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Current Practices in the Development of Decision Support Systems

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ABSTRACT

Decision support systems are one of the latest developments in computer-based information systems. There are a variety of indications that their development differs in important ways from other types of information systems. This article reports the findings of an investigation of how 18 decision support systems were developed. Six major areas were explored: (1) the nature of the developmental approach; (2) user involvement in system development; (3) the time required for system development; (4) the incorporation of the decision maker's style in the system; (5) the role of information systems and operations research/management science personnel in the developmental effort; and (6) specific procedures and techniques used in system development.

Introduction

Beginning in the late 1960s, there appeared a type of computer-based information system (CBIS) with capabilities and characteristics different from previous systems. Unlike electronic data processing (EDP) or management information systems (MIS), these decision support systems (DSS) have had a significant impact on semistructured and unstructured decision making in a growing number of organizations. They emerged in response to managers' and others' needs for decision support, evolving computer hardware and software technology, and a growing understanding of what is required in order to support difficult decisions.

Early in the evolution of DSS it became apparent that traditional DBIS developmental methodologies, such as the systems development life cycle, were often inappropriate for DSS. The decision-making environment changes too rapidly to allow a formal set of system specifications to exist for long. Decision makers are unable to specify in advance exactly what their information needs are. CBIS professionals are unable to make timely delivery of the types of systems needed.

Alternative development methodologies were suggested under a variety of names: adaptive, evolutionary, heuristic, and middle out. These methodologies contain several elements in common. Small, tentative systems should be built, used, and modified as needed. The system should reflect the user's decision-making style.

The user should be an integral member of the development team. The system should be built quickly, using the latest computer hardware and software technology. Development should be in the hands of users rather than CBIS professionals.

These generalizations have been applied to a number of decision support systems, however, it has been the authors' experience that some decision support systems are developed in ways that differ considerably from the generalizations. Because of this, the authors conducted a survy of 18 decision support systems to determine how they were developed. Six major areas were explored: (1) the nature of the developmental approach; (2) user involvement in system development; (3) the time required for system development; (4) the incorporation of the decision maker's style in the system; (5) the role of CBIS and operations research/management science personnel in the developmental effort; and (6) specific procedures and techniques used in system development. The survey's findings provide an expanded and enhanced perspective of how decision support systems are currently being developed. Also provided is a discussion of what factors appear to influence DSS development. Since all the DSS were reported as being successful by their users the findings and discussion may provide helpsul insights for DSS developers.

Relevant Literature

NATURE OF THE DEVELOPMENTAL APPROACH

DSS development can be considered from either a micro or a macro viewpoint. The micro viewpoint focuses on the development of a *specific* decision support system while the macro viewpoint is concerned with how *all* decision support systems in an organization are developed. While both viewpoints are important, nearly all research has been directed toward the development of a specific DSS (an exception is the work of Sprague and Carlson, 1982). Our study also takes the micro viewpoint, and any further reference to DSS development refers to the creation of a specific DSS.

In the literature there is a virtual consensus that the developmental approach for a DSS should differ from other types of CBIS. It is suggested that because of the difficulty of initially specifying information requirements, possible changes in the decision-making environment, and changes in the decision-making task, the development of a DSS should be iterative and evolutionary in nature with rapid feedback at all stages. Keen (1980) states that "...DSS is relevant to situations where a 'final' system can be developed only through an adaptive process of learning and evolution" (p. 15).

USER INVOLVEMENT IN DEVELOPMENT

User involvement is not a new concept in the development of any DBIS application, but is has received particular attention with regard to DSS. Again, a virtual consensus exists with regard to a need for user involvement in DSS development. User involvement, however, takes on a slightly different meaning with regard to a DSS. With traditional computer applications, users are primarily involved in the definitional stages and the users are frequently non-management. With regard to DSS development heavy user involvement is advocated throughout the developmental process and with a significant amount of direct management participation. Many researchers advocate not only user involvement (management and non-management), but also user control over the project, thus requiring continuous involvement and responsibility (McLean, 1979; Naumann and Jenkins, 1982; Sprague, 1980; Sprague, 1982).

DEVELOPMENT TIME

Length of the developmental effort is difficult to specify since many DSS are never "finished" but, rather, continuously evolve. Some research indicates that the total time for a useful working system to evolve is measured in days, weeks, or occasionally months. Keen (1981) has indicated that survey results suggest a short time period, with completion times ranging from 1 day to 20 weeks.

INCORPORATION OF DECISION-MAKING STYLE

Over the years considerable attention has been devoted to providing information to managers in ways that increase the likelihood that it will be used and will improve managerial performance (e.g., summary versus detailed reports, graphical versus tabular output). In the case of DSS, this concern has been expanded. Many researchers even suggest that a DSS should conform with an individual user's decision-making style (Keen, 1981; McCosh and Scott Morton, 1978; Scott Morton, 1981). On the other hand, Sprague (1980) presents the view that if a DSS is to support the varying styles of multiple users, then the DSS should not capture a single pattern. Huber (1983) states that " in practical terms... the DSS design effort should be directed toward creating a DSS that is flexible, friendly, and that provides a variety of options. If this focus is adopted, the matter of an *a priori* determination of the (individual) user's style as a basis of identifying the most appropriate design becomes largely irrelevant" (p. 575).

Another consideration not addressed in the literature is the maintenance of the decision maker's style when actual interaction with the DSS is through an intermediarry. In these cases, additional issues must be considered, including the availability of the decision maker to the intermediary, access by the intermediary to the DSS, and the speed of the system's response.

ROLE OF CBIS AND OR/MS IN DSS

There is considerable speculation about the relationship between DSS and CBIS and OR/MS in terms of resources and personnel. Blumenthal (1981) states that DSS and other CBIS activities " simply do not mix" and that both organizational location and use of resources must be kept separate. Sprague (1981) indicates that the location of DSS development seems to be moving in a decentralized way into the functional areas. Locander, Napier and Scamell state that "the information processing professionals must be highly involved with the users during systems development" (p. 54).

Operations research/management science professionals now recognize the potential that DSS has for their profession. Because of the important role that models play in the functioning of a DSS, many researchers believe that the OR/MS professional will play an active role in the incorporation of models in DSS. However, other observers see only a limited role for the OR/MS professional.

DSS DEVELOPMENTAL TECHNIQUES AND PROCEDURES

The development of DSS requires various technical capabilities as well as specific project management techniques. Sprague (1980) suggests that there are three levels of DSS technology. The first is the specific DSS, which is the hardware and software system used to support a specific set of decision-making tasks. Then there is the DSS generator or a package of related hardware and software which provides a set of capabilities to quickly and easily build a specific DSS. Finally, there are DSS tools which are hardware and software elements used to directly create a specific DSS or are incorporated as components of DSS generators. There is little evidence to indicate the percentage of decision support systems developed from DSS tools as compared to DSS generators.

Sprague has suggested management of the developmental process through the use of milestones, checkpoints, and documentation. Bennett (1983) suggests "yardstones" as opposed to milestones for more frequent feedback/evaluation. However, in a study of users of a particular DSS generator, Keen (1981) found that very few formal management review techniques were used. In particular, he found less than 16 percent of the DSS surveyed had used any form of project documentation.

The Study

STUDY METHOD

A field study with personal interviews was selected as the method for obtaining the desired information. This methodology was believed to be appropriate because of the depth and breadth of information desired in topic areas which, in some instances, are poorly understood. Personal interviews minimized terminology problems and allowed probing into interesting and relevant areas.

The actual interviews required 2 to 3 hours with the highest ranking individual in the company who had a high level of interaction with the DSS. In all cases, the interviewee was either a high ranking decision maker (president or vice president) or a high ranking assistant to the decision maker (senior financial analyst or middle manager). The interviewers used a questionnaire to structure the interview, but responses were tape recorded rather than written to allow for a fluid and probing discussion.

SAMPLE SELECTION

In order to minimize the cost of conducting personal interviews and to maximize the likelihood of locating a sufficient number of organizations with a DSS, the Atlanta and Dallas-Fort Worth metropolitan areas were chosen as the study sites. These areas were selected because of easy access and because a large number of organizations are located there.

The companies to be studied were determined by contacting major corporations in which upper-level decision making would most likely be concentrated. The companies contacted were chosen from published lists of Atlanta and Dallas-Fort Worth based corporations and from referrals by colleagues and other company officials. Selection was based on telephone interviews with the highest ranking company official knowledgeable about the existence of a DSS in their organization (e.g., vice-president for information services). To decide whether or not an organization had a DSS, the criteria presented below were used. Every firm included in the study had a DSS which met the essential criteria and most of the decision support systems also satisfied all of the additional criteria.

Essential Criteria for a DSS

- Supports, but does not replace decision making
- Directed toward semistructured and/or unstructured decision-making tasks
- Data and models organized around the decisions(s)
- Easy to use hardware and software interface

Additional Criteria for a DSS

- Interactive processing
- DSS use and control is determined by the user
- Flexible and adaptable to changes in the environment and decision maker's style
- Supports all phases of the decision-making process

Eighteen companies were selected from a total of 109 initial contacts. Of these 18, one was used to pre-test the interview process and was, after repeat interviews, included in the total sample. Table 1 lists the 18 companies and the purpose or use of the DSS in their organization.

INTERVIEW DOCUMENTATION

The findings from the interviews were documented in two basic formats: individual company case studies and

Table 1

Sample Companies and DSS Use

Company	DSS Use
American Airlines	Price and Route Selection
American Petrofina	Corporate Planning and Forecasting
Central and Southwest Corporation	Corporate Planning and Forecasting
Champlin Petroleum	Corporate Planning and Forecasting
First United Bankcorporation	Investment Evaluation
Frito-Lay, Inc.	Price, Advertising, and Promotion Selection
General Dynamics	Price Evaluation
Gifford-Hill and Company	Corporate Planning and Forecasting
Lear Petroleum	Evaluation of Potential Drilling Sites
Mercantile Texas Corporation	Corporate Planning and Forecasting
National Gypsum	Corporate Planning and Forecasting
Southern Railway	Train Dispatching and Routing
Texas-New Mexico Power	Corporate Planning and Forecasting
Texas Oil and Gas Corporation	Evaluation of Potential Drilling Sites
Texas Utilities Company	Corporate Planning and Forecasting
The LTV Corporation	Terms of Sale of Downtown Office Tower
The Western Company	Corporate Planning and Forecasting
Zale Corporation	Evaluation of Potential Store Sites

summary tables across companies. The case studies allowed the researchers an opportunity to capture a complete picture of each individual DSS. The summary tables provided a comparison of all of the 18 decision support systems examined.

The Findings

NATURE OF THE DEVELOPMENTAL APPROACH

During the interviews the researchers discussed the characteristics of both ends of a continuum of systems development methodologies. At one end was the systems development life cycle approach traditionally used with computerized applications. At the other end was the evolutionary approach advocated for use with DSS. After this discussion, the company official was asked to indicate on a 7 point scale which developmental approach was used. A 1 represented a pure SDLC approach and a 7 a pure evolutionary approach.

The summarized responses to this question are shown in Table 2. The data show that most DSS (two-thirds in this survey) employ an evolutionary development, though perhaps not in a pure sense. The number of DSS (one-third) falling on the SDLC end of the continuum is larger than one might expect after reading the literature. The conclusion is that while evolutionary developmental approaches are in the majority with DSS, there is considerabe variation in the approaches employed.

USER INVOLVEMENT IN DEVELOPMENT

The stages in the development of a DSS were described in the interviews as including: the initial idea for its creation; the specification of information requirements; the building of the DSS; testing; demonstration of its operation and capabilities; and its final acceptance. For each of the stages company officials were asked whether personnel at the various managerial levels were involved not at all, slightly, moderately, or heavily. The percentage of managers who were at least moderately involved (i.e., moderately or heavily) are presented in Table 3.

Several observations can be made about the data. First, the "All" column which shows user involvement independent of managerial level (i.e., lower, middle, or top), reveals that there is substantial involvement at all stages. All of the companies indicated at least moderate user involvement for the idea, information requirements, and acceptance stages. Also evident from the data is that top management had almost no involvement in building and testing their decision support systems and had only a small role in their demonstration. In the case of middle management, there was considerable involvement at all stages of the developmental process. The generally low

Table 2

Developmental Methodology Used

Developmental Approach*			Percentage of Companies
Life Cycle	1		5.5
	2		11.1
	3		16.7
	4	0	
	5		27.8
	6	22.2	
Evolutionary	7		16.7
			100%

*Measured on a 7-point scale with a 1 equal to a pure SDLC approach and a 7 equal to a pure evolutionary approach.

levels of involvement by lower management can be explained by the fact that the systems studied were almost exclusively designed to support middle and/or top management decision making. In general, these findings are consistent with those reported elsewhere.

DEVELOPMENT TIME

Investigating the time required to develop a DSS is difficult because a DSS is never completely finished. By its very nature it is expected to evolve. This problem was addressed by asking company officials to indicate how long it took to develop the initial "final product." This term was explained to mean that the DSS had passed the acceptance stage. Their responses are shown in Table 4.

The overall impression is that the time required to develop a DSS can vary considerably. Twenty-eight percent of the DSS studied were developed in less than a month, but 39 percent required a year or more. Some of the DSS were used to support decision making before they took their final form. However, the majority of the DSS which took a year or more to complete were not used until they were finalized. These findings reveal that decision support systems often take longer to complete

Table 3

Management Involvement in the Development of the DSS

Stage	Management Level* Lower	Middle	Top	All**
Idea	0	61.1	61.1	100
Information Requirements	0	77.8	61.1	100
Building	11.1	72.2	5.6	77.8
Testing	11.1	72.2	5.6	83.3
Demonstration	11.1	77.8	27.8	88.9
Acceptance	0	72.2	66.7	100

*Percentage of companies with management involvement at each management level and development stage.

**Combines management involvement from all three managerial levels.

Table 4

Time Required to Develop the DSS

Length of Project	Percentage of Companies
0-1 Month	27.8
1-12 Months	33.3
1-2 Years	33.3
2-4 Years	5.6
	100%

than has been suggested previously. Some of the longer times are similar to those associated with MIS projects.

INCORPORATION OF DECISION-MAKING STYLE

The study found that in 45 percent of the companies there was an attempt to customize the design of the DSS to accommodate a user's decision-making style. Designers did this by observing the decision maker at work (6 percent), questioning the decision maker about methods used (11 percent), or having the decision maker describe the methods employed (28 percent). Seldom was there an attempt to fully replicate a user's decision-making process. More typically, the focus was on examining information requirements and data manipulation methods. This was deemed a more practical approach because in 72 percent of the companies the DSS supports multiple users (with 6.6 being the mean number of users).

Because the DSS tend to support multiple users, they were designed to be flexible. As Table 5 shows, they are especially flexible in the questions that may be posed and the output specifications that may be requested.

Many decision makers utilize intermediaries to operate the DSS, either as a substitute for or in addition to the decision maker. The study found that 77 percent of the DSS are operated, at least occasionally, by a staff intermediary. In 33 percent of the organizations the decision maker and an intermediary sometimes work together in a terminal session. In 44 percent of the companies the decision maker operates the DSS alone.

Several issues related to the maintenance of the decision maker's style when the DSS is operated by an inter-

Table 5

Ability of the DSS to Respond to Various Methods of Use

DSS Capabilities	Percentage of Companies
Respond to Questions Posed in Any Order	88.9
Respond to What-If Questions	100
Output Available in Various Levels of Detail	100
Output Available as Graphical or Tabular	77.8

mediary were explored. It was found, for example, that in 100 percent of the companies the intermediary has unrestricted access to the decision maker. In 78 percent of the organizations, terminals which provide access to the DSS are located within 50 feet of the intermediary. Also, response from the DSS is fast. Seventy-two percent of the organizations report a turnaround time of one to five seconds to receive output from the DSS.

These findings suggest that a user's decision-making style is sometimes considered when a DSS is designed. However, accommodations for style are normally handled by making multiple dialog options available to users. This approach seems especially appropriate in light of the number of users typically served by a DSS. Intermediaries have a good opportunity to maintain a user's decision-making style because of unrestricted access to the decision maker, easy access to the DSS, and quick turnaround times.

ROLE OF CBIS AND OR/MS IN DSS

The study investigated the extent and nature of involvement of CBIS and OR/MS groups in the development of a DSS. With regard to the CBIS group, it was found that they were frequently involved but seldomly in a leadership role (see Table 6). More typically, CBIS personnel were used as consultants or as team members directed by the user group. This does not mean that CBIS was not important to the overall development of the DSS. As Table 7 illustrates, the DSS is quite often heavily dependent on CBIS for hardware, system software, and communications capabilities.

While models are important DSS components, they are normally created by functional area personnel rather than by OR/MS professionals. In only one company did the OR/MS group lead the development of the DSS, and in another they served in a consulting role. Functional area personnel were generally found to be well versed in the application of OR/MS techniques.

These findings clear up some of the conflicting statements in the literature. DSS development is user led. An organization's CBIS group plays an important role, especially in the technical support area. Separate OR/MS groups are not currently involved in most DSS projects.

DSS DEVELOPMENT TECHNIQUES AND PROCEDURES

Either DSS tools or a DSS generator can be used to build a specific DSS. Fifty percent of the companies used a DSS generator, including products such as SIMPLAN, Profile, EIS, Micro DSS/F and IFPS. Other companies relied on tools such as microcomputers, CRTs, programming languages, graphics, optimization algorithms, goal-seeking models, and statistical analysis routines. A number of companies combined DSS tools and generators in building their DSS.

Management of the developmental process through review and documentation was found to be frequent, but less so than has been suggested as being desirable. Table 8 indicates points in the DSS developmental process requiring review or approval. With the exception of

Table 6

Form of CBIS and OR/MS Involvement in DSS Development

Role Played by the CBIS Group in the Development of the DSS		Role Played by the OR/MS Group in the Development of the DSS	
CBIS Role	**Percentage of Companies**	**Operations Research Role**	**Percentage of Companies**
None	38.9	None	88.9
Leader	5.6	Leader	5.6
Participant	22.2	Participant	0
Consultant	33.3	Consultant	5.5
	100%		100%

Table 7

Source of Resources Used in Developing the DSS

Resource	Functional Area	Source* CBIS	OR/MS	Other
Hardware	16.7	66.7	5.6	11.1
System Software	22.2	61.1	5.6	11.1
Communications Capabilities	5.6	66.7	5.6	11.1
Data Entry	100	5.6	0	5.6
Applications Software	100	11.1	0	0
Developmental Personnel	94.4	38.9	5.6	22.2

*Percentage of companies where resources are supplied by various sources. The percentages summed across the rows may exceed 100 percent because of multiple sources.

project initiation, specification of information requirements, and final approval of the DSS, most reviews were conducted informally by either staff or management (usually from within the project team).

Documentation of the DSS was found to be inconsistent. Eighty-seven percent of the companies documented procedures for using the DSS. However, only 13 percent of the organizations documented the DSS programs. These figures suggest that at least partial documentation is performed more frequently than previously reported.

Discussion

Having presented the findings on *how* decision support systems are developed, it is interesting to speculate about *why* they are developed in this manner. The following comments are not based on statistical analysis but, rather, on general impressions gained from discussions with the company officials who participated in the study.

NATURE OF THE DEVELOPMENTAL APPROACH

One interesting issue involves the factors which influence whether a DSS is created using a SDLC or an evolutionary developmental methodology. Our investigation suggests that several factors are important: the scope of the DSS; the level of DSS technology employed; the ability to specify information requirements in advance; the developer of the DSS; the characteristics of the decision-making task; the availability of DSS technology in the organization; and the cost of the DSS.

One factor affecting the developmental methodology is the scope of the DSS which must be built. A life cycle approach is more often employed when the DSS supports either company-wide decisions or decisions requiring company-wide data. These situations commonly require relatively long analysis times and tend to lead to a life cycle approach.

Another consideration is the level of DSS technology used. In general, DSS generators lead to an evolutionary approach while DSS tools favor the SDLC. Clearly related to this is the ability of a DSS generator to place applications development in the hands of the user while DSS tools typically require the skills of specialists.

The ability to specify information requirements in advance is also an important consideration. In the single case where a pure SDLC was used, the information requirements were known and did not change during system development. This DSS was used at the operational level of the company, but for a critically important and recurring decision.

Table 8

Points in the Developmental Process Reviewed or Evaluated

Points	Nature of Review* Staff	Management	Written Management
None	16.7	27.8	38.9
Idea	38.9	38.9	38.9
Information Requirements	33.3	27.8	22.2
Testing	11.1	0	0
Completed System	44.4	38.9	27.8
Specific Components	22.2	16.7	11.1
Each Cycle/ Iteration	11.1	11.1	0
Weekly	5.5	5.5	0
Bi-monthly	5.5	0	0

*Percentage of companies with various types of review at different points in the developmental process.

The DSS developer is another factor. Systems created by specialists tend to be more closely associated with the SDLC approach than those developed by the end user or someone who works with the end user (e.g., an assistant or specialized staff in the same functional area).

The characteristics of the decision-making task also affect the developmental approach employed. Of particular importance is the distinction between strategic planning, management control, and operational control. The SDLC approach is most commonly associated with DSS that support operational control responsibilities. Strategic planning systems are often developed using an evolutionary approach. This observation is not surprising, since it is related to the ability to specify information requirements in advance.

The availability of DSS technology needs to either create or purchase DSS tools or a DSS generator, this outlay of time, effort, and funds tends to increase the structure of the entire DSS developemental approach. On the other hand, if all of the required technology already exists it facilitates an evolutionary approach.

The final factor is the cost of the DSS. Expensive systems are subject to more careful review than less costly ones. This review process adds structure and leads to more of a SDLC approach.

USER INVOLVEMENT IN DEVELOPMENT

Another interesting area involves the forces which influence the amount of user involvement in the development of a DSS. Three factors appear to be important: the level of DSS technology employed; the characteristics of the decision-making task; and whether the task involves independent or interdependent decision making.

In general, the availability of a DSS generator increases the amount of user involvement. Because the DSS generator often places application development in the functional areas, users become more involved in all stages (e.g., building and testing) of the developmental process. This is less likely to occur when DSS tools are used.

More structured decision-making tasks tend to require less user involvement. This is especially true in regard to the specification of information requirements. Consequently, DSS for strategic planning and management

control usually demand more user involvement than those for operation control.

Because group decision making normally requires more discussion than does individual decision making, this leads to greater user involvement for DSS which supports group rather than individual decisions. It follows then that DSS for pooled interdependent and sequential interdependent decision making have greater user involvement that those which support independent decisions.

DEVELOPMENT TIME

The time required to develop a DSS is more variable than suggested previously. A number of factors contribute to this. In particular, longer development times are associated with systems that are: developed by non-functional area personnel; expensive; support company-wide decisions or require company-wide data; support corporate strategic planning; were developed using DSS tools rather than DSS generators; require new computer hardware or software; and support interdependent decision making.

INCORPORATION OF DECISION-MAKING STYLE

Most DSS can accommodate an individual user's decision-making style. However, how this is accomplished differs somewhat from the approaches which are sometimes suggested. The key factor is flexibility of operation rather than a design that replicates a single user's decision-making process. This flexibility is often realized through the computer hardware and software used. Examples include giving the user the option of a menu or a command language, providing a choice of tabular or graphical output (or both at the same time using "windowing" technology), and layering the command language to accommodate both novices and experts.

Another way a user's decision making style is maintained is through the intermediary. Because of the close relationship between the intermediary and the decision maker, easy access to the DSS by the intermediary, the flexibility of the DSS, and the quick response from the system, the intermediary is often able to maintain much of the decision-maker's style during DSS operation. These approaches seem especially appropriate in light of the different users typically supported.

ROLE OF CBIS AND OR/MS IN DSS

The majority of DSS work is performed by specialized staff and functional area personnel. Even though this is the case, there remains an important role for the CBIS group. They are commonly needed for technical support in areas such as making hardware recommendations, evaluating software products, negotiating contracts, and placing new software on the system. They are also frequently used in an advisory role during system development.

Centralized OR/MS personnel have little involvement with most DSS projects. There seem to be several reasons for this: increased OR/MS expertise throughout organizations which reduces the need for specialized assistance; software products which facilitate modeling efforts; and the perceived remoteness of many OR/MS groups.

DSS DEVELOPMENTAL TECHNIQUES AND PROCEDURES

DSS generators have greatly facilitated the development of decision support systems. However, many DSS are built from scratch using DSS tools or combine tools and generators in their construction. Over time we should expect an increase in the role played by DSS generators as new generators are introduced and existing ones are enhanced. Some of the improvements taking place include additional dialog options, better database management capabilities, and micro and mainframe compatible versions of DSS generators capable of uploading and downloading models and data.

Review, evaluation, and documentation of DSS do not appear to be major issues with builders or users. When they do take place, they are typically informal. Perhaps this is because the builders and users are normally so close to the project that all parties know its status, functions, and capabilities. However, a potential problem with this orientation is that over time the DSS may need to be changed and may have to serve new users. Poor documentation under these conditions may cause difficulties.

Suggestions For Further Research

No attempt was made to randomly select the decision support systems used in this study. When an interesting DSS was found, it was included. This fact, along with the sample size, limits the generalizations which can be made. Follow-up studies on some of the more interesting findings of this research are needed.

Several specific recommendations for further research can be made. In several areas, conjectures have been made about the factors affecting how a DSS is developed. These factors can be empirically investigated. Another

line of research is to develop and test contingency models for DSS development. The variations in DSS development practices found in this study suggest the appropriateness of contingency approaches.

Continuing contacts with the companies who participated in this study and with other firms doing DSS work indicate that DSS development practices are not static and need to be studied on an on-going basis. For example, the purchase of a DSS generator permanently affects how decision support systems are developed in an organization. Some organizations are forming DSS groups to create decision support systems, and some firms are combining DSS efforts with their information center. These and other developments might be monitored by longitudinal studies.

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