Guidelines for developing information systems under adverse conditions.

Cynthia Z. LaPara

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GUIDELINES FOR
DEVELOPING INFORMATION SYSTEMS UNDER
ADVERSE CONDITIONS

by
Cynthia Z. LaPara

A Thesis
Presented to the Graduate Committee
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(date)

Professor in Charge

Chairman of Department

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Abstract

The analysis of four case studies forms the basis of the guidelines proposed in this thesis. Three of the four cases have appeared in the literature; the fourth is detailed in an appendix. The analysis method devised can be used during the development effort to classify problems and remedial actions.

The problems examined in this thesis are the behavioral ones which exist between the design team, users, and management; technical design problems are not considered. Only the general design phase is analyzed because in this phase, the environment for the development effort is established.

A descriptive model of the groups and interactions involved in the general design phase is proposed and used as the basis for the case study analysis. Nine potential problem areas were identified from the model. Potential problems in an additional area, implementation, were identified in some of the case studies and this area was included in the analysis. The descriptive model also identified eight types of remedial action open to the design team. A Classification Matrix was developed to display the results of the case study analysis.

The proposed guidelines are of two types: specific guidelines for each problem area; and general guidelines.
The general guidelines are as follows: 1. The Classification Matrix developed for the case study analysis is recommended as an analysis tool. The matrix can be used to identify both problems and solutions and to record both the actions taken and their results. 2. The first type of remedial action recommended for consideration is to attempt to influence the personal factors of the group involved in the problem. 3. If this action has been unsuccessful or seems inappropriate, then team policies should be examined to determine if a change will either solve the problem or enable the team to work around it. 4. Taking no remedial action to solve a problem seems to guarantee the problem will not be solved. 5. Problems with intergroup communications and user-management interaction should be addressed as early in the phase as possible. They appear to have an unfavorable affect on the success of attempted solutions.
Chapter I

A. Background

At one time, the success of an information system was determined by evaluation of its technical performance. The last ten years, however, have brought a realization that technical success is only one facet of system success. A system may process data and produce reports accurately, efficiently, and in a timely manner, and still not be used by the people it was designed for. To be successful, then, a system must be utilized, i.e., operationally successful as well as technically successful.

Information system utilization depends on various factors and interactions. The figure presented on the next page is a descriptive model of factors affecting system use. It is based on a model proposed by Lucas in *Why Information Systems Fail* (1, pg. 20), but has been expanded to include both factors and interactions which Lucas did not address.

In this model, the development process influences system use directly through the characteristics of its two products -- the system itself and the affect of the process on users and management. The relevant system characteristics are utility, or usefulness, and technical quality. System utility results from the
Figure I.

Factors and interactions affecting System Use
relevance, appropriateness, timeliness, and comprehensibility of the information produced. Technical quality results from the efficiency of operation and the accuracy and completeness of the processing algorithms. The development process both affects and is affected by user attitudes and management attitudes and policies. The attitudes and policies of these groups at the end of the development process directly affect and are affected by system use.

User attitudes, which can vary from enthusiasm to hostility, are also influenced by personal factors and the user's need. Personal factors include personal characteristics such as age, education, decision style, and data processing sophistication, as well as job position and job security within the organization. User need represents the importance of the system in the successful performance of assigned functions. Management attitudes toward users can range from supportive to punitive and policies for use can vary from permissive to coercive. Both attitudes and policies are influenced by management's personal factors and its need for the system. User attitudes both influence and are influenced by management attitudes. Thus, while the development process does not effect system use directly, it does have a major influence because it directly effects the four factors determining use.
The development process can be divided into different phases. Each phase impacts different system use factors. The technical quality of the system is determined during the detailed system design and programming phases. Non-technical aspects are determined during phases other than programming. Interaction with users and management is high during both general design and implementation phases. System utility is largely determined during the general design phase and depends on the success of the communications between the design team and both users and management. Problems with communications, attitudes and policies will become apparent at the beginning of the development process. The sooner these problems are corrected, the more successful the design process will be with respect to both utility and favorable attitudes of users and management. Therefore, the basic foundations for three of the four system use factors are determined during the initial development. This phase, then, is critical to the development of a successful system. That this importance has been recognized is shown by numerous articles which recommend techniques and approaches for securing interactions during the initial phase. There are three tactics behind these recommendations:
1. Maximize user involvement in system design (2);
2. Obtain top management support for the system (3);
3. Influence users to adopt the system as their own and thus avoid authoritarian system implementation whenever possible (4).

Involving the user in the system design is the most frequently appearing tactic. Recommendations cover the spectrum from having designated user representatives participate in the meetings of the data processing personnel to requiring that the user management be responsible for the project and that the data processing personnel involved report directly to that management (2). This is deemed to be so critical that statements can be found to the effect that system development should not proceed if user participation is not available (2).

There are several reasons for this principle. One lies with the problem of identifying the user's needs. This process is easier to accomplish successfully when both users and analysts work closely together. Successful problem definition contributes greatly to the utility of the system. The cooperative effort involved is an education for users and serves to increase their sophistication so they can function more effectively in subsequent development efforts. Furthermore, as part of the design team, they belong to the group originating the change to the status quo. As such, they identify with the objectives of the change, participate in it, and
know first hand what is being considered. Consequently, user attitudes toward the system are improved and the likelihood of resistance to system use decreased.

Obtaining top management support for the system is another important tactic for obtaining user acceptance of the system. The attitudes and behavior of users will mirror those of management. Statements of management's interest in and endorsement of the system will favorably influence user attitudes, especially if perceived to be genuine and confirmed as such by actual demonstrations of positive attitudes (5).

Influencing users to adopt the system as their own can take the form of user education or of "selling" the system. Education serves to communicate information about the system. Successful system "selling" requires identification of the advantages that are important to each user group (6). These tactics succeed because they cause the user to perceive the change as a benefit, not a threat. Furthermore, they allow avoidance of authoritarian implementation of the system by management. User resistance to imposed change was documented thirty years ago by French and Coch in a study of the effects of participation in decisions producing change (7). However, there may be conditions under which the only way the system can be installed is by management fiat (8).
The tactics proposed for successful user interaction result mainly from the recognition that the development of the new system promises changes in the status quo. This potential for change is threatening because it can affect job security, and is likely to modify the social and power relationships of the organization. It is natural for people to resist change. Behaviors associated with this resistance have been categorized as dysfunctional and are manifested as avoidance, projection or aggression (9). The use of group participation, education, salesmanship and upper management support to mitigate the effects of change results from the application of organizational development (10,11).

B. Statement of the Problem

There are times, however, when because of various adverse conditions, some tactics for successful interaction can not be implemented. The design team then has an additional problem to solve: given that the system must be implemented, what changes in approaches can be taken to ameliorate the existing adverse conditions?

Existing literature does not contain much useful information on solutions to this problem. While a fair number of case studies concerning solutions for technical problems are available, few case studies have been
published that either address behavioral problems or contain enough information to study them. Very little exists in the way of guidelines for systems development under adverse conditions.

This thesis will attempt to fill some of this void by investigating systems developed under adverse conditions. Only the general design phase will be examined because, as has been shown, this phase is critical to the development of a successful system. The problem is to determine the adverse conditions the designers perceived, the responses they made to ameliorate these problems, and the success of those responses.

C. Objective

The objective is to provide recommendations to guide the system development effort proceeding under adverse conditions through the general design phase.

D. Approach

To achieve this objective, we intend to use as information sources published case studies which contain relevant information. These case studies include that of Lucas and Plimpton (12), where the development of an information system for the United Farm Workers is presented and analyzed using a client-consulting model. The development of a Livestock
Management System reported by Lucas (13), is a good illustration of how adverse conditions were overcome by the design team. Scott Morton's report on the design and implementation of a Management Decision System (14), while technically oriented, contains information useful for examining design tactics. The initial design history of the Program Evaluation and Review System being developed at Lehigh University for a division of the U.S. Department of Energy will also be used. This information has not been previously published and is detailed in the appendix of this thesis.

The environment of each case study will be examined to determine how conditions deviated from those which are commonly accepted as being necessary for a successful development effort. The actions taken to overcome each deviant condition will be described. Each different action will be evaluated with respect to its success in negating the effect of the initial condition and permitting the design effort to continue. For the purposes of this study, a course of action is evaluated as successful if it ameliorated the specific problem to which it was addressed within the time frame of the general system design phase; no judgment will be made on the quality or usefulness of the system under development. This distinction is important because a course of action can successfully solve a problem and system
development effort can continue even though the system may be faulty for other reasons.

Finally, the results of the above analyses will be used to formulate guidelines for information system development efforts as described by the Thesis Objective.
Chapter II

Description of the Case Studies

A. Introduction

This chapter presents in summary the previously cited case studies: the SPERS system under development at Lehigh University; the United Farm Workers Organizing Committee system described by Lucas and Plimpton (12); the Livestock Management System reported by Lucas (13); and the Management Decision System designed by Scott Morton. Because no published reports of the SPERS case have appeared to date, a more detailed report of the SPERS general system design phase is presented in the Appendix. The interested reader is urged to consult this appendix and the original references for more information on the various efforts. Finally, the problem areas of each system development are identified.

B. The SPERS Case Study

1. Environment. This section will provide background information on the client (who in this case is both sponsoring the work and will use the product), the problem that the client has perceived, and the consultant hired to ameliorate the problem.

a. The client is the Division of Energy Storage Systems (STOR), a U.S. Government entity headquartered in Washington, D.C. At the beginning
of this history - early 1977 - STOR had been in existence less than two years. Since its founding, STOR had been under the Conservation Office of the Energy Research and Development Administration (ERDA). However, subsequent to the inauguration of President Carter in January, 1977, the Department of Energy (DOE) was created and in October, 1977, ERDA, including STOR, was absorbed by this new organization.

The purpose of STOR is to identify and fund promising research, development, and demonstration proposals in the area of energy storage. This task is one of the principal functions of the program managers in the division; the other being to review the performance of the project once it is approved and funded.

b. The Problem. Problem identification was made by the director of STOR. He recognized two problem areas in his division: proposal funding decisions and contractor performance review.

Proposal funding decisions were apparently being handled differently by different program managers. Thus, the steps in the decision process (15, pg.6-17) varied from individual to individual.

Once the funding documents have successfully passed through the approval process, contract negotiation occurs and a contract for the project is executed between the principal investigator and STOR. The program
manager's area of project responsibility then shifts to performance monitoring. This review of contract performance is the second problem area identified by the director.

The reporting requirements for each contract are specified by the program manager and included in the contract. Here again there was much variability among the reporting requirements defined by the program manager. Frequency and detail of reports could vary according to size or duration of the project, the technical risks involved, or the workload of the program manager.

Some information for project control was automatically produced for STOR. A semi-monthly computer-generated report listed budget figures by contract. A report from the Controller's office contained a more detailed analysis of contract budget vs. expenses. However, the information in this report had a cycle lag of 2-3 months. The contract review system, then, had no provisions for providing current detailed contract performance reports.

Recognition of these problems lead to action on the director's part to ameliorate them. The first known step was the letting of a contract in early 1976 for a decision model for use in proposal evaluation. The second step, taken in mid-1976, was the hiring of
a program manager whose responsibility was, in part, to identify and contract for the solutions to these problems.

c. The Consultant. Lehigh University is a small (total student population approximately 5000) university located in Bethlehem, Pa., approximately 200 km. from Washington, D.C. Faculty in its Industrial Engineering Department specialize in information systems and operations research, as well as other I.E. disciplines. Traditionally, they participate in sponsored research as well as fulfilling teaching responsibilities.

2. The Chronology of SPERS. This section will summarize the history of the development of SPERS from the initial contact between the client and the consultant through the approval of the General System Specifications Report.

   a. The First Steps (16). The newly hired program manager was familiar with the work being done in the I.E. Department of Lehigh University, and early in 1977 called one of the faculty members about formulating solutions to STOR's identified problems. A trip was made to ERDA where the problems and requirements of STOR were discussed. Some of the conditions for system development were also established; actual user interaction would be small, with the program manager serving as liaison between STOR users - at all levels - and the developers. This discussion lead
preparation of a prospectus which, after more dis-
cussion between the parties was enlarged to a pro-
posal. Throughout this period, the critical need of
STOR for a solution to these problems was stressed.
Consequently, a project start date was established as
June 1, 1977.

b. The Proposal (17). The research proposal was sub-
mitted to STOR at the end of April. This proposal
named the system SPERS (Storage Program Evaluation
and Review System). The solutions to the problems
described included three deliverables: standardized
reporting formats; software and associated document-
tation for proposal evaluation (the Evaluation Module),
and for contract review (the Review Module). The
effort involved in constructing the system was broken
down into four phases: General Systems Design; System
Analysis and Design; Programming; and Conversion and
Implementation. The first phase will be considered
in this thesis. The tasks of this phase are: docu-
mentation of the present system; alternative computer
site evaluation and site selection; and development
of the General System Specifications.

c. Proposal Approval. Oral approval of the proposal
from STOR was received during June and work on the
contract began on July 1. The contract itself, however,
possessed a hard copy terminal that was available for use with SPERS. To insure compatibility between report design and hardware, investigation of the terminal characteristics was made and the project team ultimately borrowed a similar model from a local company in order to simulate the reports using a typeface familiar to the users.

An in-process review of work accomplished to date was held with the designated program manager at Lehigh during September. Suggestions for changes made at this time were incorporated into the design. After this visit, work continued on all phases with the goal of presenting the completed work to STOR at the beginning of November. An initial understanding with STOR was that all levels of management would attend the meeting. The presentation was planned for this audience and the team members were anticipating feedback on the system.

However, during this time, ERDA was being reorganized into the newly formed DOE, and the attention of STOR management was focused on the change. This political reorganization effected SPERS in two areas: the site selection decision, and user interaction. The director was reluctant to make a firm commitment on the implementation site, even though he realized that this was necessary for the project to continue.

As the date for the report presentation approached,
was not finalized until October.

During early August a meeting was held at STOR. Apparent at this meeting was a fair amount of resistance to SPERS on the part of the other program managers. Reconfirmation of the director's commitment to the system was obtained by the developers at this time (18).

d. General System Specifications. Work on the current system documentation and the computer site evaluation study continued concurrently with development of the General System Specifications. The purpose of the site study was to evaluate the potential sites available to STOR for implementation of SPERS. A decision from STOR in favor of a particular site was needed before any detailed design for SPERS could be initiated. The report on the site evaluation study was presented to STOR on September 8, 1977, with a request for an early response.

One area of the report that received detailed attention was the tentative output designs and descriptions for both Review and Evaluation Modules. Report forms were designed and simulated with hypothetical information. The purpose was to give STOR personnel specific examples of the system's reports in order to elicit specific design feedback. STOR
changes in the meeting began to be made by STOR. A presentation by another group was added to the schedule, thus shortening the time available for SPERS. Information was received that the managers would not be attending the meeting, so that the anticipated user interaction would not occur, and, finally, the director would not be attending because of preparation requirements for an afternoon meeting. Because communication with the liaison was difficult and unclear, the team members who traveled to D.C. were unsure of what to expect.

The actual presentation was made to two STOR personnel, one the program manager serving as liaison and several STOR contractors and potential contractors. The anticipated direct feedback from the other program managers and the director did not occur.

The presentation of the General System Specifications report to STOR was made with, perhaps, an unusual covering letter. Because of the difficulty the SPERS team was having with communications from STOR, the covering letter specified that the approval of the report would be by default, i.e., unless word to the contrary was received from STOR before November 19, the report, including the changes requested at the meeting, would be considered approved by STOR and work by Lehigh would proceed. Because the report included the Site Recommendation Report,
this approval by default included the selection of the implementation site. These conditions were explained to the liaison, who fully understood the situation.

Since no word was received from STOR by November 21, the report, as amended to include the changes requested at the presentation, became the basis for the detailed system development.

C. The United Farm Workers Organizing Committee (UFWOC) Case Study (12).

1. The Environment. This section will provide background information on the user, the problems recognized by the users, the consultants who designed the system, and the sponsor.

a. The Users. The United Farm Workers was established in California for the purpose of obtaining higher wages and better working conditions for farm workers, many of whom were migrant laborers. Typical Union members are Mexican-American, Mexicans, Anglo-Americans, Filipinos, and Blacks. The Union itself, headed by Cesar Chavez, is staffed with volunteers who receive small living allowances. Among the benefits members receive is medical insurance through the Robert F. Kennedy Memorial Health Plan.
where benefits are based on accumulated working hours. At the beginning of this case history, a new contract had been signed and, as a result, Union membership was expected to grow rapidly.

b. The Problem. There was a feeling in the Union that an overload of paperwork currently existed. This state, combined with the anticipated membership growth, had lead the Union to seek information processing help, especially in the critical areas of membership and Health plan records. Consequently, several vendors of computerized systems had been invited to discuss their wares. But the Union did not feel it had the technical expertise to evaluate objectively any of the proposed solutions.

c. The Consultant. During the summer of 1970, a Union representative contacted the Graduate School of Business at Stanford University for assistance. The school faculty had useful technical expertise. However, being aware of the failures of other attempts to aid minority organizations, they were concerned about the prospects for success.

d. The Client. The school felt that a research project would provide a more appropriate relationship with the Union than a normal consulting relationship. Consequently, research support for this project was sought
and obtained through a grant from the Donaldson, Lufkin, Jenrette Foundation.

2. The Chronology

a. The First Steps. After the initial phone contact the director of the Health Plan visited the school to discuss both problems and available resources. It was after this initial visit that the school obtained research funding for the project. The Health Plan director then returned for further discussion. The school team described its research desires and the project goals were defined.

b. Present System Documentation. The school team was concerned about the impact of a computer system on the Union. Consequently, they employed a design approach using questionnaires and interviews to obtain information on both attitudes toward the computer system and also functions within Union which should be included in the system (19).

These interviews were conducted in the fall of 1970 and covered staff at all levels in all major departments. Questionnaire responses were coded and analyzed statistically. Several findings were important to the system design efforts. Older workers had negative reactions to the computer. The two areas of the Union where the computer was felt to be
the most beneficial -- the Membership Office and the Health Plan -- both showed a less favorable environment for change than the remainder of the Union. Identification of these attitudes alerted the school team that special attention to these potential problems was needed.

Although the problem analysis had not been completed, the decision by the Union to implement a new dues procedure on January 1, 1971, brought with it the requirement of completing the existing work backlog in both Membership and Health Plan offices by the end of the year. The school team was forced by circumstances to make recommendations for action and, apparently, to apply some coercive power in their implementation when they would have preferred to move more slowly and established a trust-based relationship.

At approximately the same time, a new Health Plan director was appointed, the former one leaving the Union because of ill health. The school team failed to explicitly renew with the new director the agreement held with the previous one.

Problem analysis resumed after the recommendations on the work backlog were made. A meeting was held with Cesar Chavez concerning the project status. This gave the team their first feedback from the Union, which consisted of problems resulting from interviews conducted
by students. The school team, therefore, requested that the Union select a liaison who would work full time in the Union on data processing. The Union, in turn, requested that the team review a program package for Credit Union accounting.

c. General System Design

i. Development. The school team, at this point, was moving into the design phase. A Union staff member with computer experience was appointed as the full-time liaison. His first job assigned by the Union was to determine if the school's design effort should continue. The team, meanwhile, included the liaison in its design meetings and supplied copies of all completed documentation. The report on the school activities was favorable, and the Union decided to continue the project.

The school team was working toward Valentine's Day 1971, as the day when a review session of the project rough draft would be held with the general staff of the Union. The liaison held an education session on computer systems in general for some of the Union officials before this date. The team had not yet reviewed the plans with the Union leaders and wanted to do so before the general meeting. The Union's denial of this request caused the team a
great deal of uncertainty over the nature of the relationship.

Shortly before the Valentine's Day meeting, computer manufacturer representatives demonstrated one of their smaller machines to several Union staff members. The Union then requested that the school redesign the system for this particular machine. The team felt strongly that the Union should not initially acquire a computer because of the Union's lack of experience with the associated cost and management problems. Consequently, the team made a recommendation that the Union not commit itself on acquiring computing power until the plans for the system were completed. This recommendation was accepted by the Union.

The school team did not consider that a normal cost/benefit feasibility analysis was suitable because of the volunteer nature of the Union staff. Rather the intangible benefits of accuracy, timeliness, and ability to successfully handle varying transaction volumes were considered to be justification for the system.

The design strategy adopted by the team was to produce a simple computer system. The goal was to handle the processing needs of both Membership
The Presentation. The review meeting was held as scheduled on Valentine's Day. In order to encourage user participation, the meeting was held as a retreat and the entire staff was invited to attend and discuss the preliminary design. Initial comments were made by Cesar Chavez at the team's request. He stressed the Union's need for volunteers in areas other than those to be automated and the extreme unlikelihood of anyone's being replaced by the computer system. These comments helped to establish a positive atmosphere for the system presentation.

The consulting team began this presentation by telling the staff that the team would not consider the meeting a success unless changes were made to the system design. The team stressed that they were not trying to sell a particular design and reinforced this message by avoiding elaborate visual aids.

The initial part of the presentation was a tutorial on the basics of computer files, reports and processing. During the presentation of the system, numerous suggestions were made. As a result, reports were created or modified, the data flow through the system was revised, and reports of summary information for management were added. The
school team felt the response to their approach was excellent. Notes on the presentation were written for Union review.

A second similar meeting was held a month later with a smaller number of Union staff present. Further design modifications were made at this session.

iii. Approval and Bidding. After the design revisions resulting from the meetings were incorporated into the design, requests for bids were prepared jointly with the Union. After examining the bids, the Union decided the most desirable and economical alternative was to recruit a volunteer computer staff for the programming, implementation, and operations phases and to obtain as many donated computer services as possible.

iv. System completion. This strategy was followed and the full-time staff gradually assumed responsibility for the system. As this transfer of control was occurring, the school team wanted to conduct a follow-up survey to complete the research on the system design process they had employed. Because of internal changes in the Union, the team had to re-convince the Union staff of the desirability of this process. In the end, an agreement was reached where the team could conduct the second survey and publish
the results, subject to Union review. In return, the team agreed to be available for consultation as needed during implementation. An interesting result of the second survey was that the Union staff perceived a low level of involvement in the design process, despite the interviews, two participative meetings and the full-time liaison in the Union. The design team found this result discouraging.

From the beginning of the project, the school team realized that the Union could not afford to become dependent on the developers, as in the normal consulting relationship. The team, therefore, planned from the beginning of the project "to establish a capability within the union so that it could deal independently with information systems" (12, pg. 30). In summary, the team felt that those objectives were achieved.

D. The Livestock Management System (LMS) (13, pg. 95-99).

1. The Environment

a. The user, in this system design effort, is also the sponsor, although it is not clear whether the design work was supported, since it was part of a class project. The user is a small investment company in Southern California, responsible for maintaining
the investment of clients in livestock for breeding and marketing. The company supplies not only services but also ranch hands under contract with its clients. In the spring of 1972 -- the period covered by this project -- the company was managing some 5000 Angus cross-bred heifers and some 5000 calves. The investment firm was more committed to change and a different management form than the other companies in this industry. Its personnel were young and had relatively little experience in the livestock field.

b. The consultants were two students who undertook this work as a class project. One of the students, because of his interest, continued the project beyond the normal course requirements. The team recognized that the user organization was open and flexible and determined to design a system that would preserve these characteristics.

c. The Problem. No information is available on the problem recognition and identification process. The computer system designed was to handle the tax reporting, inventory management, herd management, and planning (breeding, for example) functions of the company. Thus, the livestock division was the part of the company most involved with system development.
2. The published chronology begins with a long meeting between the design team and the livestock division personnel. The team both learned about the industry and its problems and also tried to determine the perceived needs of each user. Computer applications were discussed in general terms. In fact, at the first meeting, the word computer was not mentioned, and was used as little as possible subsequently. This was one approach developed by the design team for preserving the company's flexibility. The team tried to force neither computerization nor any particular system on the company.

The designers wanted the users to design as much of the system as possible. Therefore, they taught the users flowcharting and asked them to develop the major logic of the system. Given the decisions described by the managers, the design team defined and named data fields, and flowcharting continued using the variable names. This flowcharting was an iterative process, first increasing in detail and then refining the complex calculations needed, for example, for sorting on genetic qualities and developing breeding probabilities. The managers also designed their own report formats using printed grid work sheets.

Because of the distance between the users and the team, mail communication was used. Initially this was
unsuccessful. Therefore, in order to expedite task completion, the designers developed an innovative procedure they called "Balanced Work Requests."

The designers divided requests into parts and mailed them to users. If there were two parts to be developed, two users were each sent two quarters and requested to do one quarter and give the other quarter to the other user. Thus each user completed one half of the request: his own quarter and a quarter from the other user. The whole project seemed smaller, and a situation of mutual dependence was created. Each user of the pair had to help the other; this system avoided requests being given a low priority and being ignored for a long period of time (13, pg. 97).

Using this approach the designers changed their response time from apparently infinite to a four-day average turnaround.

In order to make the users sensitive to the need for including processes to handle erroneous data in their system design, the team developed "Creative Conflict" as another component of the design strategy. Each staff member created data for two imaginary head of cattle -- the only restriction being that the data had to be consistent with the field descriptions. One animal was to be the ideal from each user's point of view; the other was to have impossible data conditions in order to force other departments' algorithms to fail. Because animal descriptions contained data from all parts of the system, each person had to learn something about the operations of other divisions. The company
president established a prize and each user tried to design his processing to be foolproof. The users perceived the creation of their own processing and test data as fun.

While the design process was continuing, the team held half-day working meetings with the managers. A minimum of one-half hour was spent before each meeting, away from the office, in a discussion of the meeting's objectives. The team felt that this clear definition of objectives caused little time to be wasted during the meetings themselves.

The design team built a macroprogram to call each user's routines. At last report, part of the system has been implemented and the company plans to gradually bring up the other parts as money and data availability permit.

E. The Management Decision System (MDS) (14).

1. The Environment
   a. The User. The company involved was a large firm with approximately 70 manufacturing divisions producing products ranging from electric toothbrushes to industrial turbines. Each division was an individual profit center. The division involved in this study manufactured and sold washing machines and dryers. The company had a long tradition of
innovation in computer technology. However, the management of the division involved had no special experience in the use of computers. Both the company and the Harvard Business School supported this research.

b. The Problem involved the determination of plans for the upcoming year covering the manufacture, sales, and distribution of laundry products. These plans were revised monthly. Involved in this process were three middle-level managers: the marketing manager, who was responsible for the entire country and reported to the sales division manager; the production manager, who reported directly to the division manager; and the market planning manager, who held a staff position providing planning support for the sales division manager. The market planning manager had the job of balancing the desires of the marketing manager against those of the production manager in such a way as to optimize the decision for the company as a whole. Specifically, the decisions these managers made affected production, advertising, and pricing on the marketing side, as well as production scheduling, purchasing, work force levels, and inventories on the production side. Thus the profitability of the division was heavily influenced by the quality of these decisions.
The decision process took 22 days elapsed time. Six of these days were actually spent in meetings. The remainder were necessary for gathering the information, performing the calculations needed by managers, and waiting for a time when the managers could meet together. The process typically was an iterative one. The market planning manager initiated it every month by using historical data, a computer-generated sales forecast, and his own knowledge of upcoming special events to derive what he felt to be a reasonable sales forecast for each product line. This forecast was reviewed with the marketing manager and adjusted until the two managers reached agreement on it. The market planning manager then broke the aggregate forecast into a forecast for each model within each product line and the process described above with the marketing manager repeated itself. When agreement was reached on a sales plan by model, the market planning manager used this plan to generate a production schedule which was then presented to the production manager. These two managers then performed an iterative process to develop a production schedule supporting the sales plan. Any large changes in the sales plan necessitated by production constraints had to be verified with the marketing manager. The process began with a large
volume of calculations to produce spread sheets which were initially input to the decision process. Any changes made during the initerative process could require from 2 to 10 hours of recalculations.

The decision process described had several characteristics. It was intuitive, characterized by negotiation, and subject to loss of continuity because of the interruptions necessary to perform recalculations.

c. The Consultants. This system design was undertaken as a research project in partial fulfillment of the requirements for a D.B.A. degree. The users understood that the goal of this project was to help improve the decision-making process.

2. The Chronology. No start date is explicitly stated for this project. Because the D.B.A. was granted in 1967 and the project duration was two years, the beginning must have occurred in 1964 or no later than 1965.

a. The first steps of the system design were to attend the meetings of the managers in order to study the current system. This attendance was consistent for three months and then became intermittent, serving as spot checking during the final three. The result of this study was a descriptive model of the decision process.
b. Design work began after the first four months of the project. It was the intent of the designer to produce a decision support system which used interactive graphic displays as the primary user interface for output, and, in conjunction with a light pen, for user input. The designer did not discuss various design alternatives with the managers during this initial phase in order to avoid raising expectations about the system.

After the core of the system was debugged, the market planning manager and his staff were trained in the system and the manager himself agreed to act as a liaison with the other two managers. The training of the market planning manager using test data in the system took two months. Numerous modifications were made to the system in order to adapt it to his personal style. He then taught the other two managers to use the system. The designer obtained information on user reactions via tape recorder and Polaroid camera. Whenever analysis of these reactions showed that improvements could be made, the changes were reviewed with the managers and implemented if they desired. Thus, the system was modified continually during the learning period.
c. The Results. The Management Decision System was adopted by the three managers as an integral part of their planning process. Its use has decreased both elapsed and meeting times to one-half day. The dramatic increase in computational speed resulting from system use has allowed the entire planning function to be completed at one meeting, giving the managers the continuity that had been missing and also allowing them to search for an optimal solution rather than accepting the first satisfactory one.

F. Identification of the Problem Areas

The descriptive model of factors and interactions affecting system use, Figure I, provides a convenient method for isolating the problem areas of each case study described. Because the initial development phase is critical to the success of an information system, the problems that appeared during that phase will be identified and studied.

In order to determine where problems can occur, it is necessary to examine each factor and interaction of the model that feeds into the development process. This model identifies two factors and two interactions that have direct affects. Because the development process can be affected by the attitudes of management as
perceived by users, this affect will also be considered as a possible problem area. A summary of the following discussion is presented in Table I on the next page.

Examination of the case study of the Storage Program Evaluation and Review System (SPERS) shows that problems existed in four of the five possible areas. Interactions between the design team and both users and management were severely limited. Furthermore, management's attitude toward the users was hostile, as was the users' attitude toward the system. The only factor favorable to system development was management's support of the system.

The case study of the United Farm Workers system showed some of the same problem areas. Users were reported as being fearful of the new system, but not hostile. Interactions between the design team and both users and management were limited. Management attitude toward users was supportive. However, management attitude toward the system under development varied from support to a re-evaluation of desirability involving consideration of alternatives.

The Livestock Management System development history shows only one problem area -- that of user-design team interactions -- which were limited by physical distance. The user attitudes toward the system were positive.
### Examination of Possible Problem Areas

<table>
<thead>
<tr>
<th>Areas</th>
<th>Case Studies</th>
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<tr>
<td>User attitudes toward system</td>
<td>hostile</td>
</tr>
<tr>
<td>User-design team interactions</td>
<td>severely limited</td>
</tr>
<tr>
<td>Management Policies and attitudes toward system</td>
<td>support</td>
</tr>
<tr>
<td>Management-Design team interactions</td>
<td>severely limited</td>
</tr>
<tr>
<td>Management Attitudes toward Users</td>
<td>hostile</td>
</tr>
</tbody>
</table>

N.A. Case history contains no information on this factor or interaction

Table I.

40
While there is little direct evidence of management's attitudes, policies, and interactions, their character is deduced from the facts that management not only allowed the research effort to occur but also supported the "Creative Conflict" approach by offering a prize to the winner.

The Management Decision System case history, because it is in reality a technical case history, has the least detailed description of the initial design process. While no problem areas emerge in this gross examination of the problem areas, the design team did both anticipate and encounter several problems which will be examined in the following chapter.

To summarize the above analysis, while both the SPERS and the United Farm Workers cases had four problem areas, the problems encountered in SPERS were more severe. The Livestock Management System had one problem area and the Management Decision System none that appeared at this gross level of analysis.
Chapter III

Categorization of the Problems and Solutions

A. Introduction

This chapter will examine in detail the case studies presented in Chapter II. Two tools are presented to aid this examination: a model of the general design phase; and a classification matrix for identified problems and solutions. Using the potential problem areas identified by the general descriptive model, each case study will be examined and specific problems identified. The specific solutions undertaken to solve each problem will be classified by type of action and result. The information from this analysis will be recorded using the classification matrix. Finally, the individual classification matrices will be combined to form the basis for an overall analysis.

B. Tools for Categorization

1. The general design descriptive model

While Figure I, which models the factors and interactions affecting system use, can be employed for a gross identification of initial development problem areas, it is not a good model for a detailed problem examination of one development phase.
Therefore, a model describing the phase to be examined is proposed and presented as Figure II on the following page. This contains the parts of Figure I which are relevant to the general design phase. The development process has been broken down into the components relative to this phase: the design team, with its attitudes and policies; the general design process, and the general system design resulting from the process. For ease of reference, the user, design team, and management nodes will be referred to as groups. The personal factor and need nodes, feeding into their respective group nodes will be referenced collectively as factors.

Other additions have been made to this model. Recognition that the design team, depending on its policy, will try to influence the inputs that factors make to their respective groups has resulted in the addition of the appropriate vectors between the team and the influences of the factors. Also, if users or management participate directly in the design process, their attitudes and policies can directly influence it. These paths have also been added to the model.

This model, then, shows not only the factors and groups which influence the general system design but the interactions and influences that exist between them. Before continuing discussion of the model, let us
Figure II.

Descriptive model of the general design phase
digress shortly to consider the differences between influences and interactions. An influence is the power of a person or thing to affect another person or thing. In this model, influences are represented by lines with a single arrowhead pointing from the node having the effect toward the node being affected. Interactions occur when two groups act on each other. They are represented in this model by a single line which terminates in an arrowhead pointing at each group. An interaction may begin as an attempt to influence another group and includes the feedback to the first group of the result of the attempt.

The complexity and multiplicity of the relationships possible during the general design effort is shown by this model. Of particular interest is the number of possible feedback loops present. This can cause one problem to generate another problem, etc., and raises the question of where in the loop the most effective intervention can take place.

This model is used to identify potential problem areas and the avenues which are available for problem correction. Problem areas can exist in groups, interactions, or design input. The design team can act to remedy a problem by influencing a change in the cause or by changing the team's policies in order to work around the problem.
2. Examination Technique

In the detailed examination of the individual case studies, each potential problem area identified by the model is examined in turn. If any specific problems, either actual or anticipated, are identified in this area, then for the purposes of this thesis, a problem area is considered to exist. For each specific problem, the attempted solutions are isolated and classified by the type of remedial action chosen. Finally, the result of each action is evaluated. The classification matrix described below is the vehicle for recording and displaying this examination.

The success criterion proposed in Chapter I -- whether the action ameliorated the specific problem to which it was addressed within the time frame of the initial development -- is used in this evaluation. All design efforts have continued past the general design phase. This analysis will also investigate whether or not the actions taken had any unanticipated effects.

3. The Classification Matrix

A sample of the classification matrix is presented as Figure III on the following page. The problem areas and remedial actions listed are those
Figure III.
Sample classification matrix
identified by the descriptive model. Implementation has been added to the problem area list because anticipated problems in this phase can lead to remedial actions in the general design phase. The results of a specific solution may not be known or expected at the end of the general design phase. Results are classified as unknown when no communication concerning them has been made. In the case of anticipated implementation problems, no results to any particular solution are expected by the end of the general design phase.

The matrix used for each case study examination has the same entries for problem areas, remedial actions and results as the sample. When a problem is identified, a description of the specific problem recognized is listed under the specific problem column and a dot is placed at the intersection of the relevant problem area and specific problem lines. If a solution has been attempted for the problem, it is described in the specific solution column and analyzed to determine the class of remedial action it represents. After the class has been identified, a logical connection is shown between it and both the specific problem and solution by placing dots at the intersections of the appropriate rows.
Finally, the information available on the case study is examined to determine the result of the solution. The relationship between the solution and its result is again shown by a dot at the appropriate intersection.

Using a hypothetical case study, an example will be presented to illustrate the use of this matrix. Examining the list of potential problem areas item by item has revealed that the design team identified a real problem with user attitudes; users were indifferent to the system under development. The team chose to solve this problem by educating the users on the benefits they would receive from the system. After this education process, the user demonstrated a positive attitude toward the system. This information has been entered in Figure III using dots at the appropriate intersections to identify the logical relationships. Reading the matrix may be accomplished by following the paths indicated by these dots: user attitudes have been identified as a real problem area; the specific problem encountered was user indifference; the remedial action taken by the design team was classified as influencing user perception of need; the specific solution was educating users on the benefits of the system; and, the result was successful.
C. Results of Categorization

1. Description of the SPERS analysis

The Storage Program Evaluation and Review System (henceforth referred to as SPERS) developed at Lehigh University and described in the Appendix of this thesis emerged from the gross problem examination as having the severest problems of all the cases studied. The results obtained by applying the method of categorization described above to the details of the case history are presented in Figure IV, the SPERS Classification Matrix, on the following page.

The first potential problem area investigated was user attitudes. The design team recognized a real problem in this area because the users had demonstrated a hostile attitude toward SPERS. In considering possible remedial actions, the team hypothesized several reasons for this attitude. Because SPERS would provide information for two different functions -- operational control (The Review Module) and decision-making (the Evaluation Module) -- different problems could originate from each module. The Review Module could be causing the users to anticipate a decrease in their power and independence of operation. The program managers had been functioning fairly independently in STOR. Their educational level -- doctorate -- and job background -- research--
Specific Solutions

Result

Remedial Action

Influence user personal factors
Influence team mgmt. policies
Influence eq. perception of need
Influence eq. perception of need
No remedial action attempted

Specific Problems

Problem Area

Implementation
Mgt. design input
User mgmt. interaction
User attitudes
User interaction
Team interaction
Team attitudes
Mgt. interaction
User mgmt. interaction
User attitudes

- Users hostile
- Limited by initial agreement
- Distance between groups
- Level decreased during phase
- Failure to increase interaction
- Decision not made
- User-mgmt. conflict
- Authoritarian predicted

Figure IV.

SPERS Classification Matrix
would reinforce this expectation of independence. They
may have perceived that SPERS would change this situa-
tion and allow the director to monitor their performance
more closely than he had previously been able, thus
increasing his power in the organization. The program
managers may also have perceived this access to perfor-
mane information as a threat to their jobs.

The Evaluation Module could also have caused
feelings of job insecurity. While some control systems
existed in STOR, simulation models to aid the project
funding decision process had not previously been used and
were therefore a completely unfamiliar quantity. The
program managers may well have seen the Evaluation Module
as a job threat because of its seeming ability to take
over their decision responsibilities, and, by implication,
to do the job better. The design team applied two
solutions to the problem of user hostility. The first
was to emphasize in discussions among the team that the
Evaluation Module was intended to aid the program
manager's decision process, not replace it. This remedial
action is classified as influencing user personal factors
since the personal factor node contains considerations
of job security. However, because of the severely
limited communications between the groups, the result of
this solution is not known. It is extremely doubtful
that this action had any significant influence on the user's attitudes.

The second solution was to present SPERS in a familiar context. The team produced prototype SPERS reports, simulated using the same type of terminal employed for current system reports, for presentation to STOR at two briefings and inclusion in the General System Specifications. This remedial action is also classified as influencing personal factors since it is an attempt to use the familiarity with currently used computer systems to present SPERS in a less threatening context. Because no program managers were invited by STOR management to either briefing, the team does not know whether this influence has reached its target and, if so, what the result has been.

The second potential problem area investigated is user-team interaction. This was one of the first problem areas apparent in the SPERS case study. The specific problem was that as part of the initial agreement between the client (STOR) and the design team this interaction would be limited. To help overcome any problems caused by this limitation, it was understood that the Program Manager responsible for the management of the contract, while not available to function as a full-time liaison, would serve as a communication channel between the team and both users and management. In this case, the Program Manager was
serving as staff to the Director rather than along the traditional program manager line responsibility. The agreement was initially acceptable to the design team because the physical distance between the two groups made frequent interaction difficult. Because this initial level was acceptable, the design team did not try to change it by, for example, scheduling more in-process review meetings with STOR. The remedial action taken by the team was to change the team policies and accept interaction with a liaison as a substitution for some of the direct user interaction. This solution was unsuccessful because the liaison was unable to spend the time on the project which the team had anticipated.

Another specific problem was identified in the user-team interaction area. While the level of interaction was initially acceptable to the team, this level decreased during the development phase. This decrease was not anticipated by the team. The apparent cause was the restructuring of the organization to which STOR belonged. In order to solve this problem, the team tried to communicate the importance of user participation to management through the liaison. This action is classified as influencing management policy because management policy did not seem to include involving the users in the design effort.

The next potential problem area is liaison-team interaction. This is a real problem area because the level of
of making the decision by the time requested had failed. Unfortunately, the reorganization was occurring during this period. The specific solution described above has been classified as influencing management policies.

The design team anticipated that this problem would recur with the decision necessary for approval of the general system specifications. Therefore, the "approval by default" process was initiated. This action was successful in that it allowed the scheduled continuation of the development effort.

The interaction between users and management was seen to be another real problem area in this development. The design team had witnessed an adversary relationship between these two groups with respect to SPERS, management being for the system and the users against. The team has not initiated any action to remedy this problem. The actions taken to reduce user hostility could also produce a favorable effect on this problem.

User design input was another real problem in the SPERS case. Because of the decrease in interactions with the users, no direct design input was received from any user other than the liaison. The remedial action taken for this problem was the same as described under user-team interaction, to try to impress management with the importance of this input.
interaction also decreased during the general design phase. The liaison was concerned in the organizational restructuring mentioned above and consequently was difficult to reach. During the general design phase, the team took no action to solve this problem.

Team attitudes and policies were also seen to be a real problem area. The decrease in interaction between the team and the other groups became increasingly worrisome because the team felt that system success was being jeopardized. The team's action to increase these interactions, described under the discussion of user-team attitudes, also served to ease the team's concerns. The failure of this action became another specific problem in this area. In order to decrease any negative effect from this failure, the team decided, at least informally, to temporarily accept the existence of the problem. This specific solution was successful.

Management-team interactions were also a real problem area. The same specific problems, initial limitation and decreasing level, were identified as those detailed in the analysis of user-team interactions, and the same specific solutions attempted, with the same results.

Management attitudes and policies were also a real problem area in SPERS. Management had procrastinated on the site selection decision. Efforts by the team to impress management through the liaison with the importance
Management design input suffered from the same problem described in user design input and had the same solution. In this case, all management input was filtered through the liaison. While some of this filtering was acceptable to the team, they also had expected some direct input.

The remaining potential problem area is anticipated implementation problems. The design team saw this as a real problem area. Because of user hostility and conflict with management, the team anticipated that the implementation of the system would be authoritarian. In order to decrease the user resistance expected from this situation, the team expressed an intent to make the system easy to use.

In summary, while STOR management has expressed a strong need for the system and continued to support its development, policy seems to be to minimize the involvement of both management and users with the design team and to filter information through the designated Program Manager. This policy, combined with the fact that STOR does not want the responsibility for maintaining the system, indicates that the director is concerned with the product -- operational SPERS -- but not the process -- the development effort.

A review of the classification matrix shows that a specific problem was encountered in each problem area during the SPERS general design phase. Some specific
problems were seen to impact more than one area; the problem of decreasing level of interactions affected six different problem areas. Two specific problems were seen as having no remedy; for one (decreasing interaction levels) a solution had been attempted and failed; for the other (user-management conflict) the team took no action. The seven solutions attempted fell into three different remedial action classifications: influencing user personal factors; changing team policies; and influencing management policies. Of these solutions, two were successful (temporary acceptance of the problem and using approval by default), two failed (use of a liaison and attempts to impress management with interaction importance) and the results of the remaining three (designing an easy-to-use system, presenting the system in a familiar context, and emphasizing that the system is an aid) were unknown at the end of the general design phase. The two successful solutions resulted from the modification of team policies to adjust to or work around the given situation. None of the attempts at influencing user attitudes were successful as far as was known.

A model of the SPERS development effort during the general design phase is presented in Figure V on the following page. This model has been developed by making modifications to Figure II, the descriptive model of the general design phase, as necessary to present an accurate repre-
Figure V.

SPERS General design phase model
sentation of the interaction and influencing paths open
during the SPERS development. The dashed lines represent
interactions and influences of whose existence the design
team is uncertain.

2. Description of the UFW analysis

The United Farm Workers' (henceforth referred to as (UFW) system development effort (12) had most of the same
problem areas as the SPERS effort, but the actual problems
described in Table I seem to be less severe. The results
obtained by applying the method of categorization to the
details of the case history are presented in Figure VI,
the UFW Classification Matrix, on the following page. A
description of how these results were obtained is pre-
sented below.

The first potential problem area examined in the UFW
case was user attitudes. The interviews performed by the
design team revealed two specific problems in this area.
First, negative attitudes toward the computer were
identified among the older Union workers, who were con-
centrated in the position involving heavy paperwork
processing. Needless to say, these positions were the
prime targets for automation. These workers had also
been found to be less satisfied with their jobs but also
less inclined to leave for other work than other Union
personnel. These results apparently suggested to the
team that the users' negative attitudes stemmed from feelings of job insecurity because one of the specific solutions taken for this problem was to obtain a personal statement from the Union head that each worker was valuable to the Union and no one would lose a job as the result of a computer system. This remedial action has been classified as influencing user personal factors because job security considerations are part of the personal factor cluster. The specific action was evaluated by the team as a success.

The other specific solution taken for negative user attitudes was to appoint a pro-computer supervisor for the two departments that were prime automation targets. This remedial action has also been classified as influencing user attitudes, this time by providing a very real demonstration of management support. The case history does not report on the result of this action.

The second specific problem identified with user attitudes was also discovered through the interview process. The users did not perceive as great a need for the system as did the remainder of the Union personnel. This is a surprising result since the users, being involved in day-to-day operations, had firsthand knowledge of the backlog existing with the current system. Considering the negative attitudes discussed above, it may well be that, as Argyris
### Problem Area

- Negative attitudes toward system
- System need not recognized
- Language difference
- Interviews cause disruption
- Critical need for change
- Mgt. not committed to team efforts
- Mgt. not sensitive to user feelings
- Input prejudiced by team
- No design knowledge
- Interaction with user
- Activities affect user
- Computer inexperienced

### Remedial Action

- Influence user personal factors
- Influence user perception of need
- Change team policies
- Influence mgt. policies
- Influence mgt. personal factors
- Influence mgt. perception of need
- Influence liaison

### Result

- None expected
- Unknown
- Failure
- Success

### Specific Solutions

- Obtain job security reassurance
- Use a supervisor
- Demonstrate bias support
- Change task order
- Obtain pro-system support
- Interview users
- Obtain pro-system supervisor
- Avoid elaborate presentation
- Simple easy-to-use system
- Stress goal is design change
- Avoid elaborate presentation

### Specific Problems

- Computer inexperience
- Input prejudiced by team
- No design knowledge
- Activities affect user
has proposed (20), the users were reacting emotionally rather than rationally to the proposed change. The team did not take any action to influence this specific problem although the personal statement of top management mentioned above could also have addressed this problem.

Specific problems were identified by the team in the user-team interaction area. The design team's approach to system development included the use of questionnaires to collect data on the needs of the organization and attitudes toward the computer. Because language problems with Union members were anticipated, the team changed its policy with respect to the questionnaires and administered them in interview form. These interviews were both successful and unsuccessful. Both the desired and additional information was obtained from them. However, after the interview process was over, complaints were received from Union management that the interviews had created some internal disruption. Apparently both the use of different students and the nature of some of the questions were at fault. In order to solve this unanticipated problem, the design team changed its policy of working directly with the users and requested the appointment by the Union of a person to work in the Union full time on data processing activities and to be the Union's liaison to the team. The appointment of a Union volunteer with some computer experience was a
successful solution to the problem.

No specific problems arose from the liaison-team interaction. Therefore, this interaction was not a problem area in the UFW case study.

Two specific problems were encountered in the area of team attitudes and policies. While the design team was involved in problem diagnostic activities, the Union was experiencing a critical need for improvement in the areas where work backlogs existed. The team had planned to complete the diagnostic phase before taking any action. However, it responded to the need of the Union by interrupting its current phase to recommend changes. This interruption was successful; the backlog of orders was successfully processed by the deadline.

The team may have anticipated some problems from this interruption. They were working to establish a trust-based relationship with the Union and their association with coercive change could have been a hindrance to achieving this goal. Furthermore, the imposed change could have worsened user attitudes and made them resistant to further change. However, none of these specific problems were reported.

The other specific problem encountered in this area, lack of management commitment to the team's efforts will be discussed below under management attitudes and policies.
This problem affected team attitudes by making the team uncertain over the relationship between themselves and Union management. No specific action was taken by the team to change this problem's effects.

Management-team interactions were not a problem area; no specific problems were identified here.

Management attitudes and policies, on the other hand, were a real problem area. Throughout the design effort, management remained committed to computer use, but not to the design team's efforts. Many examples of this problem exist. Several times during the general phase management considered other computer alternatives. As a result, the team was asked to evaluate a software, or to redesign their system for specific hardware. The first duty of the liaison was to evaluate the team's effort "to determine if it should continue" (12, pg.127). The team's request for a briefing meeting before the general review meeting was denied. The design team admits this denial caused "a great deal of uncertainty over the relationship" that existed with the Union (12, pg.28). It is also likely that the other examples of management re-evaluation had the same result. The design team did not take any special influencing action or change policy in order to change the situation. What they did do was to continue to act in what they saw to be the best interests of the Union, the development of in-house computer
expertise but no hardware acquisition. In some cases this resulted in cooperation with the requests, in another case, recommending against the action. While these actions did not succeed in winning management commitment neither was the design effort terminated.

Although the article does not consider this issue further, this analysis would be incomplete without considering possible reasons for the variable support.

1. The UFW was not paying for the design effort. Therefore, the Union management may have felt less committed because no Union resources were involved. 2. A feasibility study was not performed. The team justified this omission on the unarguable grounds that a normal cost/benefit analysis was not suitable in the volunteer environment. However, a feasibility study would have examined alternative solutions and may have convinced management that the team's design was indeed the best solution. This would have permitted management to stop searching for a better solution and express its commitment to the team. 3. The background of the Union and its officials. The Union was a young organization with no established policies. The officials were also young and probably lacking in management experience; they certainly had none with computer systems. Furthermore, they were from a different subculture than the design
team and would have had different behavioral patterns and expectations. 4. Retirement of the team's original Union contact. When this occurred, the design team did not recognize the importance of reestablishing the original design agreement with the contact's successor. Consequently, the team felt that some problems experienced at the end of the effort were avoidable. The different conceptions of the original agreement may also have contributed to the management commitment problem. Most probably, all four factors contributed, to differing degree, to the problem of inconsistent management commitment.

User-management interactions were seen by the team as a real problem area. Because the interviews showed that management was more enthusiastic toward computers than users were, the team anticipated that management might not be aware of or might underestimate the resistance and anxiety of the users. For this reason, the team acted to influence management policies by obtaining the personal job security statement discussed above.

The problem area of user design input had several specific problems. The design team felt that the negative attitudes of the users toward computers would prevent the users from making objective inputs to the design modification. The team anticipated that the user inputs
would be biased because the users would be responding to their fears of the system rather than to the logic and design of the system itself. The team sought to favorably influence this fear by beginning the meeting with the personal statement of job security from the Union head. The team also acted to counter the effect of negative user attitudes by obtaining demonstrations of management support: the meeting was held at a Union retreat; top management agreed to speak; the meeting was important enough for the entire staff to be invited. These solutions were seen by the team as successful.

The problem area of management design input was also seen as a real problem area by the team. Because both groups were invited to the review meeting, the specific problems identified in this area were the same as some of the user design input problems. Therefore, the team aimed to solve these common problems with common solutions. One identified specific problem was the disruption of the activities of both users and management by the review meeting. In order to minimize any unfavorable effects, the meeting was held away from the office. Neither users nor management had any knowledge of the system design process. To facilitate meaningful input, the team taught design fundamentals at the meeting. The team recognized that any appearance of selling their
own design would discourage both groups from suggesting changes. Therefore, the team decided to avoid an elaborate presentation and to stress that the goal of the meeting was to modify the design they presented. All the solutions described above can be classified as attempts to influence both user and management personal factors. The review meeting itself was a success and on this basis all of the solutions discussed have been judged successful.

The last problem area to be examined is implementation. The design team anticipated a problem here because of the negative attitude of the users. To minimize the effect of this problem at implementation, the team decided to design an easy-to-use system. The team also realized that the lack of computer experience could also cause problems in transferring the control of and managing the new system. Therefore the team also decided to make the system a simple one to minimize the time and effort required to develop the required in-house expertise. The policy of the team seemed to be to maximize the probability of a successful implementation in order to create a favorable environment for further computer systems.

A review of the UFW classification matrix shows that at least one specific problem was encountered in every problem area except for management-team and liaison-
team interactions. One specific problem (negative user attitudes) was seen as impacting three different problem areas. Several other problems (lack of management commitment, disruption of activities, no design knowledge, and prejudiced design input) were identified with two areas; the remainder (non-recognition of system need, language differences, interview disruption, critical need for change, insensitive management, and computer inexperience) affected one area only. Only two specific problems (non-recognition of system need and uncommitted management) were seen as having no remedy. To solve the remainder, the team chose to act almost exclusively by influencing user or management personal factors or by changing its own policies. Of the specific solutions attempted, almost all were successful. One of the successes (interviewing users) was also categorized as a failure because it caused a new problem. The results of two of the specific solutions (installation of a pro-system supervisor and designing a simple system) were known at the end of the general design phase.

A model of the UFW general design effort is presented in Figure VII on the following page. Because the liaison did not seem to block the interactions between the groups, he is represented as being superimposed over them. Management interaction with users is shown with
a branch to the influence of user personal factors. This path represents management's job security statement.

3. Description of the LMS Analysis

The Livestock Management System (henceforth referred to as LMS) which was a student project reported by Lucas (13, pp.95-99), emerged from the gross problem examination with only one problem area. The results obtained by applying the method of categorization to the details of the case history are presented in Figure VIII, the LMS Classification Matrix, on the following page. A description of the analysis results is presented below.

No specific problems were identified by the team in the user attitude problem area. The team, however, did see a specific problem relating to user-team interaction. Because of the distance between the design team and the users, the team apparently felt it was important to make their meetings as productive as possible. To do this, the team changed its policy to include at least one-half hour before each meeting discussing meeting objectives. The team found that after this type of discussion, little time was wasted during the meeting itself.
Specific Solutions

- Defers technical decisions
- Avoids forcing a solution
- Avoids use of "computer"
- Teaches design basics
- Uses Balanced Work Requests
- Mail design requests
- Stresses meeting objectives

Specific Problems

- Distance between groups
- No design knowledge
- Input prejudiced by team

LMS Classification Matrix

Figure VIII.
Only one of the remaining potential problem areas was seen by the team as a real problem area. User design input had three specific problems associated with it. The first specific problem -- distance between users and the team -- was also seen to be a problem with user -- team interactions. To solve the specific problem this caused to user design input, the team changed their policy of direct design input and mailed design requests to the users. This action was unsuccessful; the mailed requests were never returned. A second solution was then devised and successfully adopted as team policy -- "Balanced Work Requests." Lucas reports this solution as effective because it makes users both responsible and mutually dependent. Thus it can be classified as a remedial action which influences user personal factors.

Another specific problem relating to user design input was the users' lack of design knowledge. The specific solution taken by the design team was to teach the design basics, especially flowcharting, to the users. This remedial action can be classified as influencing user personal factors and was successful.

The final problem the team saw in the user design input area was the possibility that this input could be prejudiced by the team. The team chose three specific solutions, all successful, to this problem. First, in
initial discussions, they avoided the word "computer." Secondly, during these same discussions they avoided appearing to force any solution to the users' problems. Finally, they decided to defer all technical decisions concerning programming languages and processing type until the design was completed. These remedial actions have been categorized as influencing user personal factors.

No other real problem areas were reported as identified in the LMS case history. The "Creative Conflict" technique developed by the design team to insure that the editing procedures of the users were complete was relevant to the detailed design phase and therefore was not considered as a candidate for the classification.

The fact that no user resistance or hostility was encountered was probably the result of several factors. Both user and management groups were young and relatively inexperienced in the business. This inexperience probably meant that there were no long established habits or procedures for an information system to change. The youth of both groups would mean they were more receptive to change. The open communications which existed in the firm, as well as the good working relationship developed with the design team probably also resulted, in part, from the age of the personnel.

The character of the company probably also had a direct influence on the design effort. The firm, which
seemed to be young and in the process of establishing itself, was reported as more committed to change than other firms in the same field. This meant that management policies were receptive to change and attitudes were positive and supportive. In this environment, along established power structure would not be likely to exist and the users would be accustomed to dealing with change. Because of the company's organization, demonstration of management support and participation in the development process should not become a problem; the president of the firm was involved in the livestock division.

A review of the LMS Classification Matrix shows that only two real problem areas and three specific problems were identified. One of the specific problems (distance between users and team) was relevant to two problem areas, the other two problems (no user design knowledge and prejudiced design input) affected only one area. The remedial area used almost exclusively by the design team was influencing user personal factors. Most of the specific problems generated more than one specific solution. Only one of the specific solutions (mailing design requests) was unsuccessful.

A model of the LMS general design effort is presented in Figure IX on the following page. The line representing the input of management to the design process
Figure IX.

LMS general design phase model
is shown as dashed, because no information about it was reported.

4. Description of the MDS analysis

The Management Decision System (henceforth referred to as MDS) was designed as a dissertation project for a division of a major manufacturing company by Scott Morton (14). This system emerged from the gross problem analysis with no apparent problem areas. The case history concentrates on the technical aspects of the system and only one general design problem has been mentioned by the author. However, because this problem had an interesting solution, this case history has been included. The results obtained by applying the method of categorization to the case history results are presented in Figure X, the MDS Classification Matrix on the following page. The results are discussed below.

The one problem area identified by the designer during the general design phase was implementation. While Scott Morton was developing the system design, he perceived that a problem could be created if the users expected higher system performance than was ultimately delivered. Interactive graphic decision support systems were a new technology at this time and apparently Scott Morton was uncertain of their
Figure X.
MDS Classification Matrix
capabilities. Therefore, he purposely did not discuss various design alternatives with the users. This means that the only user input to the general design was through the definition of the current system. This action was classified as influencing user personal factors. Although a result was not expected at the end of the general design phase, it was apparently ultimately successful. One may speculate on whether the need for the many design iterations which Scott Morton performed during the implementation phase was caused by this solution.

A review of the MDS Classification Matrix shows that only one problem area and one specific problem were identified during the general design phase. This specific problem (raising user expectations too high) generated one specific solution (avoiding discussions of design alternatives) whose result was not known at the end of the general design phase.

A model of the MDS general design effort is presented in Figure XI on the following page. The dashed lines represent interactions and influences which were not discussed in the case history. As mentioned above, the users had no direct input to the design process.
Figure XI.

MDS development effort at the end of the General Design Phase
D. Summary of the Categorization Results

1. Summary Classification Matrix

The classification matrices for the individual case studies have been aggregated into one summary matrix, Figure XII, on the following page. Identification of information by individual case study has been made possible by replacing the dots used in the individual analyses with a numeric code. The key to this code is presented in the top right-hand corner of the table. The appearance of more than one number at the intersection between lines means that the relevant items occurred in more than one case study. For example, user attitudes were seen to be a real problem area in case studies 1 (SPERS) and 2 (UFW) where the specific problem encountered was hostility or negative attitudes. Both these case studies chose to take remedial actions by influencing the personal factors of the users. However, the specific actions chosen were different in each study. Total rows have been added to aid the analysis of this summary which will appear in Chapter IV.

2. Model Summary Table

The information contained in the descriptive models developed for each case history is summarized
in Table II, the Model Summary Table, presented on the next page. This table details for each case study, the nature of the communication channels and design inputs as reported by the design team. For example, for most of the SPFRS case there was no direct communication between users and team. Furthermore, the team was uncertain if the liaison was serving as an information filter between the users and the team. In the other case studies, the user-team interaction path was open. This was true even in the UFW case study after the appointment of the liaison, e.g., the review meetings.

These two tables of summary information will form the basis for the analysis and conclusion presented in Chapter IV.
### Case History

#### Model Paths

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<th>UFW</th>
<th>LMS</th>
<th>MDS</th>
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<td>Open</td>
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</table>

#### Table II

Model Summary Table

85
Chapter IV
Analysis and Tentative Guidelines

A. Introduction

This chapter uses the results obtained in Chapter III for the analysis and development of tentative guidelines for dealing with problems arising during the general design phase of information system development. First, each problem area is examined to determine the results of attempted remedial actions. From this examination, tentative guidelines are presented for problem areas. The problem area analysis is then summarized and examined for the emergence of any general guidelines. Next, the success rate for each case study is determined and compared with the intergroup communications detailed by case study in Table II. Finally, a summary of the results of this thesis is presented, and suggestions are made for further study.

B. Analysis and Guidelines for Problem Areas

Figure XII, the Summary Classification Matrix, has been used to identify, for each problem area, the type and frequency of remedial actions attempted and the results of these actions. This analysis is presented in Table III, Identification of Remedial Actions by Problem Area, on the following page. Examination of
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Table III
Identification of Remedial Actions by Problem Area

87
Table III yields several general observations. First, there are some problem areas for which little information exists. Secondly, taking no remedial action to solve a problem is uniformly unsuccessful. Not one instance has been discussed in any of the analyzed case studies when the "do-nothing" alternative was successful. Therefore, this alternative is not recommended as a solution for any problem area and will not be included in the following analysis.

This section examines each problem area to determine if any useful guidelines can be developed. There are three problem areas where different teams attempted the same specific solution. These will be identified and discussed during this analysis.

The reader should be aware that these guidelines are based on the available information for the cases studied. Their accuracy is dependent on this information's completeness and freedom from bias.

1. User Attitudes. Of the two types of remedial actions tried for this problem area, only one (influencing user personal factors) showed success. This remedial action was attempted as a solution four different times. One attempt was known to be a success; the results of the others are unknown. Therefore, the recommendation to be made for dealing with user problems is to try to influence user personal factors. This has been thought
by various teams to be the appropriate type of action.

2. User-Team Interaction. Three types of remedial actions were attempted in response to problems in this area -- influencing user personal factors, changing team policies, and influencing management policies. The actions which have some success, influencing user personal factors or changing team policies, are effective responses and to be recommended with user-team problems.

This is one of the few problem areas where the same specific solution was attempted in two different case studies. Both the SPERS and the UFW studies used a liaison to facilitate communications between the users and the design team. In the SPERS case the liaison was part-time and in the UFW case, full-time. The failure of this solution in SPERS and its success in the UFW case suggests that the success of a liaison as a specific solution may depend on the amount of time the liaison devotes to those duties.

3. Liaison-team interactions. Table III does not suggest any guidelines for this problem area. However, the same specific action is recommended here as above, use a full-time liaison.

4. Team attitudes and policies. Changing team policies has been the only successful remedial action in this area. The other attempted action, influencing management policies, produced a failure. The tentative
guideline suggested for this area then, is for the team to remain flexible and change their policies as problems arise. The UFW case contains a good illustration of the application of this guideline. The policy of the design team was to finish their study of the current system before making any recommendations for change. However, the Union had a critical need for immediate change in some of the areas under study. This conflict between the need of the user and the policy of the team caused team policies to become a problem area. Although some trepidation of the result was expressed, the team successfully solved the problem by modifying their policies to allow resequencing of the tasks.

5. Management-team interaction. None of the attempted remedial actions -- changing team policies or influencing management policies were successful. Therefore, none of these can be recommended. However, another type of remedial action, such as influencing management personal factors or perception of need might be attempted. These actions at least, do not have a negative track record.

6. Management attitudes and policies. Each of the remedial actions attempted to solve this problem area was only tried once. Changing team policies
was successful while an attempt to influence management policies was not. Therefore, the recommendation is to change team policies in response to problems in this area. The successful use of this guideline occurred in the SPERS case. It was the team's policy to require a response to requested decisions. Failure to receive this response was identified as a specific problem with management attitudes and policies. The team successfully solved this problem by instituting the "approval by default" policy where management was not required to respond if the recommendations were approved. This is an instance where the problem was solved by working around it rather than ameliorating it. In other cases, improving the problem might seem feasible. Then, rather than proceeding directly to influence management policies, which has failed, one might try to affect the change indirectly by influencing management personal factors or perception of need.

7. User-management interaction. In this area, only one action -- influencing management policies -- has been successful. This occurred in the UFW case where the design team identified potential problems in this area. The team was concerned that management would
not be sensitive to the user's unfavorable attitude toward computers. In response to this problem, the team influenced management policies to take account of user attitudes. In fact, an improvement in the design environment resulted because management's response was to make a statement guaranteeing job security.

8. User design input. This is the problem area where the recommendations for remedial actions are the clearest. Influencing user personal factors was significantly successful, and it is proposed as the guideline for this problem area. Remedial actions which were tried and failed were changing team policies and influencing management policies.

This problem area had the largest number of different solutions attempted. That finding should not be surprising since three of the four design teams believed that user input to the design process was important to successful system development. All the successful actions occurred in the UFW and LMS cases.

This is the second of the three areas where more than one design team used the same specific action. In both the UFW and LMS cases, anticipated problems with user design input were successfully
influenced by teaching users design fundamentals. This specific action is therefore recommended as a solution to problems in this area, when the users lack computer sophistication.

9. Management design input. Here again the recommendation can be stronger than for most other problems. Influencing management personal factors is suggested as the remedial action to use for problems in management design input. This action was successful in all the instances when it was used. The other type of action tried, influencing management policies was not successful.

Successful application of influencing management personal factors to obtain design input occurred in the UFW case were the design team was concerned about the review meeting. In fact, some of the same specific actions were successfully addressed to both management and users.

10. Implementation. This thesis only examined the results of specific actions through the general design phase, and the results of these solutions were not known until the end of the development process. However, some recommendations can be made in this area. Three design teams, SPERS, UFW and MDS, identified potential problems in this area. In each case, the actions
taken by the teams were successful in allowing the design effort to continue. Therefore, the guidelines proposed for implementation problems are to influence user and management personal factors.

11. Summary. Table IV, Summary of Problem Area Guidelines, summarizes the above recommendations.
<table>
<thead>
<tr>
<th>Problem Area</th>
<th>Tentative Guidelines for Remedial Action</th>
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</thead>
<tbody>
<tr>
<td>User attitudes</td>
<td>Influence user personal factors</td>
</tr>
<tr>
<td>User-team interaction</td>
<td>Influence user personal factors Change team policies Specific action - Use a full-time liaison</td>
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<td>User design input</td>
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</tr>
<tr>
<td>Management design input</td>
<td>Influence management personal factors</td>
</tr>
<tr>
<td>Implementation</td>
<td>Influence user personal factors Influence management personal factors</td>
</tr>
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Table IV
Summary of Problem Area Guidelines

95
C. General Guidelines

Presented below is Table V, a summary of the results of different remedial actions. Several general guidelines become apparent after inspection of this table. First, the action type with the most successes is "influencing the personal factors of users". User personal factors play a part in influencing both user

<table>
<thead>
<tr>
<th>Type of Remedial Action</th>
<th>Success</th>
<th>Failure</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influencing user personal factors</td>
<td>12</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Influencing user perception of need</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Change team policies</td>
<td>5</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Influence management policies</td>
<td>1</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Influence management personal factors</td>
<td>4</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Influence management perception of need</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Influence liaison</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No remedial action</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

Table V
Summary of Remedial Action Results
attitudes and user design input. While the results of influencing user personal factors in order to change user attitudes was unknown, this remedial action was successful in dealing with problems associated with obtaining user design input.

"Influencing management personal factors" was the most effective action type used. Management personal factors influence both management attitudes and policies and management design input. All the specific actions of this type were aided at increasing management design input and were successful.

"Changing team policies" was successful in about half the attempted uses. It seems to be a good idea for team policies to remain flexible so that they can be modified or new policies can be created to either solve or work around problem areas.

"No remedial action" was seen as a specific solution for one or more problems in each problem area. At no time was this "do nothing" alternative successful.

The other non-successful remedial action was influencing management policies. Of the eight attempts to use this type of action to solve problems in different problem areas, only one was successful.

The tentative guidelines to be drawn from this analysis are these: 1. Consider using the most successful types of remedial actions first - influencing the
personal factors of users or management as appropriate.  
2. If these actions do not seem pertinent, or have been tried and failed, consider changing team policies to either solve or work around the problem.  3. Problems do not go away if no attempt to solve them is made.

D. Analysis of Remedial Action Results by Case History.

This section will examine the results of remedial actions aggregated by case history. These results are presented in Table VI below. This table shows for each case history a total number of results greater than the number of specific actions employed. This difference arises from the fact that each specific solution was evaluated for each problem area affected by the specific problem that generated it.

Table VI shows that the LMS study had the highest

<table>
<thead>
<tr>
<th>Case History</th>
<th>Success</th>
<th>Failure</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPERS</td>
<td>2</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>UFW</td>
<td>13</td>
<td>5</td>
<td>3</td>
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<tr>
<td>LMS</td>
<td>7</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>MDS</td>
<td>0</td>
<td>0</td>
<td>1</td>
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Table VI
Summary of Results by Case History
success rate, seven out of eight. The UFW study followed with 13 out of 18 known results successful. And the SPERS case trailed with two successful results out of 19. No result on the remedial action attempted in the MDS case was known at the end of the general design phase.

Examining Table VI in conjunction with Table I, the Examination of Possible Problem Areas, shows a relationship between the success rate and the attitude of management toward the users. In both the cases with the higher success rates, the UFW and LMS cases, management had a positive attitude toward users and thus provided a supportive atmosphere for the development process. This was not the case in the SPERS effort, which had a much lower success rate where management appeared to be hostile to the users.

This relationship suggests that another way to improve the results of specific solutions is to obtain a positive management attitude toward users if one does not already exist. The guidelines proposed for this by this thesis is to influence management policies.

Examining Table VI in conjunction with Table II, the Model Summary Table shows a relationship to the openness of the communication paths in the different case
histories. The SPERS case had both the most limited communications between groups and the lowest success rate. On the other hand, the LMS case had open communications and the highest success rate. The UFW case falls between these two cases. Communications were open, but a full-time liaison was also used. The success rate, while lower than the LMS case with no liaison, was higher than the SPERS rate. SPERS had both a part-time liaison and the most limited communications.

This analysis suggests that problems with inter-group communications, if they exist, should be addressed first because the success of specific solutions seems proportional to the openness of the communications between groups.

E. Summary of Thesis Results

The objective of this thesis is the proposal of guidelines for the development of information systems under adverse conditions. These guidelines have been developed from the examination of various published case studies and the system development effort detailed in the Appendix of this thesis. The stated thesis objective has been
fulfilled by the previous sections of this chapter. A summary of the guidelines by problem area is presented in Table IV. General guidelines drawn from this analysis are as follows:

1. It is important that the design team be consciously aware of actual and potential problem areas and also the types of remedial action available to solve these problems. The Classification Matrix, developed for the case study analysis, appears to provide an excellent means for both initial examination and monitor-ship of the design effort problems. Therefore, it is recommended that at the beginning of any design effort, a blank classification matrix be constituted and examined to determine if any problems can be identified at the outset.

As the design effort progresses, the matrix can be periodically reviewed. Its use in this manner can help identify new or potential problems.

The matrix can also be used to identify the problem areas impacted by the specific problems. Once these are known, the guidelines published in this thesis can be examined for suggested remedial actions.

It is further recommended that the matrix be used as a scoring sheet during the design effort.
In this way, the analyst will have a record of the encountered problems, the attempted solutions, and the results of the solutions.

If used in this manner, the Classification Matrix can alert the team to problems, identify appropriate guidelines, and provide a record of the team's efforts and results.

2. For any given specific problem, first consider trying to influence the personal factors of the group involved in the problem. Analysis of personal characteristics such as age, education, decision style, data processing experience and job situation will show whether influencing the input of these factors on attitudes will help to solve the problem.

3. If Guideline Number 1 does not seem appropriate, or has been tried and failed, evaluate team policies to determine if a change in this area will either solve the problem or enable the team to continue to work while the problem exists.

4. Trying to solve the problem by benign neglect -- not attempting any solution -- is not recommended. Following this course seems to guarantee failure. One is certainly better off attempting some solution because in this case the probability of failure is less than certainty.

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5. Problems with intergroup communications, if they do occur in the case study, should be solved as early as possible since they have an unfavorable impact on the success of attempted solutions.

6. Problems with user-management interactions also adversely affect the success of remedies and should be addressed early in the design effort.

F. Recommendations for Further Study

The main problem with research in this area of information systems development is the small amount of published case studies available in the literature. Although systems analysts meet and deal with such problems every day, this lack will probably not be filled for quite some time because of the sensitive nature of the subject. Instead of waiting for information to appear, however, why not seek it out? Both Lucas (1,19) and Dickson and Powers (21) have successfully used questionnaires for surveys in other areas of information system research. The technique reported by Lucas and Plimpton in the UFW case (12) of administering questionnaires via interviews produced more information than questionnaires alone. Candidates for information sources are firms which have experience in information system development and are willing to help support a research effort. Research along these lines
would extend the present information base into an area currently not covered -- problems faced by consultants within the business environment. The case studies included in this thesis were conducted as research efforts by consultants from academia. The gaps in Table V, Summary of Remedial Action Results, may be filled by this approach.

Another area for further work is the extension of the time period for analysis to include the evaluation of post-implementation results in light of the actions and expectations of the general design phase. The SPERS case study provides an excellent opportunity to trace problem areas over the entire project development cycle and to assess the results of both the problems and their solutions on the use of the system.

A third area for further work is in the area of consulting theory. The main body of this theory has been developed over the past twenty years and literature in the areas includes a large number of case studies concerning consulting in non-technical areas. The application of consulting theory to technical areas, such as information systems development, seems to be beginning. Articles are starting to appear that recognize the similarity of effort involved. For example, Feeney and Sladek (8) compare the systems
analyst's job functions to those of a change agent.

Lucas and Plimpton have also involved consulting theory in their analysis of the UFW case (12). They chose to use a consulting theory developed by Kolb and Frohman (22) which models the consulting process and discusses types of interactions. This approach appears to be successful when the analysis covers the duration of the consulting activity.

Blake and Mouton, in their book *Consultation* (23), propose a more detailed interaction classification method than the one used in this thesis. As the amount of available information increases, this more detailed approach may become desirable.


Appendix

Detailed History of the SPERS General Design Phase

A. The Background of the client.

The client is the Division of Energy Storage Systems (STOR), a U.S. Government entity headquartered in Washington, D.C. At the beginning of this history — early 1977 — STOR had been in existence less than two years. Organizationally, it was under the Conservation Office of the Energy Research and Development Administration (ERDA).

The purpose of STOR is to identify and fund research, development, and demonstration projects that seem likely to produce significant improvement or innovation in the area of energy storage. Because available funds are limited, it is important to identify those proposals which are both most promising technically and reasonable with respect to proposed costs and schedule. In order to facilitate this task, the division is broken down into subprograms, each dealing with one type of energy storage technology. Each subprogram is headed by a program manager. Two organizational levels exist between the program managers and the director of STOR. The chart of STOR's internal organization at the beginning of this history is presented as Figure AI on the following page.

Project ideas may originate either within STOR or from individual investigators. In the former case,
Figure A1. Initial STOR Organization Chart
various mechanisms exist for proposal solicitation. In both cases, it is the responsibility of each program manager to evaluate the proposals relevant to his sub-program and to contract for the research which seems to best forward his goals. This process is discussed in more detail in the next section and in the General System Specifications (Al, pg. 6-17). After the contract is let, the program manager must monitor contract performance to determine if terms are being met. Various mechanisms are available (Al, pg. 17-23). A program manager determines how closely performance is followed by the stringency of reporting requirements included in the contract.

The principal tasks of the program manager, then, are making proposal evaluations, funding decisions, and performance reviews.

B. The Background of the Problem

Problem identification was made by the director of STOR. He recognized two problem areas in his division: proposal funding decisions and contractor performance review.

Proposal funding decisions are approached differently depending on whether or not the proposal has been solicited. Proposals received from one solicitation are considered together. The usual technique is for experts
selected by the manager to review and rank the proposals based on technical merit and budget. The funding decision made by the program manager is based on both the results of this ranking and any other relevant information the manager may have. Unsolicited proposals are handled on an individual basis by the program manager and may or may not include review by others. For each proposal to be funded, the program manager prepares the documents which are needed in the procurement process. While these forms will be reviewed at many governmental levels, both within and outside of STOR, and returned for any necessary modifications, the funding decision itself apparently can not be reversed once it has been made (Al, pg. 9-13). Thus, the program managers are autonomous in the proposal selection area.

As the above description shows, there is no standardized funding decision process. Rather, each program manager uses some mixture of input from self and others. Furthermore, the ratio of intuition and quantification of proposal costs and benefits brought to bear on the decision process varies between managers and probably for each manager over time. This variability of formalization and quantification in the decision process, then was seen by the director as a problem area.
Once the funding documents have successfully passed through the approval process, contract negotiation occurs and a contract for the project is executed between the principal investigator and STOR. The program manager's area of project responsibility then shifts to performance monitoring. This review of contract performance is the second problem area identified by the director.

The reporting requirements for each contract are specified by the program manager and included in the contract. The frequency and detail of performance reporting may be a function of the technical risks of a project and/or the size of the contract. Because a program manager may have review responsibility for as many as 40 different projects, work load may also be a factor in determining reporting requirements. The program manager also has available the use of field office personnel for contractor visiting to determine technical performance.

Two additional sources of contract budget information are available for contract review. Both are computer-generated financial reports, based on the expense information received from the contractor. One is generated by INFONET Timesharing service and lists, for each program manager, budget figures by contract. This report is produced semi-monthly. The other is provided by the Controller's office and contains a more detailed breakdown of
contract budget vs. expenses. The information in this report has a cycle lag of 2-3 months.

The contract review system in STORS, then, had no provisions for providing current, detailed contract reports to any management level above the program manager except through personal request. Fulfilling information requests in this manner was time consuming. Furthermore, the desired data might be missing because of the variability in reporting requirements. Also, formalized exception reporting was not available at any level. Thus, the program managers are also autonomous with respect to contract control.

Recognition of these problems lead to action on the director's part to ameliorate them. The first known step was the letting of a contract in early 1976 for a decision model for use in proposal evaluation. The second step, taken in mid-1976, was the hiring of a program manager whose responsibility was, in part, to identify and contract for the solutions to these problems.

C. The Background of the Consultant

Lehigh University is a small (total student population approximately 5000) university located in Bethlehem, Pa., approximately 200 km from Washington, D.C. Faculty in its Industrial Engineering Department specialize in information systems and operations research, as well as
other I.E. disciplines. Traditionally, they participate in sponsored research as well as fulfilling teaching responsibilities.

D. The Development History

1. The initial contact (A2).

The newly hired program manager was familiar with the work being done in the I.E. Department of Lehigh University, and early in 1977 called one of the faculty members about formulating solutions to STOR's identified problems. This faculty member was reluctant at the time to take on more work. However, a trip was made to STOR where their problems and requirements were discussed. This discussion also established some of the conditions that would exist during system development: actual user interaction would be small, with the program manager serving as liaison between STOR users - at all levels - and the developers.

The result of this trip was the preparation of a prospectus (a sketchy proposal) including a loose schedule outline. Because of the critical need of STOR, the start date for the project was established as June 1, 1977. A meeting at Lehigh between the program manager and the faculty to discuss the prospectus resulted in agreement that a proposal
would be submitted by May 1, 1977.

2. The Proposal (A3).

The research proposal was submitted to STOR at the end of April. This proposal named the system SPERS (Storage Program Evaluation and Review System). The solutions to the problems described included three deliverables: standardized reporting formats; software and associated documentation for proposal evaluation (the Evaluation Module), and for contract review (the Review Module). The effort involved in constructing the system was broken down into four phases: General Systems Design; System Analysis and Design; Programming; and Conversion and Implementation. The first phase is described in this Appendix. The tasks of this phase are: documentation of the present system; alternative computer site evaluation and site selection; and development of the General System Specifications.

Because of STOR's critical need, the work on SPERS continued to be scheduled for commencement on June 1, 1977. Submission of the proposal by May 1 gave STOR one month for evaluation and approval. Agreement to these dates had been given by the program manager at the Lehigh visit. Nevertheless, oral approval did not come from STOR until into June. On this basis, work was begun on July 1, 1977; the contract itself was not
finalized until October.

During early July, the program manager forwarded the Uniform Contractor Reporting Guidelines (UCRG) to the Lehigh team. This document contains a comprehensive set of report formats for use in contract management. Its use in the proposal approval and reporting process was permissive, not required. Examination of the reports showed that some would be very useful to SPERS and would eliminate the effort required to develop standardized reporting formats. None of the program managers present at a meeting with STOR in early August were requiring contractor reports using the guidelines. Also apparent at this meeting was a fair amount of resistance to SPERS. Reconfirmation of the director's commitment to the system was obtained by the developers at this time. (A4)

3. Present System Documentation (A1, pg.6-23 and Appendix A).

During August, two of the faculty involved with SPERS traveled to Washington to obtain information on the present evaluation and review systems used by the program managers. The report of their findings included the general system description summarized in the background of the problem given above and an item by item documentation of the information available through the computer reports presently used, the documents of the
4. Computer Site Evaluation Study (Appendix C of Al)

Concurrent with the present system documentation effort was the site evaluation study. The purpose was to evaluate the potential sites available to STOR for implementation of SPERS. A decision from STOR in favor of a particular site was needed before any detailed design for SPERS could be initiated.

The sites evaluated were suggested by STOR personnel: three large timesharing services, a computer facility subsidized by STOR at Lawrence Livermore Laboratory (LLL) in Arizona, and the Lehigh University Computing Center (LUCC). The evaluation process was designed to minimize subjectivity. Eight criteria important to SPERS development and operation were identified and assigned point values relative to their importance. Information on the various services was gathered, studied, and discussed by the faculty on the SPERS team. Each investigator then independently scored each alternative site. Sites were then ranked according to total number of points. The highest ranking alternative was the LUCC site. Grouped somewhat below it were the three commercial timesharing services. Trailing was the LLL site. The report on the site evaluation study was presented to STOR on September 8, 1977, with
a request for an early response.

5. General System Specifications Report (Al)

Both the Site Evaluation Study and the Present System documentation described above were intended to be part of the General System Specifications report but were completed and reported before the remainder in order to have early feedback from STOR. In particular, the knowledge of the information currently available was necessary for other parts of the general design.

One area of this report that received detailed attention was the tentative output designs and descriptions for both Review and Evaluation Modules. Report forms were designed and simulated with hypothetical information. The purpose was to give STOR personnel specific examples of the system's reports in order to elicit specific design feedback. STOR possessed a hard copy terminal that was available for use with SPERS. To insure compatibility between report design and hardware, investigation of the terminal characteristics was made and the project team ultimately borrowed a similar model from a local company in order to simulate the reports using the typeface which was familiar to the users.

On September 12, an in-process review was conducted at Lehigh for STOR. It was attended by the program
manager. Topics included were the current system documentation, the review module reports, the evaluation module, and the site selection study. Suggestions for changes were made and incorporated into the design. Work continued on all phases of the specifications with the goal of presenting the completed report to STOR at the beginning of November.

In mid-October, the team members who would present the report were selected and plans were laid. An initial understanding with STOR was that all levels of management would attend the meeting. The presentation was planned for this audience and the team members were anticipating feedback on the system. The morning was to be spent with the presentation and audience feedback, and the afternoon in discussion with the program manager.

However, during this time, ERDA was being reorganized. Subsequent to the inauguration of President Carter in January, 1977, the Department of Energy (DOE) was created in October, 1977, and ERDA, including STOR, was absorbed by this new organization. This organizational change caused a great deal of concern in STOR over job security. And, indeed, the concern was justified since some personnel changes occurred at this time. A chart of the internal organization of STOR after this change is presented as Figure AII on the following page.
This political reorganization effected SPERS in two areas: the site selection decision, and user interaction. The director of STOR was reluctant to make a firm commitment on the implementation site, even though he realized that this was necessary for the project to continue. The principal investigator pointed out that this decision was not irrevocable and the implementation site could be changed further down the road, although at a cost.

As the date for the presentation approached, changes in the meeting began to be made by STOR. A presentation by another group was added to the schedule, thus shortening the time available for the SPERS presentation. The location of the meeting was changed. Information was received that the various program managers would not be attending the meeting, so that the anticipated user interaction would not occur, and, finally, that the director would not be attending because of preparation requirements for an afternoon meeting. Because communication with the program manager was difficult and unclear, the team members who traveled to D.C. were unsure of what to expect.

The actual presentation schedule began with a presentation by another group on another system that would be installed. The SPERS presentation followed.
Present were two STOR personnel, including the program manager, two STOR contractors, and one potential contractor. The presentation format covered the general system flowchart, the Review module reports and reporting levels, the Evaluation Module and model, and the assumptions around which the system was designed. The SPERS team wanted explicit approval of these assumptions and they were discussed at the conclusion of the presentation. Some changes in system details were requested by the program manager, who also expressed an intention to brief the director on the presentation. The remaining discussion centered on the evaluation model.

The presentation of the General System Specifications to STOR was made with, perhaps, an unusual covering letter. Because of the difficulty the SPERS team was having getting decisions from STOR, the covering letter specified that the approval of the report would be by default, i.e., unless word to the contrary was received from STOR before November 19, the report, including the changes requested at the meeting, would be considered approved by STOR and work at Lehigh would proceed. Because the Site Recommendations were included in the report, this approval by default included the selection of LUCC as the implementation site.
These conditions were explained to the program manager who understood the situation.

Since no word was received from STOR by November 21, the General System Specifications, amended to include the changes requested at the presentation, became the basis for detailed system development.
Appendix References


Vita

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