the major organizational and individual behavioral factors affecting knowledge-based system development.

Edward Mahler, who was in charge of the knowledge-based system development at DuPont used a "participative" and "supportive" approach. He reports expert/user "ownership is the key ingredient for success" in overcoming both individual and organizational barriers to success (Mahler, 1986). The following is a brief summary of the DuPont experiences, based on the authors' interviews with Mahler and on Bailey's (1987) study of the company.

Early on, DuPont realized that it was dealing with a new and complex computer technology that was not widely understood or accepted, and that much more expert and user involvement was required than for conventional computer system development. The technology also involved considerably more expert/user interest in the system to ensure the system's use after it was introduced. In addition, the company had widely dispersed and diversified facilities and fairly autonomous local management.

An initial strategy was developed from this situational analysis, designed to help overcome anticipated organizational and individual resistance to the new technology.

- The majority of the organization of the system development effort would have to be done by the operating managers (the experts/users), both for corporate cultural reasons and because it was necessary in order to give the experts/users a proprietary interest in the system, thereby helping them to understand the benefits and payoffs of the systems.

- Experts/users would be required to attend a two-day training session, during which they would walk through the scenario development and system prototyping of a small problem of their choosing useful to them at their job. This procedure would assure both their adequate computer competence and the

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practical usefulness of the system.

- In consideration of the need to strike a balance between the viewpoints of computer technicians and operating managers (users) in the organization and implementation of the development effort, the computer technicians would have to function in a supporting role, with their primary responsibility in assisting the managers build the systems.

- The manager's role was perceived to be one of user, knowledge engineer, system developer, and initiator. In most instances, these multiple roles helped ensure the manager's involvement in the development of, and interest in using the final system.

- The project would have to be allowed to grow from the ground up, rather than being initiated and run from the top down, in order to allow time for an informal support network to develop.

- Early efforts were to be treated as learning experiments (the technology was developing and there were limited benchmark experiences). The capital investment was initially kept low (the risk of mistakes is high in an uncertain environment).

- The operational organization (dispersed and localized knowledge arising from the widely diversified products manufactured nationally) seemed to indicate that small systems would be appropriate and useful.

- Expert system development shells were being introduced, enabling computer literate, but non-programmer, managers to create their own systems requiring low capital outlay and reducing the cost of the anticipated and likely mistakes associated with new projects.

Such a strategic approach, where used in similar company situations, has several advantages:

- It involves the expert/user in a way that helps considerably in overcoming the psychological, emotional, and intellectual barriers to technological change, by making the point, payoff, benefits, and professional justification apparent to the expert/user on the job in a timely manner.

- It reduces the risks involved in the introduction of a new technology by lowering entry costs, by allowing the organization a way to correct errors at a low cost, and by reducing the possibility of experts viewing the introduction as a threat.

- It offers familiarity and encourages the use of the technology to grow more rapidly throughout the organization, which helps to sustain the interest and enthusiasm of the organization and makes the technology less threatening.

- It provides quick, documentable results which help sustain both higher management interest in the project and operating management/user participation.

The project was greatly helped by the managerial style adopted by Mahler, who genuinely believed in his own subordinate, supportive role.

Based upon economic evaluations (Bailey, 1987), DuPont's knowledge-based system development program was successful. Several hundred small expert systems, ranging from equipment failure diagnostic systems to machine scheduling systems, were developed during the first year.

DuPont's approach was also particularly successful in overcoming the individual psychological, emotional, and intellectual barriers described in the preceding section because it provided an organizational and management mechanism for effectuating the solutions to the problems previously suggested. Where a company's particular situation permits, DuPont's approach can serve as a useful model.

Different Approaches Dictated by Different Situations: The Digital Approach

Other types of companies and systems will naturally require different approaches. Martin & Oxman (1988) and Leonard-Barton (1987) describe in some detail the development of the XSEL expert system at Digital Equipment Corporation. This system was designed to support several hundred field sales personnel nationwide in originating computer configuration designs to meet their customers' needs.

The situation characteristics included:

- a need to develop a large and complex system for a major technological corporation by highly trained computer technicians using sophisticated computer hardware and software;
- the use of the system by many sales personnel at widely dispersed geographic locations; the sales people have a wide range of experience in selling, from very little to over 20 years, and an equally wide range of computer literacy;
- a long development and introduction time span, measured in years;
- a need for sophisticated computer hardware and software support designed specifically for users of the system after it was in place.

Such a situation required attention to:

- cultivating experts/users as co-developers, in a situation where users range widely in skills and interests, and where user turnover was high over the development period;
- taking steps to sell the system during development by creating a network of supporters among management and operating personnel involved;
- designing a delivery and support environment which accommodates the specific needs of the personnel and organization involved.

These organizational and managerial steps were all in addition to satisfying technical system requirements.

The following guidelines were developed from the XSEL study for use in situations involving large systems with many users (Leonard-Barton, 1987).

"When the majority of the end users of a system are not able to participate in its development, it is essential to test very early versions of the system to ensure that it meets the needs of all the intended end users, and not just the needs of the experts primarily involved in its development."

1. When developing a large system for use at numerous locations, it is important to find experienced, high-performing experts interested in, committed to, and enthusiastic about working on the system development. These factors contribute to giving the experts/users a proprietary interest in the system, thereby overcoming individual psychological and emotional barriers such as those discussed earlier. In the case of XSEL, this interest was developed through a User Design Group (UDG). The UDG was comprised of experienced, interested experts/users in the Sales Department who heard about the project by word of mouth. Those not truly interested in the development of the system would not be expected to volunteer for a project where their services were so informally requested.

2. When developing large systems to be distributed to a diverse group of users at various locations, systems such as XSEL can benefit by

having recognized, high-performing experts in the problem domain (in this case, sales of computer systems) advocating the system's use and value. In the case of XSEL, the User Design Group, comprised of experienced and successful sales people, accomplished this objective.

- The UDG experts involved in system development were also used to sell the system to the end users. These experts provided a mechanism for helping others, particularly potential users, and overcame any potential resistance barriers.

- UDG members were also used to help sell XSEL to top managers in the sales division. Having multiple experts supporting a system adds credibility to the system before its value is proven in the field. Further, their inclusion enabled superior knowledge to be built into the system, creating a better product.

"Early prototypes with numerous bugs should not be distributed to the general user population. Premature distribution may prejudice users against the final product."

3. When the majority of the end users of a system are not able to participate in its development, it is essential to test very early versions of the system to ensure that it meets the needs of all the intended end users, and not just the needs of the experts primarily involved in its development. The testing can be accomplished by involving a wide range of end users at various stages of the system's development, with particular emphasis on testing in the earliest stages. The system should be able to handle the problems that may seem simple or mundane to the experts but are challenges to those who are less experienced, such as the newly hired, less experienced sales personnel at Digital.

4. Prototype systems should be developed frequently during the system development process as a means of obtaining feedback from experts/users. Where possible, initial prototypes should be developed by experts/users themselves, as well as by users who are not necessarily considered to be experts. Admittedly, this is harder to do in larger projects, such as Digital's, as opposed to a smaller project, such as DuPont's. The prototypes must be working systems and must be promoted only for what they are: tools for obtaining feedback. This step, like the preceding three steps, provides the organizational mechanism, and so the opportunity, needed to focus on overcoming the individual psychological and emotional barriers to system development discussed above.

5. Early prototypes with numerous bugs should not be distributed to the general user population. Premature distribution may prejudice users against the final product. It also creates doubt among the future users of the worth and effectiveness of the system. These early users may not recognize the product as an early prototype used to further refine the knowledge represented in the system.

6. The process of designing a delivery and support environment that accommodates the specific needs of the personnel and organization involved (organizational prototyping) may span the development, implementation, and post-implementation of the system. This design process also considers who the actual users of the system are, how they use the system, and the actual value of the system to the company and how this value should be measured. As the system evolved, it was found that XSEL was used primarily by the sales representatives to verify a configuration designed manually (62%), with others using it to complete a partial configuration started manually (21%), and the remainder (17%) using it to guide the configurations from the outset.

7. Adequate delivery systems, including the proper hardware, should be available to users from the first introduction of the system. Otherwise, innovation assassins (those who

have negative experiences using the system and advise others not to use it) may be encouraged. Such negative publicity may ultimately hamper the integration of the system into established work routines. The availability of sufficient hardware dedicated to the new system can avoid defeat of the system before it gets off the ground.

8. Realistic time frames should be developed for the widespread use of the new system. The system development team should not be rushed into distributing the system by managers enamored of the technology's potential.

9. The system should not be oversold and expectations for the system should not be unrealistically raised. If a properly functioning system is not delivered as advertised or when expected, it will add to the skepticism about the value of the system.

Leonard-Barton's (1987) study conclusions concerning large system development efforts have been confirmed by others. For example, Cupello and Mishelevick (1988) found that because user advocates or champions are so important to the system's success, an equal number of computer technicians and user advocates should be included in the system development team. In addition, because senior management and user support is so important, it is their recommendation that a user advocate head the development team and report directly to the senior management of the user operation. In light of the well-documented potential organizational and individual barriers to system development outlined within this article, such a plan seems to be mandatory.

Leonard-Barton's (1987) study offers a major contribution to the research literature on knowledge-based system development. It is one of the first to deal with the problems of making the technical approach work in an actual organization. Unless these problems, and ways to resolve them, are given attention, organizations risk system development failure.

Other computer system researchers (e.g., Benjamin & Scott Morton, 1986; Buchanan et al., 1983; Cupello & Mishelevick, 1988; DeLong & Rockart, 1986; Hoffman, 1987; Leonard-Barton, 1987; Prerau, 1987) are also working to fill this gap by helping others to anticipate and solve potential cognitive, organizational, and individual behavioral problems encountered in knowledge-based system development, particularly during the knowledge acquisition and definition stages.

Conclusion

The discussion in this article begins with a description of the knowledge-based system development process. Knowledge-based system development, particularly for systems involving management decision making, can require the intense participation of individual noncomputer experts.

Several critical organizational and individual human behavior factors affecting this development process are then identified. One key factor, obtaining the expert/user involvement needed for successful knowledge-based system development, is discussed in some detail. Based on the experiences of the authors and others, specific roadblocks are identified, and ways to overcome these roadblocks, particularly those involving management style, are considered.

In addition to management style, several other factors, including organization structure, task or decision situation definition, and technology selection, as well as their impact on the success of knowledge-based system development are also identified.

This article concludes with a discussion of two specific company situations, and the different ways in which the general approaches described earlier were adapted in their application to meet the differing situational requirements of each company.

At both companies, for example, the objective was to involve the experts/users and afford them a proprietary interest in the system, in order to produce an expert system that would in fact be used to improve operations and profitability. The manner in which this objective was realized at each company, however, was substantially different.

The situational requirements at Digital dictated less reliance on management style and more of a focus on major formal organizational mechanisms to overcome the problems encountered in introducing the new technology in the company. For example, a User Development Group was established, through which experts/users could formally assist computer technicians who developed the system. The guidelines arising from Digital's experiences are applicable to large systems at large companies with multiple users at different locations. The guidelines are clearly not all applicable in the same way to other types of situations.

In contrast, DuPont's situation requirements dictated that an entirely different approach be used to implement the general knowledge-based system development process and to managerially and organizationally overcome the potential individual psychological and emotional barriers to that system development. As an example, individual experts/users at DuPont did their own system development, with computer technicians assisting them in a subordinate role. There was a greater reliance on management leadership style in order to render the project a success.

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