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• N E W D O C •

# MEASURING USER INVOLVEMENT IN INFORMATION SYSTEM DEVELOPMENT

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## ABSTRACT

"User involvement" in information system development and management is generally accepted as an important mechanism for improving system quality and ensuring successful system implementation. This paper critically reviews research to date on user involvement and its relationship to system quality, system use, and user attitudes toward information systems. It presents a multi-dimensional framework for defining and measuring user involvement and explains the process undertaken to validate the framework and derive an adequate measure of user involvement in information system development and management.

## 1. INTRODUCTION

Developing information systems to meet users' requirements has often been claimed to be a major problem of information system design and implementation. A common prescription for solving this problem is "user involvement," participation in the development process by a member or members of the target user group. The concept of user involvement is, however, poorly defined and poorly understood. Practice therefore falls far short of prescription in involving the right users in the right activities at the right times to ensure successful system implementation.

In this paper the concept of user involvement is examined. The prescriptive and empirical literature regarding user involvement is reviewed, and methodological issues regarding its measurement are discussed. A framework for defining and measuring a number of different activities that constitute user involvement is presented.

## 2. PRESCRIPTIONS FOR USER INVOLVEMENT

Many authors contend that user involvement positively affects the success of information system implementation. It has been suggested that a major contributor to system failure is the user not understanding how the system works, an understanding that can be acquired through participation in the system design effort (36). Others have contended that user involvement reduces the probability of

misunderstandings between the systems and user groups (2, p. 173). Another suggestion is that user involvement will "reveal potential resistors and give them their chance to negotiate openly" (15). Lucas (20) suggests that involvement can have direct benefits to the user: it can be ego-enhancing, challenging, and intrinsically satisfying; it provides greater knowledge of and training on the system; and it may allow the user to retain control over system operations.

There are many different ways users can become "involved" in the system development process. One common prescription is for a representative from the user department to be selected as a member of the project team (17, 18, 27, 35). The management level of the user and the degree of involvement may vary widely. Some authors believe that the operating manager is ultimately responsible for the system, rather than a representative of the manager or a staff member, must actively participate in the design process (13, 20, 31). Others have suggested that users take full responsibility for certain aspects of development such as report design and user training (20). It has also been suggested that user management assume the leadership role throughout the entire development process (30).

Steering committees have been recommended as a mechanism for involving executive-level managers in system planning, problem definition, and implementation (18, 20). Charging users directly for development of new systems has also been suggested as a method for

increasing top-level user involvement (7, 27).

In order to involve operating users in the development process, questionnaire techniques have been suggested (5, 17, 20, 26). "County agent" approaches, where a user representative serves as a liaison between the design team and operating users, is another suggested method of communicating with users at all levels (20, 28). "Evolutionary" system design strategies have been suggested to elicit user feedback in development of relatively unstructured systems (1, 3, 4, 23).

Although the prescriptive literature generally suggests that user involvement improves the chances of successful implementation, there is very little indication of why or how this should occur. However, an extensive amount of research has focused on user involvement and other variables as they relate to system implementation and use. The next section provides a brief review of this research.

### 3. RESEARCH ON USER INVOLVEMENT

User involvement has been considered in a number of studies. The variables to which it has been compared fall into three general categories: system quality, system use, and user attitudes toward information systems. The expected relationships among these variables, summarized from previous research, are shown in Figure 1.

Terms other than "user involvement" with similar meanings have been used: "Participation" (16, 20, 32), "a priori involvement" (36), and "influence" (9, 32) have been considered. User involvement has also been considered at two different levels: general involvement in information systems activities within the organization and involvement in design of a specific system.

#### 3.1 USER INVOLVEMENT AND SYSTEM USAGE

The implementation of a computer-based system is usually justified on economic grounds. The system is expected to produce a favorable cost/benefit tradeoff. Unfortunately, it is often difficult or impossible to assess the benefits derived from a system to improve decision-making performance. Once a decision has been made to proceed in one direction it is usually not possible to look at the benefits accruing from alternative actions. Furthermore, even where this data might be determinable, it is not

usually recorded and is, therefore, unavailable for research purposes (9).

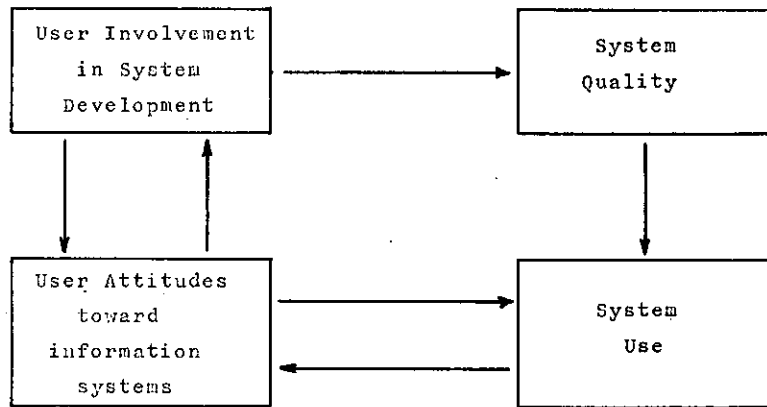
Although it is rarely feasible to judge the economic implications of an information system, it is often possible to evaluate behavioral consequences of system implementation. System usage represents such a behavioral measure of system implementation. Usage has also been considered a surrogate measure of system quality: if the system is used, this is assumed to indicate that it is satisfactory. Usage is only an acceptable surrogate measure when it is voluntary; even in these cases it is a somewhat controversial indicator because whether usage is truly "voluntary" is difficult to determine in many organizational settings.

Usage as a surrogate measure for system quality is expected to vary positively with user involvement. Furthermore, user involvement may increase system usage independently of system quality as the user develops a better understanding of the system and how it works (20).

The evidence supporting a relationship between system usage and involvement is mixed. Several studies have found no significant relationships (10, 21, 25, 33). In other studies weak or moderate support has been demonstrated. King and Rodriguez (16) manipulated user involvement in an experimental planning system. They found that involvement did not correlate with total system usage but did significantly impact the nature of usage. Swanson (36) found a significant (at the .10 level) relationship between "a priori involvement" and "inquiry involvement" (i.e., system use).

Two studies found a positive relationship between user involvement and system implementation, although they did not consider usage directly. Alter (1) found that in only 2 of 18 systems in which user participation was rated as high did users resist using the system. This contrasts with 13 of 38 where user participation was rated low. Furthermore, user-initiated systems were much less likely to experience user resistance than were systems initiated by other groups (4 of 25 versus 11 of 31). Lonnstedt (19) reports similar results for his study of operations research/management science projects. Eighty percent of 64 projects were classified as being successfully implemented when users participated. Only forty percent of 28 systems developed without user participation were successfully implemented. Lonnstedt also showed that seventy-five percent of 43

Figure 1  
 A Descriptive Model  
 Of Expected Relationships  
 Between User Involvement and Other Variable Classes



systems initiated by users were implemented; only forty percent of twenty projects initiated by OR/MS specialists were implemented. Interestingly, ninety-five percent (of 23) projects initiated by top management were implemented successfully.

### 3.2 USER INVOLVEMENT AND USER ATTITUDES

The attitudes of information system users have been examined by many MIS researchers. Several research models have suggested that attitudes will influence system usage (21, 33, 36), user involvement (38) or MIS success (24, 38). User attitudes have in turn been hypothesized to be influenced by user involvement (21, 36).

Most studies examining the relationship between user involvement and attitudes have concentrated on information satisfaction as the attitudinal measure of interest. However, many of these studies consider information satisfaction to be a surrogate measure for system quality rather than a predictor of user behavior. These studies will be reviewed in the next section. Five studies, however, consider the relationship between user involvement and other attitudinal variables.

Igersheim (14) found user involvement in system design activities to be significantly and positively correlated with job satisfaction, job skill, job opportunity, job originality, job status, and job salary in one or more of five organizations investigated. Maish (25) found a significant positive relationship between involvement and a user's "feelings about the information systems staff."

Lucas examined the relationship between user involvement and attitudes in several studies. In two studies (24) he found involvement to be significantly related to "computer potential for administrative/clerical activities" but not related to "user feelings about the information systems staff". In a third study, (22), Lucas found significant positive associations between involvement and "database quality", "model contribution", and "potential of computer-based planning systems". Interestingly, in this study, attitudes about the "user interface" correlated negatively with involvement, suggesting that having users participate in design may have negative implications for user attitudes or for system quality itself.

### 3.3 USER INVOLVEMENT AND INFORMATION SATISFACTION

Information satisfaction is the extent to which users believe the information system available to them meets their information requirements. Information satisfaction is often seen as distinct from the other attitudes we have discussed above. We considered it an attitude as the term has been defined here. However, it normally serves as a surrogate measure for system quality rather than as a predictor of user behavior such as other user attitudes already discussed.

User involvement is expected to lead to greater user information satisfaction (20). However, the evidence is mixed. Spence (34) and Maish (25) found no confirmatory evidence. Igersheim (14) found a significant relationship between user involvement and "system acceptance", while Swanson (36) demonstrated a positive relationship between "a priori involvement" and "MIS appreciation."

Gallagher (11) found that users who had participated in system design activities were more likely to be satisfied with the system than were non-participants. Powers and Dickson (31) found information satisfaction to improve with involvement by operating management personnel but found no relationship between satisfaction and use of project teams containing users as members. Unfortunately, Powers and Dickson provide little information about the measures used in their study. Guthrie (12) found a negative relationship between measures of user participation and "felt need" for information systems.

The only study to examine involvement in different stages of the system development life cycle was Edstrom (9). He found user involvement in "determining project scope" and "systems analysis" stages of the system development life cycle to be positively correlated with a measure of system success as perceived by individuals in four different positions. However, involvement by the user's supervisor in "systems analysis" and "programming" stages of the system development life cycle correlated negatively with the same measure of success.

#### 4. PROBLEMS WITH RESEARCH TO DATE

Although considerable research has been generated focusing on user involvement, the results are inconclusive. We suggest three alternative explanations. First, there may be problems with the methodologies employed. Second, it may be

that the relationship between user involvement and system implementation is more complex than has been assumed in previous studies. Third, it is conceivable that user involvement does not lead to successful system implementation.

Given the state of research to date, we feel it would be premature to conclude that user involvement is unimportant. In the remainder of this paper we shall focus on the other alternative explanations. First we turn to problems with the methodologies employed. Two classes of potential problems concern the definition of user involvement and the measures employed.

#### 4.1 PROBLEMS WITH THE DEFINITION OF USER INVOLVEMENT

One problem with the definition of user involvement generally employed is that it does not distinguish between token and substantive involvement. Kling (17) refers to two forms of involvement: symbolic, where user contributions are essentially ignored, and substantive, where the user actually influences the system design through participation. Lucas (20) points out that having users actually exert influence over the design process is much more difficult, and much more rare in practice, than symbolic involvement.

Another important problem with most definitions of user involvement is that it is viewed as a one-dimensional concept. Researchers generally do not differentiate between types of involvement, such as membership on or leadership of a project team, formal approval of completion of project phases, formal liaison with the information systems group, etc. Some studies (36, 37) have considered involvement in different stages in the system development life cycle, but rarely do studies refer to specific behaviorally anchored activities.

#### 4.2 PROBLEMS WITH THE MEASUREMENT OF USER INVOLVEMENT

Most studies of user involvement rely on user perceptions of user involvement rather than behaviorally anchored measures. Although in many cases behavioral measures are not feasible, the substitution of perceptive measures should be considered cautiously and care taken to establish their validity.

Some comparisons between information systems managers' ratings of user involvement and users' ratings show considerable inconsistencies. Vanlommel and Debrabander (37) found substantial disagreement between the two ratings; they

chose to use the information systems managers' responses, reasoning that "the EDP staff was in a better position to make an expert judgement since a user might be biased by his personal experience with a specific project." Although Kling (17) has hypothesized that information systems managers will overreport user involvement, we found that information systems managers' ratings of user involvement were generally lower than the users' own ratings (29).

Another problem with measurement of user involvement in previous studies is heavy reliance on self-reports, usually measured after the system has been developed. Furthermore, self-report measures of involvement appear frequently on the same questionnaire as measures of other variables of interest, suggesting that common method variance (6) may be responsible for the occurrence of significant relationships.

An important problem with the research to date is the fact that each study has used a different measure, and a somewhat different definition, of user involvement. The lack of generality across studies has severely limited the contribution of this research to our understanding of user involvement and information system implementation.

## 5. A FRAMEWORK FOR DEFINING AND MEASURING USER INVOLVEMENT

We propose that user involvement is a complex, multi-dimensional concept and must be examined as such. Furthermore, it can be defined as a finite set of operations or activities which the user did or did not perform. These activities can be classified by type of users and by the stage in the system development process where involvement by these users is appropriate.

We assume that the degree of user influence in the design process is contingent at least partly on whether the appropriate users participate in appropriate stages of the system development life cycle. Other situational factors, such as organizational structure and individual differences, affect the feasibility of user participation in particular activities.

The three dimensions considered in the proposed framework of user involvement are: specific types of activities in which the user can participate, the level of user (from executive management to operating personnel), and the stage in the system development life cycle. The dimensions of user involvement are shown in Figure 2 and explained below.

### 5.1 SPECIFIC ACTIVITIES

One dimension of user involvement includes all specific activities in which a user might participate. Much of the prescriptive literature on user involvement does refer to specific activities. A typical example is the suggestion to have users as members on, or leaders of, the project team. Other commonly suggested activities in which users can become involved are report design, design of control procedures, and user training.

For measurement purposes, these mechanisms are too general as they stand to adequately demonstrate user influence over the development process. For instance, indicating that a user is a member of a project team does not tell how much time the user spent, or whether she or he had any distinct responsibilities or simply attended group meetings and provided information.

### 5.2 LEVEL OF USER

An important aspect of user involvement that affects the degree of user influence over development is the organizational level of the user who participates. There is some evidence that the level of user participating is critical to successful system implementation.

We differentiate four general levels of users who may be involved in systems activities: executive (top level) management, operational (middle level) management, supervisory personnel, and operating personnel. The fourth category generally included those who would be "information providers" rather than users of system output. It also includes any non-managerial personnel who would be direct users of the system output (e.g., a staff analyst using a decision support system).

Clearly, some activities are appropriate for some organizational levels and not for others. For instance, one would not expect to find operating personnel as members of steering committees (although in some European countries this is standard practice and mandated by law). Neither would one expect to find executive management designing screen layouts (although it might be a good ideal). Other activities, such as membership on project teams, may be done by users at multiple organizational levels. The appropriate level of the user member may be contingent on the organizational context, type of system, and personal characteristics of the "pool" of users who may participate.

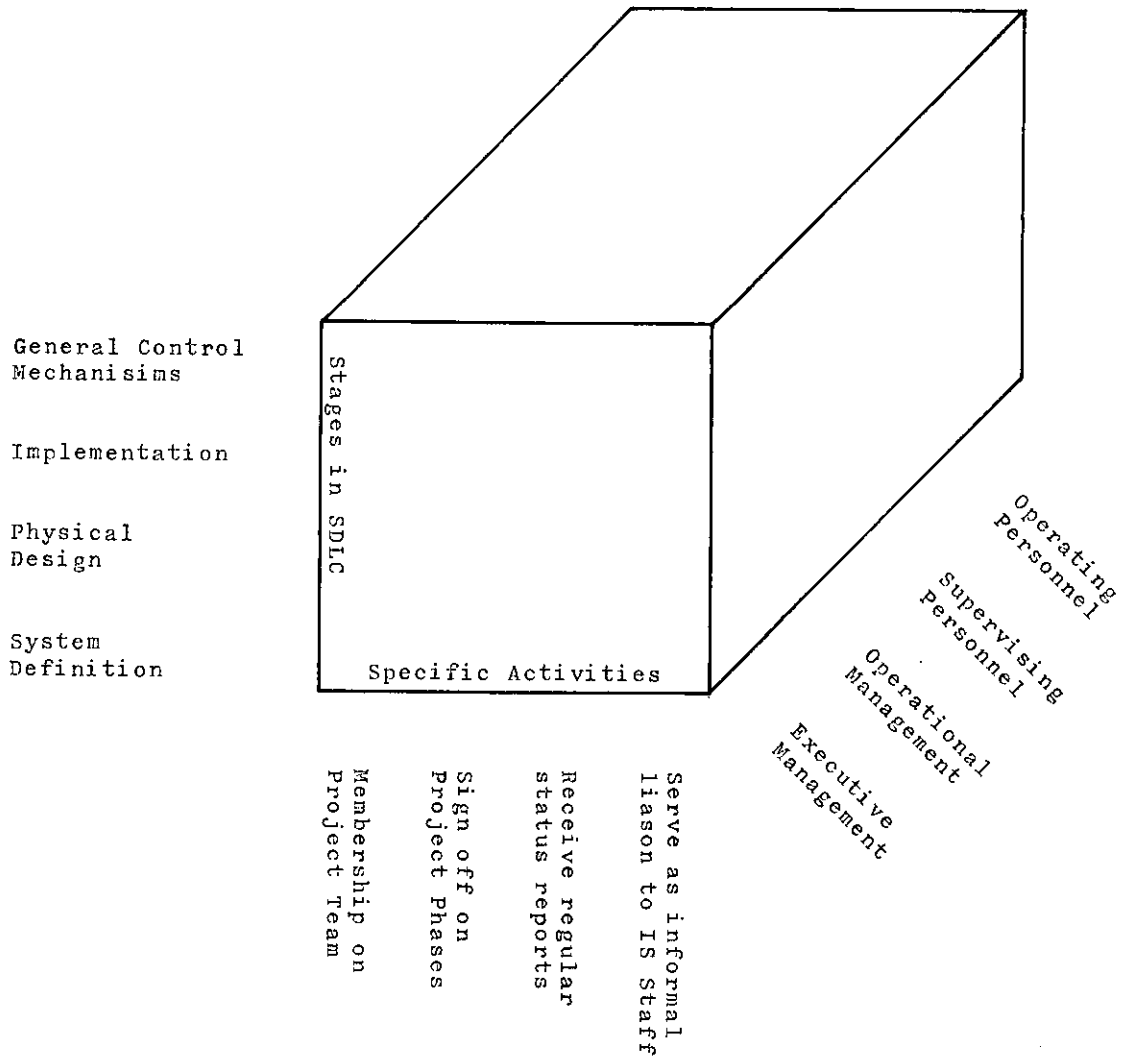


Figure 2  
 A Framework for Specifying Types of User Involvement



### 5.3 STAGES IN THE SYSTEM DEVELOPMENT LIFE CYCLE

The third dimension of user involvement we are considering is the stage in the system development life cycle in which different activities are appropriate. For our purposes, the stages defined by Davis (8) are appropriate:

#### System Definition

Feasibility Study  
Information Analysis

#### Physical Design

System Design  
Programming  
Procedure Development

#### Implementation

Conversion  
Operations & Maintenance  
Post-Audit

A preliminary review of the literature revealed over thirty-five prescriptions for increasing user involvement. Many of these were specific activities taking place during the system development process. A number of others referred to general mechanisms for increasing user control over information systems rather than specific activities. Some examples are user liaisons, steering committees, and chargeback of system costs. In our framework these latter mechanisms are considered separately and not associated with specific stages of the system development process.

Some activities are more appropriate for some stages than for others. On the other hand, activities such as having users as members of project teams can be appropriate at multiple stages. For instance, one might expect middle management users to take part in the feasibility study and information analysis but not physical design and programming.

In Figure 2, the three dimensions are illustrated as a cube. Theoretically, each intersection of specific activity, organizational level, and stage in the system development life cycle represents a potential mechanism of user involvement. In practical terms, many of the intersections are not feasible. In the next section, the method of identifying those mechanisms that are feasible and can be used to exert user influence on the design process will be explained.

### 6. DEVELOPMENT OF THE FRAMEWORK

The framework of user involvement is being derived in a three-stage process. In the first stage, described previously, a review of the literature revealed thirty-five different mechanisms for implementing user involvement. In stage two, a sample of "experts" listed possible mechanisms. In the third stage, a survey has been sent to practitioners to provide information about the practical use of those mechanisms. The second and third stages are described below.

#### 6.1 SAMPLE OF EXPERTS

In the second stage, about fifty people working in the field of information systems were asked to provide a list of "mechanisms for ensuring user involvement in the system development process." Half of the experts were professors in schools of business administration who teach and do research related to the information systems field. The other half were information systems managers who had been in that position for at least six months and had responsibility for both information system operations and development. The questionnaire was designed to be very open-ended, so that the respondent would answer based on his or her own notions of user involvement rather than being guided by the biases of the researchers. The respondent was also asked to specify a target user group where possible.

From the thirty-five responses, a composite list of mechanisms for ensuring user involvement was made up. A comparison with the list derived from the literature showed that all of the thirty-five mechanisms in the original list had been suggested by the experts. However, there were also many new suggestions; after combining similar responses, eighty-one distinct mechanisms were identified. These formed the basis for the activity dimension of the user involvement framework.

The list was further refined in that ambiguous or unclear suggestions were eliminated. Several activities that had been stated in very general terms were also eliminated if other more specific mechanisms could be used (for instance, "communication between users and systems analysts" was eliminated in favor of several specific activities for accomplishing it). As a result forty-seven different specific activities were incorporated into the final list.

The activities were classified by stage in the system development life cycle

and by target user group. The purpose of this exercise was to eliminate those intersections of the three dimensions that were clearly inappropriate (e.g., user training in the information analysis phase). For the sake of simplicity, the three general stages of the system development life cycle were used rather than the more detailed breakdown of phases within each stage. Many activities, such as user membership on project teams, were appropriate at multiple stages and were therefore listed under each one. General control mechanisms not referring to system development activities were listed separately. There were twenty such general mechanisms and twenty-seven activities related to the system development process in the final list. The activities, with system development stage where employed and possible organizational level of user, are shown in the Appendix.

#### 6.2 FEEDBACK FROM PRACTITIONERS

In the third stage, fifty information systems practitioners were asked to rate the activities shown in the Appendix. This group was comprised of managers of information systems activities including both system operations and development, drawn from the same sample as the "experts" but not including anyone who had participated in Stage 2. The purpose of this phase was to eliminate activities representing symbolic rather than substantive involvement, so that the remaining list would represent true "user influence" over the system development process.

Activities were listed on the questionnaire, with system development stage and organizational level of the user specified where necessary. For each activity, respondents were asked to what degree, in their opinion, it was effective in increasing user involvement. They were also asked to rate (on a four-point scale from "almost never" to "almost always") how much that activity was actually carried out in their own organization.

As of the writing of this paper, questionnaires were being returned and the data had not yet been analyzed. The results of the third stage will be presented at the Conference on Information Systems.

#### 7. RELEVANCE OF A FRAMEWORK FOR MEASURING USER INVOLVEMENT

We believe that the framework proposed here for measuring user involvement is an important contribution to the field of information systems. For reasons

identified earlier, previous measures have been inadequate. This framework is substantially better in two ways: it identifies specific behaviorally-anchored, relatively unambiguous activities, and it includes only those activities that can represent substantive rather than symbolic involvement.

#### 7.1 RELEVANCE TO INFORMATION SYSTEMS RESEARCHERS

We believe this framework can provide a significant contribution to research on user involvement. The adoption of such specific relatively non-ambiguous instruments can afford comparisons of results across studies that is now not really feasible. The framework developed here can be used to develop such an instrument. One major advantage is that such an instrument refers to behaviors rather than perceptions of involvement or influence which are often biased or misleading.

#### 7.2 RELEVANCE TO INFORMATION SYSTEMS PRACTITIONERS

We believe the framework can be useful to practitioners because it provides a concise summary of mechanisms that can be employed to ensure user involvement. Having evolved from the feedback of other information systems practitioners, it helps the manager eliminate mechanisms that are unfeasible or ineffective. For instance, many organizations have attempted to appoint user liaisons out of the pool of operating personnel in a user department; this tactic has generally been unsuccessful, primarily because such a person does not have the authority or knowledge to communicate effectively with both sides and "get results" (28). It is expected that this mechanism (for that organizational level) will be eliminated from the framework based on feedback from practitioners that it is ineffective in eliciting user involvement.

#### 7.3 RELEVANCE TO INFORMATION SYSTEMS USERS

We are concerned about the growing demand on the part of users for more control over their own information services and their potential lack of knowledge and expertise to handle this control effectively. This framework communicates to users as well as information systems professionals which activities are effective for them to exert true influence over the system development process and eventually obtain greater control over it. We call on both users and information systems managers to work together to identify those activities in their own organizations that will

facilitate true user involvement in and control over information services. The trend toward decentralization of control is strong and continuing. We hope this framework and other ongoing related research can help prepare both sides for this trend.

## 8. CONCLUSION

"User involvement" is an accepted commandment of the information systems profession. Despite the abundance of prescriptions for its adoption, however, there has been surprisingly little research investigating its usefulness. The research that has been done has produced equivocal results. Future studies need to employ more rigorous research methodologies and validated measures of involvement. This paper has presented a first step toward providing such a measure.

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Summary of Activities Constituting User Involvement

Activity	Stage in System Development Life Cycle					Level of User		
	System Definition	Physical Design	Implementation	General Control	Executive Management	Operational Management	Supervisory Personnel	Operating Personnel
User as member of project team.	X	X	X			X	X	X
User as leader of project team.	X	X	X			X	X	
Users take entire responsibility for this stage.	X	X	X			X	X	
Users formally review and approve work done by IS staff.	X	X	X		X	X	X	
Users draw up, and sign off on completion of, a formalized agreement of work to be done by IS staff.	X	X	X		X	X	X	
IS staff informs users on progress and problems of this stage (no user evaluation).	X	X	X		X	X	X	
IS staff solicits project proposals and requests from users.	X				X	X	X	
Users develop cost justification for project.	X				X	X		
Users evaluate and approve cost justification developed by data processing.	X							
Users develop information requirements.	X				X	X	X	X
Users evaluate and approve information requirements developed by IS staff.	X				X	X	X	X

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APPENDIX

Activity	Stage in System Development Life Cycle					Level of User		
	System Definition	Physical Design	Implementation	General Control	Executive Management	Operational Management	Supervisory Personnel	Operating Personnel
Users are interviewed by IS staff.	X				X	X	X	X
Users respond to questionnaires administered by IS staff.	X				X	X	X	X
IS staff develops a prototype system for the users.		X			X	X	X	X
IS staff presents a "system walkthrough" for the users.		X			X	X	X	X
IS staff follows a "structured design" methodology.		X				X	X	X
Users define system controls and security procedures.		X				X	X	
Users review system controls and security procedures defined by IS staff.		X				X	X	
IS staff develops a "user friendly" system.		X				X	X	X
Users define I/O forms, screen layouts, report formats, etc.		X				X	X	X
Users develop test data specifications.			X			X	X	X
Users review and approve results of system test done by IS staff.			X			X	X	
Users perform system training.			X			X	X	X
Users design training program to be conducted by IS staff.			X			X	X	

Activity

Stage in System Development Life Cycle

Level of User

	<u>System Definition</u>	<u>Physical Design</u>	<u>Implemen- tation</u>	<u>General Control</u>	<u>Executive Management</u>	<u>Operational Management</u>	<u>Supervisory Personnel</u>	<u>Operating Personnel</u>
Users create system procedures manual.			X			X	X	X
IS staff holds an "event" to introduce the system to users.			X			X	X	X
IS staff rewards "willing" users (e.g. providing their own terminals).			X				X	X
All system development costs are charged back to users.				X	X	X		
Users are responsible for budgeting for their own system development projects.				X	X	X		
Users define system development standards for information services.				X	X	X		
A user steering committee does long-term planning for information systems.				X	X	X		
A user steering committee sets priorities for new system projects.				X	X	X		
Users are responsible for their own hardware and software acquisitions.				X	X	X		
Systems Analysts are assigned to, and located in, user departments.				X				
The manager of information services is from a user function rather than data processing.				X				

Activity	Stage in System Development Life Cycle							Level of User	
	System Definition	Physical Design	Implementation	General Control	Executive Management	Operational Management	Supervisory Personnel	Operating Personnel	
There is a formal request process for users to initiate information systems activity.				X	X	X	X		
A member of the IS staff acts as "formal liaison" to information services.				X	X	X			
A member of each user department acts as "formal liaison" to information services.				X		X	X		
Project management schedules and progress reports are made available to users.				X	X	X			
Information services provides technical seminars to educate users.				X	X	X	X	X	
User time on project teams is included in project budgets.				X		X	X	X	
Users are evaluated by their own management on their performance on project teams.				X		X	X	X	
Users have responsibility for system success rather than the IS staff.				X	X	X			
The IS staff is rewarded on the basis of user evaluations of system success.				X	X	X			



THE SYSTEMS DEVELOPMENT PROCESS:  
A DATA-THEORETIC APPROACH

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ABSTRACT

This paper describes the logical design of a data base to support the software development process by analyzing the information content of common systems analysis techniques such as IBM's Business Systems Planning, structured analysis, structured design, and data base design. It is shown that these techniques can be represented in a single data base schema. The data base can be extended to allow for project control.

1. INTRODUCTION

The development of information systems that are truly responsive to user needs has proved to be a deceptively complex, error-prone, and expensive process. Much research has been directed to improving the process over the last 20 years and many different approaches and techniques have been tried. This paper provides a framework for systems development by proposing a conceptual data base model or schema of the information needed to specify a software project through several stages of its development. The model provides a basis for comparing and integrating different systems analysis techniques. Given the conceptual schema in network form, the software development process can be viewed from a data theoretic point of view as developing an instance of the database through iterative traversals of the network.

The schema is developed by integrating the data models underlying three well-known formal systems analysis techniques (1) IBM's Business Systems Plan (BSP) (12), (2) Structured Analysis (DeMarco (9), and Gane and Sarson (10)), and Structured Design (Myers (19), and Yourdon and Constantine (28)). With some exceptions the combined information requirements for these three techniques span those for many other systems analysis techniques such as ADS (20), the ISDOS group's PSL/PSA (23), Systematics (11), HIPO (13), and the ISAC approach (18).

The model covers the following stages of the 'structured life cycle' (DeMarco (9)): (1) Feasibility Study, (2) Structured Analysis, (3) Structured Design, (4) Coding, and (5) Testing. However, the coding and testing phases are

not discussed in detail. A final section of the paper extends the data base model for the purpose of project control.

A data model of the systems development process can be useful in several different contexts. First, it can be used to design a coherent set of documentation standards and to specify alternative possible sequences for their development over time. The actual sequence in which the various pieces of information should be gathered and documented will depend on the particular project deadlines, scope, manpower allocation, etc. and the strategy chosen for the development process. Possible strategies in this sense range from relatively strict adherence to the stages of the development life cycle, with some looping back to earlier stages to prototyping, where the latter strategy is most useful in novel and unstructured situations; e.g., Decision Support Systems (Keen and Scott-Morton (14)).

Secondly, the schema can be implemented using any conventional Data Base Management System (DBMS). In this way it can serve as an extended Data Dictionary containing a repository of information about the systems being developed. The ultimate objective is to have the data base maintain the complete system specification in machine readable form using text-processing and interactive graphics for input and output. However, the viewpoint adopted in the illustrations in this paper is that much of the documentation will remain in hard-copy form in project diaries, designer's note books, etc. The database will contain key summary information and act as an index to the remaining documentation. Thus a