

A PLANNING METHODOLOGY
FOR
INTEGRATING MANAGEMENT SUPPORT SYSTEMS

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1.0 Introduction

In recent years, the impact of information technology on organizations has been extensive. Driving forces include the rapidly improving price/performance ratio of technology and a general increase in computer literacy. Perhaps most significantly, the role of technology in establishing competitive advantage is emerging as a new and powerful driving force. Rockart and Scott Morton (1983), Parsons (1984), and others have stressed several alternative approaches by which competitive advantage can be achieved through technology. A common theme among all advocating this concept is the importance of strategic information systems planning and the need to link the information systems plan to the strategic business plan.

Of particular interest to most organizations is how this investment in information technology will support and improve the productivity of professionals. The rapid influx of microcomputers (Quillard et al., 1983; Henderson and Treacy, 1984) into organizations is one response for better support of managers and professional staff. The concepts of Decision Support Systems (DSS) and Executive Support Systems (ESS) have been widely accepted and organizations are investing significant capital into development efforts to build these systems. Just in terms of numbers, the growth of end users has dramatically increased the resources directed toward management support systems. And yet, trends clearly suggest that many of these systems, while initially viewed as stand-alone, will ultimately increase requests for access to corporate data bases and improved communications. The investment in management support systems will directly impact the investment in the large

transaction systems that make up the technological infrastructure of the firm. Research suggests a key to success for DSS and ESS rests on the ability to link these support systems to the traditional system infrastructure (Henderson and Schilling, 1984). Given the magnitude of the investment and the potential for strategic impact, there is a need for a strategic planning methodology that can achieve the following goals:

- (1) Provide a linkage between the strategic business plan and strategic information systems plan;
- (2) Provide a means to coordinate the investment in a range of management support systems¹ that are responsive to management needs; and
- (3) Provide a basis for understanding data as a corporate resource through the construct of a strategic data model.

These goals are not new. In fact, they reflect an evolution in the management of information technology from a perspective that is technically oriented to one that is business oriented. This evolution has produced many design methodologies, each attempting to address one or more of these goals.

This paper discusses an extension to the Critical Success Factor (CSF) planning methodology that provides a basis for achieving these goals.

The CSF methodology has proven an effective approach for introducing a top management perspective and, hence, strategic direction into information systems planning. Cresap et al.'s recent survey (1983) of information system planning methodology shows CSF second to BSP in terms of actual usage.

¹The concept of management support systems is discussed in detail in Section 2.2.

The CSF methodology has been used to identify the management needs that must be addressed through investments in Management Information Systems (MIS). More recently it has been used to identify DSS prototyping opportunities (Rockart and Crescenzi, 1984). The extension described and illustrated herein will also address needs for executive support and provide important input into the development of a strategic data model for the firm. The former provides for both enhanced management support and, often, an additional mechanism to link the strategic information systems plan to the strategic business plan. The latter provides a means to coordinate investments across the range of management support systems and establishes a foundation for managing data as a corporate resource.

Section 2 of this paper provides a description of the original CSF methodology and a definition of management support systems. Section 3 details the extended methodology indicating how the new approach achieves the goals discussed earlier. Section 4 describes an application of the extended methodology and discusses the benefits of the new approach based on this experience. Finally, Section 5 provides general conclusions.

2.1 Information Systems Planning Using Critical Success Factors

Rockart (1979) developed the CSF approach as a means to understand directly the information requirements of the Chief Executive Officer. He defined CSFs as "those few critical areas where things must go right for the business to flourish." Bullen and Rockart (1981) elaborated on the methodology providing a means to use CSFs at any organizational level and to

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derive management information systems requirements. Boynton and Zmud (1984) provide a detailed analysis of the use of CSFs as an information planning methodology. They conclude the CSF approach is very effective.

A key aspect of the CSF approach is to elicit success factors that directly affect an individual's ability to achieve his or her goals. This individual-based approach provides two key advantages. First, since the goals of key stakeholders (e.g., top management) form the basis for the CSF analysis, the methodology will directly identify how MIS investments can be responsive to management needs. As Mason and Mitroff (1980) point out, organizations do not have goals, people have goals. Thus, the CSF approach creates an effective context or starting point for the planning process.

Second, to the extent that management goals are linked to the business strategy, or mission, the CSF approach will identify MIS investments that are also linked to the business strategy. As will be discussed later, the CSF approach provides another means to strengthen this goals-strategy linkage. King and Zmud (1982) have suggested such linkages should reflect a need to manage MIS functions as well as general MIS resources. Boynton and Zmud (1984) argue a CSF-based approach provides a means to address both of these needs. Ferguson and Dickinson (1982) suggest CSFs provide a method to establish guidelines for monitoring and controlling organizational activities. Munro and Wheeler (1980) draw a direct linkage between the CSF method and other methods to develop corporate strategy. In fact, the CSF approach is consistent with many of the current strategic planning methodologies. For example, the stakeholder methodology proposed by Mitroff and Emshoff (1979) utilizes the goals of key stakeholders as the context for strategic planning. This method attempts to narrow the planning focus by

examining critical assumptions. Extensions of this approach are discussed by Mason and Mitroff (1981). More generally, the notion of prioritizing or focusing on the critical opportunities to achieve strategic advantage has long been recognized and is quite consistent with the CSF approach. Thus, its wide acceptance by planners is not surprising.

The CSF approach does have limitations. Davis (1979) suggests three possible areas of concern: (1) the dependence on skilled analysts; (2) the risk of analyst bias introduced by the interview process; and (3) the possibility that CSFs overemphasize current concerns and crises and thus may not address the full range of organizational needs.

As Boynton and Zmud (1984) note, the concern relative to dependence on skilled analysts is common to most, if not all, strategic planning methodologies. Munro and Wheeler (1980) indicate the CSF process produces consistent results and, thus, the issue of bias appears to be of less concern. Boynton and Zmud (1984) support this finding. The issue of focusing on narrow, perhaps inappropriate, factors is still an area of concern. Rockart (1979) suggests a corollary to this: CSFs are time dependent. Thus, even if the appropriate factors are identified, events may alter the criticality of these factors. One major contribution of the extension proposed herein is to provide a direct means to validate the proposed CSFs and to provide an "early warning" mechanism to alert management to change in what is critical.

2.2 Management Support Systems

In many respects, the field of information systems management can be characterized by an evolution in its areas of study. The earliest focus of study was on introducing and automating clerical systems. These efforts led to the concept of management information systems (MIS) as a type of management support system. MIS systems are typically characterized as related to the development of the reports necessary to manage well-specified, structured activities. These activities have clear benefits or products which can be achieved through the design and implementation of an MIS. The implementation of large transaction systems such as order entry coupled with the capability to extract information for management is the classical domain of MIS. Such systems have historically impacted low level management, since these individuals carry the responsibility for overseeing the day-to-day structured activities of the firm. Aggregated reports and ad hoc query of the systems have produced useful, but somewhat narrow, support for high-level management. A primary objective of the CSF methodology is to understand better how these types of systems can be designed to yield enhanced support of middle- and upper-level management.

A major evolution in information systems study centered around Decision Support Systems (DSS) (Keen and Scott Morton, 1978). This type of management support system addresses semistructured decisions where the key benefits lie in qualitative improvements in the decision process. The systems need to be interactive and highly flexible and, hence, require different technology and design methodologies. DSS systems are still task specific, although the semistructured nature of the decision process is the key unit of analysis

rather than a standard operating procedure. As might be expected, these systems have had their major impact on middle-level management and professional staff. They find their way to top executives most often through these types of intermediaries.

A third and fairly recent area of study concerns Executive Support Systems (ESS). These are systems used directly by senior executives. They address a broad range of issues and take on different technological characteristics than DSS. Further, they have significant implications for organization support structures; so while they are process oriented like DSS, their effective implementation generates unique problems (Rockart and Treacy, 1982). Obviously the key benefits center around improving the effectiveness of these top executives.

While this evolution has often carried with it attempts to define these different systems in a specific, mutually exclusive manner, Scott Morton (1983) argues they in fact form a range of management support systems with significant areas of overlap. This suggests a need to coordinate investment across this range of systems so that each system can contribute directly to achieving corporate strategy. Henderson and Schilling (1984), for example, discuss the interdependencies between DSS and MIS and suggest the introduction of DSS can have major strategic impact on the firm.

While progress has been made with respect to linking investments in MIS to the business strategy, little or no efforts have been made to develop methods that produce coordinated plans that span the range of management support systems. Providing such a method is a second major goal of the proposed extension of the CSF approach.

3.0 Extended CSF: A Strategic Planning Framework

3.1 Key Requirements

With the increasing distribution of computer technology through the firm combined with increasing total resources invested in management support systems, there is a critical need for a strategic planning methodology that provides an integrated approach to the design of MIS, DSS, and ESS. We suggest two key requirements for this methodology. First, the methodology must provide for an appropriate context for the planning effort. Existing design methodologies, to varying degrees, address this need. For example, the BSP methodology uses the notion of generic business processes as the context for investigating specific information needs. The assumption surfacing methodology by Mason and Mitroff (1981) provides a context for the planning process through evaluation of the positions and needs of key stakeholders. In essence, current MIS design theory recognizes Ackoff's (1967) proposition that users can not effectively respond to a noncontextual request for the definition of information needs. For a strategic process to address MIS, DSS, and ESS simultaneously, this context formulation step is critical.

Second, the methodology must delve deeply enough into the system design life cycle process to support design at a technical level. Obviously there is a tradeoff between maintaining a macro viewpoint consistent with strategic planning and generating the detail required for technical design. The need is

to provide a pragmatic link from the conceptual design to the detailed design. Such a link must provide relevant insights from both the user, viewing the design from a strategic business perspective, and the technician, viewing the design from a technical requirements perspective.

The following section describes a methodology addressing both these needs. Section 2.3 clarifies how these needs are met by this methodology and discusses additional benefits derived from its use.

3.2.1 A CSF Based Strategic Planning Approach

Building upon the Critical Success Factor (CSF) approach developed by Rockart (1979), the proposed method (Figure 1) creates a planning context using the CSF approach.² These CSFs provide the context for definition of three products: Critical Information Set (CIS), Critical Decision Set (CDS), and the Critical Assumption Set (CAS). The critical information set is the product of CSF analyses as they were first carried out. The extended method provides the means to analyze the critical assumptions underlying the CSFs and the decision processes that are critical to achieving these CSFs. Each of the set definitions becomes the basis for a functional analysis of the requirements for MIS, DSS, and ESS, respectively. Finally, these three sets of requirement definitions provide important insight into a strategic data model that identifies the necessary linkages to both the internal and external data sources.

²See Bullen and Rockart (1981) for an excellent tutorial concerning the definition of CSF.

3.2.2 Strategic MIS Planning

The difficulty of building information systems that effectively support management has long been acknowledged (Keen and Scott Morton, 1978). The history of information systems design, discussed earlier, is a broad commentary on the difficult tradeoffs between the technical requirements of implementing organizational systems versus the needs of individual managers. As Rockart (1979) notes, the CSF methodology does provide a design focus on "those few things that must go well to ensure success." However, the actual implementation of systems that provide these critical insights require extensive investment in the organizational information system infrastructure.

The original CSF process has helped direct this investment in technological infrastructure to achieve strategic goals. The methodology provides for direct assessment of goals and CSFs. The critical information set indicated by CSFs clarify how the technological infrastructure can directly or indirectly support strategic goals.

The process of generating CSFs and eliciting the critical information set involves personal interviews with key management, but further steps are necessary to implement systems. As illustrated in Figure 1, this further analysis builds on the critical information set to define high payoff MIS opportunities and to begin the development of a strategic data model. This function may be carried out in several ways but generally follows the top down planning orientation of methodologies such as BSP. The strategic data model shows how sources of information, many of which currently exist, must be joined to provide the monitoring and analysis of a CSF. In practice, existing

systems rarely are structured in a form directly capable of producing this critical information. Rather, elements of the necessary information reside in large transaction systems spread throughout the organization. Data external to the firm often must be integrated with this internal information. Finally, many information requirements are "soft" in nature, requiring subjective or expert opinion. Thus, the planning process must go beyond identifying the strategic requirements of the MIS. The process must indicate how the data supporting these strategic requirements will be derived from the existing systems or provided by investments in the new systems. The strategic data model attempts to identify the major sources of data classes and how these sources interrelate. In this way the data model provides one tangible link between the strategic direction provided by the CSF and the eventual technical and economic consequences of design and implementing systems.

There is growing experience with strategic MIS planning approaches that utilize the CSF method as a strategic requirement definition. For example, Arthur Young (Arthur Young & Co., 1983) has used the CSF approach to provide the strategic direction for the information system plan in over fifty planning engagements. They combine the CSF approach with a modified version of the Business Systems Planning methodology to provide the basis for building a strategic data model. As a result, they not only provide a top-down strategic direction for MIS investment, but link this direction to a comprehensive data resource model of the firm.

3.2.3 Strategic DSS Planning

As discussed in Section 2, a key characteristic of DSS is its focus on specific critical decisions. Traditionally, the decision to design and build DSS has been made outside the framework provided by information systems planning. In fact, those involved in DSS design efforts often do not include representatives from the information services organization. This is not surprising. The decision focus creates a natural opportunity for end-users or functional staff to work independently of the traditional MIS areas. However, Henderson and Treacy (1984) note that the end user trend can be viewed as DSS evolving from an isolated individual issue to an organizational issue. Both the level of resources consumed and the impact of DSS suggest a critical need to define a strategic direction for DSS. Rockart and Crescenzi (1984) illustrate how the identification of DSS can result from a CSF analysis. An organization must be selective in the allocation of resources for DSS development to ensure that those investments will contribute to improved decision making in critical areas. Thus, the need to identify a Critical Decision Set (CDS).

The critical decision set serves the same function for DSS as the Critical Information Set does for MIS. It provides a strategic direction for development efforts in DSS. The CSFs provide a contextual frame for generating the Critical Decision Set. Most success factors will have one or more decision processes which are critical to the effective execution of activities associated with this factor. For example, the need to obtain and retain skilled personnel, a critical success factor, may suggest the hiring or merit pay increase decision may be critical. Each success factor will suggest

one or more decision processes which are fundamental to success. It should also be noted that the DSS opportunities identified via the critical decision set will not constitute the entirety of the DSS activities within the firm. There will be significant DSS at an individual end user level. The intent of the strategic planning approach described herein is to ensure a significant portion of the DSS resources is directed toward strategic decisions.

As shown in Figure 1, the opportunities for DSS are developed through analysis of the critical decision set. Each DSS has information requirements that can be reflected in the strategic data model. As in the case with MIS, the strategic data model identifies sources of data, perhaps external to the firm, that are necessary for DSS. Often, the DSS analysis will identify or clarify MIS reporting data needs not recognized during the MIS analysis. For example, as will be discussed in Section 4, the importance of distinguishing specific property/land tracks (the geographical data source) resulted from a decision analysis for project management. This clarification had a fundamental impact on the design requirements for MIS systems.

This clarification provides the means to integrate major activities in DSS with those in MIS. Thus, the priorities of the MIS action plan may be altered to provide necessary support for efforts related to implementing a given DSS. To the extent that the DSS may require data coming from the large transaction systems, this DSS-linkage will provide a valuable basis for technical MIS design decisions.

3.2.4 Strategic ESS Planning

Rockart has noted the temporal nature of CSFs. Research on strategic planning has consistently highlighted the need to validate the planning context and adapt this context over time (Mason and Mitroff, 1981). The system designer or strategic planner must attempt to validate CSFs and consider when a particular set of success factors are no longer adequate. Mason and Mitroff (1981) argue a key to the validation problem, as well as to the dynamic character of information needs, lies in understanding the assumption set underlying the strategy. They argue that the assumption held about the environment, competition, and particular businesses are key factors in the development and prioritization of management goals. In this light, there is a need to identify a Critical Assumption Set underlying the goals and CSFs for a strategic MIS plan.

The assumption surfacing process may be similar to that suggested by Mason and Mitroff (1981). In their methodology, key stakeholder analysis provides the contextual frame for investigating the assumption set. They argue only individuals have goals; hence, any organizational strategy must be built upon the assumption and goals of key stakeholders of that organization. This concept has proven effective in strategic business planning. We suggest CSFs provide an appropriate context for surfacing the critical assumptions of management in a strategic MIS planning effort.

The set of underlying assumptions provide the backdrop for CSFs and the implied critical information set. Changes in these assumptions will be a primary cause of changes in CSFs. Analysis and monitoring of assumptions can, therefore, help to identify when CSFs and the subsequent MIS plans require change.

Obviously, an alternative source of change may be changing goals. However, changing goals are often due to changing assumptions; therefore, an assumption monitoring and analysis process will provide insight into both the CSF analysis and goal setting process. As shown in Figure 1, the Critical Assumption Set also is linked to the strategic business plans. Since changes in business strategy will impact goals and therefore CSFs, exploring the assumption set offers the added benefit of more closely linking the strategic information plan to the strategic business plan.

Given a critical assumption set, a further analysis can define the requirements of a system to monitor and analyze the status of these assumptions. We suggest that a major implicit reason for existing ESS's is to support executives in the analysis of critical assumptions. For example, an assumption underlying the establishment of acquiring skilled personnel as a critical success factor may relate to the ability of technology to replace or augment the activities of these individuals. With the growth in expert systems, this assumption may no longer be valid. An ESS data set could be developed to assist in the monitoring of the status of this assumption, and thus provide the means to identify when the CSFs should change.

Of course, the need for ESS creates yet another view of the strategic data model. The data model will, in turn, indicate where a linkage exists with DSS and MIS efforts and thereby provide the means to integrate investment and design efforts in these three areas.

In summary, the proposed planning methodology starts with a top level, business analysis to predict information requirements and to identify high payoff opportunities for management support systems of all types. Information needs of all types are integrated through a strategic data model. As shown in Figure 2, this strategic data model also depends upon the results of a more detailed information and technical analysis. The information analysis carries the functional requirements and the associated data resource needs to a technical level. This provides the opportunity to reflect the operational requirements of lower level management and staff and to identify existing data resources.

The upper half of Figure 2, and the focus of this paper, provides a strategic perspective and, ultimately, a major basis for establishing priorities and implementation plans. Consistent with traditional bottom up planning approaches, however, the lower half of Figure 2 is a planning process that yields specific hardware/software, major application systems, and data architecture recommendations. The strategic data model is a lens through which senior management can focus on the technical requirements of information system development. Similarly, it provides a mechanism for systems professionals to focus on how investments in the technological infrastructure will impact both the specific needs of management support systems and the strategic issues of the firm.

4.1 Application of the Method

A test of the extended CSF method was conducted with the CEO, President, and Vice President of Systems and Planning from a medium sized energy related firm. The objectives of this study were:

- (1) To identify opportunities for ESS and DSS development.
- (2) To assess the need to coordinate investments currently proposed in the MIS area.
- (3) To evaluate the quality of results generated by the method.
- (4) To assess the effectiveness of the techniques used to implement this planning method.

The site for this test was chosen because the participants had recently conducted an extensive CSF analysis and had linked their strategic business plan to the results of this analysis. Further, the organization had developed a comprehensive MIS investment plan based, in large part, on the information demands implied by the CSF analysis. Thus, the goals, CSFs, and Critical Information Set were well established.

The Nominal Group Process (Delbecq et al., 1975) was used to generate both the critical assumption and decision sets (Figure 3). Two separate planning sessions were conducted, each lasting approximately two and a half hours.

The steps illustrated in Figure 3 were followed in both sessions. Tables 1A and 1B provide examples of the task statements generated for both the assumption set and decision set analysis. A round-robin generation and a clarification stage provided an opportunity to define issues, combine issues that were redundant, and ensure there was a common understanding of terms. An evaluation stage used a vote-discuss-vote technique to evaluate and prioritize the individual items. This technique provided a solid basis for debate, where the results of the first vote indicates areas of disagreement, and acted as a means to achieve group consensus (Delbecq et al., 1975). Finally, the results of the evaluation were used to identify primary and secondary opportunities for development of ESS and DSS. As will be discussed in the following sections, the criteria used during the evaluation were chosen to enable a meaningful discussion of needs and priorities for ESS and DSS.

The generation stage for the Critical Assumption Set resulted in 34 assumptions. The clarification step eliminated 2 and combined 8, resulting in the 24 assumptions shown in Table 1A. The evaluation stage involved two steps. First, each participant was asked to select the 10 most important assumptions from the complete set of 24. The participants indicated the relative importance and the stability of these 10 assumptions. The definitions used in this evaluation are shown at the bottom of Figure 4.

The results of the vote were fed back in both a tabular and graphic format and used as a basis for discussion. Table 2 shows the voting pattern. This table facilitated discussion in two regards. First, high variance in the voting pattern indicated a need for discussion. For example, assumption 7 showed commonality on importance but high variance on stability. Subsequent

discussion indicated that one participant misinterpreted the meaning of stability in this context and changed his vote to be consistent with the other participants. In another instance, assumption 19 surfaced a fundamental disagreement about the appropriate asset base and size of the organization. One participant argued strongly that the existing organizational size was inappropriate to sustain growth. Another felt the size was adequate and management emphasis should be placed elsewhere. This disagreement was not resolved; rather, a need to monitor and continually analyze the need for further reduction in asset base and personnel was identified and given a high priority.

A second source of discussion centered around assumptions given very high importance by a single individual. This pattern reflects the unique demands and information needs of individual executives and underscores the importance of customized ESS.

Figure 4 is a graphical presentation of the voting results. The lower right corner is the primary opportunity set for ESS. The assumptions falling in this quadrant are critically important and yet unstable. Since many aspects of critical elements of the strategic business plan and current operations depend on these assumptions remaining valid, there is a clear need to monitor and evaluate them continuously.

The assumptions in the upper right quadrant are also critically important but more stable. For example, the participants indicated a desire to monitor and evaluate a new bonus plan impact on performance and retention of skilled

employees. While they agreed that the need for such a bonus plan was a stable assumption, they felt the critical nature of the impact justified investment in an ESS so that senior management could carefully monitor the actual effect of the bonus program.

Finally, a brief examination of the information needs for a high opportunity ESS was undertaken. Table 3 provides the set of information needs in relation to the assumption that the economics of the energy industry are positive and price and demand will be stable. Note the wide range of information sources implied by this list as well as the need for both quantitative and qualitative data. This list has clear implications for the linkage between the ESS and existing or planned MIS. For example, the need for comparative drilling and development information implies a requirement to access organizational information in a form compatible with industry or competitive data. Similarly, there are significant implications for consistent data definitions across organizational sub-units implied by the macro financial and operational information that is required.

4.2 Critical Decision Set

The process shown in Figure 2 was also used to generate and evaluate the critical decision set. The initial generation resulted in 34 critical decisions. The clarification stage reduced this to 21 critical decisions (Table 1B). Two of the three participants selected the 10 most important decisions and evaluated them based on their relative importance and the need

for enhanced analysis.² Figure 5 provides the definition of each criterion used to rate the decisions. The upper right quadrant of Figure 5 corresponds to these primary opportunities for DSS investment. That is, it corresponds to decisions that are very important and have high need for enhanced analysis. The firm may invest in a wide range of DSS via mechanisms such as end user computing. However, this planning process indicates those DSS which will have major strategic value.

The need for integration between MIS and DSS is also apparent for this project. For example, the exploration project selection decision (Table 1B) requires a comprehensive assessment of all projects using a common methodology. The transaction systems that provide source data on operations and cost for these projects must be in place to provide common measures if such a project selection DSS to be truly effective. Similarly, efforts to pursue competitive advantage (Table 1B) could be supported with an ESS that monitors industry and competitive activity. Analysis of such interdependencies offers the opportunity to coordinate both investments and priorities among the various types of support systems.

²The lack of response was due to both time constraints and diminished interest. See discussion 5.0, Conclusion.

4.3 A Strategic Data Model

The process of surfacing critical assumptions, information and decisions and translating these issues into requirements for management support systems provides important input into the development of a strategic data model. Figure 6 shows a partial data model for this firm. A detailed data model results from a top down functional analysis of the ESS, DSS, and MIS opportunities. The model also reflects the need to address operational concerns via an information analysis (Figure 2). The model is presented as a modified entity/relation model that defines data classes and their relationships. Combinations of these data classes can portray subject area data bases. Each CSF will project on this data model differently. Further, DSS and ESS requirements will require joining different classes of data that may span across traditional subject area data bases. Thus, the data model provides a means to examine and communicate strategic data requirements. For example, the need to monitor and manage drilling projects (a CSF) requires linking those data classes that are shaded in Figure 6. A DSS to support this area would include these classes plus additional specific types of competitive information. Further, the specific nature of the property/land data class changes significantly when viewed from a DSS perspective. Finally, an ESS designed to monitor and evaluate the assumption that drilling investments are being made in stable areas that maximize current competitive advantages extends the view of the required competitive data and introduces a need for geopolitical data. The strategic data model can be adjusted to reflect these needs and to identify where issues of data compatability and communication may be critical.

5.0 Conclusion

This study provides a basis for several conclusions. First, the capability to generate the critical assumption set and the critical decision set proved quite valuable in the view of the participants. The assumption analysis indicated specific areas in which all participants shared common assumptions. Individual discussion about the stability of these assumptions proved helpful in focusing the executive team on issues of critical importance to the firm. As the CEO stated to the two other participants, "This has really provided me an opportunity to get inside your heads." Areas of disagreement as well as areas of concern unique to a given individual were highlighted. Finally, these discussions often illustrated how the strategic information system plan could be better integrated with the strategic business plan.

Similar benefits resulted from the generation of the critical decision set. Yet it appeared that the level of enthusiasm waned as the discussion focused on the decision set. We suggest this relates to the responsibilities of those participating. The participants clearly understood the critical decision set. Yet this is an area in which they can, to varying degrees, delegate. The project selection decision, as critical as it is, is largely delegated by executive management via a well-structured capital budget process. The management of assumptions, on the other hand, can not be delegated. The assumption set is the domain of executive management and the responsibility for ensuring the validity of assumptions rests clearly with executive management. Thus, the discussion of the assumption set related more to the primary interests of the top executives. The authors believe this

reduced interest in DSS opportunities is partly responsible for the lack of their evaluation by one of the participants. Nevertheless, the generation and prioritization of the critical decision set provided a direction for the MIS manager and offered the means to ensure that investments in the DSS area would have strategic impact.

A second conclusion is that the methodology does provide a means to integrate ESS, DSS, and MIS. In essence, the approach provides a comprehensive framework with which to build and refine a strategic data model for the firm. This data model illustrates the sources of data and indicates how they directly or indirectly affect a support system. By addressing the assumption, decision, and information sets simultaneously, a functional analysis draws from very broad views of the business. The strategic data model provides a means to represent these diverse needs in a form consistent with the insights gained through a more traditional information analysis. The strategic data model thus serves as a linking device between the strategic data needs of top management and the operational and technical needs of the IS organization.

Finally, the group process techniques used to generate and evaluate the CAS and CDS proved quite effective. These techniques were efficient and stimulated productive discussions. Of course, the original CSF analysis was conducted using individual interviews. These interviews between key managers and systems analysts are important in that they provide specific links to individual goals and, hence, organizational goals. The group techniques used to generate the CAS and CDS complements the traditional CSF approach by increasing communication between individuals. In this way, CSFs and goals are ultimately challenged and either verified or changed. Thus we see an implicit link from the assumption set back to organizational goals and the overall business strategy.

The role of information technology in the competitive advantage of the firm is rapidly increasing. However, the opportunity for competitive advantages can not be fully exploited until management can coordinate its investments in professional and management support systems to ensure they will impact the strategic issues of the firm. This study supports the notion that these investments can be coordinated in a efficient and effective manner.

Acknowledgement

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Figure 1

A Strategic Planning Methodology

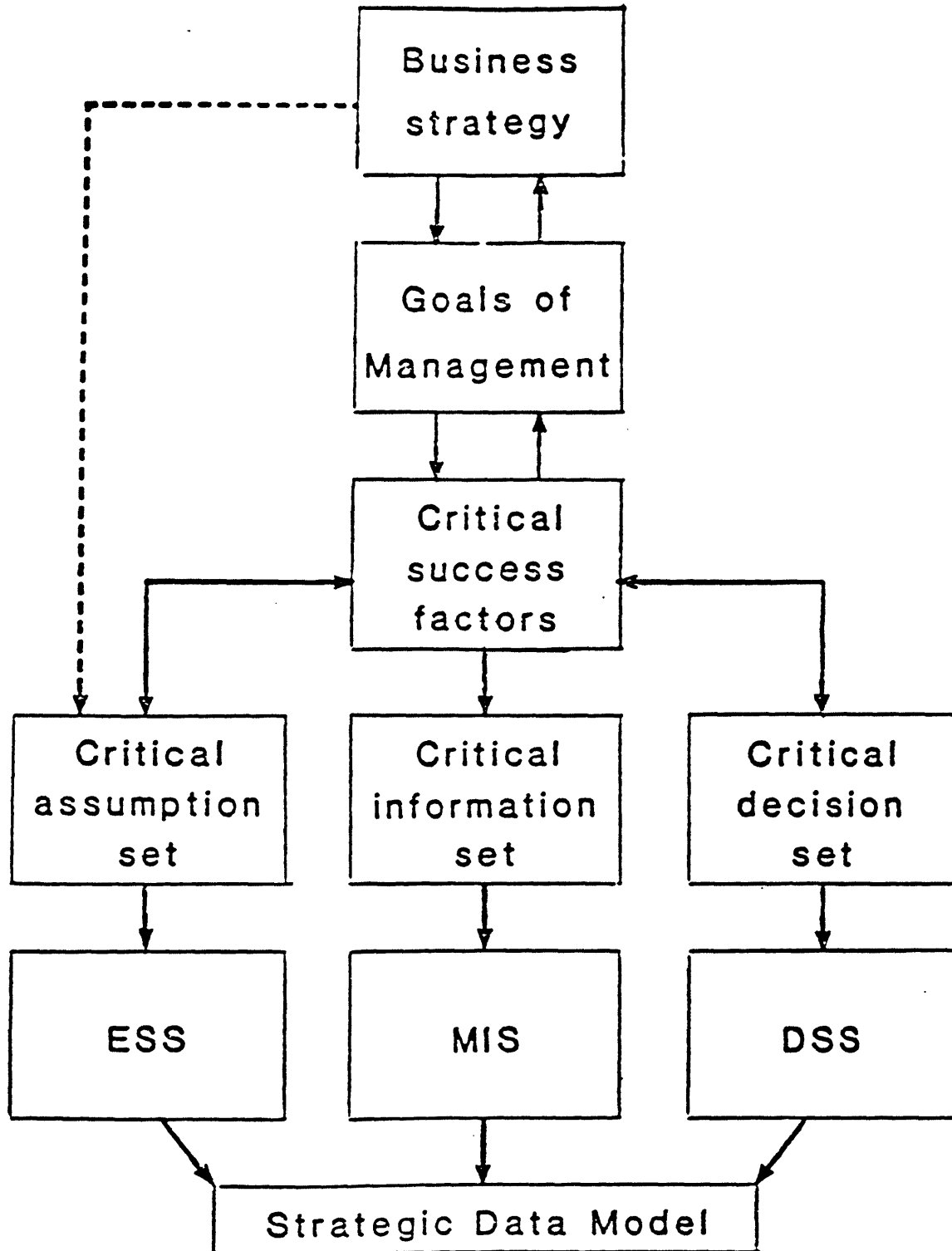


Figure 2

An Integrated Framework for DSS, ESS, and MIS Planning

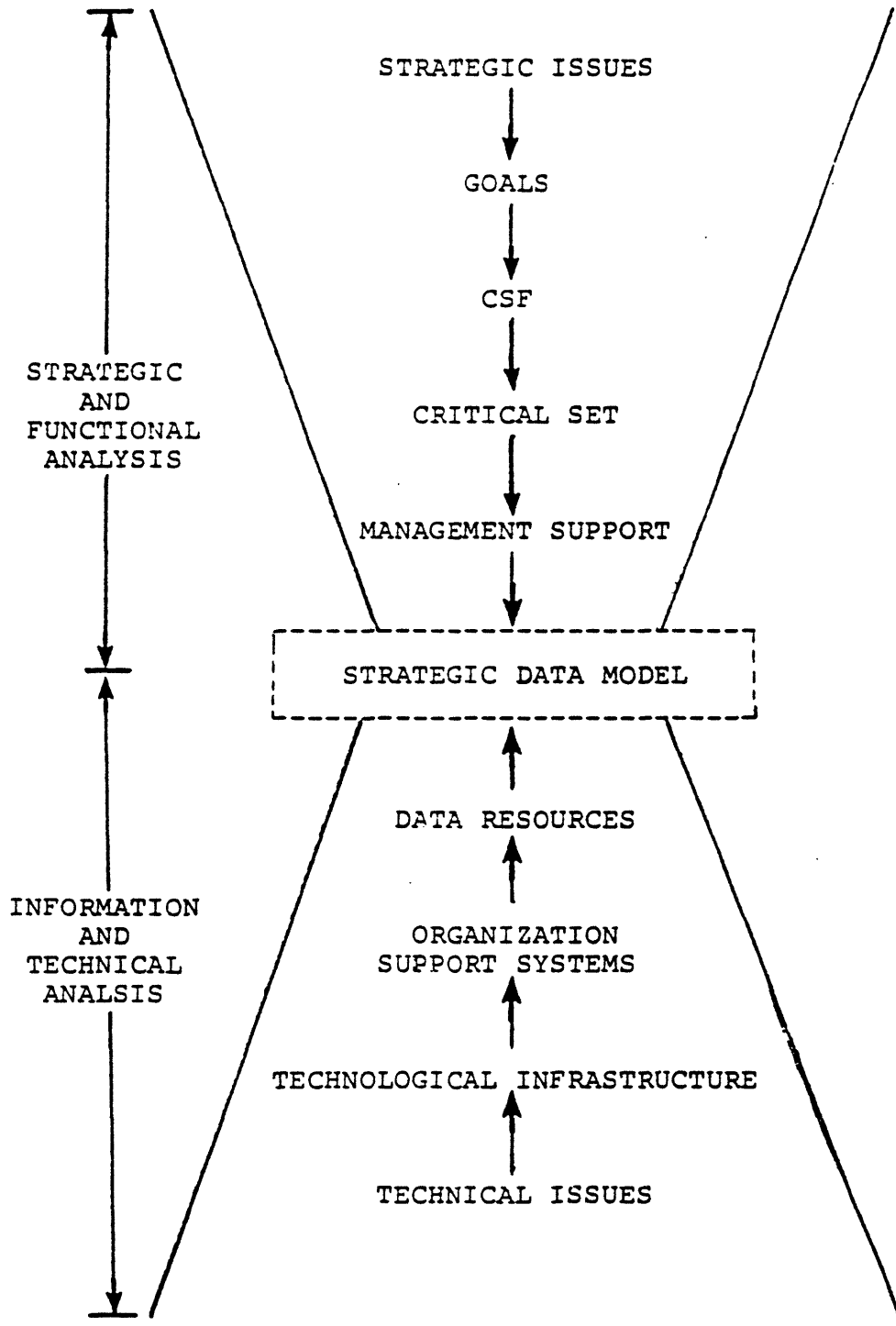


Figure 3
The Planning Process

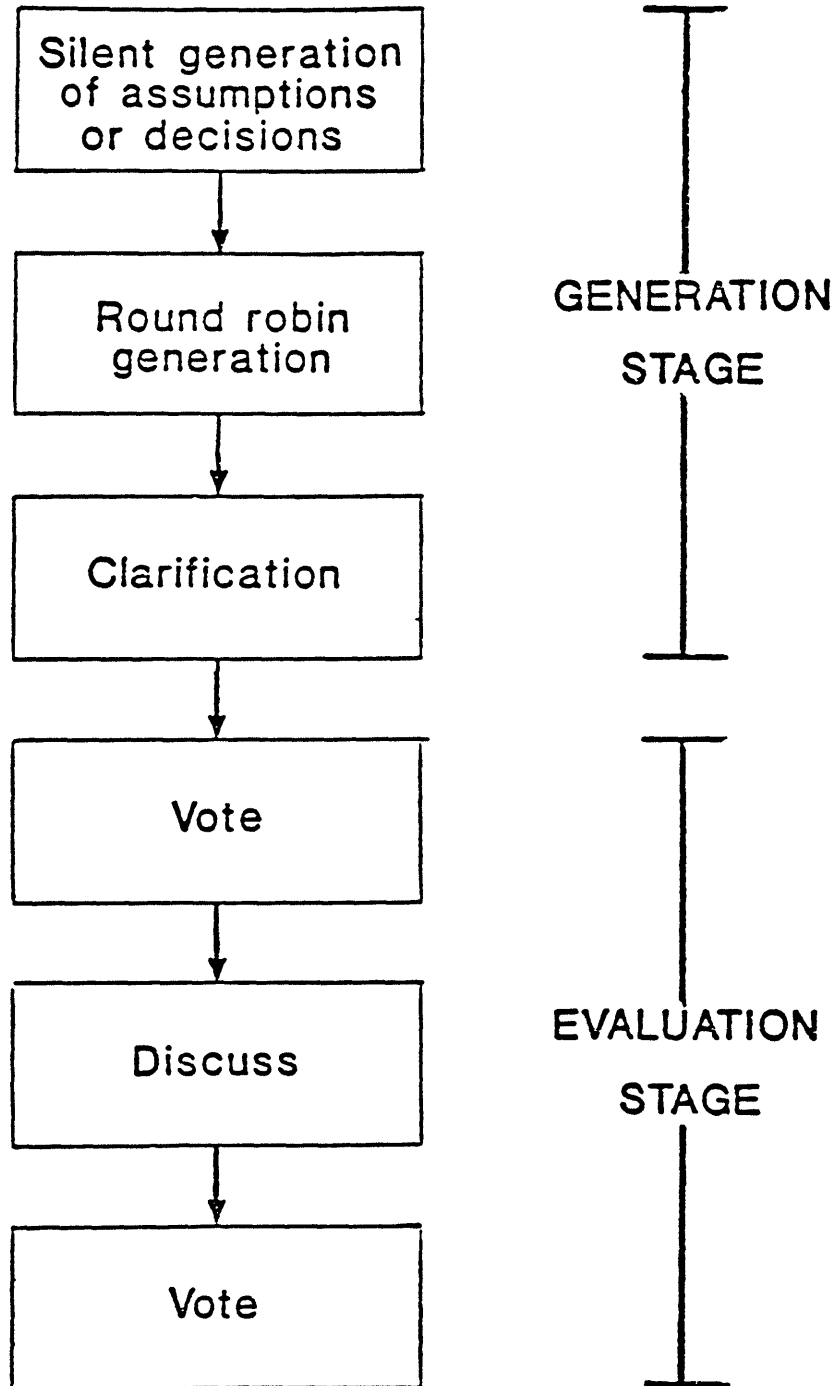
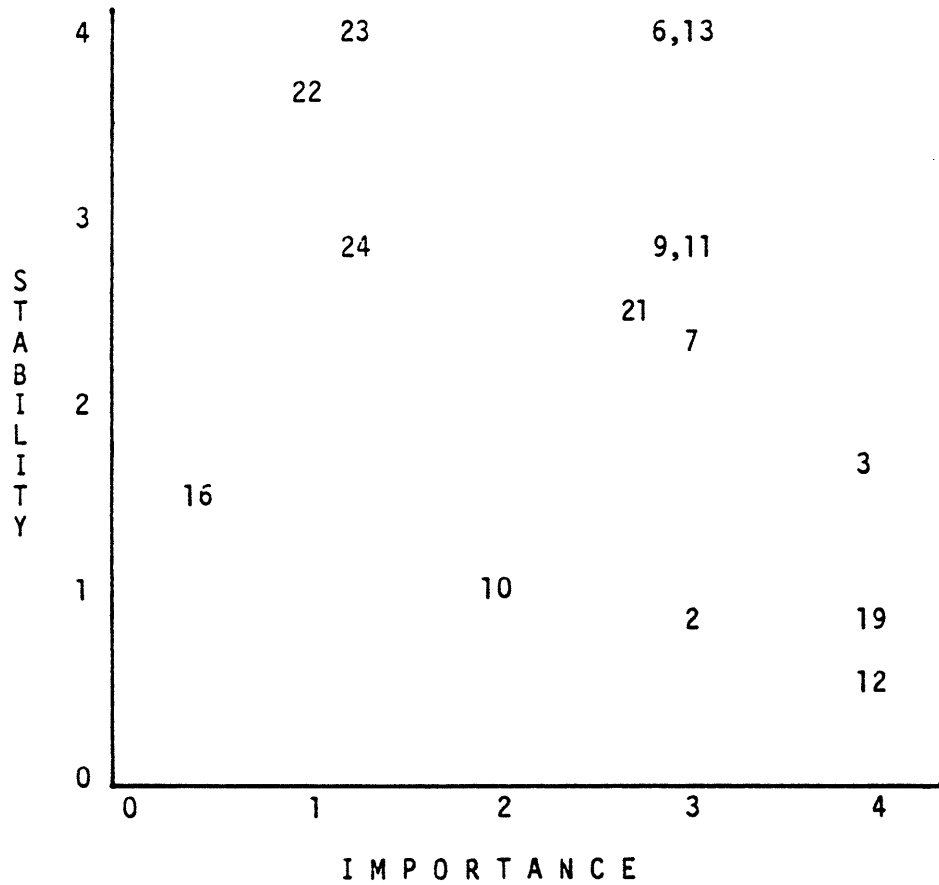


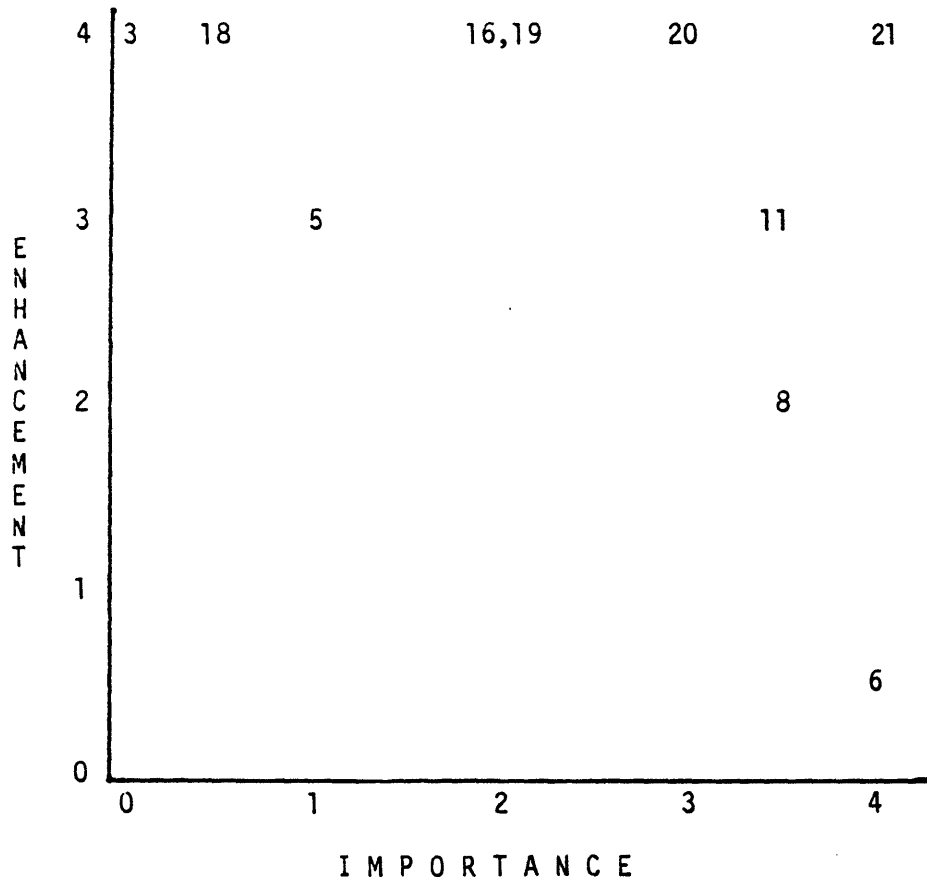
Figure 4
Assumption Set Evaluation



STABILITY: The extent to which an assumption is likely to remain constant or unchanged over the planning horizon.

IMPORTANCE: The relative importance of any given assumption to the successful attainment of the CSFs.

Figure 5
Decision Set Evaluation*



ENHANCEMENT: Potential for analytic aid or enhancement in the decision process.

IMPORTANCE: The relative importance of any given assumption to the successful attainment of the CSFs.

*The "least important" have some existing support.

STRATEGIC DATA MODEL

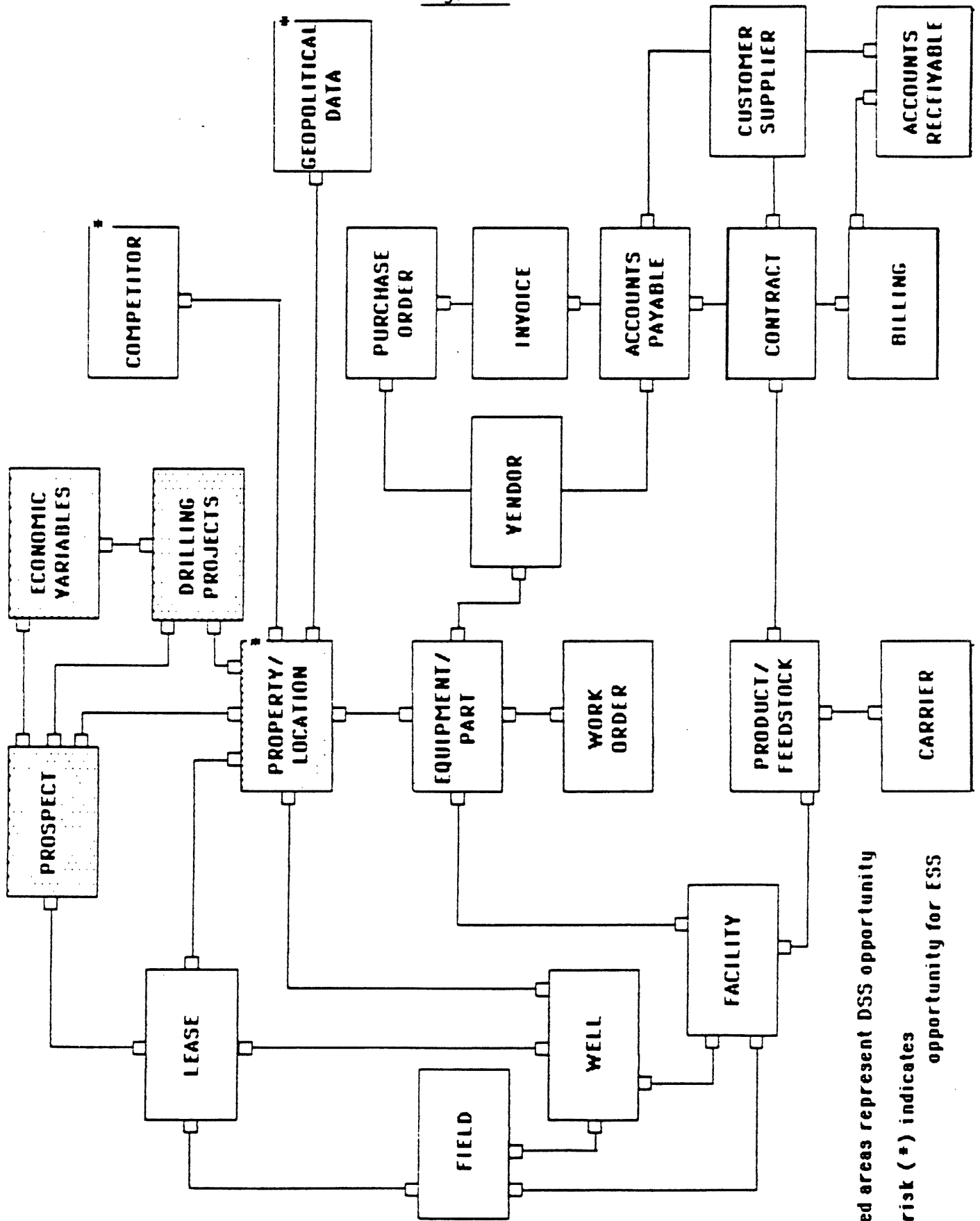


Figure 6

Shaded areas represent DSS opportunity
 Asterisk (*) indicates opportunity for ESS

Table 1A

Critical Assumption Set*

1. Exploration programs will be funded by cash flow.
2. Improved ability to attract new capital from outside.
3. Stability of price, cost, demand.
4. Use cashflow to reduce debt.
5. Exploration can be managed.
6. All projects can be compared.
7. Stay in business, geographical and technical areas, where we have a competitive advantage.
8. We can grow without betting the company.
9. Technology will be disseminated so small companies can compete.
10. No restriction on approaches to adding reserves.
11. Cash flow is the most significant restriction to growth.
12. We maximize shareholders wealth by operating company.
13. Quality people will make a difference.
14. Technology cannot replace high-skilled people.
15. Equity through stock market will not be available.
16. Increase shareholders wealth as a means of attracting capital.
17. Can increase earnings within the defined risk posture.
18. Assume net income is relevant; e.g., net income is secondary to cash flow and reserves.
19. Continue cost containment focus, but current organization size is appropriate.
20. Market for high skilled people continues to be strong.
21. Bonus program will impact performance and increase retention of high skilled people.
22. Strategic planning has an impact.
23. Investment in information technology will have an impact.
24. Total program will be funded by cash flow and asset sales.

* This set was generated in response to the direction, "For each CSF, list the primary assumptions (2 or 3) about your company, business environment, competitors, or industry that makes this a valid CSF."

Table 1B

Critical Decision Set*

1. Allocation of expenditures, short and long-term.
2. Allocation between expenditures and debt retirement.
3. Exploration project selection.
4. Deciding which producing properties to sell, acquire, retain.
5. Determine priority between exploration, development, acquisition.
6. Determine best organization structure and size to achieve 5.
7. Who to retain and how much to pay them.
8. Define the measures for success among different skills and disciplines.
9. Who has authority/responsibility and how much.
10. Balance of entrepreneurial/control and feedback.
11. Allocate rewards so as to impact each individual--reward success.
12. Match people and skills to project requirements.
13. Level of debt at a point in time.
14. Level of administration budget approval.
15. When to change production rates at a given well.
16. Determine areas of competitive advantage.
17. What is minimum economic parameter for project acceptability.
18. Acceptable level of investment for a project and acceptable level of risk.
19. Equity financing, debt/equity ratios for financial risk.
20. Should one objective be to have earnings parallel cash flow.
21. Determining what return on investment is acceptable to investors/owners and how to provide that return.

* This set was generated in response to the direction, "For each CSF, list the critical decisions that most impact the successful execution of this CSF."

Table 2

Voting Pattern for the Critical Assumption Set

Assumption Set		
Number of Assumption*	Importance	Vote
		Stability
1		
2	3,3	1,1
3	4,4,4	1,2,2
4		
6	0.5,3,3	4,4,4
7	3,3,3	0,3,4
8		
9	3,3	2,4
10	2	1
11	4,2	3,3
12	4	0.5
13	4,2	4,4
14		
15		
16	2,0.5	1,2
17		
18		
19	4,4	1, 0.5
20		
21	2.5,3	2,3
22	1.75,2	3,4
23	1.25	4
24	1,2,3	1,5,4,1

* See Table 1A for Assumption definitions.

Table 3

ESS Information Set for Assumption 3

1. Spot price of crude (historical, current, projected).
2. Cost of oil field services and equipment.
3. Political unrest in Middle East.
4. Trend for demand in energy products.
5. Inter-fuel competition (oil or gas or coal).
6. Natural gas price negotiated last month.
7. Comparative finding and development cost.
8. Track tanker fleet movement.
9. Domestic political situation.
10. Crude oil/product inventories/natural gas storage user.
11. Track transactions competitors are using to raise funds.
12. General economic/monetary information.

References

- Ackoff, R. L. "Management Misinformation Systems," Management Science, Vol 14, No 4, Dec 1967, pp. 147-156.
- Arthur Young & Co. Strategic Information Systems Planning (New York: Arthur Young, 1983).
- Boynnton, Andrew C. and Zmud, Robert W. "Critical Success Factors: A Case-Based Assessment," Sloan Management Review, Vol 25, No 1, Summer 1984.
- Bullen, C. B. and Rockart, J. F. "A Primer on Critical Success Factors," CISR Working Paper # 69, Center for Information Systems Research, Sloan School of Management, MIT, Cambridge, MA, June 1981.
- Cooper, R. B. and Swanson, E. B. "Management Information Requirements Assessment: The State of the Art," Data Base Quarterly, Vol 11, No 2, Fall 1979, pp 5-15.
- Cresap, McCormick, and Padgett, Management Consultants. Information Systems Planning to Meet Business Objectives: A Survey of Practices. (Cresap, McCormick, and Padgett, 1983).
- Davis, G. B. "Comments on the Critical Success Factors Method for Obtaining Management Information Requirements in Article by John F. Rockart," MIS Quarterly, Vol 3, No 3, Sept 1979, pp. 57-58.
- "Letter to the Editor," MIS Quarterly, Vol 4, No 2, June 1980, pp. 69-70.
- Delbecq, A., Van de Ven, A., and Gustafson, D. H. Group Techniques for Program Planning (Glenview, IL: Scott-Foresman & Co., 1975).
- Ferguson, C. R. and Dickinson, R. "Critical Success Factors for Directors in the Eighties," Business Horizons, May/June 1982, pp. 14-18.
- Henderson, J.C. and Schilling, D. A. "Decision Support Systems in the Public Sector," forthcoming in MIS Quarterly, 1984.
- Keen, P. G. W. and Scott Morton, M. S. Decision Support Systems: An Organizational Perspective (Reading, MA: Addison-Wellsley Publishing Co, 1978).
- King, W. R. and Zmud, R. W. "Management Information Systems: Policy Planning and Operational Planning," Proceedings, Second International Conference on Information Systems, Cambridge, MA, Dec 1982, pp. 299-308.
- Martin, E. W. "Critical Success Factors of Chief MIS/DP Executives," MIS Quarterly, Vol 6, No 2, June 1982, pp. 1-9.
- "Critical Success Factors of Chief MIS/DP Executives - An Addendum," MIS Quarterly, Vol 6, No 4, Dec 1982, pp. 79-81.

- Mason, Richard O. "A Dialectical Approach to Strategic Planning," Management Science, Vol 18 (1969), pp. B403-B414.
- and Mitroff, Ian F. "Assumptions of Majestic Metals: Strategy Through Dialects," California Management Review, Winter 1980.
- and ----- . Challenging Strategic Planning Assumptions: Theory, Cases, and Techniques (New York: Wiley, 1981).
- Mitroff, Ian I. and Emshoff, James R. "On Strategic Assumption-Making: A Dialectical Approach to Policy and Planning," The Academy of Management Review, January 1979, pp. 1-12.
- Munro, M. C. and Wheeler, B. R. "Planning Critical Success Factors, and Management's Information Requirements," MIS Quarterly, Vol 4, No 4, Dec 1980, pp. 27-38.
- Parsons, Gregory L. "Information Technology: A New Competitive Weapon," Sloan Management Review, Vol 25, No 1, Fall 1983, pp. 3-14.
- Quillard, Judith, Rockart, J. F., Wilde, E., Vernon, M., and Mock, G. "A Study of the Corporate Use of Personal Computers," CISR Working Paper #109, Center for Information Systems Research, Sloan School of Management, MIT, Cambridge, MA, 1983.
- Rockart, J. F. "Chief Executives Define Their Own Data Needs," Harvard Business Review, Vol 57, No 2, March/April 1979, pp. 81-93.
- . "The Changing Role of the Information Systems Executive: A Critical Success Factors Perspective," Proceedings, Third International Conference on Information Systems, Ann Arbor, MI, Dec 1982, pp. 185-197 (reprinted from Sloan Management Review, Fall 1982).
- and Crescenzi, A. "Engaging Top Management in Information Systems Planning and Development: A Case Study," CISR Working Paper #115, Center for Information Systems Research, Sloan School of Management, MIT, Cambridge, MA, 1984, (forthcoming in Sloan Management Review).
- and Scott Morton, M. S. "Implications of Changes in Information Technology for Corporate Strategy," Interfaces, Vol 18, No 1, Jan/Feb 1983, pp. 84-95.
- and Treacy, M. E. "The CEO Goes On-Line," Harvard Business Review, Jan/Feb, 1982, pp. 82-88.
- Scott Morton, M. S. "The State of the Art of Research in Management Support," CISR Working Paper #107, Center for Information Systems Research, Sloan School of Management, MIT, Cambridge, MA, 1983.
- Sprague, R. H. Jr. and Carlson, E. D. Building Effective Decision Support Systems. (Englewood Cliffs, NJ: Prentice Hall, Inc., 1982).
- Zmud, R. W. Information Systems in Organizations (Glenview, IL: Scott, Foresman and Company, 1983).