NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

Strategic Planning for
DFAS-Cleveland Expert Systems

by

Frederick J. Schwarz II

March, 1991

Thesis Advisor: Tung Bui

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Naval Postgraduate School 6b. OFFICE SYMBOL *(If applicable)* AS	7a. NAME OF MONITORING ORGANIZATION Naval Postgraduate School
6c. ADDRESS *(City, State, and ZIP Code)* Monterey, CA 93943-5000	7b. ADDRESS *(City, State, and ZIP Code)* Monterey, CA 93943-5000
8a. NAME OF FUNDING/SPONSORING ORGANIZATION DFAS-Cleveland 8b. OFFICE SYMBOL *(If applicable)* Code 514	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS *(City, State, and ZIP Code)* 1240 E. 9th Street Cleveland, Ohio 44199-2055	10. SOURCE OF FUNDING NUMBERS Program Element No. / Project No / Task No. / Work Unit Accession Number

11. TITLE *(Include Security Classification)*
Strategic Planning for DFAS-Cleveland Expert Systems

12. PERSONAL AUTHOR(S) Schwarz, Frederick J. II

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT *(year, month, day)*	15. PAGE COUNT
Master's Thesis	From To	March, 1991	93

16. SUPPLEMENTARY NOTATION
The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

17. COSATI CODES

FIELD	GROUP	SUBGROUP

18. SUBJECT TERMS *(continue on reverse if necessary and identify by block number)*

19. ABSTRACT *(continue on reverse if necessary and identify by block number)*

Managing expert system development is complicated by fear of the unknown - a new technology and a new approach to problem solving. This thesis proposes a scenario approach to expert system technology planning for the Defense Finance and Accounting Service - Cleveland. The intuitive logic method used in this study suggests four scenarios that would progressively take place over time. Ultimately, the expert system technology at DFAS-Cleveland would move towards an open system architecture environment. Expert systems would be run on a network of distributed systems with micro-mainframe connectivity.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT X UNCLASSIFIED/UNLIMITED ☐ SAME AS REPORT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Bui, Tung	22b. TELEPHONE *(Include Area code)* 408-646-2630 22c. OFFICE SYMBOL AS/Bd

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted. All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

Strategic Planning for DFAS-Cleveland Expert Systems

by

Frederick J. Schwarz II
Lieutenant Commander, United States Navy
B.A., Catholic University of America, 1978

Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN INFORMATION SYSTEMS

from the

NAVAL POSTGRADUATE SCHOOL
March 1991

Author: ______________________
Frederick J. Schwarz II

Approved by: ______________________
Tung Bui, Thesis Advisor

____
John W. Griesser, Second Reader

______________________ for
David R. Whipple, Chairman
Department of Administrative Sciences

ABSTRACT

Managing expert system development is complicated by fear of the unknown - a new technology and a new approach to problem solving. This thesis proposes a scenario approach to expert system technology planning for the Defense Finance and Accounting Service - Cleveland. The intuitive logic method used in this study suggests four scenarios that would progressively take place over time. Ultimately, the expert system technology at DFAS-Cleveland would move towards an open system architecture environment. Expert systems would be run on a network of distributed systems with micro-mainframe connectivity.

TABLE OF CONTENTS

I. INTRODUCTION

A. BACKGROUND DISCUSSION

The Defense Finance and Accounting Service-Cleveland Center (DFAS), formerly Navy Finance Center (NAVFINCEN) is a shore (field) activity. It is currently under the command and primary support of DFAS Headquarters, Washington D.C. The mission of the DFAS Cleveland is to develop, design, implement and maintain systems to administer Navy pay, with its special situations and requirements, for the Department of the Navy (DON). The DFAS Cleveland has adopted the policy of significantly improving information system performance while reducing development costs. This is the results of significant pressures of the DFAS organization due to the:

- Complexity of Information Technology in Information systems, Telecommunication, and Office Automation
- The potential decline in the average aptitude level of personnel administering the navy pay system due to personnel losses
- The impending, but yet unstructured, consolidation of all Department of Defense (DOD) financial institutions
- The continuing restraints on defense spending

One of the inroads to addressing the perceived problems while dealing with shrinking budgets has been their investment into Expert Systems (ES) Technology. As part of an effort to reduce cost by automating various levels of management activities, Expert System Technology was introduced to the organization in September of 1988. A core group of personnel were trained in expert system development, resulting in six expert systems going into production with eight more in varying stages of completion as of June 1990. The cost-benefit analysis for four of the six systems in production showed a savings of close to $300,000.00 during the next five years. The distribution of expertise in the form of expert systems, has given managers the ability to distribute peak workloads and avoid backlog, while improving quality. Within the DFAS community, Cleveland center is acknowledged as a leader in ES development.

It is inevitable that, with the DOD financial consolidation, the architecture of future information systems will be different from those in production today. It is believed that the center's reliance on expert system technology continues to generate positive impact to the effort, as procedural and system policies are discussed between the services. Additionally, DFAS Cleveland has exported standardized Expert Systems to other members of the DFAS community. DFAS Cleveland is viewed as the leader in Expert System Technology.

This thesis will address information technology, with a emphasis on Expert System development strategies for matching organizational goals and objectives, while looking toward the future.

B. RESEARCH OBJECTIVES

The primary objective of this thesis will be to provide DFAS Cleveland with a strategic development plan for implementing Expert System Technology, given the current status of information systems available today and their present configuration. A secondary objective would be to present future trends in the Expert System Technology that DOD financial institutions can utilize in new development efforts.

C. THESIS SCOPE, LIMITATIONS AND ASSUMPTIONS

The main thrust of this thesis will be an examination of the various roles, functions, management and technical issues of Expert System Technology available including an examination of DFAS requirements for Expert Systems in the future.

This thesis will attempt to consider the requirements for the organization as a whole, but with focus on the Operations Directorate and the Accounting and Finance Department. The literature advocates that the level of awareness by top and middle management is critical. Their degree or lack of clarity become instrumental in addressing the organization's data processing requirements. It may be well informed actively seeking innovative data processing improvements, or it may be considered a necessary evil which if ignored will fade away. However, the burden for raising the level of consciousness, at the present time, lies principally with the Information System Manager. He/She must consider the degree of education required and the means available to best achieve that level of understanding.

The mission, directives and laws of the organization is assumed not to change drastically for the next five years. However the organizational structure of DFAS is expected to undergo drastic change.

D. METHODOLOGY

The methodology employed in this research effort is a new approach to perform ES strategic planning. Our investigative approach utilizes questionnaires, coupled with an extensive literature review of current books, periodicals, articles and journals, as well as DFAS Cleveland directives, plans and policy guidance. Due to the qualitative nature of the data that could be gathered for this research, a scenario approach was selected to perform strategic planning.

Intuitive logic is regarded as the most appropriate scenario technique for developing ES planning at Cleveland center, because it provides the ability to develop flexible, internally consistent scenario's from a logical perspective. It provides the business decisions which are based on a complex set of relationships among economic, political, social, technological, resources and environmental factors. Since this scenario approach is not tied to a mathematical algorithm it can, with tailoring, be adjusted to the particular needs and political environment of any organization. Some of the decision factors in the intuitive scenario are external to Cleveland Center information systems but must be understood in order to provide insights and improve decisions relating to Expert System development strategy.

E. ORGANIZATION OF THE THESIS

Figure 1 depicts the planning process devised for this study. The organization of the study consists of describing and analyzing each of these building blocks. These models provide for the detection of change as Cleveland center adopts information technology and implements organizational mechanisms to benefit from it.

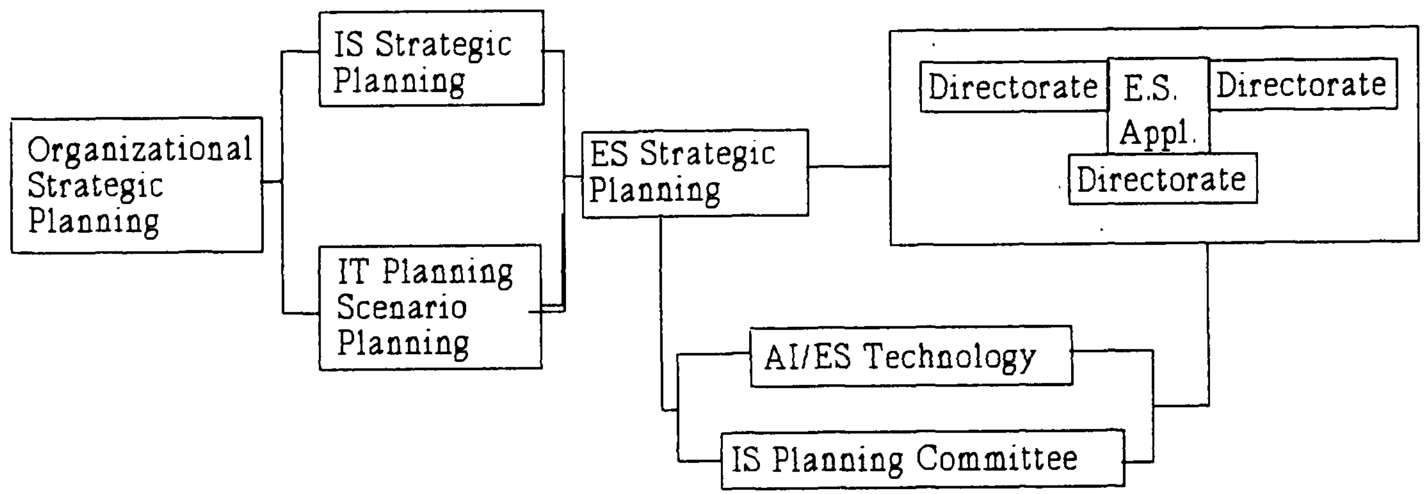

Figure 1 : Overview of the scenario planning process at DFAS Cleveland.

II DEFENSE FINANCE AND ACCOUNTING SERVICE-CLEVELAND CENTER

A. INTRODUCTION

Navy pay is at the heart of the organization. Administering, developing and implementing systems which can better serve active duty, reserve, and retired military members are critical. The issues which must be dealt with may take precedence over information systems development, but information systems is the corner stone of the business. All personnel, in the course of their jobs, utilize systems (on line or batch) to do their jobs. The organizational structure, upgrading of standard operating procedures, radical changes in policy from the Department of Defense or Congress, etc., may take priority over the introduction of major information systems development activities. So, it is important to differentiate between whether an organization 'can' embark on a new information project and when it 'should' embark.

The organization of the center can be best described as a typical fragmentation of responsibility. There are six major departments at Cleveland center, all of which compete for information services. The control of these services is centralized for maintenance but diversified for functional usage areas. Each department has developed its own procedures and processes for information handling.

B. INFORMATION TECHNOLOGY

As in many large organizations, and until quite recently, the acquisition of information was pain staking and laborious. It took a long time to translate data, raw facts, into usable pieces of information. The foundation for information technology in DOD, as in other organizations, was the application of data processing using mainframe computers in a centralized data processing center with a major emphasis placed on batch processing. Since then, the proliferation of mini and macro computers have placed new capabilities at our fingertips. A demand for faster, more complete information processing capabilities is the result. The transition from computer system batch processing to desk top interactive processing has had a great impact on end-user computing. The ability to connect these assets into vast networks provide an endless array of possibilities. This boom in Information Technology (IT) has caused us to change our traditional methods for dealing with the business environment. Data, the commodity of fifteen years ago, has been replaced by Information.

> Just as previous technological developments put their stamp on an era, information technology is becoming so central to our economy, our culture, and our daily lives that we are entirely likely to regard the emerging era as the **Information age**. (Emery, 1987)

In addition, the immense data processing facility is the responsibility of the data center, stand alone personal computers are owned by the department in which they reside and personal computers connected to local area networks (LAN) are owned by the department and managed by the LAN development group in the IS department. As a consequence of such diversification in ownership, each competing department could pursue conflicting ADP implementations without the necessary interface required to effectively manage resources center wide, were it not for the existence of the Information Systems Directorate. Proposals are reviewed to ensure hardware and software interoperability as well as economic feasibility. This will become more important as the move is made toward an integrated Department of Defense financial organization, a more integrated resource management system is on the horizon.

This evolution in Information Technology (IT) has lead Cleveland center to seek newer, more efficient and cost effective processing techniques. It is in this context that Expert Systems Technology (EST) was introduced at Cleveland Center in August 1988. In an effort to test the appropriateness of expert system technology on the organization, a copy of the M.1 expert system shell was supplied from the Artificial Intelligence Program Office at Headquarters, Air Force Logistics command. A pilot project was initiated and in completion by March 1989. The success of the project was evaluated in five areas:

- timeliness of response
- distribution of knowledge
- audit trail of decision process
- cost avoidance
- product quality

Subsequently, twenty personnel from various departments attended training in ES development utilizing the M.1 system shell. Each person brought an ES project with them. The participants were not programmers but function specialists. This showed a deviation from traditional software development and the first attempt at end user computing at Cleveland Center.

C. EXPERT SYSTEMS TECHNOLOGY

1. Implementation

Initially eighteen projects were undertaken by domain experts (end users). The projects were all begun during a two week training course. To date, twelve systems have been developed and are in production.

- Deceased Accounts Settlement
- Successor check Determination
- FOCUS Logic Applications
- PRIM Control Procedures
- Edit and Update Error Resolution (Reserve Pay)
- Unfunded Issue Papers advisor

- Social Security Offsets
- Dual Compensation System
- Separation Work Sheet
- LAN Troubleshooting
- FSSBP (Former Spouse Servivor Benefit Plan)
- Arrears of Pay

The remaining eight systems have either been abandoned or held in abeyance due to infeasibility, inappropriateness or domain expert work loads. Subsequently, three additional systems were designed and implemented:

- BAQ Project
- Expert Coster
- Priority Assignments

2. Expert System Development Tools

There are currently two different Expert Ssytems shells available at Cleveland center. They are both PC based and represent two distinct technological categories.

a. *M.1*

M.1 is an expert system shell manufactured by Teknowledge.Inc. It is designed for use on an IBM compatible PC. The source code is written in C. M.1 is a structured rule based tool in the mid-size range. Some of the unique features are its use of an external editor to create the knowledge base. This feature requires you to leave M.1 in order to make changes to the KB and then return to the shell for use. Another unique feature is that variable rules permit a single rule with variables to be instantiated as a number of particular rules. M.1 is targeted at programmers desiring to develop an Expert system. It is easily integrated into the conventional computer environment. Rules can be used in a consultation only once, while variable rules may be tried more often. Rules with a repetitive pattern can be collapsed into a single generalized rule. Facts can be represented as attribute-value pairs or you can use variable rules to represent facts with several levels of description. It can manipulate structured data such as lists and symbolic expressions. It supports the notion of inheritance: the ability of an object to inherit the characteristics of a more general grouping to which it belongs. It supports built in confidence levels in both rule statements and in user responses. confidence factors range from +100 to -100. The primary control strategy is backward chaining, however limited forward chaining can be accomplished. A text trace can be produced to show the rule path used and conclusions which have been reached.

b. 1ST CLASS

1st Class HT, is manufactured by 1st Class Expert Systems Inc., formerly Programs in Motion Inc., and designed for use on an IBM compatible PC. 1st Class is written in

Microsoft Pascal and assembly language and runs in the DOS environment. It is in the category of a small inductive tool. It can hold a matrix of 32 factors, 32 results and 255 examples. It is easy to use if the data is organized into factors and values. Utilization of 1st Class begins with the naming of the knowledge base and the creation of a matrix. Outcomes are entered first, followed by attributes and finally values for each attribute. Once all examples are entered into the matrix, the knowledge engineer has four options:

- **Optimize**: Lets 1st Class automatically create a rule or decision tree from the examplis. Unnecessary data are eliminated and remaining factors are rearranged into optimal order to ensure minimal question sequencing.

- **Left - Right**: Questions are asked based on the order the factors were input to the knowledge base. Some planning is therefore required of the knowledge engineer, however rearragnement is possible.

- **Customize**: The knowledge engineer is able to build his own rules using the decision tree diagram. This process is similar to the simple rule based tools.

- **Match**: This option avoids the process of compiling examples into a decision tree. It works through factors one at a time trying to find a match for the inputprovided by a user. This option is for more complex systems which are too complex for a decision tree.

1st Class uses a logic engine that allows for linking to external programs. This allows for retrieval of info from databases, computation in a spreadsheet, or writing output to a special format. The hypertext capability allows users to make ad-hoc comments and can enhance the decision trace with explanations. 1st Class also comes with a run time routine allowing for the combination of a Knowledge Base and runtime system to create a working copy for dissemination outside the shell.

The first ten systems were implemented in M.1. Since then, 1st Class has been introduced to replace M.1. 1st Class was chosen because of its interface with computational software as well as the hypertext capability. This tool also supports easier implementation of decision graphs frequently found in pay manuals or directives.

3. Expert Systems Application: Benefits and Pitfalls

The type of information systems used by the Operations directorate may be described as a hierarchy of 'free standing, but closely interfaced subsystems.' In other words, there are a number of systems, each oriented toward specific areas of business concern. Each subsystem is run on its own cycle and is largly independent of the others. Expert systems (ES) were introduced as stand alone applications and because of this they were easily integrated with the existing departmental needs. The practical advantages of ES implementation were:

a. Independence of Development; since any one or several of the Expert Systems can be designed and tested without burdening existing Information Systems developers.

b. Quicker and more reliable results; Backlog reduction using a standardized and more detailed decision process.

c. Realized Savings; With reduction of backlogs and the speed of accurate decision making a cost savings or cost avoidance could be derived.

4. Problems and Issues in Expert System Development at Cleveland Center

The heavy computational requirements found at Cleveland Center requires tools which can directly or indirectly manipulate numbers. Expert system shells typically deal with symbolic manipulation and are very limited in numeric calculation. Therefore, matching the application requirements to the correct tool is essential when applying ES technology. An application requiring mathematical calculation must be paired to a shell which is capable of fulfilling that requirement. Applications which do not require numeric calculations may have more options in the selection of the ES shell in which they will be developed in.

A second issue, which is central to ES development at Cleveland center, is the availability of in-house domain experts. To date, the center has relied on end-user computing for their ES application development. The domain experts are given training in specific expert system shells, which allow them to learn the basic tools required in application development. Effectively, they become the knowledge engineer for their project. Based on on-site interviews with some managerial staff, the time investment for training (two weeks), and the consequential backlog in their assigned jobs receives a mixed reaction from management. The support by managers, therefore, can waver. If managers have no clear vision of the long-term benefits associated with the ES application under development, then support for development will conflict with other priorities and time availability will become minimal. Currently development by end-users is done on a time available basis. There is no period set aside for application development. This reduces the organizational incentive for the end-user to develop an application. It could also result in the transition from EUC to ADP programmer involvement, which would add to an already burdened workload.

Finally, in the mid-1970's, management information systems (MIS) was primarily concerned with the relationship between managers and mainframes. The main intermediary between these two entities was, and remains, the information systems department. Traditional information processing applications were geared toward organizational transaction processing, decision support and control. The introduction of the micro computer into the organization, in the 1980's, created an alternative for computing known as End-User Computing (EUC). The micro computer was initially viewed as a clerical or personal support tool for individual users. Hence, little control was imposed on these assets initially. This "early" model of micro-mainframe computing's relationship with the manager is depicted in Figure 2 (a).

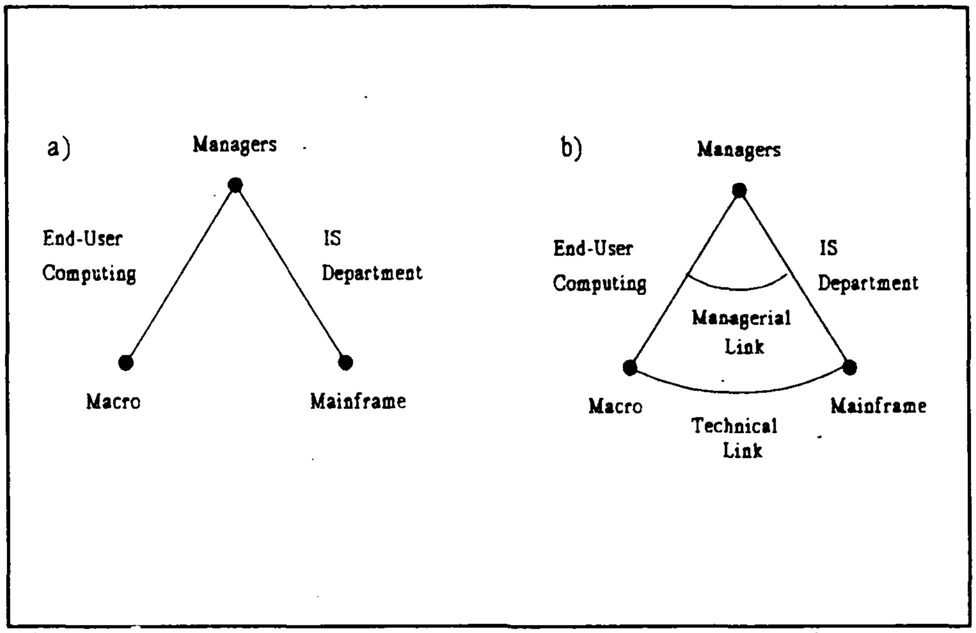

Figure 2 : Early and later models of micro and mainframe computing (Jarke, 1986).

The ease of use and software availability, made it apparent very quickly, that the micro computer was a tool that could have significant impact on the organizational processing requirements. The introduction of standards provided for consistancy and quality of EUC throughout the organization. It is clear that the distribution of tasks between mainframe and micros is the answer to many managerial and organizational requirements. This distribution of tasks necessitates a need for providing links between micro based end-user computing and mainframe data processing in Figure 2 (b). Technical links such as mainframe emulation, mainframe backbone networking, LAN architectures, telecomunication and data transfer protocols are needed for effective interfacing between micro and mainframe in order to convert stand alone micro computers into workstations with distributed data records and processing facilities. The threats of incompatability, processing errors, data security, etc., to this micro-mainframe system can be reduced by managerial linking mechanisms such as strategies, policies, training and audits. Most importantly, managerial links provide for the interaction between EUC and the IS department (Wiley, 1986).

III ORGANIZATIONAL STRATEGIC PLANNING

A. INTRODUCTION

Organizations are created to serve a purpose. They do not exist, nor are they created in a void. The purposes for which, and the climates surrounding their creations vary greatly from one organization to another. The environmental circumstances surrounding any two organizations are therefore different by definition.

Strategic planning is a function that is uniquely that of top management and cannot be delegated. Strategic planning takes place in most all organizations, but is shrouded with an aura that makes it unclear and misunderstood.

A good strategy is rarely complex. It is one that can be communicated to and understood by those who are involved in its implementation. It guides the decision making needed to accomplish the purpose of the strategy. It is the key to achieving the desired organizational results (Carr, 1991) During the early to mid 1970's, strategic business planning was approaching the zenith of its popularity as a formal process and organizational activity within U. S. corporations. Most firms retained staffs who conducted extensive annual planning processes that comprehensively examined the strategic choices involving the firm's missions, objectives, strategies, programs and budgets. These planning processes were typically a combination of "top-down" and "bottom-up" design, in that they were initiated when general policies, guidelines, and environmental assumptions were promulgated by top management, while the plans themselves were typically prepared at business unit levels and sent upward for review and consolidation (King, 1988).

B. A BRIEF REVIEW OF THE SCENARIO APPROACH TO PLANNING

A scenario can be defined as a narrative description of a consistent set of factors which define, in a probability sense, alternative sets of future business conditions (Goldfarb, 1988). Generating scenarios help bring to light potential problems a particular option could create if some factors changed. A large number of scenarios could be generated spanning a wide range of activities scenarios in each organization.

Once the scenarios have been generated, a sorting process must be conducted to weed-out those which are impractical, leaving those which are feasible. It is from this smaller grouping that a most-likely scenario is picked. This becomes the basis for long range strategic planning.

The scenarios which are considered feasible, but are not chosen as most-likely are not discarded. Instead, they provide an element of flexibility to the chosen plan as a means of escape or fall-back should it be necessary. As a grouping, these fall-back scenarios provide a list of indicators that management needs to monitor. the passage of time will show how closely some views depict the future, while others will prove to be quite inaccurate.

The scenario chosen as the most likely view of the future, is used to plan a step wise approach to achieve the desired ends. Projects or actions required to implement the scenario are broken into manageable chunks or phases and the decision to proceed from one phase to the next is given by management over time. Of primary importance is the recognition of unexpected changes which require assessment in the context of the scenario.

A by product that scenario creation can have is the protection against errors of judgement, by flushing out mind sets or basic assumptions which, over time, are no longer valid. During the implementation of the plan, some old beliefs which were based on common happenings in the past may no longer apply.

There is some skepticism about scenario analysis as a management tool. Skeptics levy little credence in this approach since no one is able to consistently forecast the future. The view has some validity since the environment is constantly changing. Our technology base is never stagnant, but always in flux. The analysis we are discussing expects change. Reviews and corrections are an integral part of the process. As the future unfolds into the present, scenarios are reviewed and assessed to determine whether the current plan must be modified or if a new approach is needed.

C. THE INTUITIVE LOGIC METHOD

There are a number of methods to apply the scenario planning approach. The intuitive scenario method (SRI International, 1988) is selected for this study because of its simplicity as well as its successful use in previous planning studies . Other scenario methods include: Trend impact analysis, Cross impact analysis, and Battelle scenario inputs to corporate strategies. These other methods focus on dependant and independent variables, intuitive economic forecasts, and implicit assumptions affecting business (Huss and Honton, 1987). The intuitive logic method, as depicted in Figure 3, involves a five step process (Goldfarb, 1988):

1. Step One: Analyzing the Organization Decisions

This step defines the scope of the analysis by concentrating on key organizational decisions with long range consequences such as capital allocation, diversification, facilities investment and market strategies. The narrower the scope of decision, the easier the scenario development will be.

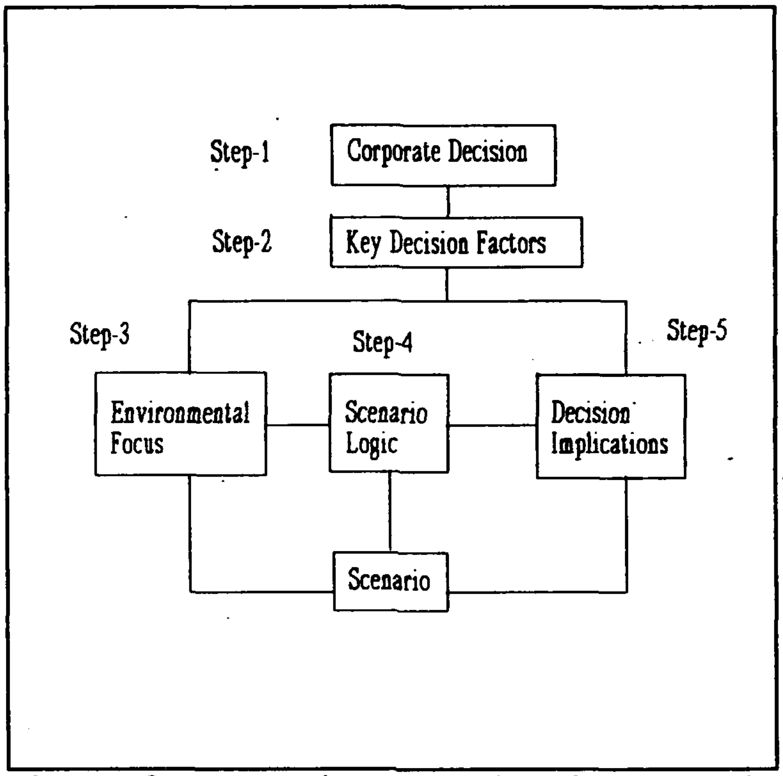

Figure 3 : The five step intuitive logic method for scenario planning.

For scenarios to be useful in decision making, they must be 'decision focused'. That is, their analysis of the alternative futures must focus on the specific trends and issues that are important to the decision being made. Doing so would ensure that the resulting scenarios are focused on those trends, events and uncertainties that are strategically relevant to the decision-making process.

2. Step Two: Identifying Key Decision Factors

Once the decisions are defined, factors which most directly influence their outcomes must be identified. The more that is known about these factors, the better the quality of decision making. Standard management analysis tools usually suffice for identifying these factors. The factors must form the basis for the scenario stories of the future.

3. Step Three: Analysis and Environmental Forces

Analysis of the environmental forces will shape the future business strategy confronting the decision makers. These environmental forces are usually analyzed in two categories: micro level forces which most directly impact the key decision factors, and macro level forces that set the overall (global) context for the business environment.

The environmental factors are identified through the use of environmental monitoring and scanning systems, business models, special information services, general literature about the future, and outside consultants.

4. Step Four: Defining Scenario Logic

This step represents the core of the intuitive approach and establishes the basic structure of the scenarios. Scenario logic is organizing themes, principles, or assumptions that provide each scenario with a coherent, consistent and plausible logical underpinning. Scenario logic should encompass most of the conditions and uncertainties identified in the preceding steps. Trial and error are usually necessary in arriving at useful scenario logic. The logic does not simply consist of optimistic or pessimistic scenarios. Instead, they describe alternative futures.

5. Step Five: Analyzing Implications for Decisions and Strategies

This final step focuses on determining what implications each scenario has on the decisions and strategies in Step one. The most important part of this step is to ensure that the information is presented in a way which is clear and informative to decision makers. Often, more detailed implication analyses are addressed by these questions:

- What do the scenarios imply for the design and timing of particular strategies?
- What threats and opportunities do the scenarios suggest to the future environment?
- What critical issues emerge from the scenarios?
- What kinds of flexibility do the scenarios suggest are necessary from organization's planning perspective?

IV INFORMATION SYSTEMS PLANNING

A. INTRODUCTION

The importance of information which must be used effectively if its contribution is to be maximized before it depreciates, the importance of computers in information handling, and the complexity of the information technology environment suggests that information system planning is vital to success. The planning for an information system which meets the organization's strategic plan is difficult.

Alignment of information systems planning with the organizational strategy is one of the more central issues confronting management information systems (MIS). Generally, organizational planning is done by reviewing current objectives and projecting a role of the organization into the future. The Nolan stage model and McFarlan-McKenny strategic grid are probably the most appropriate tools for describing the current stage of growth of the Cleveland center's information system and for planning its move toward the next stage.

B. STRATEGIC PLANNING FOR INFORMATION SYSTEMS

Traditional approaches to identify areas for the application of information technology have focused on its capability to improve specific functional areas of the organization. It is often difficult to ascertain the strategies and goals to which the information system plan should be aligned. Without this alignment, the information system plan will not obtain long term organizational support. If the selection and scheduling of IS projects is based solely on proposals submitted by users, the projects will reflect existing biases rather than reflecting the overall needs and priorities of the organization (Dickson & Wetherbe, 1984). The first generation of methodologies utilized a strictly operational view of the organization, with an objective to improve the efficiency of requisite managerial processes. Representative of this approach are Business Systems Planning (BSP) and Office Automation Methodology (OAM). These techniques represent ways of formally modeling the operations of the enterprise so that potential improvements in efficiency and effectiveness can be analyzed. They are not easily applied to ill-structured functions which are not amenable to formal modeling. These approaches fall short of treating strategic considerations as the driving force for the identification of information technology opportunities. Yannis Bakos and Michael Treacy have identified four general areas of opportunity for Information Systems to support an organization's strategy (Bakos & Treacy, 1986).

1. Efficiency and Effectiveness

The employment of systems to improve operations are traditionally the focus of applications within the Information Systems community. They are generally central to the support of the internal strategy of the organization. These systems can also support the external competitive posture of the organization to the extent that the system may be a real innovation to the industry. This would give an advantage to the originator. Usually this only applies to critically functional areas within the organization.

2. Cooperative Systems

The concept of improved operational efficiency and functional effectiveness could be extended outside the boundaries of an individual organization, typically in the contest of inter-organizational information systems. Strategies for exploiting synergies can concentrate on opportunities for better coordination. With better coordination, operations can be made more efficient to the benefit of all participants. This Coordination can be achieved by coupling functional areas between organizations.

3. Product Innovation

Information technology (IT) provides organizations with unique tools to exploit opportunities for product innovation. Information technology is providing new avenues for development and delivery of new service based products.

4. Bargaining Advantage

An important tactic for improving the organization's bargaining position is to provide unique information and valuable service. While not easy to achieve, an organization can reap advantages from a well conceived information system. The mere introduction of an attractive new technology without any other sustaining factors, is likely to provide, only short term gains. The key to achieving a more sustainable advantage is to exploit the technology in a way that makes it difficult and time consuming for competitors to match. An organization stands a chance of doing this if it can bring to bear its existing strengths (Emery, 1990). Even where the industry itself is not being overhauled by technological innovation the competitive position of the business may be altered by the changing balance of competitive forces due to the advantages to be gained by using existing technology in new ways (Ward, 1987).

C. PLANNING IN THE NOLAN STAGE MODEL

The stage model of computer growth originally proposed by Gibson and (1974), and later expanded by (1979), is one of the most well known models that provides a useful guideline for an organization, allowing it to see where it stands and where it may be headed in terms of computerization.

The model is a contingency theory which states that **if** these features exist, **then** the information system is in this stage (Davis and Olson, 1985). The basic theme of the model is that organizations must go through each stage of growth before it can progress to the next one. The IS development typically undergoes six stages of growth towards an automated solution to information system planning. These six stages of growth are described below.

1. **Stage One: Initiation**

During this stage, the computer is first introduced into the organization. Although the participation of users is encouraged, their unfamiliarity with computers means that user involvement is minimal. The applications developed in this stage tend to serve the operational needs of the organization in areas such as accounting, payroll, and personnel administration. Little overall control of the computer systems is apparent.

2. **Stage Two: Contagion**

In Contagion, computer usage booms. Users become enthusiastic participants and begin to demand new applications which reflect their job requirements. Consequently, there is a sharp rise in computer service expenditures. Management of computer services, although possibly centralized, is ineffective due to very little overall or long term Information Resource Management (IRM). Applications development is performed in isolation, with a consequent proliferation of incompatible and redundant data.

3. Stage Three: Control

Here, the user's insatiable demand for information becomes unsatisfied. The ever-increasing computer budget and minimally perceived increase in benefits begin to draw the attention of upper management. Consequently, the budget expansion is either sharply curtailed or fixed at its current rate. The focus is now to inject the IS function with the type of professional management found in other segments of the organization. Planning and system controls are the nucleus of the new management effort. Charge back for computer usage is the main byproduct of this stage.

Heavy emphasis is placed on documentation of existing applications and moving control of them to middle management. This reduces scrutinization and focus by top management on operational systems. The impact of this restructuring phase is that the backlog of application programs increases and maintenance costs for those in production skyrocket.

4. Stage Four: Integration

It is at this stage where computer usage takes a significant step. Emphasis turns from the management of computer usage to the management of data resources. The shift, although hampered by the redundancies and incompatibilities carried over from earlier stages, is reflected in the attempts to integrate existing systems using database technology.

5. Stage Five: Data Administration

Database technology is in place by now. Corresponding data administration is being used to plan and control the organization's use of data. The emphasis is on common, integrated systems with shared data used among the various functions of the organization.

6. Stage Six: Maturity

Very few organizations ever achieve maturity. The attainment of maturity represents the true integration of computer resources with managerial processes. The information resource is meshed with the strategic planning of the organization, thus the applications reflect overall corporate policies.

Nolan proposed that an organization can determine which stage of maturity it falls into by observing four main characteristics. First, the application portfolio of information systems that are in use will change from functional, simple applications to more integrative organization-wide systems as the organization matures. Second, the Information Systems department will shift from a centralized structure in a supportive role to a more decentralized structure functioning as the data custodian for the entire organization. Third, as the organization matures, IS planning and control will shift from slack to standardized. Finally, User awareness of IS will shift from reactive to participatory as the level of maturity increases.

Traditional placement within the Nolan model requires one to assess the overall Information System. Identification of the appropriate stage of growth, for an organization, is determined by the least common denominator. Under this method, an Information System at the Integration stage which is making strides in data and technological integration, can be placed in a lower stage of growth by the introduction of a new technology. The implication is one of an information system which is fragmented and maintained along managerial boundaries.

This is precisely the situation at DFAS Cleveland. Their mainframe system is considered their strategic system. It is the repository and processing mechanism for all military accounts. This system has achieved stage four - Integration, under Nolan's model. Distributed computing and networking improvements have integrated these mainframes with other functional areas. Although some incompatibilities and redundancies exist, the system does reflect a maturing process. The introduction of expert system technology has only taken place within the last three years and would clearly reduce the level of attainment within the Nolan model if taken as part of the larger system. For this reason expert system technology is separated out in an attempt to present a clearer picture of the IS condition at DFAS Cleveland.

Expert system technology is within the Contagion stage at DFAS Cleveland. The introduction of this technology has fostered a strong desire among information system managers to develop several systems, center wide, which would help worker efficiency and task performance. End-user computing has promoted the use and development of expert system applications. To date these applications have been stand alone. Management is taking steps and progressing toward stage three in Nolan's model; the Control stage. An implementation of standards and selection criteria for expert system applications have been developed.

It is clear that management recognizes the disparity between the two stages identified by this analysis. They are taking steps to advance expert system technology into a level commensurate with their strategic information system. The need for architectural compatibility and integration is required for further growth.

D. PLANNING IN THE McFARLAN-McKENNEY MODEL

The strategic grid (McFarlan-McKenney, 1943) is a diagnostic model used to understand the role of the information system in an organization. The position in the grid explains the needed level of top management involvement and the relationship of an information systems plan with the organizational plan.

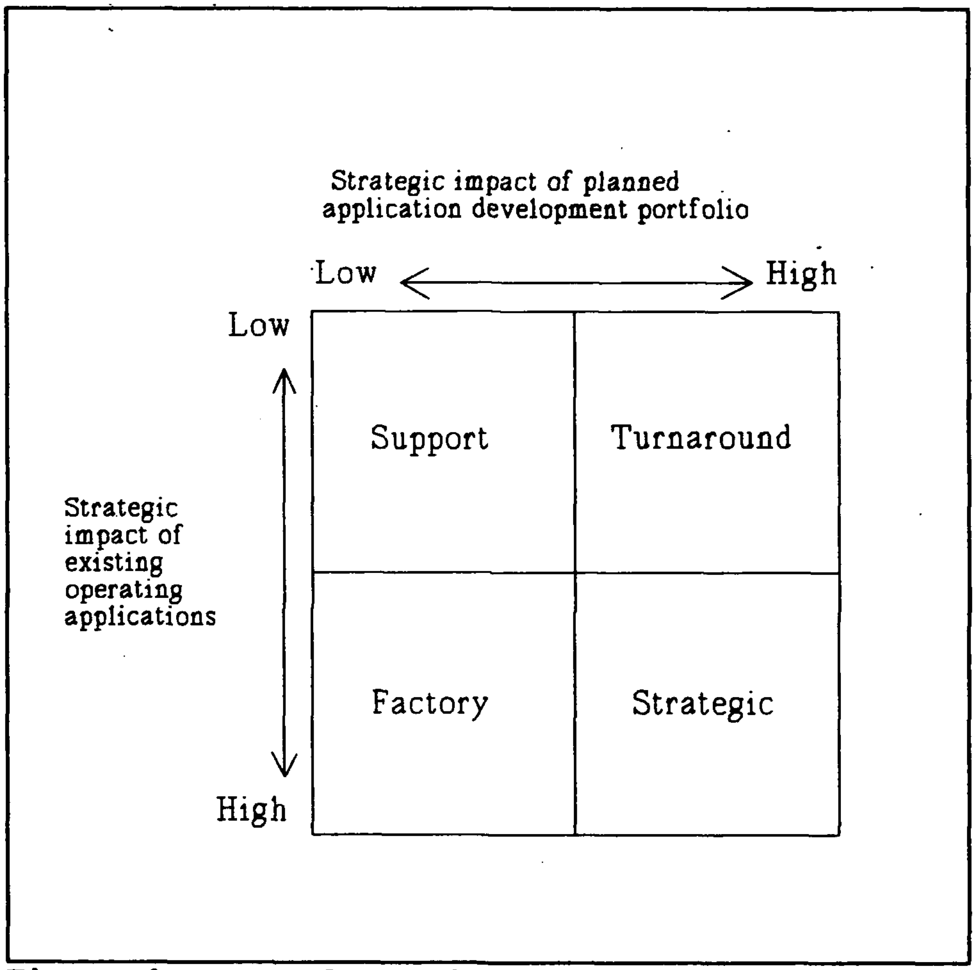

Figure 4 : McFarlan and McKenney's strategic grid (Davis and Olson, 1985).

The grid (Figure 4) defines four types of information system planning situations, depending on the strategic impact of the existing information applications and the strategic impact of the planned information system. The grid can then be used to suggest the organization and management of information systems planning. The four strategic grids are described below.

1. **Strategy**

Information system activities are critical to the current business strategy and to future strategi directions of the organization. Information systems are part of new strategic directions.

2. **Factory**

Information system applications are vital to the successful functioning of well-defined, well-accepted activities. However, information systems are not part of future strategic operations.

3. **Support**

Information system applications are useful in supporting the activities of the organization, but are vital to critical operations and not included as part of future strategic directions.

4. **Turnaround**

This is a transition from 'support' to 'strategic'. The organization has had support type applications, but is now planning for applications vital to strategic success of the organization.

In order to place Cleveland Center into one of the quadrants described in the Mcfarlan-McKenney strategic grid, an evaluation of the characteristics must be conducted. It must be noted that the perspective of this study is from the Center implementation of Expert Systems, and not that of the overall information system.

Utilizing the same arguments used in the Nolan model, the strategy which best describes the current Expert system planning will be Turnaround strategy. All of the current expert system applications are in the supporting transactional role, however there is strong support and involvement from upper management. There is guidance about implementation requirements and standards. There is no explicit strategic plan involving ES to date, however the implicit value of this technology is well known to management. Because Expert system technology is still in the infancy stage within Cleveland Center, and with the continuing consolidation and integration of DOD financial institutions, it is premature to place Expert Systems directly into the Strategy quadrant. Time is required for maturation of the program. Once the positioning of the organization is determined, with respect to planning, using this model, Cleveland Center should evaluate the Expert System program in the flow of its own planning activity for developing an integrated information system.

V END USER COMPUTING

A. INTRODUCTION

There has been an abundance of literature on End-User Computing (EUC). Despite the attention, EUC is still poorly understood. EUC occurs when individuals develop their own computing applications independent of the existing data processing infrastructure (Euske & Dolk, 1986). EUC is the unstructured use of computers by someone who is not a professional in data processing, to solve their business related problems (Goldberg, 1986). Companies that are encouraging the use of PC-based expert system shells are drawing on lessons learned in managing general EUC. Here are four of the more important lessons which carry over.

1. Establish A Support Organization

Establishment of a support organization to guide use of a new technology is important. This group establishes the strategy, chooses the products, coordinates the training, provides consulting help, and markets the technology within the company. This group is likely to be a subset of the existing end user support organization.

2. Standardize On A Few Tools

As companies encouraging EUC have learned, it is wiser to offer users a few tools than to give them the freedom to choose whatever tool they desire. Free reign over tool selection can lead to interface problems in the short run, ie. when the need arises to call other programs. The migration of an application from a small ES shell to a large one, in the long run, can be easily accomplished as a result of the standardization process.

3. Stress User Self-Sufficiency

One of the goals of EUC is to make users self-sufficient "programmers". Information centers may teach an end user how to use a tool and they may help the user get started using the tool, but they will not finish a project for a user. Users are expected to complete and maintain their own work. Knowledge systems are never finished because their requirements keep changing as the level of user's maturity continue to increase. They can always be expanded. So user self-sufficiency is important to avoid creating an expert system backlog in the information system department.

4. Encourage Prototyping

The usefulness of prototyping is a major lesson (Carr, 1988). Rather than try to fully specify a system beforehand, the basic functions can be listed and prototyped. For larger application developments, modularization should be encouraged, each performing a specific function.

B. EUC Support: The Information Center

The Information Center (IC) is simply a center within a business organization which typically serves the needs of those who computerize information resources (White, 1988). The IC can be seen as a new link between the Information system and the end user community within an organization. The relationship is built on cooperation and a joint dedication to accomplishing a task (Hammond, 1982).

The IC is comprised of a group of employees specially trained in the use of information technology, more specifically in this case ES technology. It is generally the source of training, technical assistance and general support services.

1. Benefits of EUC / IC Connection

Often, IS related business can be addressed immediately. User benefits are generally short term, since most of their development is on a one time basis. Their technical requirements are handled in an efficient manner. Increase in job productivity is the number one benefit

(Garcia, 1987). The organization benefits because a scarce and valuable resource, the programmer, is also used in a more effective manner (Carr, 1988).

Another benefit is in cost savings. The end user's creation of software products earns dividends in the area of software maintenance. Applications which users develop are most easily and accurately maintained by the developer. This reduces the learning curve for the maintenance effort and results in more timely fixes for software products (Carr, 1988).

The existence of "user-oriented programmers" will confirm that many users look to solve their own data needs before looking to major mainframe tools.

VI EXPERT SYSTEMS STRATEGIC PLANNING

A. INTRODUCTION

Expert system technology has its foundations in Artificial Intelligence (AI). The fundamental issues in AI involve knowledge representation, search, perception and inference. Knowledge can be available in many forms: collection of logical assertions, heuristic rules, procedures, statistical correlations, etc. Much of AI is concerned with the design and understanding of Knowledge representation schemes. How can the application domain knowledge be represented so that it:

a. can be easily used in reasoning,

b. can be easily examined and updated, and

c. can be easily judged as relevant or irrelevant to particular problems.

B. EXPERT SYSTEM DEFINITIONS

Expert systems are programs that mimic the behavior of human experts. They use information that a 'user' supplies to render an opinion on a certain subject. Expert systems are composed of two parts:

a. Knowledge base - a database which holds specific information and facts about a particular subject.

b. Inference engine - is the part of the ES which attempts to use supplied information to find a match of objects in the Knowledge base. There are two general types:

   1. Probabilistic: varying degrees of certainty may be added to responses.

   2. Deterministic: responses are considered absolute.

Within the Expert system branch of Artificial Intelligence, there are five types of tools available.

1. Inductive Tools

With inductive tools, rules are generated from examples. Large inductive tools exist for mainframe use, while small tools exist for personal computer usage. With these tools a Knowledge engineer (KE) enters a large number of examples into the information base (Knowledge Base). The tool uses an algorithm to convert the examples into rules and determine the order the system will follow when questioning a user in order to make a recommendation.

2. Simple Rule Based Tools

These simple rule based tools utilize if-then statements to represent knowledge. These tools are designed for small application domain and are limited to less than five hundred rules. These tools lack the context trees available in structured rule based tools. These tools are good for very unstructured problems.

3. Structured Rule Based Tools

The use of if-then statements are used to form rules, however these rules are arranged into sets. Each set is like another knowledge base. One set of rules can inherit information acquired when other rule sets are examined. Structured tools offer the use of context trees, multiple instantiation and confidence factors. A large number of rules can be accommodated. Both large mainframe and mid-size PC based tools are available.

4. Hybrid Tools

This is the most complex Expert System development environment available. The mid-size PC based tool and the large mainframe tool are very different. They are separated both functionally and structurally. In effect they are two separate tools.

a. *Mid-Sized Hybrid*

Object oriented programming techniques are often used to represent elements of each problem that the system will work on as objects. These objects can contain facts delineated in if-then statements, or pointers to other objects. They are designed for systems that would contain five hundred to several thousand rules and can include the features of several different paradigms.

b. Large Hybrid

Unlike their mid-size cousins, these large hybrid tools lack focus. They are not designed to build a specific type of knowledge system. Instead, they are designed to build other tools that in turn will build a Knowledge system.

5. Domain Specific Tools

These tools are designed to specifically develop expert systems for a particular domain. They could incorporate any of the previous techniques and could therefore be classified under the previous categories, however, these tools provide special developmental and user interfaces that make it possible to develop an ES in a specific domain faster than other conventional tools.

C. EXPERT SYSTEM TRENDS

Journals, books and conferences continually stress a need for the ability to integrate expert systems into the business environment. However, few articles offer any description of the environments in which the expert systems are running. One would infer that all expert systems are stand-alone rather than entities functioning in some business context (Freundlich, 1990). In the opening address of the Third Artificial Satellite Symposium, Mr. Harry Tennant made two observations about expert systems. His first observation was that Knowledge Based systems can have strategic significance to companies. He encouraged corporate wide investigation into uses for this technology. Secondly, he observed that expert systems are becoming integrated with real time and database systems, thereby challenging Freundlich's inference (Tennant, 1989).

1. Strategic Value

Few executives realize the strategic potential Expert systems can bring to a company (McNurlin & Sprague, 1989). Knowledge Based systems can help people make better and more consistent decisions (Figure 5). They can disseminate knowledge and expertise, not just data, to employees. These systems are good at handling complex tasks, making it cost effective to perform such tasks.

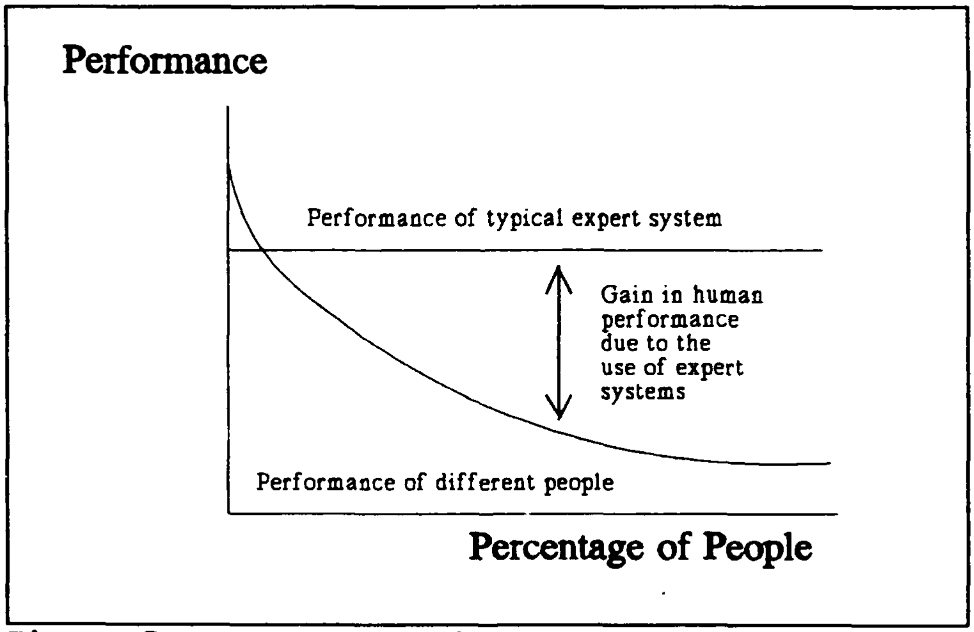

Figure 5 : Problems having a performance histogram like this are ideal for expert system technology (Bahill and Farrell, 1986)

In their publication, *TekSolutions: Customer Success Stories*, Teknowledge describes twenty-five expert systems applications written in M.1 or S.1, the expert system tools they offer. Many of the examples demonstrate the strategic advantage expert system applications can give to organizations. They specifically target the fourth area of opportunity for information technology described earlier by Bakos and Treacy: Competitive Advantage.. Common to most examples was a realization that both speed in system responsiveness and increases in product quality had significant impact on the organization and were considered to give important advantages over their competitors. A similar argument can be made for Cleveland's FSSBP (Former Spouse Survivor Benefit Plan). It provided for quick adjudication of very highly visible legal problems within the DoD. It was the first expert system to be exported to other DoD agencies. This helped identify DFAS Cleveland as a leader in expert system development within the DFAS community.

2. Integration

There are three types of integration which are important in incorporating expert systems technology with traditional MIS. First, the system must run on conventional hardware. More specifically, it must run on pre-existing hardware that is being employed. Second, the expert system application needs to access existing programs and information in the conventional environment. It must possess the ability to call an appropriate program, regardless of where it resides, to do the required analysis and return the needed results. Third, expert systems need to be viewed as part of larger, more comprehensive programs (Freundlich, 1990).

3. Development Trends

Development of expert systems applications by traditional programming techniques requires the availability of a cooperative domain expert. This is vital to successful development. Domain experts must be readily available and willing to participate fully. Domain expert ownership of the project is critical to its success and promotes user buy in of the final product. System acceptance is greatly facilitated if the user community has been actively involved during development (Irgon et al., 1990).

With ever increasing availability of PC based expert system shells, the traditional development process is being replaced by "End User Computing". A great share of the total applications load will be developed by end users and will be processed outside the central data center. Increasingly, the IS organization will be called upon to deliver general purpose technical support for end users to accomplish their work (Dooley Group, 1986).

D. MANAGEMENT ISSUES

Managing expert system development is complicated by fear of the unknown--a new technology and a new approach to solving problems. It should not suppress one's natural desire to control. It is important to manage on two fronts. The first front involves the end-users. Encouragement and educational opportunity is essential. Domain experts who develop applications for PC based stand alone applications today, may migrate and expand their work to a distributed network or to a transparent mainframe routine. As this type of migration takes place the end-user developer may play an essential role in strategic application developments of the organization.

The second front that the IS manager must confront is that of the greater organization. He is its advocate and protector. Several considerations must be given.

1. Deep Rooted Beliefs

Many managers have been conditioned to expect low returns from information technology. Their recollections of wildly optimistic systems which greatly underachieved are deeply rooted. For them improvements within Information Systems Technology over the last decade have gone unnoticed at best. Frequent dissemination of successful innovations within the organization will generally begin to under-mine the long cherished belief that information systems generally, and expert systems specifically are difficult to implement, unresponsive to real needs and unworthy of precious resources. It is important to ensure that ES are not oversold nor underestimated.

2. Changes in Task Structure

Prior to the implementation of expert system applications, the knowledge workers spend a sizable portion of their time performing tasks which might as easily have been performed by others less critical or by an automated process. With tasks like data retrieval, analysis, data input etc... redistributed, knowledge workers have increased time for tasks that they are uniquely qualified to perform. The hierarchical sharing of tasks within the organization fosters a growth in appreciation for and understanding of the tasks required. The intrinsic attractiveness of the job is enhanced for subordinates and promotes higher levels of motivation and satisfaction within the organization (Foster & Flynn, 1984).

Expert systems clearly free time previously held in repetitive tasks. As time is freed across the organization, managers have an opportunity to reassess and redefine jobs. The redefinition takes two forms:

1. Jobs are redefined into natural work units which allow workers to feel that they "own" a task in the organization.

2. Jobs can be consolidated to free additional time for critical knowledge workers.

Generally, greater payoffs have come from investing incremental time saving in the effectiveness of the organization rather than from trying to increase efficiency through reduction in staffing (Foster & Flynn, 1984).

3. Validation

Validation and evaluation of expert systems require considerably more attention then they presently receive. Some useful guidelines follow:

- Validate systems only against an acceptable performance range for a prescribed input domain.
- Build validation into the development cycle.
- Consider the risk in using invalid systems.
- Must choose an appropriate qualitative method: Field test, Turing test, Predictive validation, Sensitivity analysis.
- Must use quantitative methods where applicable.

At present, expert system validation experience is limited. A methodology will evolve only in light of continued collective experience (O'Keefe, 1987).

4. Sensitivity

A criteria for deciding whether end-users should develop certain applications is the sensitivity of the application. This means that the potential exposure to fraud or the disclosure of important information to unauthorized persons need be considered.

5. **Ownership**

Clear policies must be written to safeguard sensitive or proprietary information. Many companies establish a policy that employee developed applications belong to the company if they have been written on company time (Zawrotny, 1989). Such policies should be administered by either end-user department management or the IS department. Additionally, master copies of the ES applications should be kept in a software library.

6. **Data Integrity**

If end-user applications can access corporate data on their own, and if they are allowed to change data, then an integrity risk exists. Most corporations restrict end users to only extracting data from corporate files. The most likely use of PC's would be to extract data from corporate databases, store it on the micro, and manipulate it locally. For those who want or require access to upload data, having proper validation programs in place, they must get permission from the department responsible for maintaining the data.

7. **Security**

Currently, there are no internal security measures found in expert system shell designs. They should use many of the same security measures required for other information systems, however, because of their unique characteristics, developers have been reluctant to implement security functions (O'Leary, 1990). We are therefore required to fall back on organization implemented measures, however feeble.

When considering data security, PC's may be more secure than corporate mainframes. Users can lock up floppy disks that contain sensitive information. Without proper care, however, floppy disks can be a greater security risk. They can be carried off and widely distributed. Security becomes even more serious when addressing a multi-user machine. Most multi-user systems do not have data security features. This problem exists whenever there is data on hard disk that is shared by multiple users.

VII EXPERT SYSTEM PLANNING FOR DFAS CLEVELAND

A. INTRODUCTION

The strategic planning process has had several false starts at DFAS Cleveland as well. A plan has been devised but never implemented or updated. It was not a living document. There are currently efforts to generate a functional and realistic strategic plan by which managers can look toward the future.

Most of the expert system implementation projects have been opportunistic in nature. They have been designed as add on applications which fit into existing architectures. The growth in technology has caused IS managers to consider a more central role for expert systems. Top managers are beginning to consider ES development within the framework of their strategic IS plan.

The planning process for DFAS Cleveland utilizes the scenario approach discussed in chapter three. The scenario approach to planning is not new to management, however, it is a relatively new discovery within the MIS discipline. The approach is gaining in popularity, supported by computer based decision support systems and driven by the key words 'what if'. In planning information systems or their architectures, the scenario approach provides a way to manage the assumptions required for planning by combining scenarios that incorporate trends, events, environmental factors and the relationships among them.

We will first discuss the data gathering technique used to identify pertinent technological and managerial issues. A discussion of available resources will also be conducted. Finally, the actual scenario logic will be reviewed, with an assessment of implications resulting from the scenarios.

It is essential to remember that in examination of the Cleveland center, tactical and strategic decisions are implemented to respond to the circumstances both for DFAS Cleveland and for DFAS as an entity. Actions which may be appropriate for Cleveland center are not necessarily suitable for other financial institutions. The organizational structures reflect the uniqueness of the climate from which organizations were brought forth. It is this uniqueness which inhibits organizations from blindly applying solutions from one organization to another.

Historically, the information system function was not a very active participant in business strategic planning. The IS function had been regarded as a service group, whose role was to react appropriately to business requirements. They were regarded as 'cost centers' and viewed as an expense to the organization. IS "strategies" were often just summaries of activities and rationalizations of policies, to provide a sense of direction toward goals, perceived by IS management, as supporting the needs of the organization.

B. DATA GATHERING PROCESS AND MAJOR FINDINGS

To gather information necessary to apply the proposed scenario analysis for implementing ES technology, two questionnaires were designed. The first one (see Appendix A) is intended to gather technological issues as they are viewed by the management at DFAS Cleveland. Twenty questionnaires were distributed and seven questionnaires were returned. The second questionnaire (see Appendix B) seeks to understand the operational aspect of the center in using existing expert systems applications. Subjects were primarily IS professionals holding little planning responsibilities. Out of thirty questionnaires sent to the center, twelve were returned. Because of the complexity surrounding identification of strategies, goals and objectives, the questionnaires were primarily designed to gather information regarding the corporate history and culture. As a consequence. the questions are open-ended and no quantitative data were sought.

All of the respondents stated that their jobs were either primarily computer based or at least partially computer based. The data required by these individuals to perform their job tasks reflect a 70% automated input, while 30% remain tied to hardcopy data. Those respondents who required archiving services after a job task completion cited hardcopy as the predominant form.

The most interesting data came in the area of expert systems. Between the general and managerial version of the questionnaires, those who use or have been trained in ES technology accounted for only 32%. Yet, there was an overwhelming consensus (89%), between ES trained and untrained, that procedures for recommending ES applications were either unclear or unknown to the respondents. The responsibility of the ES group was also unclear. There exists a general lack of knowledge about expert systems technology, within the Operations Directorate, despite the recognition of DFAS Cleveland as a leader in ES applications within the larger DFAS organization.

The managers who responded, believed that expert system technology was a legitimate tool in accomplishing the mission of DFAS Cleveland. The vast majority believed that in times of fiscal constraint, expert systems development would allow them to retain the current levels of customer service. They were keenly aware of the potential for cost avoidance which could be realized through enhanced production systems.

The following proposed list of ES applications were generated by the questionnaires:

- Debt collection
- Active duty death process
- Dependency and Indemnity Compensation
- Incapacitated Pay
- Foreign Income Tax
- Pay adjustment Authorization
- Retroactive SBP
- Returned Bond \ Check
- Arrears of Pay
- Software Testing Procedures
- Programming Techniques
- Project Management

Analysis of the recommended applications is required to determine the feasibility and merit of each proposal before development and implementation. Aside from normal cost benefit analysis, the availability of domain experts and knowledge engineers will be a major consideration if development is done through End-User computing. Task prioritization for end-users must be considered.

C. THE EVOLUTION OF EXPERT SYSTEM TECHNOLOGY AT DFAS CLEVELAND

As an emerging technology, expert system development at Cleveland center requires different management approaches at various points of its life cycle. The expected evolution of expert systems development is adapted from the information systems development as described by the four phases of *information technology assimilation* (Cash, McFarlan, McKenney, Vitale, 1988). The four phases are characterized as: investment/project initiation; technology learning and adaptation; rationalization/management control and maturity/wide spread technology transfer.

1. Investment / Project Initiation

This first phase was initiated by a decision to invest in a new information processing technology called expert system technology. Retrospectively, the choice of M.1 as a system tool was not optimal for the environment. However, its relatively inexpensive start up cost and simplicity of use was perceived as beneficial for initial development. This simplicity of use helped the technology catch on as a popular application tool for the organization. Software was the only item purchased. Installation into the existing hardware was a turn-key operation.

2. Technology Learning and Adaptation

The second phase involves an intensive program of new developments within the finance center to satisfy the initial requirements of the various functions and systematic development of a series of operational tools.

The foundations have been laid down and it is now appropriate to review the approach to the technology and selection of appropriate projects for the future. A generally forward looking view is taken. An observation that some of the projects worked out as expected while others did not (no calculation capability by M.1). Each project undertaken did give a significant opportunity for learning.

3. Rationalization / Management Control

The third phase -- appropriate tools bought, increase in system development, life cycle considerations for ES are established. Committee to ensure cross functional coordination exists and that priorities can be allocated on development in different areas. Senior managers have a detailed knowledge of requirements and implementation desires.

4. Maturity / Wide Spread

The focus of this phase is the development and installation of controls for the new technology. Efficiency rather than effectiveness is the concern in this phase. Cleveland Center can be expected to judge the feasibility of the new technology to their tasks better than during the initiation phase. Managers will generally exhibit a delegated leadership style. Guidelines and requirements are quite clear. Middle management is responsible for running this program.

In employing these four opportunities, DFAS Cleveland Center has become effective in applying information technology to corporate strategy. Efficiency and effectiveness were key elements in choosing to incorporate artificial intelligence (AI) into the organization. Management sought to improve processing techniques for several ill-structured tasks by employing ES technology. As a cooperative information system venture, an improvement at Cleveland Center could reap its benefits across the DOD spectrum by distributing ES applications to other services. The utilization of the expert system as a tool to accomplish mission requirements and improve working conditions by reducing backlogs was an innovative venture within the industry. The introduction of several ES applications by Cleveland Center increases its competitive advantage relative to other DFAS Centers with respect to ES implementations. This has had positive influence on Cleveland Center's role in expert system development within the greater DFAS organization.

D. SCENARIOS FOR IMPLEMENTING EXPERT SYSTEMS AT DFAS-CLEVELAND

1. Step One: Analyzing ES Decisions at DFAS Cleveland

As discussed in Chapter III, the first step in scenario analysis consists of analyzing the key decisions with long range implications on expert systems development. The Information Systems Directorate has consistently been proactive in identifying potentials of expert systems applications. Such a proactive approach has led to the implementation of a dozen of PC-based expert systems. Cost-benefit analyses have been conducted and show significant return on investment of these systems (Goldfarb, 1988). More importantly, the success of these systems has also created a credible environment for future exploration of expert system technology. Top management at the DFAS Cleveland has recognized the value and potential of pursuing the development of future expert systems.

2. Step Two: DFAS Cleveland Key Decision Factors

The key decision factors to a make it possible for in-house expert systems development include application domain expertise, availability of knowledge engineers, user department participation and involvement in development, time availability of domain experts, availability of state-of-the-art development tools and EUC support and training. The involvement of IS staff in making directive decisions for

Expert system development will become the norm. A need to access the corporate mainframe master file (active duty, retired pay, reserve pay, drill pay, and accounting & finance) will push for increased integration between architectures.

3. Step Three: Analysis of DFAS Cleveland Environmental Forces

Analysis of the environmental forces is conducted by listing pertinent considerations and then applying them to the three scenarios generated in step 4 (Figure 7-1).

By using the questions raised in Chapter III, the following environmental factors apply to DFAS Cleveland:

- DoD Budget
- IS personnel including Knowledge engineers,
- Acquisition of hardware and software,
- Legislation pertaining to military pay, and
- Expert System and related IS technology

Table 7.1 provides some estimation on the future trends of these five environmental factors.

TABLE 7.1 : ESTIMATION ON FUTURE TRENDS

ENVIRONMENT	ESTIMATION	PROBABILITY OF OCCURRENCE
BUDGET	DOWN	HIGH
PERSONNEL	DOWN	MEDIUM
ACQUISITION	NEUTRAL	LOW
LEGISLATION	INCREASE	HIGH
TECHNOLOGY	INCREASE	HIGH

4. Step Four: Defining DFAS Cleveland Scenario Logic

Scenario 0:

To design scenarios, it is necessary to review the actual status the expert system development at DFAS Cleveland. Until recently, expert systems were initiated by both the Information System directorate and Operations directorate (ie. end-users). The information directorate offers training, technical support, verification and validation of knowledge bases. It also serves as a central repository of systems ready for production. Although the EUC-Information System Directorate liaison has produced successful systems, the EUC approach to expert system development was plagued by problems. The end-user time devoted to ES development was perceived as low priority by the end-users' managers, and thus considered as an infringement to the accomplishment of the primary tasks of the day to day operation of the military pay system. As a consequence, the ES development process was often fragmented. While the interest in using ES in the organization remains strong, the devotion to develop EUC expert systems has declined by the end-user personnel. Table 7.2 lists some major characteristics of this situation.

TABLE 7.2 : SCENARIO 0

DESCRIPTOR	CHARACTERISTICS
Technology	Fragmented
Architecture	PC Based
Integration	Stand alone
Application Portfolio	Functional
Development	Decentralized
Development Criteria	End-User (70%), IS (30%)
Data Transfer	Manual
Goals	Establish Technology

This situation leads to a number of possible scenarios. Three of them are proposed in this section. Each scenario has a descriptive title and a brief story line that outlines its central thrust and action. The scenarios are:

Scenario 1 :

This scenario finds a mixture of centralized and decentralized development modes. The centralized development is done by IS knowledge engineers, while the decentralized development is done by associate knowledge engineers. The centralized emphasis is placed on high return applications which benefit Cleveland center directly. Application development is weighed by its merit either as a large cost saver or as a politically visible innovation. The decentralized effort becomes stagnant due to the lack of line manager support. Domain experts who function as knowledge engineers develop applications on a time available basis. They are given little organizational incentive for completion. Day-to-day problems take precedence.

TABLE 7.3 : SCENARIO 1

DESCRIPTOR	CHARACTERISTICS
Technology	Fragmented / Integrated
Architecture	PC Based, LAN
Integration	Stand alone, Interactive
Application Portfolio	Functional / Partial Integration
Development	Decentralized / Centralized
Development Criteria	End-Users / IS planners
Data Transfer	Manual and Automated
Goals	Internal applications

Scenario 2 :

The desire to export ES applications is most important. Maintaining a position as the ES leader within the larger DOD organization is a strategic goal for DFAS Cleveland. Development is conducted only on systems which show high potential for DOD cost savings through utilization at several DFAS sites. The purchase of a mainframe-based expert system is required to migrate and expand PC-based applications to the mainframe environment. A centralized development posture is taken with IS programmers functioning as knowledge engineers.

TABLE 7.4 : SCENARIO 2

DESCRIPTOR	CHARACTERISTICS
Technology	Partial Integration
Architecture	PC, LAN, Mainframe
Integration	Interactive, Distributed
Application Portfolio	Partial Integration
Development	Centralized (70%), Decentralized (30%)
Development Criteria	IS personnel have sole responsibility
Data Transfer	Fragmented Automated
Goals	External and Internal

Scenario 3 :

A long term view toward strategic benefits of both LAN and ES applications is key. Mainframe database access is available to all architectural applications (stand alone, LANs, MF/3270). Mainframe ES applications are both embedded and interactive. Development criteria is focused on exporting of both LAN and ES applications. This requires application selection to be DOD generic vice DON specific. An emphasis is placed on modularity for potential re-use. ES applications permeate all available architectures: PC stand-alone, LANs and mainframes.

TABLE 7.5 : SCENARIO 3

DESCRIPTOR	CHARACTERISTICS
Technology	Fully Integrated
Architecture	Mainframe, LAN, PC
Integration	Interactive, embedded, distributed
Application Portfolio	Strategic
Development	Centralized (60%), Decentralized (40%)
Development Criteria	IS personnel have sole responsibility
Data Transfer	Automated
Goals	Primarily exportation

5. Step Five: Analyzing Implications for Decisions and Strategies at DFAS Cleveland

To perform a thorough analysis of the implications of each of the four scenarios presented earlier, it is critical to obtain information regarding mission statements and goals of DFAS as a whole, policies regarding resource allocation, and the evolution of major environmental factors that affect the outcomes of the scenarios. At the time of this writing, it is impossible to obtain this information. By default, a trend analysis of the key factors are proposed in Table 7.6. Top management should perform sensitivity analysis of the ramifications of their preferred scenario.

TABLE 7.6 : SCENARIO ENVIRONMENTAL IMPACTS

ENVIRONMENT	ESTIMATE	PROB. OF OCCUR	ENVIRONMENTAL IMPACT		
			1	2	3
BUDGET	DOWN	HIGH	NO	NO	NEG
PERSONNEL	DOWN	MEDIUM	NO	NO	NEG
ACQUISITION	NEUTRAL	LOW	NO	NEG	NEG
LEGISLATION	INCREASE	HIGH	NO	NO	NEG
ES TECHNOLOGY	INCREASE	HIGH	NO	NEG	NEG

VIII CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The propose of this thesis was to apply the intuitive logic method of strategic planning to the Expert System technology at DFAS Cleveland. The concept behind our approach was to integrate organizational strategic planning to information systems planning using a scenario approach. Two questionnaires were distributed to gather environmental information.

As a result of our methodology, four scenarios were presented and discussed. In our view, we believed that DFAS Cleveland would, under the best environmental conditions, move progressively towards scenario three. Ultimately, this would consist of an open system architecture environment that allows expert system applications to be run on a network of distributed systems with micro-mainframe connectivity. The expert systems would be coupled with mainframe databases to automate data transfer. This process would require data staging - a mechanism that selects and transforms data from / to the mainframe DBMS.

B. RECOMMENDATIONS

This thesis has proposed a first step in applying scenario analysis to expert systems planning at DFAS Cleveland. To fully implement the findings of this study, it is necessary to develop in greater detail the characteristics and elements of each of the proposed scenarios. The following questions or issues are suggested for further investigation. By no means exhaustive, they apply for both current and projected trends:

- Will ES development make us competitive within the DFAS organization?
- Can we continue our leadership role in ES development?
- What are the types of applications that would best promote our strategic plans as an ES leader?
- Should we focus on DON specific applications development or should we broaden our scope to include DOD?
- Is end-user computing the best resource for ES application development?
- To what extent should ES "user" departments become involved in the development and planning process?
- What is the appropriate size and capability of the ES tools available for future applications?
- To what extent should IS programmers be involved in the ES development process?
- Should management become more directive in their approach to commissioning new ES applications?
- Will future ES applications be centralized or decentralized?
- How well a fit will ES applications make into existing IS architectures?

- Is the ES technology to remain PC based or will it transition toward mainframe applications?

- Will embedding ES applications into existing mainframe systems improve the quality and efficiency of production systems?

- Will funding permit the expansion of this program?

- Who will maintain the knowledge bases of ES applications in the long term?

- What level of scrutiny should be applied to new ES before they are approved for production?

- Should projected manpower levels promote or discourage the pursuit of ES development?

APPENDIX A

The purpose of this questionnaire is to gather information and solicit your expertise and opinions on the current and future use of information technology at NAVFINCEN. This is part of an academic research project conducted at the Naval Postgraduate School to test a new approach to information system planning. The information you provide below will be used solely for the purpose of this research. It will be kept confidential and will be destroyed after completion of the project.

MANAGERS SECTION

1. What is your code? ____________

2. What is your job description? ____________

3. What do you see as the mission of your Department? ____________

4. In what manner are production objectives determined? ____________

5. What is the main constraint in production? ____________

6. Are you a computer user? Yes / No

7. How many years have you used computers? ____________

8. Is computer usage critical to your department job performance? Yes / No

9. To what extent do the various Department Heads influence data processing (to include expert system) decision making? (to include purchase distribution and new system development) ____________

10. Are there others that enter the data processing decision making process besides department heads? (Yes / No) If so, who and how?

____

____

11. To what extent are your computers geographically dispersed or consolidated?______________________________

____

12. Are most of your computers stand-alone? If so to what extent do they have the same applications installed?Yes / No

____

13. To what extent are your computers interconnected (LAN)?__________

____

14. To what extent is interaction with the mainframe database req'd?

____

____

15. How does mainframe interaction take place?Modem (PC to MF)
Magnetic Tape Xfer
Hardcopy Printout
Not Applicable

16. Are you familiar with what Expert systems can provide? Yes / No

17. Are you familiar with the capability of expert system technology? Yes / No

18. Does your department have Expert systems implemented Yes / No

19. Do you have people trained in Expert System technology? Yes / No
If yes, what was the duration of the training?(ie. 1 week)______
By whom were they trained? (ie. in house)________________

20. Are the implemented Expert Systems impacting positively on production requirements? Yes / No

21. How do you measure the impact? (ie. solely financially)__________

____

22. Do you see areas where an Expert systems may improve working conditions or production? (list and assign priority 1-3)Yes / No

______________________ ______
______________________ ______
______________________ ______

23. Is it cost effective to allow an employee time to develop an expert system application in order to improve efficiency? Yes / No

24. How do new expert systems originate? ______________________

____

25. Are there clear procedures for recommending new expert system applications? Yes / No

26. Are the responsibilities of the Expert System Group clear and documented? Yes / No

27. Does the Expert System Group provide adequate service when desired? (ie. training, help in development...) Yes / No

28. Do you think cutting the expert system program in times of fiscal constraint counter-productive to your mission? Please explain your reasoning.____

____

____

29. How do you see the impending DOD reorganization affecting your department?____

____

____

____

____

30. What do you foresee as the Projected Organizational structure?___

____

____

____

31. Briefly describe the differences/similarities between your department and your counterparts in the other services.________

____

____

____

____

32. What issues, pertaining to effective computer utilization, need to be addressed at the NAVFINCEN?____________________________

____

____

____

____

33. What future computing issues and concerns need to be addressed at the NAVFINCEN?____

____

____

____

____

APPENDIX B

The purpose of this questionnaire is to gather information and solicit your expertise and opinions on the current and future use of information technology at NAVFINCEN. This is part of an academic research project conducted at the Naval Postgraduate School to test a new approach to information system planning. The information you provide below will be used solely for the purpose of this research. It will be kept confidential and will be destroyed after completion of the project.

General Questionnaire

1. What is your code? ____________

2. What is your job description? ______________________

3. What is your basic business process?(ie. Successor check verification) ____
____

4. Are you a computer user? Yes / No

5. How many years have you used computers? _______________

6. My job is:(Circle one)

   Computer based   Paper based   A Combination

7. Is computer usage critical to your job?   Yes / No

8. Does your job require you to use any of the following? (Check all that apply)

   Wordprocessing _________   Spreadsheet ___________
   Database _________   Other(specify)___________
   Expert System _________   ___________

9. What initiates a new job (case file) for you?(ie. computer flagged record)____

10. How do you obtain your data to process a case file? (ie.computer transfer) ____________________

11. What type of data (not references) are used during that process? (ie. LES) ____________________

____

____

12. What references are required to completely process a case file?

____

____

13. What percent of input data required to process a case are:
-automated? (ie. obtained from a computer system) __________
-hardcopy? (ie. LES, financial records) __________

14. The information required to process a case is: (check one)
straight forward __________ intricate and variable __________

15. What kinds of activities do you undertake while processing a case file? ____________________

____

____

____

____

16. How often is this task required to be accomplished? __________

17. Are there other people assigned to perform the same task? (How many) ____________________

18. What limits are placed on processing a case file by time? ______

____

19. What limits are placed on the process by volume of work? ______

____

20. How is the resulting information utilized? __________

____

21. Is a hardcopy of the resulting information required? Yes / No

22. Is archiving of the resulting information required? Yes / No
If Yes, how is this being done now? __________

____

23. Is archiving the decision making process desired? Yes / No
If Yes, how is this being done now? __________

____

24. Is interaction with a mainframe database required to access data for decision making? Yes / No

25. How does mainframe interaction take place? Modem (PC to MF)
Magnetic Tape Xfer
Hardcopy Printout
Not Applicable

26. Is your computer stand-alone or on a network? ________________

27. Do most stand-alone computers have the same basic applications installed on them? Yes / No

28. Does the need exist to interact with other computers/users in order to process a case file? Yes / No

29. Are you familiar with the capability of expert system technology? Yes / No

30. Do you use an Expert System? Yes / No
If so, which one? ________________
Has it been beneficial? (how) ________________

31. How do new expert systems originate? ________________
____

32. Are there clear procedures for recommending new expert system applications? Yes / No

33. Is there an Expert System Group in your organization? Yes / No

34. Are the responsibilities of the Expert System Group clear and documented? Yes / No

35. Does the Expert System Group provide adequate service when desired? (ie. training, help in development...) Yes / No

36. What issues, pertaining to effective computer utilization, need to be addressed at the NAVFINCEN? ________________
____
____
____
____

LIST OF REFERENCES

Bahill, A. Terry, Ferrell, William R., Teaching an Introductory Course in Expert Systems, IEEE Expert, Winter, 1986.

Bakos, J. Yannis, Treacy, Michael E., Information Technology and Corporate Strategy : A Research Perspective, MIS Quarterly, June 1986.

Carr, Frank J., Information Technology Management : An Executive View, Annapolis, 1991.

Carr, Houston H., Managing End-User Computing, Prentice Hall, 1988.

Cash, James I. Jr., McFarlan, F. Warren., McKenney, James L., Vitale, Michael R., Corporate Information Systems Management : Texts and Cases, 2nd ed., Irwin, 1988.

Davis, Gordon B., Olson, Margrethe H., Management Information Systems : Conceptual Foundations, Structure and Development, 2nd ed., McGraw-Hill, 1985.

Dickson, Gary W., Wetherbe, James C., Management of Information Systems, McGraw Hill, 1984.

Dooley Group, Linking Business and Information Systems Planning, Spectrum, Part I & II, Vol. 3, No. 3, June & August 1986.

Emery, James C., The Strategic Role of Information Systems, The Wharton School, 1990.

Euske, K. J., and Dolk, D. R., Control Strategies for End-User Computing, European Journal of Operational Research, Special Issue, Vol.46, No.2, 25 May 1990.

Foster, Lawrence W., Flynn, David M., M1 Tech : Its Effects on Organizational Form and Function, MIS Quarterly, December 1984.

Freundlich, Yehudah, Transfer Pricing : Integrating Expert Systems in the MIS Environment, IEEE Expert, February 1990.

Garcia, B., Information Center Identity Crisis, Computerworld, Vol. 21, No. 40, October 1987.

Hartman, W., Matthes, H., Proeme, A., Management Information Systems Handbook : Analysis Requirements, Determination Design and Development Implementation and Evaluation, McGraw-Hill, 1968.

Irgon, Adam., Zolnowski, Jean., Murray, Karen J., Bellcore, Marvin G., Expert System Development : A Retrospective View of Five Systems, IEEE Expert, June 1990.

King, William R., Strategic Planning for Information Resources : The Evolution of Concepts and Practices, Information Resource Management Journal, Fall, 1988.

Martin, James., Oxman, Steven., Building Expert Systems : A Tutorial, Prentice Hall, 1988.

McNurlin, Barbera C., Sprague, Ralph H. Jr., Information Systems Management in Practice, 2nd edition, Prentice Hall, 1989.

Navy Finance Center Organization Manual, NAVFINCEN INSTRUCTION P-5400.2G, 10 February 1989.

O'Keefe, Robert M., Balci, Osman., Smith, Eric P., Validating Expert System Performance, IEEE Expert, Winter, 1987.

O'Leary, Daniel E., Expert System Security, IEEE Expert, June 1990.

Ward, John M., Integrating Information Systems into Business Strategies, Long Range Planning Journal, Vol. 20, No. 3, 1987.

White, Clinton E. Jr., The Information Center Concept : A Normative Model and A Study of Six Installations, MIS Quarterly, December 1988.

Wiley, John., Managers, Micros and Mainframes : Integrating Systems for End-Users, John Wiley & Sons, 1986.

Zawrotny, Stanley B., Key to IS Success Alignment with Corporate Goals, Information Resources Management Journal, Vol. 2, No. 4, 1989.

BIBLIOGRAPHY

Asplund, Gisele., Asplund, Goran., An Integrated Development Strategy, John Wiley & Sons, 1982.

Beckhard, Richard., Harris, Reuben T., Organizational Transitions : Managing Complex Change, 2nd ed., Addison-Wesley, 1987.

Bowman, B. Davis., Gordon, B. and Wetherbe, J. C., Three Stage Model of MIS Planning, Information and Management Journal, Vol. 6, No. 1, February 1986.

Burges, Leigh., Distributed Intelligence : Trade offs and Decisions for Computer Information System, South Western, 1987.

Chorafas, Dimitris N., Applying Expert Systems in Business, McGraw-Hill, 1987.

DeGross, Janice I., Olson, Margrethe H., Proceedings of the Ninth International Conference on Information Systems, 1988.

Freiser, Theodore J., Bearing the Burdens, Reaping the Rewards of End-User Computing, Information Strategy : The Executive Journal, Vol. 3, No. 4, 1987.

Galbraith Jay R., Organization Design : An Information Processing View, Interface, Vol. 4, No. 3, May 1974.

Golfarb, David L., Building Scenario for an Electric Utility, Long Range Planning, Vol. 21, No. 2, 1988.

Goldberg, E., Rise of End-User Computer Brings New Challenge to MIS/DP, Computerworld, Vol. 20, No. 28, July 1986.

Huss, William R., Honton, Edward J., Scenario Planning - What Style Should You Use?, Long Range Planning Journal, Fall 1988.

Keen, Peter G. W., Morton, Michael S. Scott., Decision Support Systems : An Organizational Perspective, Addison-Wesley Publishing Co., 1978.

King, W. R., Strategic Planning for Management Information Systems, MIS Quarterly, Vol. 2, No. 1, March 1978.

Klepper, Robert and Ryan, Terence F., Dynamic Theories of End-User Computing : An assessment and Critique, IEEE Journal, 1991.

Moulin, Bernard., Strategic Planning for Expert Systems, IEEE Expert, April 1990.

Ng, Keung-Chi and Abramson, Bruce., Uncertainty Management in Expert Systems, IEEE Expert, April 1990.

O'Leary, Timothy J., Goul, Michael., Moffitt, Kathleen E., Radwan, A. Essam., Validating Expert Systems, IEEE Expert, June 1990.

Perrow, Charles., Organizational Analysis : A Sociological View, Brooks/Cole Publishing Co., 1970.

Peters, Thomas J., Waterman, Robert H. Jr., In Search of Excellence, Warner Books, 1984.

Senn, James A., Linking Business and Information Systems Planning, Society for Information Management, Vol. 3, No. 3, June 1986.

Thierauf, Robert J., User-Oriented Decision Support Systems : Accent on Problem Finding, Prentice Hall, 1988.

Tom, Paul L., Managing Information As A Corporate Resource, Scott and Foresman Company, 1987.

Tozer, Edwin E., Developing Plans for Information Systems, Long Range Planning Journal, Vol. 19, August 1986.

Turban, Efraim., Watkins, Paul R., Integrating Expert Systems and Decision Support Systems, MIS Quarterly, June 1986.

Weihmayer, Robert., Brandau, Richard., Cooperative Distributed Problem Solving for Communication Network Management, Long Range Planning Journal, Vol. 13, No. 9, November 1990.

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center — 2
   Cameron Station
   Alexandria, Virginia 22304-6145

2. Superintendent — 2
   Attn: Library, Code 1424
   Naval Postgraduate School
   Monterey, California 93943-5000

3. Professor T. X. Bui — 2
   Attn: Admin Sc ience, Code AS/Bd
   Naval Postgraduate School
   Montery, California 93943-5000

4. DFAS-Cleveland — 5
   Code 514
   1240 E. 9th Street
   Cleveland, Ohio 44199-2055

5. Lcdr. Frederick J. Schwarz II — 2
   Navy Operational Intelligence Center
   4301 Suitland Road
   Suitland, Maryland 20395-5001