1994

The Design of an Effective, Economical Executive Information System For Cedarville College

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The Design of an Effective, Economical Executive Information System for Cedarville College

A Dissertation

Submitted in Partial Fulfillment of the Requirements for the

Doctor of Philosophy Degree

Nova University

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April, 1994

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Acknowledgements

I want to thank several individuals who have contributed to this dissertation. The chair of my dissertation committee, Dr. Jacques Levin, has been an encourager and willing listener throughout the entire dissertation process. Dr. Marlyn Kemper Littman has given helpful advice, particularly regarding form and presentation style. I also appreciate Dr. Junping Sun's efforts in reviewing the dissertation. I am grateful to Cedarville College for providing financial support to pursue this research. The external reviewers (Mary Cox, Bob Zinck, Jane Evans, and Laird Sloan) gave freely of their time to help this project along. My wife and children have been especially patient as my doctoral studies consumed many hours which would have otherwise been spent on family activities. I also want to thank the Creator who gave me the abilities and interest to pursue a degree in information systems.

Abstract

The managers of a corporation have an obligation to make the best use of available organizational resources for daily operational activities of the corporation and for long-range development. This requirement for efficient management certainly obtains for higher education, as declining student populations and shrinking funding sources argue for an even greater need to manage well.

One important aspect of efficient management is having sufficient information for decision making. This dissertation addresses the need for electronic tools to assist officers of a higher education institution in the management of the institution by improving access to information. College administrators need information about the status of their institution, projections of enrollment and funding, and comparative data from other institutions. This dissertation presents a systems analysis model for provision of that management data in the form of an executive information system (EIS).

A review of the literature on executive information systems reveals extensive EIS activity in the commercial environment, but very little EIS activity within higher education. Recent declines in hardware pricing and the appearance of economical productivity software have made the development of an EIS more feasible within higher education. The literature review includes a discussion of information requirements for executives, historical development

of executive information systems, and commercial executive information systems.

The design section of the dissertation presents a framework for development of an EIS for Cedarville College. The recent installation of a campus-wide network has provided desktop computing access to administrative officers of the college, but there is not yet an appropriate software system which would utilize this network for administrative information delivery. The design framework includes a requirements analysis, a preliminary feasibility study, testing procedures, and an implementation plan for the development of an executive information system for Cedarville College.

The requirements analysis performed as part of the study are based on interviews with administrators and middle-managers at Cedarville College. The identified requirements include a description of major decision making to be supported and the types of data which are typically used in support of that decision making. Following the requirements analysis, the author presents a review of five commercially-available EIS software packages. The review includes a description of each product, pricing information, and an overview of the data structures used by each product. As part of the analysis procedure, a prototype EIS was designed and implemented in three of the packages. The entire EIS design and prototype implementations were reviewed by Cedarville College participants and by four external reviewers.

The systems analysis efforts performed as part of this study have resulted in an increased awareness of information requirements within the College administration and middle-management. The proposed EIS design and corresponding prototypes have demonstrated the feasibility of improving executive information support within the College. Such a design can provide an **effective** EIS for Cedarville College. However, development of the EIS prototypes has highlighted the importance of continued active participation by executives and systems analysts in the ongoing evolution of the executive information system. While EIS software costs can be identified and kept within a fairly small budget, personnel support issues may outweigh any software costs involved in an EIS project. Thus, delivery of an **economical** EIS for Cedarville College and other similar colleges remains an area for ongoing research.

Table of Contents

List of Tables

List of Figures

Chapter 1 Background

Introduction

> Up to this point in history, executives have functioned with a variety of intellectual tools: meetings, speeches, books and periodicals, pens and paper, and telephones. The computer is a relatively new addition to this list. It provides tools that can significantly increase the capacity of the executive brain to deal with complexity--a capacity that is sorely needed in an age of globalization and rapid change...But top executives, for the most part are not using computers. (Boone, 1991, p. xiii)

The situation which Mary Boone describes concerning corporate America certainly obtains in higher education. A review of documented case studies (see chapter 2) reveals that few colleges and universities are providing extensive computing support for top administrative officers. Presidents, vice-presidents, and deans perform analyses and make strategic decisions without the benefit of substantial information systems support. This lack of support is true not only in the general case, but in the specific case of Cedarville College. Computing support within Cedarville College has been focused on transaction-processing systems such as admissions, student records, general ledger, and payroll. There have been limited attempts at providing longitudinal data, but this information seldom reaches the president, vice-presidents, or department chairpersons.

Previous attempts at providing computing support for top administrative officers in the corporate world have been expensive, with costs often exceeding $20,000 per executive (Thierauf, 1991) and therefore limited to larger, wealthier organizations. Several authors (Nash, August 12, 1991; Watson, July 22, 1991; and Watson, Rainer, and Koh, March, 1991) reported executive information system (EIS) developmental costs ranging from $200,000 to $550,000. Watson et al. surveyed 286 firms, receiving responses from 50 firms which had an EIS in-place. For the 33 firms which reported costs, the average developmental cost for the EIS was $365,000. The average annual operating costs were $205,000. Watson et al. also observed that "These numbers suggest that an EIS is expensive and, consequently, may be limited to larger firms with considerable financial resources" (p. 23).

There is additional evidence in the literature to suggest that development of an executive information system is expensive. A survey conducted by Sullivan-Trainor (July 22, 1991) found a median EIS development cost between $100,000 and $500,000. An aborted EIS development effort at Maricopa Community College District provides a simultaneous example of both cost and risk in developing an EIS. The district cooperated with Information Associates in developing an EIS, including placement of several IA staff members on-site (Leslie, Pociask, and Alexander, 1988). After extensive design and development efforts, the project was put on hold.

This investigator developed this dissertation project to demonstrate that an executive information system can be designed for Cedarville College so that the EIS is both effective and economical. The literature review in chapter 2 summarizes recent developments in powerful microcomputer hardware and software and advances in computer networking which make the creation of an EIS for Cedarville College an economical possibility. A successful implementation at Cedarville should provide a basis for implementation at other small, liberal-arts colleges and corporations of similar size.

As Director of Computer Services for the College, it is appropriate that this investigator explore means of improving executive support. The Director of Computer Services is responsible for all computing on campus, including the recently-installed campus-wide academic network and all administrative systems. The director's job duties include promoting "effective computer utilization by faculty, staff, and students" (Cedarville College Faculty Handbook, 1992, p. 11). The director reports to the academic vice-president. The academic vice-president, in turn, is one of five vice-presidents who oversee the day-to-day operation of the College.

Cedarville College has its roots in the liberal arts tradition, requiring each student to take a variety of course work in literature, humanities, social science, history, and Bible. This liberal arts emphasis is complemented by the availability of professional programs in business, nursing, engineering, and education. The College enrolled 2,172 students in the fall of 1992 (an increase of 126 from the prior year). Over 2,100 of these students were full-time and more than 1,600 of them lived in College residence halls. Cedarville students are fairly young; 70% of the students taking classes in the fall of 1992 were under 21 years of age. The average ACT score for new Cedarville freshmen in the fall of 1991 was 23.5, compared with a national average of 22.1 for college-preparatory students (Cedarville College Fact Book, 1992).

The College has made a significant commitment to computer networking. During the last 18 months, the College has connected all of its academic buildings and several service buildings with fiber-optic cable. Over 95% of the faculty have a networked microcomputer in their office. By the fall of 1993, 75% of the residence-hall rooms were equipped with a computer, a printer, and a network connection. Commuter students and students in non-networked residence halls access the campus network using one of the four public computer labs. Counting the residence-hall computers and computers in specialized labs, there were over 850 computers available to students in the fall of 1993.

Since the introduction of commercial computers in the 1950's, substantial progress has been made in automating routine business functions. Computers have also been used to enhance scientific computing and, perhaps to a lesser extent, to improve education. The actual number of computers in use within the United States has grown dramatically within the last fifteen years due to the availability of microcomputers.

With all of this computing power available, colleges and universities ought to be making effective use of the technology. Colleges have invested time and effort into providing computing resources to perform routine administrative functions such as registration, grade reporting, purchasing, and financial accounting. One indication of the extensive use of computing for routine administrative functions is the size of the customer base for software providers. For example, over 170 institutions of higher education (including Cedarville College) currently use the Colleague software package from Datatel, Inc., of Fairfax, Virginia. While individual institutions negotiate their own "net" pricing, the list price for the complete Datatel package is over $200,000--a substantial investment for each of the 170 Datatel clients.

Are colleges and universities utilizing their computing power for executive support in addition to transaction processing? There is some evidence that computer usage is low and relatively ineffective at the presidential and vice-presidential levels of many institutions. J. F. Rockart (Ryland, Fall, 1989) has studied multiple executive support systems in corporations but reported in late 1989 that he had not yet found such a system in higher education. Searches of the ERIC and Dissertation Abstracts databases for the years 1982 through 1992 reveal few documented examples of executive information system support within higher education (see table 5 in chapter 2).

This dissertation project was designed to address the problem of utilizing computers as management tools within educational institutions. It is important during the current period of declining student populations, reduced Federal funding, and increasing costs, that colleges make efficient use of their existing resources and make good strategic decisions for the future. The design for executive computer support is intended to provide the Cedarville College administrators with the information they need for daily decision making and for strategic planning. The subsequent evaluation process was carried out so as to help critique the EIS design and to identify critical areas where information systems could aid high-level administrators in resource allocation, management, and strategic decision making at other institutions.

The current lack of executive computer support is partly a reflection of the historical development of electronic computing (Viehland, Fall, 1989; Mc Laughlin, Fall, 1989). Early systems were envision and utilized as electronic adding machines; installed to provide more accurate records in a shorter time period. During the late 1960's and the 1970's, much of the computer industry focused on management information systems (MIS). These systems tried to achieve some management support by using integrated database systems and providing a more robust array of reports. The MIS approach did, in fact, provide useful information for management--but this information was frequently out of date, limited to the "canned" reports provided in the system, and was oriented towards first-line managers rather than executives.

The 1980's saw a period of upheaval in the computer industry, as massive amounts of raw computing power moved from mainframe glass rooms to personal computer desktops. In general, this desktop power was utilized for productivity applications (word processing and spreadsheets) while the corporate data remained on the mainframe. Early attempts to provide executive computer support during the 1970's and 1980's failed due to the high costs of mainframe computing, requirements for a programming staff, expensive remote access, and due to the failure of the information systems staff to understanding the business needs of the executives.

The stage is now set for rapid advancement of executive information systems. During the late 1980's and early 1990's, computer networking has evolved from a risky experiment to a reliable, accepted operational pattern. Reliable networks have subsequently fostered the development of better software for communication between desktop personal computers and mainframes. Sophisticated application packages, including some which are specifically oriented to executive support (like the Lotus Notes groupware package and various personal information managers), have appeared. Thus, technical capability to distribute information has improved during a time when competitive market pressures make it imperative for executives to maximize the use of their corporate resources. As reported by Rockart and DeLong (1988), the executive of the 1980's and 1990's is also more computer-knowledgeable than the executive of the 1960's, so that communication with the information systems staff is facilitated. This combination of factors--improved hardware and software coupled with higher executive interest and ability--make the implementation of executive computer support possible in the 1990's.

Problem Statement

Currently, there is minimal computing support for executives at Cedarville College. Only one member of the administrative council (whose membership includes the president and the five presidents) makes direct use of the administrative computer system. The only longitudinal reports which are run are done for the Office of Institutional Research, and seldom reach the members of the administrative council. Planning reports are generally prepared by hand, with minimal data obtained from institutional databases.

This lack of information systems support for the administrators reduces the effectiveness of the executives in the areas of planning and management of resources.

While improved information systems support for management is desirable, most published examples of executive computing support in business corporations have been expensive and implemented primarily by large organizations. Executive computing support in higher education has followed this pattern. The challenge which presented itself, therefore, was to:

Design an effective, economical
executive information system
for Cedarville College.

To be effective, the system must produce demonstrable benefits for the strategic planning process and for the routine management of the institution. To be economical, the system must be cost-justified, or--if a formal cost/benefit analysis is not performed--at least not adversely affect the institution's financial position. To be an executive information system, the system must be oriented towards, and used by, administrators at the college. The EIS must be more than a method of presenting mere facts. To be designed for Cedarville College, the system must address the unique needs of the small, liberal-arts college. As background for addressing the problem of designing an executive information system for Cedarville College, chapter 2 of this dissertation presents a summary of literature on executive information systems and literature on systems analysis and design. The literature review includes an exploration of information requirements for managers, a study on the evolution of executive information systems, a brief description of some commercially-available executive information systems, and an overview of systems analysis and design strategies. Chapter 3 of the dissertation presents a design framework for performing the actual analysis and design of an executive information system for Cedarville College. Sections within chapter 3 include a description of the current environment, a systems-analysis philosophy, a design for requirements analysis, an overview of the systems analysis process, and a format for evaluating the resulting design. Chapter 4 of the dissertation presents the actual results of the design project. Major sections of chapter 4 deal with the identified systems requirements, overviews of commercially-available EIS software, prototypes implemented as part of the analysis, and summaries of design evaluations. Chapter 5 of the dissertation presents a discussion of the conclusions and implications of the EIS development project.

Assumptions and Limitations

This dissertation is presented with the following assumptions and limitations:

1. Management of an institution of higher education is a complex task.
2. The management task can be facilitated through the use of computing technology.
3. Persons in positions of executive leadership within education in general and within Cedarville College in particular have a strong desire to improve their management performance.
4. While portions of the study may have general application to higher education, the primary focus of the research is on enhancing the executive management of Cedarville College.
5. The systems analysis tasks being performed are themselves complex, with results varying according to the skill, experience, and approach of the analyst. Different researchers studying the same situation may construct a different model while still meeting the design requirements.

Definitions

CASE

Computer Aided Software (or Systems) Engineering; a procedure for using specialized software to help automate the systems development life cycle. The software often provides analysis tools such as data flow diagrams and data dictionaries. Some CASE tools include modules for generation of source code. (Amadio, 1989)

Cohesion

A measure of the degree by which each module in a software system carries out a single, problem-related, and understood function. Current design theory emphasizes maximization of cohesion. (Burch, 1992)

Coupling

A measure of the relative interdependence among two or modules in a software system. Current design theory emphasizes minimization of coupling. (Burch, 1992)

Drill-down

A software capability which allows a user to select a summary item presented on-screen and, by the simple press of a key or mouse button, obtain supporting detail for that item. (Viehland, 1990)

Executive information system

An executive information system is an on-line computer system (Gray, King, McLean, and Watson, 1989) which involves the executive in data interpretation for decision making (Lukesh, 1988). This interpretation is done using the latest internal and external data (Kador, 1991), often using modeling tools and graphical presentations (Graham and Freely, 1991). The EIS typically is designed for a higher-level executive than traditional management information systems and therefore development of the EIS often emphasizes ease of use over economy (Legatt, 1991; Emery, 1987). Information handled by the EIS is obtained from internal corporate databases, internal communications, external databases, and external communications (Thierauf, 1991).

Economical EIS

An economical EIS is one whose benefits can be justified, or--when formal cost/benefit analyses are not performed--at least not place the corporation in a detrimental financial position. (Yeh, Zave, Conn, and Cole, 1984).

Effective EIS

An effective EIS produces demonstrable benefits for the strategic planning process and for the routine management of the institution. (Frank and Lesher, Fall, 1991)

Graphical user interface (GUI)

A mouse-driven user interface which typically includes dialogue boxes, menus, buttons, and list boxes. (Burch, 1992)

Groupware

A software system which provides concurrent sharing of information between members of a work team, supporting the workflow of the organization. Information to be shared might include spreadsheets, word processing files, or real-time line" conversations. Electronic meeting systems are often part of a groupware system. (Morse, 1991; Nunamaker, et al., July, 1991)

Modularity

A measure of the degree to which a software system has been decomposed into self-contained units (which can be analyzed as somewhat independent systems). (Burch, 1992)

Network

An operating environment in which several small computers can be combined to form a data processing or communications operation at more than one location. Networks can be point-to-point, hierarchical, star, ring, or hybrid in design. (Thierauf, 1987)

Reliability

Successful operation over a specific time duration and the ascription of a probability to that success. (Deutsch, 1979)

Validation

The end product satisfies the requirements document. (Jalote, 1991)

Verification

The software fulfills specifications established during the previous phase of the design. (Jalote, 1991)

Summary

Through this introductory chapter, the reader has been introduced to the general concept of computer support for corporate executives and the facilitation of executive computing by recent advances in microcomputing, networking, and application software. A problem statement has been presented for tentative review by the reader and further elaboration by this investigator in the subsequent chapters. Definitions were presented as the concluding element of chapter 1, so as to provide a common understanding of terms for both the researcher and the reader.

Chapter 2 Literature Review

Introduction to the Literature Review

Computers have made possible great changes in the way that front-line workers perform their jobs in American business. Have similar changes occurred for top business management? Is information technology assisting executives in their planning and decision making? This chapter presents a survey of methodology for providing information to upper management through "executive information systems" (EIS) software. In particular, the chapter includes a discussion on the definition of an EIS, some case studies, highlights of common implementation problems, and a summary description of some commercially-available EIS products. The chapter concludes with a survey of systems analysis and design procedures which have applicability to the development of executive information systems.

Evolution of Executive Information Systems

Introduction

A precise definition of an executive information system is somewhat elusive; there is no standards body which has defined the contents of an EIS. Rather, a definition must be synthesized from various descriptive writings in the literature. Identification of a definition in the literature is difficult since many of the authors in this field use a variety of terms interchangeably while other authors make large distinctions between these same terms. Of particular relevance to this study are the terms:

decision support system (DSS),

executive information system (EIS),

and executive support system (ESS).

Emery (1987) is one author who takes a broad view of the definition for a decision support system: "all of the MIS except for transaction processing" (p. 100). The lack of uniformity in definition and usage has been highlighted by Watkins (Spring, 1991) and by Graham and Freely (1991). The discussion which follows approaches the definition of an EIS on the basis of common characteristics (executive participation, quick access, analytical tools, and management impact) and an historical and functional comparison of EISs with other computerized information systems.

Definition of Executive Information Systems

Executive Participation

Some authors view executive participation as ***the*** key component of an executive information system. J. F. Rockart defines an executive support system as "...any use of a terminal which aids an executive" (Ryland, Fall, 1989, p. 10). Though Rockart's definition may be extreme, an EIS certainly lacks the "executive" touch unless executives are actively involved in the system. Boone (1991) lists three types of qualifying use:

1. By the executive alone (e.g., a word processor);
2. By the executive and others (e.g., an electronic mail system); or
3. By others on behalf of the executive (e.g., an expert system which has captured the executive's ideas).

Other authors take a more formal approach in describing the importance of executive participation in an EIS. The Watkins article (Spring, 1991, p. 20) suggested that DSS is "...is a software system which enables the business professional to quickly and easily analyze corporate data to make intelligent business decisions." Mary Boone supported this concept of an EIS as she expanded on a preliminary definition of EIS ("access to data") to include "any application of a computer or communication tool in which the executive directly participates in the selection of the problem and the selection, design or use of the tool" (Boone, Spring, 1991, p. 25). Thus, an EIS includes executive access to data in such a way that the executive is more than a passive recipient. An EIS may be organized around simple menu selections or it may include more modern icon buttons. The underlying processes may include graphical manipulations and more sophisticated simulations. This definition of EIS would exclude any system which consisted primarily of routine data processing reports. Boone presented one aspect of EIS which was not mentioned by the other authors cited here: the role of an EIS in decision amplification: publicizing and propagating executive decisions throughout the organization.

A recent trend in the use of EISs is the expansion to use by the next layer of management (Fickel, 1991; Nash, August 12, 1991). Originally designed for use by the CEO and the vice-presidents, the EIS is proving to be a worthwhile tool for directors who report to the vice-presidents. Fickel reported that the 3M Company's EIS is targeted at product managers and marketing managers. Mid-level managers are the primary users; top-level executives are viewed as secondary users.

Executive participation is both a goal and a requirement for a successful EIS (Mautz, Merten, and Severance, 1983). Often there are barriers to this participation: communication gaps (use of jargon) and cultural differences (differing backgrounds, training, and experience for IS professionals and management) exist between the management and the information systems staff which must develop the EIS. In addition, senior management has a natural interest in "business-related" problems, but may express hesitation to interact with a computer.

Quick Access

R. B. Legatt (1991) highlighted the importance of quick access to information: A manager needs to "...react to change as quickly as it happens. That requires information--not just enough information, but the right information, in the right format, in the right time" (p. 5). Emery (1987) also highlighted the need to have quick access to just the right data; providing too much data will slow down the executive using the system.

The EIS definition presented by John Kador (February, 1991) emphasized the integration of internal company data with external data, in addition to the need for a quick and meaningful presentation. Kador identified six critical success factors for EIS systems:

1. Having a high level champion for the project;
2. Building the system on an E-mail foundation;
3. Delivering a visible system rapidly;

4. Exploiting only existing sources of information;

5. Making the system fast and easy to use; and

6. Emphasizing color graphics

Kador did, however, make a distinction between an ESS and an EIS. He considered an ESS to include only canned reports and graphs, while and EIS offers modeling, what-if analysis, and ad-hoc reporting. In Kador's particular situation, an ESS was chosen because executives were more interested in pre-determined reports than in performing ad-hoc analysis. Generating the canned reports requires less central processor time than performing multiple ad-hoc queries.

Analytical Tools

It is important for EISs to include analytical software and appropriate data to be used by the software:

> Decision support systems integrate information from multiple data sources, both internal and external, to produce concise analytic reports for both decision making and planning. (Lukesh, Winter, 1988, p. 6)

Sometimes the analytical portion of an EIS is backward looking, allowing comparison of historical data, and other times the EIS is forward looking, making predictions about future events. Rushinek and Rushinek (Spring,

1991) described two such support systems, one which presents historical data in summary form and one which predicts an outcome based on modeling. These systems examine the interaction between variables and a possible course of action and "...do much of the analysis, information recall and inductive and deductive reasoning formerly accomplished by the intellect of the manager, but in a more expeditious manner" (p. 42).

The Rushineks identified three major areas which should be addressed in a DSS: operations management, resource management (people, raw materials), and financial management. Such a DSS is often implemented using a mainframe for data access and a microcomputer for the actual analysis. This emphasis on analytical capability is also supported by Graham and Freely in their Datamation article (January 1, 1991). In fact, Graham and Freely distinguished an ESS from an EIS by how much control the executive has over the underlying models being used.

The analytical capability within an EIS is critical, due to the less well structured, underspecified problems that upper level managers typically face (Sprague, 1980; Frank and Lesher, Fall, 1991). Sprague divided an EIS's technical capabilities into three parts:

1. data subsystem (combine data from a variety of sources, add and delete data sources, portray logical data structures in user terms);

2. modeling subsystem (create new models easily, maintain wide range of models, integrate model "building blocks", management tools for manipulating the data base); and

3. interface between subsystems and user (action language--what the user can do; display or presentation language--what the user sees; knowledge base--what the user must know).

Sometimes the analysis performed by an EIS consists primarily of summarization and information filtering. As described by Ryan (May, 1991), many managers have a problem of information overload (data overload). Ryan's article described some information filtering techniques, products, and companies which could be used in an EIS. Of particular note is Ryan's concept of an "information refiner" (p. 155).

An excellent narrative regarding the analytical capabilities of an EIS is in Emery's 1987 text titled "Management Information Systems: The Critical Resource." Emery suggested the following decision aids be included in a DSS or EIS:

1. Selective retrieval of information (summary reports, ad hoc queries, exception reports, graphical displays) and

2. Decision models (predicting outcome variables based on input variables, using mathematical programming, objective functions, spreadsheet models, simulations, and expert systems)

Key to the success of these tools is limiting the volume of reports and generating useful information, not just reams of data.

Management Impact

Often the categorization of a support system as an EIS is dependent on the perceived management impact of the system. Mary Boone and Dean Meyer provided a description of the strategic impact to be achieved from any particular system:

> Strategic systems are those that contribute directly to the organization's mission, profits, and competitive position. Although there may be situations in which extensions to DP/MIS applications are strategic, we believe that the majority of strategic opportunities will be found in end-user computing. (Boone and Meyer, 1991, p. 2)

Frank and Lesher (Fall, 1991) claimed great strategic potential for an appropriate EIS system:

> The Executive Information System (EIS)...could profoundly change the way colleges and universities are managed. Through a combination of graphics, icons, and mainframe data retrieval software, senior and middle management can now track through the mountains of

financial, operating and other data generated throughout the organization. (p. 31)

This view of the strategic importance of an EIS was echoed by Emery (1987). Emery felt that an effective information system must focus on the achievement of the organization's critical success factors. A well designed system will provide support at the operational, tactical, and strategic management levels. Thierauf (1991) viewed information as so important that he called information the sixth organization resource for the executive (the first five being the five Ms: men, machines, money, materials, management). In another work (1987), Thierauf presented a theoretical framework for evaluating the decision-making impact from various types of information systems. An adaptation of Thierauf's scheme appears in table 1.

Table 1: Thierauf's Characteristics of Management Information

Characteristics of Essential Management Information	Categories of Decision Making		
	Strategic	Tactical	Operational
Information that is "What if?" in nature	Very high	High	Low
Predictive information centering on long-term trends	Very high	High	Low

Table 1: Thierauf's Characteristics of Management Information

Characteristics of Essential Management Information	Categories of Decision Making		
	Strategic	Tactical	Operational
Predictive information centering on short-term trends	High	Very high	Moderate
Dependence on external information	Very high	Moderate	Very low
Dependence on internal information	Moderate	High	Very high
Information capability of on-line availability	Moderate	High	Very high
Information capability of being reported periodically	Moderate	High	Very high
Current performance information	Moderate	High	Very high
Historical Information	Low	High	Very high

Table 1: Thierauf's Characteristics of Management Information			
Characteristics of Essential Management Information	Categories of Decision Making		
	Strategic	Tactical	Operational
Notes: Adapted from figure 1.6 in Thierauf, Robert J. (1987). Effective management information systems: accent on current practices, second edition. Columbus, OH: Merrill Publishing Company. "Very high," "high," "moderate," and "low" refer to the manager's needs.			

Fredericks (1971) also approached the topic of decision-making impact from information systems, but provided practical examples. Table 2 contains a representative sample of Fredericks' ideas.

Table 2: Fredericks' Task List for Tactical and Strategic Information Support		
Strategic Level	Planning	Determine future product line requirements and strategies.
		Estimate long range demand for existing and planned products by demand region.

Table 2:
Fredericks' Task List for Tactical and Strategic Information Support

		Determine production and warehousing facilities requirements.
		Plan management, administrative, labor, and other resources required for planned growth.
		Determine capital requirements and financial conditions for successful growth.
	Control	Control against predicted performance to adjust strategic plans on a continuous basis in response to: economic trend changes, inflationary changes, political situations, industry and competition, technological developments, and current performance accomplishments.

Table 2:
Fredericks' Task List for Tactical and Strategic Information Support

	Administration	Maintain continuously updated planning data base containing feedback from the tactical control system and monitoring of external environment.
Tactical Level	Planning	Forecast of sales in detail of each specific product within lead time of material acquisition.
		Translation into future build program.
		Determination of sourcing pattern.
		Planning of inventory levels of raw material, work in progress, and finished goods.
		Planning of purchasing quantities and orders on suppliers.
		Planning and scheduling of utilization of existing facilities and available labor.

Table 2:
Fredericks' Task List for Tactical and Strategic Information Support

		Planning of requirements for cash to finance any seasonal needs.
	Control	Monitoring accuracy of all forecasts up to cut-off point determined by lead time of materials and components.
		Continuous feedback in response to market changes and production achievement modifying tactical plan on a continuous basis.
	Administration	Maintenance and communication of all tactical planning and feedback information.
		Acquisition, maintenance, and extrapolation of historical data.

Table 2: Fredericks' Task List for Tactical and Strategic Information Support
Note: Adapted from table 1, p. 70, of Fredericks, W. A. (1971). A manager's perspective of management information systems. In Wetherbe, J. C.; Dock, V. T.; and Mandell, S. L. (1988). Readings in information systems: a managerial perspective. St. Paul, MN: West Publishing Company.

Much of the benefit from an EIS is the result of being able to spot trends earlier, allowing the executive to respond more rapidly and creatively to market shifts (Watkins, Spring, 1991). Watkins identified five situations where a DSS is useful:

1. The company needs high value decisions in short time frames using data intensive ad hoc analysis;
2. Executives spend time on data gathering--downloading files or re-keying data--thus reducing time spent on analysis;
3. A programmer is required to access the corporate database;
4. The organization has large databases (over 100 megabytes) which are difficult to navigate; and
5. Executives need to analyze data from different computers or different sources.

An executive information system can make a large difference in the effectiveness of upper management. To obtain this impact, the EIS must provide high-level information and the tools to manipulate that information. The EIS must be developed within a time-frame where visible results can be obtained while project enthusiasm is still high. The EIS must make some provision for "fuzzy" information and interpretation, and for differing management styles.

Historical and Functional Contrasts

Some early detractors to executive computing offer a fitting backdrop to a historical and functional review of EIS development. Tolliver observed that there has been little management impact from computerization, and there is likely to be none:

> Today, many top executives are worried because competitors are reportedly using computers to make major breakthroughs in executive level management techniques and effectiveness. These executives tend to have an uneasy feeling that somehow they have failed to exploit the potentials of modern management science--and that the penalty will soon become painfully visible in the profit and loss statement. Relax, Mr. Worried Executive. Computers have not resulted in major

breakthroughs in executive level management and none are in prospect. (Tolliver, 1971, p. 75)

Dearden places management computing into the fad category:

> Some years ago I expressed the opinion that 'of all the ridiculous things that have been foisted on the suffering executive in the name of science and progress, the real-time management information system is the silliest.' I no longer believe this statement is true. We now have something even sillier: the current fad for 'THE management information system...' (Dearden, 1972, p. 92)

About ten years after these pieces were written, prophecies had changed dramatically. Dickson (1983) predicted a management support facility which would include writing, communications, individual applications, data management (both local and distributed databases), decision support, decision conveying, and problem finding.

Evolving EISs were categorized in a taxonomy of information systems applications presented by Gray et al. (1989). In the Gray taxonomy, EISs were characterized as giving "...top management on-line access to information about the firm's current activities" (p. 10). The EISs were contrasted with DSSs (providing data modeling and support for poorly-structured decisions) and expert systems (containing a knowledge base from experienced managers).

The sample EIS cited by Gray et al. included report preparation, inquiry capability, a modeling language, graphical displays, and subroutines for financial and statistical operations. Gray et al. further distinguished EISs from DSSs in that the EISs are:

1. Used directly by top managers;
2. Provide easy on-line access to current data;
3. Designed with management's critical success factors in mind; and
4. Use state-of-the-art graphics, communications, data storage, and data retrieval methods.

According to Gray, ease of use is one of the most important factors in an EIS. Ease of use in modern EISs is further enhanced by the use of graphics (Emery, 1987).

A common feature of modern EISs is "drill-down" (Viehland, 1990). The EIS software is often arranged in hierarchical screens, so that an executive who is viewing a particular item can highlight that item and get further detail on the item.

Though he called them "lessons," Jeffrey Stamen (Spring, 1991) presented seven general characteristics of EISs:

1. An EIS is not a fixed application, but a set of technological capabilities;

2. An EIS is reflection of the specific corporate structure, style, and culture;
3. A GUI by itself is not an EIS, but a GUI adds value to an EIS;
4. The "briefing book" approach was fine for 1980's but is no longer sufficient;
5. An EIS changes the way organizations think about end user computing;
6. An EIS must include functions beyond sharing data and providing summary reports; and
7. An EIS application has to be independent of the hardware platform being used.

Robert Thierauf (1987) presented DSSs in an historical context, tracing computing from "backward looking" systems such as accounting through integrated management information systems, distributed processing, and (currently) decision support systems. DSSs employ mathematical models and present only selected information. The manager remains in control of the information system session. Frequently, the EIS includes an easy-to-use interface and graphical presentations. Thierauf claimed that many EISs fail because of poor communication between the managers and the programmers. His recommendation is to provide an EIS which does not require programmers--let the manager develop the system rather than having a programmer do it so that the system is a perfect match for the manager. In a later work (1991), Thierauf summarized the typical features found in a modern EIS: non-keyboard interface to simplify use, access to internal and external data bases, exception reporting, time-series information, modeling tools, electronic mail, "what-if" calculations, and projections.

Historically speaking, the typical cost of an EIS can approach $500,000 ($2,000 to $20,000 per executive). Watson, Rainer, and Koh (March, 1991) reported on a study which showed typical development costs for an EIS ranging from $300,000 to $500,000; with annual operating costs in excess of $200,000. The authors attributed some of this high cost to the heavy use of mainframe computing resources (83% of the respondents who specified their computing platform were basing their EIS on a mainframe system). The respondents to the Watson survey tended to be large firms, with only 3 of the 50 firms having sales under $1 billion per year. This preponderance of large firms may be a reflection of the traditionally-high cost of development.

Another article which presented a historical contrast was the EIS II article by Information Resources (1991). Information Resources described early executive information systems which "...were designed to take raw data from a company's operational systems, visually enhance it, and deliver it directly to top-level executives" (p. 3). Later systems added modeling, statistical analysis, spreadsheets, graphics, and database management modules. These modules tended to be separate packages with loose integration between them. Current EISs (Information Resources called them EIS II systems) have three major characteristics. They:

1. Extend through the organization, providing enterprise-wide, closed-loop systems;
2. Stress "data driven" systems rather than predefined slide-shows; and
3. Combine ease-of-use with extensive functionality.

EIS II systems represent an integration of the earlier EIS and DSS software.

Emery (1987) reinforced the enterprise-wide nature of modern EISs, predicting that "The DSS will become increasingly integrated with an office information system..." (pp. 137-138). Such systems will feature text processing with integrated graphics; document preparation, including high-quality printing; document distribution; electronic mail; time management; and desktop functions (e.g., corporate telephone directory, electronic memo filing, calculator functions).

Since many major decisions are made by groups, recent additions to EISs include various forms of "groupware" (Briere, 1991; Scheier, 1991). Nunamaker and others (1991) reported on research at the University of Arizona on attempts to provide computer support for group decision making. Electronic meeting systems allow meetings to occur when participants are in different geographical locations and (if desired) with participation at differing times. This type of support enables executives to handle consensus building and task-team work electronically. Another approach to groupware is the sharing of documents under development, as in a Lotus Notes environment or a WordPerfect Office environment. Participants can review documents simultaneously or asynchronously, attaching comments and suggested changes, without having to distribute physical copies.

Modern EISs tend to be LAN-based rather than host-based (Brandel, 1991). The LAN-based systems offer greater flexibility for the user interface while minimizing costs. LAN-based systems typically require less maintenance, can be implemented with less effort, and provide better response time.

R. B. Legatt (1991) presented a different contrast between EISs and historical management information systems. Legatt claimed that EISs tend to support a higher-ranking executive than traditional systems do. The targeted EIS executive is responsible for corporate-wide decisions, while users of previous computing systems were responsible only for specific functional areas. The higher-ranking executive also demands (and gets!) more sophisticated computing hardware and software than the functional managers.

Definition Summary

This investigator has synthesized the definition components presented above to formulate the following definition for an EIS:

> An executive information system is an on-line computer system which involves the executive in data interpretation for decision making. This interpretation is done using the latest internal and external data, often using modeling tools and graphical presentations. The EIS typically is designed for a higher-level executive than traditional management information systems and therefore development of the EIS often emphasizes ease of use over economy. Information handled by the EIS is obtained from internal corporate databases, internal communications, external databases, and external communications.

Where appropriate, a moderate distinction can be made between executive information systems and decision support systems. The following is a comparison from an article by Graham and Freely (1991, p. 77):

> ...many decision makers also use two other categories of software--spreadsheets and executive information systems (EISs)--to accomplish some of the same functions as DSS...While there is increasing overlap between these three classes of software, there remain some differences. Spreadsheets can certainly do modeling, but they

generally cannot support the number of variables and the complexity of equations (Monte Carlo simulations and time series, for example) that DSS programs traditionally do. And EIS software generally presents summaries and conclusions, with the underlying models and data hidden from the end user. Put another way, DSS is for people who want to manipulate data themselves, while EIS is more for people who want to see regular, formatted presentations of data at the push of a button...With more companies producing their own custom EIS applications and traditional DSS developers beginning to produce EIS packages, whether their differences will be as distinct in the future remains questionable.

Case Studies

There are several cases in the literature which cite specific strategic impact from implementing an EIS. For example, Doug Bartholomew (1991) reported on an EIS implemented at MasterCard. This system was developed over a nine-month period in support of nine senior executives. The system proved its worth by providing sufficient information for an immediate decision regarding a change in marketing policies in a Korean bank. By utilizing the EIS system, executives were able to respond immediately to a proposed policy change in the Korean bank. Without the EIS, the decision would have been delayed and business would have been lost.

David Hertz (1988) emphasized the usefulness of artificial intelligence in an EIS to make "... [the] thinking process more insightful, more precise, and more timely" (p. 33). A system which fits this type of use is the Underwriting Advisor by Syntelligence, Inc. Underwriting Advisor not only presents information, but aids in making better decisions regarding insurance underwriting.

Three other cases were referenced by Stamen (1991). The comments included in the Stamen article confirm the strategic importance of EISs:

1. Kevin Armstrong, Vice President for Listening and Responding, Burger King:

   "Information is essential to be responsive to regardless of the business you may be in. An EIS integrates the many sources of data necessary for a truly informed, rapid response" (p. 22).

2. Robert Klein, Vice President, The Chase Manhattan Bank:

   "In our experience, EIS users quickly value the system's ease of use and the fact that it provides insight and depth to the data not available otherwise. In a competitive industry like financial services these qualities make Executive Information Systems invaluable" (p. 23).

3. Tom Pike, Director of MIS, AT&T Paradyne:

"If a CIO is going to fully exploit the information age they [sic] need an EIS. Without an active EIS program they are missing a critical element to their business" (p. 23).

In some recent marketing literature, Apple Computer has reported on successful EIS projects using Macintosh computers (Apple, Spring, 1991 and Summer, 1991). A project at San Joaquin Delta College involved accessing 3 DEC VAX minicomputers and 9 file servers. The goal of the San Joaquin project was to provide a "Virtual Desk...a comprehensive information system that gives administrators easy and immediate access to campuswide data from the Macintosh desktop" (p. 11). Current applications include Budget Worksheet, Business Summary Stack, Dean's Grade Viewer, Planning Instrument, campus policies and procedures, staff directory, and an events calendar. A smaller project at Indiana University involved 29 finance and administration executives and their assistants. A special feature of the Indiana system is access from the executive's home via a modem.

Georgia Power and Light has had a long history of using executive information systems (Gunter and Frolick, Fall, 1991). Georgia Power and Light's first EIS was CADET ("computer aided decision tool"). CADET was based on a pc-network and was designed to meet five business needs: eliminate redundant data; reduce paper use; provide immediate access to data; display data in a useful format; and provide a centralized, secure database that could easily be updated. Later versions included on-line viewing of management reports, model building, and ad hoc queries of the corporate databases.

Another pioneer in the EIS field is Ball State University, which implemented its ASAP system in the mid 1980's (Neff, January, 1986). The ASAP system was designed "specifically for administrators who don't have the time or patience to learn the syntax and commands of a data base language" (p. 25). ASAP is menu-driven, self-explanatory, and requires minimal typing. Information is presented from a broad range of applications, including human resources, course offerings, scheduling, and student records. Administrators have access to historic and summarized data bases. Use of the summarized data bases helps to minimize ad hoc scans of the large, production data bases.

Another early EIS is the PULSE system at Dickinson College (Doernbach, November, 1987). This system is somewhat unique in that it was developed at a college with only 2000 students. The PULSE system was implemented using electronic mail as the common transmission medium. Various offices produce reports which are then sent via e-mail to targeted administrators. No graphical-based or hierarchical software was used in the PULSE system. All reports were limited to a single page and were hand-entered into a word processor. At the time of the writing, only three screens had been implemented.

One of the oldest EISs within an educational institution is the system in use at the University of Hartford (Glover, Fall, 1989; Hicks, 1990; Glover and Wilcox, 1991). The Hartford system is based on extracts of production databases. These extracts are processed via standard software such as Lotus 1-2-3 and Foxbase. Though the system was designed to be usable directly by executives, it is currently used only within the office of institutional research and planning. A somewhat similar system within the Alamo Community College District was reported by Burmeister (1986, 1988).

Wager (1990) described a more elaborate system called AIDA (administrative information decision aid). AIDA uses parameter-driven report generation to access extract copies of the production data bases. Using copies of the data bases provides consistency of results over an academic term and faster reporting (the extract files are organized for efficient batch processing rather than for transactions).

Thierauf's text (1991) contains an extensive list of successful EIS implementations. One of these examples is Traveler's Insurance; which has an EIS in operation on 100 management workstations. Primary users are divided into two groups--the executives (home office vice-presidents, regional vice-presidents, product managers) and the executive direct support team. Each group spends about an hour a day reviewing the revised information. The remainder of Thierauf's examples are shown in table 3.

Table 3:

Thierauf's Examples of Successful Executive Information Systems

American Cyanamid Corporation	Pilot Executive Software color coding of boxes to indicate relative performance
Columbia Gas	CASE approach to design of the EIS Volume Balancing System tracking natural gas loss (e.g., transmission line leakage)
Combustion Engineering, Inc.	CIM project with EIS to monitor financial performance, program management, and manufacturing processes
"Computer Software Company" (anonymous)	first EIS gathered information about external competitive factors sales productivity human resources identification of high turnover rates development of new procedures for recruiting and performance appraisal

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Table 3:
Thierauf's Examples of Successful Executive Information Systems

Liberty Mutual	IFPS software forecasts of financial position of the entire company, such as tax law changes, customer sales, and wage inflation
Los Angeles Department of Power and Light	Power Systems Information System (PSIS) fuels management module to control cost of fuels graphical presentation budgets, capacity, energy purchases, claims analysis, electric rate analysis
Mellon National Bank	Pilot Executive Software's Command Center and Advantage G integration of data from multiple storage locations cooperative processing with DEC VAX and IBM PC mouse driven
Norton Company	Comshare W migration from e-mail to Commander EIS

Table 3:
Thierauf's Examples of Successful Executive Information Systems

Phillips Petroleum	originally on IBM 3081 mainframe, now on IBM 3090 FOCUS 4GL graphics PROFS e-mail, calendar, scheduling menuing system "Gateway PC" by Software Corporation of America simplified access to external data bases 45 executives and 35 support staff
Polaroid Corporation	primarily a homegrown system some components of IFPS
Public Service Electric and Gas	Pilot Executive Software's Command Center and Advantage G financial snapshots 30 executives using the system (5 from their homes) manage corporate cash position use of Pilot's Newstrack feature for integrating external news

Table 3: Thierauf's Examples of Successful Executive Information Systems	
Quaker Oats Company	partially based on Execucom software some homegrown components access to external databases 50 users
Note: Data were obtained from various chapters in Thierauf, R. J. (1991). Executive information systems: a guide for senior management and MIS professionals. New York: Quorum Books. Companies are listed alphabetically in this summary, but appeared in scattered topical sections in Thierauf's text.	

Another book which contains extensive documentation on executive uses of computer technology is Boone's Leadership and the Computer (1991). Boone's examples are summarized in table 4.

Table 4: Boone's Examples of Successful Executive Use of Computers	
Commander leadership style	Richard Pogue, Managing Partner, Jones Day Reavis & Pogue
	Senator Gordon Humphrey (R-NH)

Table 4: Boone's Examples of Successful Executive Use of Computers	
	Mark Edmiston, Chairman and CEO, The Cable Guide
	Ellen Gordon, COO and President, Tootsie Roll Industries
	Sandy Sigologff, CEO, JL Hooker Corporation
Communicator leadership style	Burnell Roberts, Chairman and CEO, Mead Corporation
	Ken McCready, CEO and President, TransAlta Utilities
	Thomas Plaskett, Chairman, CEO, and President, Pan Am
	Thomas Stephens, Chairman, CEO, and President, Manville Corporation
Coach leadership style	Wilbur Gantz, President, Baxter International
	William Esrey, President and CEO, United Telecom and Chairman and CEO, US Sprint

Table 4: Boone's Examples of Successful Executive Use of Computers	
	Richard Crandall, CEO and President, Comshare Inc.
	Debbi Fields, CEO and President, Mrs. Fields Cookies, Inc.
Change-agent leadership style	Ron Compton, President, Aetna Life & Casualty Company
	Michael Jordan, Chairman, Pepsico International
	Robert Wallace, Former President, Phillips 66
Note: from Boone, M. E. (1991). Leadership and the computer. Rocklin, CA: Prima Publishing.	

Based on a survey of 51 businesses, King, Grover, and Hufnagel (1989) emphasized that the advantages of EIS are from the use of information itself, not the use of advanced technology. The authors' study found that the 51 respondents had gained operational benefits by applying information **technology** to areas of customer service and cost competitiveness. Benefits from application of **information** as a strategic resource were most common in the areas of customer service and market segmentation. Improving the quality of information allowed executives to improve service offerings (e.g., position field service personnel in areas of greatest need) and to better target selected market populations.

Most of the case studies cited above are from commercial sites like Mead Corporation, Tootsie Roll Industries, Frito-Lay, and Kraft Foods. In an attempt to determine the level of EIS use within the academic community, this investigator searched ERIC citations from 1982 through 1992 using the subject designators "decision support," "executive support," and "executive information." A tabulation of these citations is shown in table 5. Since several of the citations referenced the same institutions, the actual number of institutions represented in the ERIC citations is less than the number of citations.

Table 5: Tabulation of ERIC Citations, 1982-1992

Subject Designator: DECISION SUPPORT

	'92	'91	'90	'89	'88	'87	'86	'85	'84	'83	'82	TOT
Government		2	1	1	1		4	1	1	1		12
Health Sys.	1	2	1				1	2			9	16
Higher Educ.	2	4	7	10	12	8	19	12	20	15		109
Libraries			1	1		3	2	1	2	2		12
Schools		2	2	1		1	3	1	4		4	18
Misc.	2	1	3	3	4	4		3	3	2	2	27
Total	5	11	15	16	17	16	29	20	30	20	15	194

Subject Designator: EXECUTIVE SUPPORT

	'92	'91	'90	'89	'88	'87	'86	'85	'84	'83	'82	TOT
Government								1				1
Health Sys.												0
Higher Educ.			1	1								2
Libraries												0
Schools												0
Misc.												0
Total	0	0	1	1	0	0	0	1	0	0	0	3

Subject designator: EXECUTIVE INFORMATION

	'92	'91	'90	'89	'88	'87	'86	'85	'84	'83	'82	TOT
Government												0
Health Sys.												0
Higher Educ.	1	1	1	1		1						5
Libraries						1					1	2
Schools												0
Misc.	1		1					1				3
Total	2	1	2	1	0	2	0	1	0	0	1	10

Note: The ERIC database on compact disk was searched using the three subject designators shown in the table. The investigator then reviewed each citation, classifying the organization which was referenced in the article.

In an attempt to further identify the extent of EIS usage in higher education, this investigator obtained data from CAUSE ("the association for managing and using information technology in higher education") based on that organization's annual member survey. Summarizations of survey results are shown in tables 6 and 7. The reader is encouraged to follow Viehland's caution (1990, p. 15) regarding an institution's claim of using an executive information system: "...what one institution labels as an 'electronic factbook' may be considered an EIS at another institution."

Table 6:

CAUSE Member-institution use of Executive Information Systems

(by Carnegie Classification)

Institution category	Use of EIS	N	Percent
All institutions	Currently in use	81	21
	Planning for use	232	60
	No interest	72	19
	Totals	385	100
Comprehensive	Currently in use	29	21
	Planning for use	82	61
	No interest	24	18
	Totals	135	100

Table 6: CAUSE Member-institution use of Executive Information Systems (by Carnegie Classification)			
Institution category	Use of EIS	N	Percent
Liberal arts	Currently in use	22	22
	Planning for use	44	47
	No interest	27	29
	Totals	93	100

Source: CAUSE Institution Database Service custom report, January 11, 1993. Institutions were free to use their own definition of "executive information system."

Table 7: CAUSE Member-institution use of Executive Information Systems (by Institution Size)			
Institution category	Use of EIS	N	Percent
All institutions	Currently in use	81	21
	Planning for use	232	60

Table 7:
CAUSE Member-institution use of Executive Information Systems
(by Institution Size)

Institution category	Use of EIS	N	Percent
	No interest	72	19
	Totals	385	100
Under 2,000 FTE	Currently in use	29	24
	Planning for use	64	53
	No interest	28	23
	Totals	121	100
2,000 - 7,999 FTE	Currently in use	27	21
	Planning for use	79	62
	No interest	22	17
	Totals	128	100
8,000 - 17,999 FTE	Currently in use	14	19
	Planning for use	52	71
	No interest	7	10

Table 7:
CAUSE Member-institution use of Executive Information Systems
(by Institution Size)

Institution category	Use of EIS	N	Percent
	Totals	73	100
18,000 and up FTE	Currently in use	8	19
	Planning for use	30	71
	No interest	4	10
	Totals	42	100

Source: CAUSE Institution Database Service custom report, January 11, 1993. Institutions were free to use their own definition of "executive information system."

Design Methodologies

One major debate which appears in the literature is whether the EIS ought to be designed for a specific executive or made more general for use by any subsequent holder of the executive's position. Boone (1991) described four leadership styles and the differing computing needs of those leadership styles: commander, communicator, coach, culture change agent. Thierauf (1991) recommended designing the EIS for specific executives and their needs. McLaughlin (1989) argued the opposite position, stating that the EIS should provide information support based on structure and situation, rather than specific individuals. Rockart and DeLong (1988) imply a customized approach in specifying their three key development steps (from figure 2-1, p. 27):

1. Obtain the executive's understanding of what is important.
2. Determine the data base(s) required by the executive.
3. Provide data base access to the executive or the executive's staff.

Several authors have described recommended procedures for designing an executive information system. Burmeister (1986) listed nine goals for the design of an EIS within the Alamo Community College District:

1. Simple;
2. Inexpensive, using existing equipment where possible;
3. Doable with current levels of technology;
4. Using existing technology (e.g., packaged communication programs) rather than developing custom applications;
5. Offering measurable and real benefits;
6. Reducing processing load on central computers;

7. Providing effective distribution of information center functions;

8. Developing professional partnership with users; and

9. Standardization to maximize the use of resources.

Burmeister also described various methods of linking corporate data into the EIS, ranging from the brute force method (re-keying data into a personal computer from a mainframe report) to dynamic linking where personal computer programs transparently access mainframe data.

A more formal method for designing an EIS is presented by Boone (1991). Boone lists a five step approach (figure 7, p. 285):

1. Define the business goal.

2. Define the business strategies.

3. For each business strategy, define the necessary leadership strategies.

4. For each leadership strategy, select one or more information success factors.

5. For each information success factor, select one or more tools.

Of particular note is the use of information success factors, rather than the more traditional critical success factors. Information success factors would include such items as staying well informed, thinking and making decisions, leveraging time, designing organizations and cultures, communicating with people, and coaching people.

Leslie et al. (1988) presented design goals for the Maricopa pilot EIS project. This project used the FOCUS fourth-generation language to provide data access from personal computers. FOCUS was selected because it provided access to RMS files on Digital Equipment mainframes, and because it can access other databases. (The Maricopa Community College District used software from Information Associates, so the district wanted a tool which would still be usable in the event Information Associates changed its underlying database.) The personal computers at Maricopa were configured to run standard productivity software (dBASE III+, Lotus 1-2-3, and Harvard Graphics). A delphi approach was used to gather suggestions from administrators regarding the content of the executive information system. Several EISs, such as the one at North Carolina State University, stress the application of standard software packages (Carson, Howard, Hunter, and Kemerait, 1990). The NCSU system required the use of "cross-over" tables to translate administrative definitions for data to their academic counterparts.

EISs are not always complete at installation time. Carson et al. emphasized the evolutionary development of EISs, with a primary emphasis on data integrity. Other authors, like Rockart and DeLong (1988) have also emphasized the evolutionary nature of EIS development.

Not all features of the EIS have to be exotic. Software which is already in use within the corporation may fit nicely into the EIS design. For example, most of the executives interviewed by Mary Boone used electronic mail as a major component of their computing activity (Boone, 1991). Other than electronic mail, the word processors and spreadsheets were the most common application programs used by the executives. Table 8 contains Boone's thorough list of tools used by the executives.

Table 8: Boone's Technology Tools Used by Executive Interviewees
electronic mail
voice messaging systems
outline editors
word processing
graphics packages
spreadsheets
audioconferencing
videoconferencing
computer conferencing
videotape
cellular phones
calendars
commitment tracking systems
expert systems
internal databases

Table 8: Boone's Technology Tools Used by Executive Interviewees
external databases
personal databases
group databases
models
project management systems
reminder systems
spell checkers
facsimile
Note: Adapted from figure 4, p. 238, in Boone, M. E. (1991). Leadership and the computer. Rocklin, CA: Prima Publishing.

Rockart and DeLong (1988) also provided a useful classification of typical EIS tools, as shown in table 9.

Table 9: Rockart and DeLong's Tool Classification		
Communications-based applications	Electronic mail	Influences on the use of e-mail include: being a role model, personal style, nature of the tasks, and capability of the e-mail system.
		E-mail can be used for monitoring, passing information, coordination, and document review.
		E-mail provides logistical support, reduces information float and telephone tag, increases the communicator's visibility within the organization, has the potential for reducing the organizational hierarchy, and provides spontaneous communication of ideas.

		Some e-mail problems include the intrusion of work into home life, the proliferation of junk mail, and the decline in personal contact.
	Access to news	
	Word processing	
Data analysis tools	Spreadsheets	
Organizing tools	Automated filing	
	Calendaring	
Note: Adapted from chapter 4 of Rockart, J. F. and DeLong, D. W. (1988). Executive support systems: the emergence of top management computer use. Homewood, IL: Dow Jones-Irwin.		

In a study conducted at the University of Georgia (Watson, et al., March, 1991), developers of executive information systems reported on the features found in their systems. 88% of the respondents included access to current-status data (financial results, sales performance). Other leading features were electronic mail (65%), access to external databases (57%), and access to external news sources (56%).

Implementation Problems

Implementation of an EIS is not without its difficulties, as illustrated by Professor Loveman of the Harvard University Graduate School of Business Administration:

> Despite years of impressive technological improvements and investment, there is not yet any evidence that information technology is improving productivity or other measures of business performance on a large scale...The fundamental blame rests with organizations. Information technology holds great potential, but companies have failed to provide structures and processes that facilitate the use of information technology in ways that create significant net value. (Loveman, November 25, 1991)

How can substantial investments in EIS produce so little return? Boone (1991) found in her research that executives viewed computers as administrative processors rather than management aids; that the use of computers in executive support requires learning time, effort, and creativity;

and that the benefits of computing are not obvious to the executive. Often, the EIS is developed to show off some new technological "gizmo" or to satisfy the needs of one particular executive rather than to enhance overall corporate management. Watkins (Spring, 1991) suggested that problems can be avoided if the development focuses on executive needs, rather than technological tools and innovation. Vogel and Wetherbe (Summer, 1991) and Friend and Norment (Fall, 1991) encouraged EIS development to be oriented towards the total business entity, rather than designed for particular individuals or organizational structures.

Rockart and DeLong (1988) reported from their research that ESSs often fail because they do not fit management needs and do not provide the types of information executives need most. One common pitfall is the reliance on quantifiable data to the exclusion of textual data. Other problems identified by Rockart and DeLong include imprecise definition of requirements (by the executives requesting the system), failure of the operational sponsor, the lack of flexibility to meet changing business needs, the intensive support requirements, and the difficulty in documenting the value of providing top management with electronic access to corporate data.

Development of an EIS is not the same as, and not as easy as, the development of ordinary transaction-based systems (Friend and Norment, Fall, 1991). Eric Clemons compared the development of an EIS with traditional data processing systems:

Developing a strategic application--intended to make a company more flexible, more responsive to customer needs, or more able to adapt to rapidly changing conditions in the competitive environment--is fundamentally different from investments undertaken to automate the back office to reduce expenses or increase capacity. (Clemons, January, 1991, p. 23)

Clemons cited two major problems in developing strategic information systems: difficulty in assigning monetary value to benefits and the long lead times for development of the EIS. Mintzberg (1983) identified failures in earlier information systems due to inappropriate aggregation of information and simple lack of use (of the information system). Mintzberg's comments imply a need to recognize the executive's reliance on oral communication and soft information such as gossip and speculation.

Another potential problem in the development of EISs is the use of multiple data sources by multiple executives. Data from differing sources might not agree. Conversely, different people viewing the same data may draw different conclusions. The multiple-sources and multiple-view problems are not unique to EISs, but may be aggravated within the EIS. Since the data are obtained rapidly, there is little time for consistency checking. Also, high-level generalizations are being presented to executives with widely-varying backgrounds and decision-making styles.

Emery (1987) offered five reasons why an effective information system is so difficult to implement:

1. Conceptual difficulty (development is genuinely difficult)
2. Technological gaps ("The necessary technology usually exists, but lashing the parts together is not easy." [p. 13]. There are no standards for connecting the pieces.)
3. Rapid rate of technological change
4. Lack of vision by technical personnel
5. Lack of vision by general management

Emery also cited the need to do a thorough business analysis so as to build effective data models. This analysis is often difficult and time consuming, but worth the effort. Emery's thoughts on the difficulty of constructing an EIS were echoed by King and Kraemer (1989): Strategic systems are difficult to build because systems people have little practical experience building them. Strategic systems are more costly to build than transaction systems, and are more difficult to evaluate upon completion.

Frank and Lesher (Fall, 1991) reported that few EISs are in operation because of three major problems:

1. Missing databases and pipelines;
2. Inability to gain access to executives during the EIS development; and
3. Too broad of a scope with inadequate funding.

An example of the "broad scope" EIS is the $10 million project being undertaken by Britain's National Health Service (Hunter, July 1, 1991). The National Health Service has deliberately tried to subdivide the project to minimize the risk of failure. One danger in the design of an EIS is the temptation to provide too much information too rapidly (Ryan, May, 1991; Vogel and Wetherbe, Summer, 1991).

Info Innov included an excellent explanation of a major problem which arises in developing an EIS:

> Once a traditional application has been developed, changes are rare. An EIS is often developed to handle a business problem. Once this problem is under control (possibly due to the EIS), the focus and preoccupations of the executive will shift to a new problem and he will expect his EIS to do the same! If not, executives get the information anyway and the EIS becomes overdated. (Info Innov, 1991, p. 11)

Info Innov's solution to this problem is to design an EIS which can be adapted by the executive, without support from the information systems department.

One author (Young, 1983) reported a potential problem with EIS design which may not be obvious: right-brain support is lacking in most DSSs. Table 10 highlights Young's thoughts on the left-brain, right-brain problem with EISs.

Table 10:

Young's Left vs Right-brained DSS Functional Characteristics

	"Left-Brained"	"Right-Brained"
Level of DSS Function		
Level 1 Information Retrieval	Deals mainly with numeric databases.	Deals with alphabetic (words, phrases, statements) databases
Level 2 Filtering and pattern recognition	Numerical summarizing, graphing, statistical data reduction, analysis of covariance, time series analysis	Qualitative similarity analysis, taxonomy, formulation of non-numeric concepts and relationships, content analysis
Level 3 Extrapolation, inference, and logical comparison	Simple numerical computation, numerical comparison and ranking	Combinatorial generation, restructuring, and ordering of qualitative elements

Table 10: Young's Left vs Right-brained DSS Functional Characteristics		
Level 4 Modeling	Heuristics, optimization and simulation dealing with quantitative outcomes	Aiding scenario building, simulation, and evaluation of qualitative outcomes
Model Features		
Nature of objectives	Pre-defined variables, numerically measurable objectives	Often not known at the outset
Michael Jordan, Chairman, Pepsico International Nature of constraints	Relatively "closed," allows for variable numerical parameters of pre-defined dimensions	Qualitatively described, relatively open, categorical parameters of dynamically changing dimensions

Table 10:
Young's Left vs Right-brained DSS Functional Characteristics

Proposed DSS Modules		Information Retrieval: Fetch references Fetch experiences Fetch knowledge Fetch wisdom
		Filtering and pattern recognition: Dimensionalize Classify Analogize
		Extrapolation, inference, and logical comparison: Combine Compare Generalize

Table 10: Young's Left vs Right-brained DSS Functional Characteristics		
		Modeling: Build scenario Build policy
Notes: Adapted from exhibit 1, p. 49, of Young, L. F. (1983). Computer support for creative decision-making: right-brained DSS. In Sol, H. G., ed. (1983). <u>Processes and tools for decision support. Proceedings of the Joint IFIP WG 8.3/IIASA Working Conference on Processes and Tools for Decision Support</u>. Amsterdam: North-Holland Publishing. Levels are from a work by Keen and Morton: Keen, P. G. W. and Morton, M. S. S. (1978). <u>Decision support systems: an organizational perspective</u>. Addison-Wesley.		

Another type of implementation problem relates to non-developmental issues. As presented by Burmeister (1986), there are potential usage and security problems with implementing an EIS:

> Overly creative users will put data to uses for which it was never intended. There are several categories of data usage that signal potential problems including multiple purposes, mixed time frames, big

categories/small analysis, misunderstood definitions, and institutional vs. private data. (Burmeister, 1986, p. 4)

Users of the EIS may not fully comprehend the meaning of the information they are manipulating, nor the importance of maintaining confidentiality of that information.

Some of the EIS implementation problems are caused by or aggravated by human resistance: "Information is power, and changes in the information flow almost always create countervailing efforts to maintain the status quo" (Rockart and DeLong, 1988, p. 212). This resistance may be from staff personnel who fear loss of control over the information used by executives; by subordinate line managers who fear giving top management too much visibility into their operations; or by employees with legitimate reasons to resist ("The business is doing fine, why change things?" "This system represents all costs and no benefits for my group." "Even if we send up the data they want, our executives won't have the context to understand it.").

Not everyone is excited about the development of EISs. Barbara Garson (1988) cited the dehumanizing effects of computerization, including attempts to automate managers and managerial processes. She was particularly concerned about the mechanization of decision making and the decreased emphasis on interpersonal relationships. Thyfault (July 15, 1991) reported on a conversation with Karen Berg of Comm-Core, Inc., where Berg observed that EISs and their use of e-mail make "an already emotionally alienated society even more alienated" (p. 42). Whether or not an EIS contributes substantially to this dehumanization problem, the EIS developer needs to be aware of the personal impacts of the systems being implemented.

Commercial Executive Information Systems

If an executive information system can truly be of benefit in management, there ought to be several commercially-available products available. A brief survey of the literature shows that not only are products available, but the market is projected to grow dramatically in the next few years. WorkGroup Technologies predicts the EIS market will grow from $1 billion in 1990 to $1.5 billion in 1993 (Avakian, November 12, 1990). International Data Corporation predicts a more dramatic growth rate, though its base figures are lower: sales of $79 million in 1990 rising to $230 million in 1995 (Pinella, May 1, 1991). The large difference in 1990 sales figures between the two organizations may be a reflection of differing definitions for what constitutes an executive information system. One factor driving this market growth is the availability of powerful microcomputers. (Ironically, one study cited this as a problem--executives would need more skill to run the microcomputer EIS than the corresponding mainframe version [Hildebrand, December 24, 1990]!)

Watson et al. (March, 1991) reported that 76% of their survey respondents had developed their EIS using vendor-supplied software (with 2/3 of those respondents supplementing the vendor-supplied software with in-house development). 24% of the respondents were using Pilot's Command Center and 18% were using Comshare's Commander. According to Watson et al., "These results are not surprising; Pilot and Comshare are generally recognized to be the two leading vendors of EIS software" (p. 24).

Systems Analysis and Design

Analysis and Design Methodologies

> "The basic goal of software engineering is to produce high quality software at low cost. The two basic driving factors are quality and cost." (Jalote, 1991, p. 4)

Obtaining high quality and low cost for a software project are certainly desirable, but may not be obtainable without a formal methodology for developing the software. Strategies for software development are addressed in the study of systems analysis and design, as the following material will illustrate. Two parts of the analysis and design process (requirements analysis and design evaluation) will be further emphasized in separate sections dedicated to those respective topics.

Several authors divide the design process into phases (Jalote, 1991; Tonies, 1979; Burch, 1992; Adams, Powers, and Mills, 1985; Enos and Van Tilberg, 1979; DeMarco 1979). Jalote uses four phases: requirements analysis, design, coding, and testing. Jalote further divides the design phase into a system design (top-level design, module specifications, naming of the components) and detailed design (internal logic, data structures, functioning of the components). The actual design can be done using a waterfall model (one phase is declared complete prior to commencing the next phase), iterative enhancement, prototyping, or using a spiral model. For the prototyping method, Jalote recommends building a throwaway prototype so as to better understand the user requirements. In the spiral model, the systems design process is repeated several times with each iteration addressing a larger piece of the problem being solved.

Enos and Van Tilberg use three design phases:

1. a requirements definition phase ("formalizing the statement of user's requirements", p. 65);
2. a systems design phase ("translating requirements into a system design", p. 65); and
3. a software design phase ("developing the overall architecture of the software", p. 66)

Boehm (1984) emphasized the importance of the transition between phases in the waterfall development model. Each phase must be culminated by a verification and validation (V+V) activity. This effort at measuring milestones builds some natural resistance to change and therefore encourages a more stable product. Boehm's phases include:

1. system feasibility;
2. plans and requirements;
3. product design;
4. detailed design;
5. code and unit test;
6. implementation;
7. operations and maintenance; and
8. phaseout.

Boehm also provides two enhancements to the waterfall model: incremental development and advancemanship. With incremental development, functionality is added in "chunks" so that there is a functioning deliverable at each phase. These intermediate developments are easier to test than intermediate products produced in the usual top-down design. The incremental development also makes the incorporation of user suggestions for change easier. Boehm's advancemanship concept is based on the concept of load leveling: as much work is done in advance as possible. Anticipatory documentation is prepared, defining detailed objectives and plans for future software development activities and producing early versions of user documentation. Also, "scaffolding" work is done in advance: preparation of stubs, drivers, small datasets, and test generators. Advancemanship reduces overall costs by reducing entropy in the software life cycle and it tends to front-load manpower requirements.

C. C. Tonies (1979) treats software projects in the context of procurement mechanics. Every software project is undertaken by some sort of a "buy/sell" agreement: The seller learns of the buyer's need. The seller describes a sales offering to the buyer (the proposal). The buyer expresses interest but may suggest changes in the seller's offering. The seller counters with an adjusted offering. The buyer counters the seller's latest offering, if necessary. The iteration of offer and counter-offer is repeated until a real or apparent agreement is reached. Once an agreement is reached, a formal statement of work and price is produced and signed by both parties. One advantage of using Tonies' analogy is the emphasis on mutual understanding which must occur prior to starting a project.

With the advent of powerful microcomputers and software tools, prototyping has become a more common component of systems analysis and design. Harker (1991) reports that prototyping seems to encourage user feedback, in contrast to the waterfall model which makes changes difficult. Whether or not prototyping actually improves design efforts has not yet been clearly demonstrated, but users feel better about the results--the subsequent "buy in" to the project may be sufficient justification for prototyping. Prototyping does require resources which may not be present in the development organization (skilled personnel, development machines, specialized software). The CASE tools in use may not support prototyping. Harker found that the timing of the prototype might affect its success; prototypes demonstrated late in the day were less successful than those demonstrated early in the day.

The actual systems analysis and design is done using a combination of three common decomposition methods: abstraction, partitioning, and projection (Yeh et al., 1984). An abstraction suppresses details of objects and events and concentrates on essential properties. Partitioning represents and entity or event as the sum of its parts. Projection involves viewing and understanding the system from different vantage points--different types of users, the designer, the manager, and the worker.

One of the early proponents of structured analysis and design (DeMarco, 1979) has emphasized the defensive nature of analysis:

> "The overriding concern of analysis is not to achieve success, but to avoid failure...Computer system analysis is like child-rearing; you can do grievous damage, but you cannot ensure success" (p. 9).

Major problems which occur during analysis include:

1. communication;
2. changing computer system requirements;

3. lack of tools;

4. problems of the target document (excessively redundant, wordy, physical, tedious to read, unbearable to write);

5. work allocation; and

6. politics.

When considering different methods for performing systems analysis and design, it would be wise to consider advice from two major research centers. Researchers at the University of Georgia (Watson et al., March, 1991) found that 92% of the respondents to a survey on EIS development used an iterative, prototyping methodology. The other 8% used a standard systems-development life cycle approach. J. C. Wetherbe (1991) lists four fundamental mistakes in determining what information is needed by executives. One of those four mistakes is not allowing trial-and-error during the detailed design process. Wetherbe's recommendation for correcting this mistake is to rely heavily on prototyping. (Wetherbe discusses these other fundamental mistakes: viewing systems as functional instead of cross-functional; interviewing managers individually rather than jointly; and asking the wrong questions during the interview.)

The purpose of requirements analysis is to "understand the problem which the software is to solve" (Jalote, 1991, p. 7). It would be foolish to solve a problem without truly understanding what the problem is. Requirements analysis includes two major activities: problem understanding (analysis) and requirement specification. The problem understanding phase includes a study of the existing system (data entities, major centers of action, purposes of actions, inputs and outputs) and the proposed new system. Understanding the new system may be difficult, since the system itself is only loosely defined at this point in the analysis. Also, the problem is more complex since a newly automated system offers possibilities that did not exist in the old system, and can affect the way in which the system operates. Consequently, even the client may not really know the needs of the system. The analyst has to make the client aware of the new possibilities, thus helping both client and analyst determine the requirements for the new system. (Jalote, 1991, p. 8)

Jalote's second activity--requirement specification--includes the selection of language(s) to be used, functional requirements, performance requirements, formats of input and output, design constraints (political, economic, environmental, security), and even the development of a preliminary user manual. Jalote emphasized the importance of requirements validation through the use of a requirement review. The requirement review is done in a group meeting where analysts and representatives of the client review the requirements specification. The deliverable from Jalote's two activities is a software-requirements specification (SRS) document. The SRS must address:

1. functionality

   outputs to be produced

   relationships between input and output

   validity checks

   parameters

   equations, algorithms

   behavior in abnormal situations

2. performance

   capacity (number of terminals, file sizes, disk space)

   dynamic requirements

   response time, throughput

3. design constraints

   standards compliance

   hardware limitations

   reliability and fault tolerance

   security

4. external interfaces

   screen design

   user manuals

Tonies (1979) presents a more detailed list of deliverables:

- scope description (what does this plan cover?)
- technical description of the system
- configuration items and deliverables
- organization plan
- methodology
- configuration management plan
- documentation plan
- data management plan
- resources management plan
- integrated test plan
- training plan
- security plan
- schedule

The Tonies article also presents a caution on requirements definition using the entropy concept from natural science. Some energy will be dissipated during the project; the goal of a good design is to minimize that dissipation. A summary of Tonies' entropy causes is presented in table 11.

Table 11: Tonies' Common Causes of Entropy	
Undersized task	Schedule too short, budget too small, contingencies and inefficiencies not considered
Project resources not matched to task	Types and amounts of talent, roles and responsibilities, scheduling and phasing of activities
Poor requirements baselines	Fuzzy understanding of requirements, requirements documents incomplete, requirements changes not tightly controlled, incomplete or untimely distribution of change information, lack of appreciation for impact of requirements changes
Weak design and programming methods	
Poor test discipline	
Spotty configuration controls	

Table 11: Tonies' Common Causes of Entropy	
Poor communication	Poor communication between user and customer, between customer and project, between design groups
Ineffective project management controls	
Note: Adapted from table 2-2, p. 57, of Tonies, C. C. (1979). Project management fundamentals. In Jensen, R. W. and Tonies, C. C. (eds.). Software engineering. Englewood Cliffs, NJ: Prentice-Hall.	

Yeh et al. (1984) have highlighted the importance of a good requirements document, citing studies where up to 95% of the software had to be re-written due to a mismatch with user requirements. Having a poor requirements document (or none at all) may result in a lack of management control, an inability to use top-down design or other software engineering techniques, user hostility, and lawsuits. Yeh et al. recommend developing the requirements document by working from the outside in--starting with the environment and then determine functioning of the internal system. The requirements can be specified in the form of a conceptual model, where the activities and states of the target system are reflections of entities and events in the real environment. The resulting requirements document must be understandable, modifiable, precise, complete, unambiguous, internally consistent, and minimal. Yeh et al. refer to a category of requirements as nonfunctional--nonfunctional in the sense that they are not a logical necessity in the process being accomplished. These nonfunctional requirements include:

1. target system constraints (performance, resource utilization, accuracy, reliability, security, physical size)
2. system development, evolution, and maintenance (abrupt installation, phased installation, scale of effort, quality control standards, priority, changeability, maintenance)
3. economic context of system development (cost tradeoffs, cost of iterative system development, cost of each instance of target system
4. human factors (communications, user interface)

Enos and Van Tilberg (1979) address other topics which should be covered in the requirements analysis: human factors engineering, work-study analysis, semantic analysis, and Yourdon's structured analysis. The Enos and Van Tilberg article also identifies specific tasks to be accomplished during the requirements analysis:

1. structuring (identifying the nature of the problem relative to its environment);

2. human factors considerations (physical response times, level of mentality, level of training, orientation or type of training, response time, error handling, work-study analysis);
3. validating operational concepts through scenarios, simulation, and modeling; and
4. sizing the user's problem based on desired attributes of the system.

The presentation of user requirements should include a description of the environment in which the system is to operate, other systems to be interfaced, people who will work with the system, functions to be performed, data that will enter the system, and desired outputs.

The actual sources of information for the requirements analysis are varied. Ghosh and Lum (1984) indicate that the acquisition of the information required is intrinsically labor intensive and imprecise. Techniques used to gather the information include formal interviews, informal interviews, reading documentation, and--in extreme situations--reading software source code. Interview candidates include potential users of the software, managers, and executives of the firm.

If the development of software was a cost free process, then a software design could be evaluated on the basis of the finished software. However, software development does cost time and money--so it is wise to evaluate the design prior to implementation. Enos and Van Tilberg (1979) list several characteristics desired in the final software product and the requisite qualities of the design. The final product must be reliable, testable, maintainable, efficient, understandable, and adaptable. To help ensure quality of the final product, the software design should be reviewed for:

1. necessity (absence of extra features)
2. completeness (all modules identified, all interfaces specified)
3. consistency
4. traceability (forward ability to connect user requirements with design specifications)
5. visibility (backward ability to trace design elements back to trade-off decisions made)
6. feasibility

Enos and Van Tilberg organize the software review into two categories: verification and validation. Verification ensures conformance of the design with the stated desirable design attributes. Validation ensures conformance with the end-user's requirements. Thus there are two types of tests to be applied: Does the design meet the specifications of the requirements analysis? Does the design meet the expectations of the user? (In a sense, this dual-pronged test also validates the requirements analysis.)

Jalote (1991) describes five methods for evaluating a software design:

1. reading (have a third party read the design document);
2. constructing scenarios (describe different business situations and the anticipated system behavior in those situations);
3. requirement reviews (review committee studies the design);
4. automated cross-referencing (e.g., using a CASE tool); and
5. prototyping.

Jalote indicates that the requirements review is the most common evaluation method. Typically, the review committee includes the author of the requirements document, a client representative, and a member of the design team. Errors which the committee seeks to find include errors of incompleteness, inconsistency, translation of actual requirements, and infeasible requirements. While prototyping is often viewed as a development methodology, it can also be used to validate a design prior to beginning the actual software development.

Some evaluation strategies focus on internal software structure. Ghosh and Lum (1984) suggest evaluating a software design on the basis of completeness, minimality in storage, correctness (constraint enforcement in data content and corporate rules), independence, stability, and extendibility.

Adams et al. emphasize the need to evaluate the cohesion and coupling levels in the design. One typical design goal is to utilize modularity to maximize cohesion and minimize coupling.

In a text which focuses on removal of software defects, Dunn (1984) presents an entire chapter on the review of design requirements. Dunn's common types of requirements and design defects are shown in table 12.

Table 12: Dunn's List of Common Requirements and Design Defects

Requirements defects	failure to reflect a more abstract specification
	omitted functions
	higher-order requirement improperly translated
	software requirements incompatible with the operational environment
	incomplete requirements
	infeasible requirements
	conflicting requirements
	incorrect specification of (computer) resources
	software specification incompatible with other systems
	specifications wrong or missing external constants

Table 12: Dunn's List of Common Requirements and Design Defects	
	incorrect or missing description of the initial system state incorrect error allocation incorrect input or output descriptions
Design defects	omission or misinterpretation of specified requirements inability to operate on the full range of data infinite loops incompatibility with hardware resources incompatibility with software resources
	unacceptable processor load incorrect analysis of computational error incompatible data representations nonexisting or inadequate error traps failure to handle exceptions weak modularity

Table 12: Dunn's List of Common Requirements and Design Defects	
	inexpansible control structure control structure ignores processing priorities detailed design does not conform to top level design failure to conform to standards

Note: Adapted from pp. 70-75 of Dunn, R. H. (1984). Software defect removal. New York: McGraw-Hill Book Company.

Dunn (1984) divides the review process into three phases: preparation, the meeting, and follow-up. Preparation includes scheduling the meeting, determining participants, and distributing material to be reviewed. Participants should include:

1. those who prepared the earlier work (to the one being reviewed);
2. those who performed the subject work;
3. those responsible for the next phase;
4. a third party (e.g. software engineers), not involved in above groups but knowledgeable about the situation; and
5. representation from the documentation group.

The actual review meeting normally lasts no more than two hours. The focus should be on identifying problems rather than solving them: "Six persons are not likely to solve problems faster than one, but the solution will be six times as expensive" (p. 93). A common approach is to use checklists, like those reproduced in table 13. The review meeting should be conducted with sensitivity to the authors of the work, but yet be reasonably aggressive in identifying problems. Deliverables from the meeting should include a prioritized list of action items. Followup includes the distribution of minutes from the meeting and the completion of action items.

Table 13: Abbreviated Dunn's Checklist for Review Meetings
Requirements Reviews
Is the output from the requirements language processor complete and fault-free?
Are all hardware resources (available memory, and so on) defined?
Have applicable response times been defined?
Do all data interfaces identify sources and sinks, formats, ranges, and scales?
Have external software linkages been defined?

Table 13: Abbreviated Dunn's Checklist for Review Meetings
Have all functions required by the user or the systems design been accounted for?
Have algorithms that are intrinsic to the functional requirements been described?
For each function, can acceptance criteria be inferred?
Are all significant accuracies specified?
Is the specification capable of being comprehended by those who will implement it in the design phase?
Are the requirements overspecified? That is, will the designers be overly constrained on unimportant matters?
Have any identifiable plans for later expansion been provided?
Has the experience level of operational personnel been defined?
Does the requirements documentation include descriptions of aspects of the overall systems operation the designers should know about?
Are all assumptions, limitations, and constraints identified? Are they all acceptable?

Table 13: Abbreviated Dunn's Checklist for Review Meetings
Are all planning documents required by local standards complete and feasible?
Top-level Design Reviews
Is the output from the design language processor complete (with respect to top-level design standards) and fault free?
Is the architecture decomposed to the point at which the next phase of design can be started?
Is the modular decomposition consistent with local standards for modular strength and coupling?
Is each aspect of the requirements specification addressed?
Are there analyses to demonstrate that required throughput, response times, and accuracies will be achieved? Are they sufficiently fine-grained to be credible?
Have file maintenance procedures been addressed?
How are processing priorities handled?
Are operator interface considerations addressed?

Table 13: Abbreviated Dunn's Checklist for Review Meetings
Are hardware and software test resources identified? Is further action required to obtain them when needed?
Does pretest documentation (including integration plans) conform to standards?
Are any unique programming conventions, tools, or techniques anticipated that are not covered by the computer program development plan?
Are all assumptions explicit and acceptable?
Are there any limitations and constraints beyond those found in the requirements documentation?
Note: Adapted from pp. 95-96 of Dunn, R. H. (1984). Software defect removal. New York: McGraw-Hill Book Company. Omitted items related to real-time process control systems.

Summary

This investigator has attempted to present an appropriate review of literature in the field of executive information systems. The presentation has included an historical section tracing the development of executive information systems, while highlighting functional features which could be incorporated into a definition of executive information systems. The chapter has also included a brief summary of case studies, design methodologies, and implementation problems. The chapter concluded with a more general overview of systems analysis and design techniques.

Chapter 3 Design, Procedures, and Methodology

> There are a variety of reasons why executives are not using computers in more interesting and significant ways. The most important one is that executives simply don't know what computers can do for them personally. (Boone, 1991, p. xiii)

Current Environment

As noted in chapter 1, there is a lack of information systems support for executives in higher education. Cedarville College is not atypical in this regard. The college has invested heavily in recent years on computer hardware and software to perform the routine transactions involved in the business of higher education. However, the lack of information systems support for executives has hampered the management impact of the college administration--hence the need for the design project:

Design an effective, economical
executive information system
for Cedarville College.

Later sections in this chapter identify a systems-analysis philosophy, a methodology for performing a requirements analysis, a design process, and a procedure for evaluating the resulting design. First, however, it is necessary to describe the college's current information systems environment. The current environment is foundational to the EIS which is to be implemented.

Cedarville College is a comprehensive college founded in 1887, currently enrolling 2172 students and employing 120 full-time faculty members. In keeping with the liberal arts concept, the curriculum centers on a basic program of required general studies, including Biblical education, communications, humanities, physical education, science and mathematics, and social science. The college offers 32 majors and 14 special programs. Recent additions to the program include a Bachelor of Science in Nursing (NLN accredited), electrical engineering, mechanical engineering, international studies, and an honors emphasis. The largest majors are business administration, education, nursing, science, and engineering. The college administrative structure is shown in table 14.

Table 14: Cedarville College Administrative Structure

Board of Trustees	
President	

Table 14: Cedarville College Administrative Structure

Academic Vice-President	Academic Departments (12) Academic Progress Academic Records Admissions Athletics Computer Services Honors Institutional Research Library Services Summer School
Vice-President for Business	Bookstore Controller Food Service Physical Plant Post Office Public Safety Staff Personnel

Table 14: Cedarville College Administrative Structure	
Vice-President for Development	Alumni Relations Annual Giving Church Relations Donor Relations Planned Giving Public Relations Radio (WCDR)
Vice-President for Student Services	Campus Activities Career Planning and Placement Counseling Services Deans of Student Life Financial Aid Health Services
Vice-President for Christian Ministries	Community, Puppet, and Lifeline Ministries Missionary Internship Service (MIS) Music Gospel Teams Swordbearers

The Computer Services department is responsible for providing both academic and administrative computing support. Current administrative facilities include a Prime 5340 minicomputer with 96 terminal ports and approximately two gigabytes of storage. Academic computing is based on a campus-wide microcomputer network using Novell Netware. The network is being installed in phases over a three-year period. Table 15 illustrates the approximate overall distribution of microcomputers on campus for the fall of 1993.

Table 15:

Cedarville College Microcomputer Distribution (Fall, 1993)

Student-accessible Microcomputers	
College Center Laboratory	22
Business Administration Laboratory	25
Engineering/Nursing/Science Public Laboratory	32
Engineering CAD Laboratory	27
Library	18
Residence Hall Rooms (75% of student rooms)	677
Residence Hall Lounges	5
Other departmental laboratories	60
Sub-total	866

Table 15: Cedarville College Microcomputer Distribution (Fall, 1993)	
Other Microcomputers	
Faculty offices and homes	125
Other offices	80
Sub-total	205
Grand total	1061

It is particularly relevant to note the current availability of microcomputers to the college administration. The president's office has one computer, located on the secretary's desk. Each of the five vice-presidents (academic affairs, business, Christian ministries, student services, and development) has computers for their own personal use. All of the vice-presidential secretaries have computers at their desks. Approximately three-fourths of the managers reporting to vice-presidents use computers. The only computer networks which are used exclusively for administrative functions is in the physical plant department (8 nodes) and in one of the campus radio stations (12 nodes).

Software support within the college is heavily oriented towards transaction processing. The college has been using the Colleague administrative software package from Datatel, Inc. since 1987. The in-house administrative computer staff (director, assistant director, programmer, and operator) have customized about one-fifth of the 2,500 programs in the Colleague package and have written another 500 programs in areas not covered by the packaged software. A longitudinal student database has been established for use in institutional research, but the database has received relatively little use due to a change in research personnel. Some of the internal programming effort has been directed at producing reports for management use by administrative personnel, but no attempt has been made to provide direct support for the president, vice-presidents, or academic chairpersons.

The availability of computing resources such as those described above is certainly important in regards to establishing an executive information system, but these tools must be configured to support the particular management style and formal structure of the organization. Cedarville College is owned and controlled by a self-perpetuating board of trustees. The trustees work with the president to determine organizational mission, strategic objectives, and operating principles for the institution. Day-to-day operation of the college is managed by the five vice-presidents. The president and the vice-presidents provide general direction to their subordinates, but delegate the development of specific operational procedures.

The work of the trustees, president, and vice-presidents is strongly influenced by the annual strategic planning process. The strategic planning is coordinated by the director of planning and a steering committee. Each manager submits a strategic plan annually, based on data provided by the steering committee (external environment, internal environment, planning premises) and after receiving input from each employee within the manager's department. The strategic plan is evaluated each summer by the president and the vice-presidents. The resulting priorities guide operational decisions, budgeting, and approval of major projects during the following year.

The Cedarville College environment is, therefore, one in which employee participation in management is encouraged and where administrators make use of both internal and external data. Though documents might be developed in some offices using word processors, the acquisition of information, communication of the information, and the subsequent decision making is done through manual methods.

The installation of a campus-wide computer network provides an ideal environment for changes in information delivery. As Rockart and Short (1991) have written, a networked organization obtains several characteristics which facilitate change:

1. shared goals;
2. shared expertise;
3. shared work;

4. shared decision making;

5. shared timing and issue prioritization;

6. shared responsibility, accountability, and trust; and

7. shared recognition and reward.

There are many computer and communications facilities within the College. There is a willingness to change procedures to use the new technology. What is lacking is a good design for the executive use of these new capabilities.

Systems Analysis Philosophy

Systems analysis and design projects are not completed in a vacuum--the analysis and design are influenced by the corporate culture and the design philosophy of the analysts. The following assumptions were used as a basis for designing an executive information system for Cedarville College. These assumptions are based on the literature review presented in chapter 2.

The basic problem being addressed is the design of an effective, economical, executive information system for Cedarville College. To be effective, the system must produce demonstrable benefits to the planning process and to the routine management of the institution. To be economical, the system must not require substantial outlays for new hardware or software.

To be an executive information system, the system must be oriented towards--and used by--administrators at the college; and must be more than a method of presenting mere facts. To be designed for Cedarville College, the system must address the unique needs of the small, liberal-arts college with a Christian orientation.

Effective

Two primary effectiveness goals must be considered when creating the EIS design: improving the planning process and facilitating management (Boone, 1991). The planning process relies heavily on planning premises which are developed using external scan data on demographics, economic trends, and governmental policies; and using internal data on mission, objectives, financial performance, student body composition, and previous planning objectives. The EIS design must, therefore, provide easy access to this foundational data (Glover, Fall, 1989). A good design would also assist the planning committee in the actual development of the planning premises.

The second effectiveness goal is the facilitation of management, particularly management of personnel resources. In a collegiate organization with 120 faculty members and 200 full-time staff members, there is a considerable amount of paperwork which moves through the organization. An effective EIS design should optimize the use of each manager's time and minimize the flow of paper (moving paper tends to be non-productive). Particularly within the academic division, the organizational structure of the college is relatively flat. An effective EIS will help managers cope with the wide span of control which results from the flat organizational structure.

Economical

An effective EIS design is of little practical significance if the cost of the EIS is beyond the means of the organization, so a second major design goal to be considered is that of economy. Economy can be achieved be maximizing the use of existing resources (personal computers, cabling, software, people) and minimizing the acquisition of new resources. If new resources are required, their cost can be kept as low as possible by using standard hardware and software (as opposed to developing customized packages or buying single-function software). Using standard microcomputer productivity tools like spreadsheets and database systems is generally less costly than acquiring commercial EIS systems and running on mainframe-class computers. However, acquiring a commercial EIS package may be less expensive than performing internal software development.

As a means of determining the availability of commercial EIS packages, this investigator tabulated references to executive information systems in "Computer Select," a compendium of 80,194 computer-related articles published in 1992. The results of this tabulation are shown in table 16.

Table 16: Tabulation of EIS-related Articles Published During 1992

Company	Product	Product Announc.	Other Mentions
Channel Computing	Forest & Trees	11	14
Comshare	Commander EIS	3	12
Cognos	Powerplay	1	12
Compex Business Systems	DataLens		1
Computer Associates	CIO-Vision		1
Dimensional Insight	Cross Target	3	3
Holistic Systems	Holos EIS	2	2
IBM	Data Interpretation System		1

Table 16: Tabulation of EIS-related Articles Published During 1992			
Company	Product	Product Announc.	Other Mentions
IMRS	OnTrack	1	
Indigo	Reportsmith	1	
Individual, Inc.	(not reported)		1
Information Builders	FOCUS EIS		1
Information Resources	Express EIS		3
Lotus	Notes		8
Mainstream Data	(not reported)		1
Microsoft	Open EIS Pak	4	1
Microsoft	Windows for Workgroups		2
MicroStrategy	EIS ToolKit	3	1
Occam Research	MUSE		3
Pilot	Command Center and LightShip	8	21

Table 16: Tabulation of EIS-related Articles Published During 1992			
Company	Product	Product Announc.	Other Mentions
Sales Technologies	Snap for Windows	1	
SAS Institute	SAS/EIS	8	21
Show Business Software	Show Business		1
Softklone	Talking Windows		1
Software 2000	Vital Signs		2
Totals		45	104

Table 16: Tabulation of EIS-related Articles Published During 1992			
Company	Product	Product Announc.	Other Mentions

Note: Data obtained from Ziff Communications Company. (1993). Computer Select (limited edition) [compact disk]. New York: Author.

This is a CD-ROM collection of 80,194 computer-related articles published during 1992. 299 of these articles were retrieved using "executive information" as the search criterion. These 299 articles were then examined for references to commercial executive information system products and companies. Of the 149 references found, 45 were listed by Computer Select as product announcements submitted by the vendors.

The listing of available packages in table 16 is presented here to confirm the availability of commercial packages prior to launching Cedarville's EIS analysis and design. The absence of such products would indicate potential problems for implementing an EIS at Cedarville College. (If there are no commercial packages, why not? Is it because there is no need for an EIS? Is it because the implementation of an EIS is always a custom project?

Can Cedarville College support the implementation of a custom software project of this size?)

While costs are important, it is interesting to note that Rockart and DeLong (1988) found that none of the 30 firms discussed by the authors had performed a formal cost-benefit analysis prior to developing executive information systems. This finding indicates that the decision to implement an EIS is not based solely on economic factors.

Executive

To qualify as an EIS design, the system must be oriented towards the executives within the institution. At Cedarville College, this certainly includes the president and the vice-presidents. Given the participatory nature of management within the college, the EIS design should extend to managers who report to vice-presidents. A case could also be made that faculty assume managerial roles within the institution. This is particularly true at Cedarville College, as the faculty members respond to policy issues as an entire body--there is no faculty senate. The EIS design may need to address the faculty members directly, though many of the communications functions within a general design for the administrative council would be of great benefit to the faculty also.

An orientation towards executives is necessary for a good design, but not sufficient. The executives must actually use the system (Frank and Lesher, Fall, 1991). The possibilities of improving planning and management will provide a large incentive to use the system. This incentive can be maximized by providing for appropriate training support and for an "ease of use" emphasis within the design. An **executive** information system will not meet its potential if executives find it too difficult to use.

Information

One of the challenges in designing an EIS is to provide information rather than mere volumes of data. Conversely, sufficient appropriate data must be available so that the information produced is useful to the executive. The EIS design will assume that the information needs of the executive will be broad-ranging in terms of data sources and varied in terms of information-generating analyses to be performed on the data. Thus, the focus of the design will be towards providing tools and connectivity for data access and programs for data analysis rather than providing only "canned" information. The information and its presentation to the executive are important. Paller and Laska (1990) emphasized the need for good access to corporate information:

> Speed of information means two things: rapid access to the information and effective packaging for quick uptake by key executives. Just having access to the information is of little use if that information is so hopelessly buried that it never gains top-level visibility. (Paller and Laska, 1990, p. 51)

System

A classical view of "system" is that the final product must be more valuable than its parts, or must accomplish something which the parts cannot do individually. In this sense, the EIS design should be a design where the overall improvement in planning and management cannot be achieved by the individual components of the system. From an information systems viewpoint, the EIS must internally present a consistent set of data definitions and be designed to properly protect data integrity. The EIS is a system which interacts with the existing transaction processing system--the existence of the EIS should enhance the usefulness of the transaction system while minimizing any transaction performance degradation in providing data to the EIS.

The EIS is an evolving system, not a static one (Turban, 1988). The EIS design must therefore be sufficient to provide reasonable initial functionality, and flexible enough to meet the changing requirements of the users. Some of this flexibility can be achieved in an economical fashion by relying on standard software packages rather than doing custom program development and by utilizing "non programmer" development tools where possible.

For Cedarville College

How should the effectiveness and economy of an EIS design be judged? In part, these characteristics must be evaluated in relation to a particular institution which will be using the EIS. Does the EIS design meet the needs of a small college (limited financial resources, intense competition for students)? Does the EIS design support the comprehensive, liberal-arts nature of the institution (emphasis on instruction rather than research, broad range of executive interests and responsibilities)? Does the EIS design reflect the Christian orientation of the college (extensive support for service and missionary opportunities, spiritual tone of operations)?

Summary of Systems Analysis Philosophy

If the EIS design actually flows from the design philosophy outlined above, the system will become a useful tool for the management of Cedarville College. The EIS will support some of the unique needs of the small, comprehensive, Christian college while relying on fairly standard hardware and software components. The EIS will help executives improve the planning process and the management of the organization.

Analysis and Design Methodologies

As related in chapter 2, many authors divide the systems development life cycle into a small set of phases. There are minor differences between the approaches recommended by various authors, but the phases presented by Burch (1992) are fairly typical:

1. systems planning
2. systems analysis
3. general systems design
4. systems evaluation and selection
5. detailed systems design

6. systems implementation

7. systems maintenance

This investigator worked under the assumption that completion of a modified version of Burch's first three phases would accomplish the objectives of the problem statement: Design an effective, economical, executive information system for Cedarville College. A description of the activities for each phase appears below. The activities include the use of prototyping, as recommended by Wetherbe (March, 1991).

Phase 1: Systems Planning

The systems planning phase is designed to involve three participant groups:

a. administrative council (president and vice-presidents);

b. selected mid-level managers (ADTAB, the Administrative Technology Advisory Board); and

c. Computer Services analysts.

The administrative council is included since its members are the potential primary users of the executive information system. ADTAB is included because this committee was formed for the express purpose of advising the Computer Services department on issues related to administrative computing.

Membership of ADTAB is shown in table 17. Computer Services analysts are involved in the planning since they have great familiarity the daily operation of the College and an intimate acquaintance with the transaction-processing database.

Table 17: ADTAB (Administrative Technology Advisory Board) Membership
Controller
Director of Academic Records
Director of Financial Aid
Associate Director of Admissions
Director of the Annual Fund
Director of Institutional Research
Director of Computer Services
Assistant Director of Computer Services

The systems planning phase is divided into three activities: developing project proposals, reviewing the proposals, and writing a systems planning report. Tasks to be accomplished within each activity are shown in table 18.

Table 18: Phase 1 Activities and Tasks: Systems Planning	
Developing Project Proposals Activity (Preliminary Requirements Analysis)	Investigator meets with each of the three participant groups to introduce the concept of executive information systems.
	Investigator solicits proposals regarding information requirements.
Reviewing Project Proposals Activity	Investigator works with ADTAB and Computer Services analysts to consolidate proposals.
Systems Planning Report Activity	Investigator prepares a systems plan report, including evaluation of feasibility factors and strategic factors.
	The systems plan report is reviewed and accepted by the administrative council.

Phase 2: Systems Analysis

The systems analysis phase is designed to further define the scope of the executive information system by performing a more in-depth analysis of the system requirements which were identified during the systems planning phase. One difficulty in refining the requirements definition is the fuzzy nature of executive work (Rockart and DeLong, 1988). According to Wetherbe (March, 1991), executives may not be able to express clearly what their full requirements are. To work around these difficulties, the systems analysis activities are designed to use the preliminary requirements supplied by the executives in the systems planning phase and further delineate those requirements by indirect means. Commercial executive information system packages are examined, looking for those packages which fit the preliminary requirements. Features of these packages are then examined to determine more detailed requirements.

The commercial packages to be investigated have been selected on the basis of their frequency of citation (see table 16) and on the basis of generally-accepted market leadership. The six commercial packages with eight or more mentions in Computer Select were:

Channel Computing's Forest & Trees;

Comshare's Commander EIS;

Cognos' Power Play;

Lotus' Notes;

Pilot's Command Center/Lightship; and

SAS Institute's SAS/EIS.

Although Lotus Notes is not marketed directly as an executive information system, 8 of the articles tabulated in table 16 made reference to the product. This frequency of citation warrants the inclusion of Notes in the list of products to be reviewed.

According to Watson et al. (March, 1991), two of these six packages are also market leaders: "...Pilot and Comshare are generally recognized to be the two leading vendors of EIS software" (p. 24). This prominence in the literature will warrant a particularly careful review of these two packages.

Executive information systems can also utilize standard productivity packages (Rockart and DeLong, 1988). For this reason, productivity packages which are already in use on the Cedarville network are also reviewed for possible use in the EIS:

WordPerfect (word processing);

WordPerfect Office (electronic mail, calendaring, scheduling);

Borland's Quattro Pro (spreadsheet); and

Borland's Paradox for Windows (database).

The actual activities and tasks included in the design of phase 2 are listed in table 19.

Table 19: Phase 2 Activities and Tasks: Systems Analysis	
Establishing System Scope Activity (Expanded Requirements Analysis)	The investigator obtains product information from providers of selected commercial EIS packages: Channel Computing's Forest & Trees; Comshare's Commander EIS; Cognos' Power Play; Pilot's Command Center/Lightship; SAS Institute's SAS/EIS.
	The investigator obtains product information from providers of selected application software packages: Lotus' Notes; WordPerfect; WordPerfect Office; Borland's Quattro Pro; Borland's Paradox for Windows.

Table 19: Phase 2 Activities and Tasks: Systems Analysis	
	The investigator works with Computer Services analysts to identify which pre-determined requirements can be met by the various software packages.
	The investigator works with Computer Services analysts to identify desirable features in the commercial EIS packages which were not identified as requirements in phase 1.
	The investigator works with Computer Services analysts to explore the underlying data model(s), management approach, and technical specifications for each of the commercial EIS packages.
Reporting Activity	The investigator prepares a systems analysis report. This report will include an expanded requirements definition and a summary of each commercial software package.

Table 19: Phase 2 Activities and Tasks: Systems Analysis	
	The systems analysis report is reviewed by the administrative council, and permission is granted to proceed with phase 3.

Phase 3: General Systems Design

The third and final phase of the project includes a general systems design for the executive information system. This phase involves another "visit" to the requirements, to further refine the requirements and determine the supporting data elements needed. This refinement makes use of prototyping, as recommended by Wetherbe (March, 1991) and Jalote (1991). Specific activities and tasks are detailed in table 20.

Table 20: Phase 3 Activities and Tasks: General Systems Design	
Attribute Identification Activity	The investigator identifies those entity attributes which are essential for the decision-making to be supported by the executive information system.

Table 20: Phase 3 Activities and Tasks: General Systems Design	
Data Definition Activity	The investigator creates a central data dictionary (CDD) for the attributes identified in the previous activity. Part of this activity will include assigning data elements to data stores.
Process Identification Activity	The investigator identifies those computer processes which are essential for the decision-making to be supported by the executive information system.
Modeling Activity	The investigator prepares a prototype (using either paper mockups or actual software) to demonstrate selected potential system features to the three participant groups.

Table 20: Phase 3 Activities and Tasks: General Systems Design	
Reporting Activity	The prototypes are reviewed by the three participant groups. The purpose of this review is to further clarify requirements prior to performing a detailed system design and to gain permission to proceed with the detailed design.

Requirements Analysis

The concept of requirements analysis was treated as a separate item in the literature review (chapter 2) due to the heavy emphasis on this concept in discussions of systems analysis and design. Rather than being conducted as a separate phase, however, requirements analysis has been included as an integral activity within each of the three proposed phases.

Evaluation of the Design

The design which results from the three phases needs to be evaluated so as to verify its appropriateness. The evaluation procedure includes an internal review within the College and a review by external experts. The internal review is conducted by the three participant groups, while the external review is conducted by three information systems managers from colleges which use the Datatel Colleague software package and by the director of marketing and product development for Datatel. Details of the review are provided below.

A synopsis of the requirements document and the proposed design are prepared and distributed to the evaluators. An evaluation instrument accompanies the synopsis. The evaluation instrument focuses on EIS features described in chapter 2: executive participation, quick access, analytical tools, management impact, and ease of use (from the section on historical and functional contrasts). The instrument design is shown in table 21. Some modification to the instrument might be necessary so as to accurately reflect the Cedarville EIS requirements when those requirements have been identified. The evaluation instrument compares favorably with the evaluation items presented by Rockart and DeLong (1988), as shown in table 22, and the items presented by Thierauf (1991), as shown in table 23.

Table 21: Designed Evaluation Instrument	
The following characteristics are generally considered to be important in supporting executive information systems (EIS). Please rate the proposal for Cedarville's EIS using a scale of 1 (strongly agree) to 5 (strongly disagree).	
1.	The proposed design will encourage executives to actually use the system (Rockart and DeLong, 1988).
2.	The proposed design will deliver the required information as fast or faster than current methods (Legatt, 1991).
3.	The proposed design includes tools which will help executives perform strategic analyses (Rushinek and Rushinek, Spring, 1991).
4.	The proposed design will contribute to the mission and competitive position of the institution (Boone, 1991).
5.	The proposed design will help the institution achieve its critical success factors (Emery, 1987).
6.	The proposed design will help give executives access to internal information (Thierauf, 1991).
7.	The proposed design will help give executives access to external information (Kador, February, 1991).

Table 21: Designed Evaluation Instrument	
8.	The proposed design will aid the executives in predicting long-term trends in higher education (Thierauf, 1991).
9.	The proposed design will aid the executives in planning for long-term curricular changes (Fredericks, 1971).
10.	The proposed design will be easy to use (Sprague, 1988).
11.	The proposed design makes appropriate use of graphics (Emery, 1987).
Note: Citations are given to provide correlation between the literature review in chapter 2 and the evaluation design. These citations do not appear in the instrument given to evaluators.	

Table 22: Rockart and DeLong's Criteria for Measuring Success of an ESS	
1.	How much time will the executive spend using the system?
2.	Will the system save the executive time and allow more work to get done?

Table 22: Rockart and DeLong's Criteria for Measuring Success of an ESS	
3.	Will the ESS change how the executive thinks about using and managing information technology?
4.	Will the ESS change the way the organization utilizes technology?
5.	Will the system improve the executive's understanding of and control over the business?
6.	Does the system improve the organization's planning and control process?
Note: From pp. 36-37 of Rockart, J. F. and DeLong, D. W. (1988). Executive support systems: the emergence of top management computer use. Homewood, IL: Dow Jones-Irwin.	

Table 23: Thierauf's EIS Evaluation Factors
Is the package easy to use?
Does the package actually do what the executives want?
Is the package designed for the organization's size or will it be outgrown in a few years?

Table 23: Thierauf's EIS Evaluation Factors
How are changes and updates in the package handled?
Does the package provide flexibility?
Will the vendor support the installation adequately?
On what hardware does the package run?
Is all documentation clear?
Can the executives visit at least one other user of the package?
Is the package reasonably priced?
Note: From figure 4.1, p. 107, of Thierauf, R. J. (1991). Executive information systems: a guide for senior management and MIS professionals. New York: Quorum Books.

The idea of preparing a design proposal and then seeking interaction with the intended executive users is consistent with the literature review in chapter 2. In fact, several authors recommend having executives review prototypes as part of the development project (Jalote, 1991; Wetherbe, March, 1991; Paller and Laska, 1990). For the Cedarville College EIS, this internal review by executives is supplemented by reviews from the Administrative

Technology Advisory Board and by the systems analysts from the Computer Services department.

So that external collegiate feedback might be obtained, the design is also presented to three information systems administrators from colleges which use the Datatel Colleague software package. These administrators are asked to complete the same evaluation instrument used for the internal review. A second external review is obtained via a private presentation to representatives from Datatel, Inc. Dr. Laird Sloan, Marketing Director at Datatel, would be the chief participant in this session. Dr. Sloan's evaluation is to focus on the general suitability of the design for Cedarville College and on the design's potential as a basis for Datatel's development of an executive information system for its other customers. Datatel has expressed a strong interest in this potential product area, having devoted some research and development time to the topic, and is anxious to interact on design possibilities.

Summary of Dissertation Design

In light of the need for improvement in management within Cedarville College, and the availability of modern computer technology, a case has been made for improving executive computer support at Cedarville College. A recommended design process has been presented, based on a review of the literature. Finally, the chapter has included a suggested method for evaluating the design. This dissertation project has been prepared with the intent of providing an organized method for meeting the challenge of designing an effective, economical executive information system for Cedarville College.

Chapter 4 Results

Overview

The discussion presented in earlier chapters of this dissertation was focused on identifying a need for executive information and a procedure for meeting that need. Examination of Cedarville College's computing environment revealed an opportunity to utilize extensive network computing capabilities for support of management's information requirements. A review of the literature included conceptual material regarding the purpose and functioning of an executive information system (EIS), as well as examples of EIS utilization. The availability of commercial software for executive information systems offered at least the appearance of feasibility for providing this information support. All of this discussion culminated in the formulation of a problem statement:

Design an effective, economical
executive information system
for Cedarville College.

Formal systems analysis and design procedure for accomplishing the design of the Cedarville College EIS was outlined in chapter 3. The present chapter documents the results of implementing the systems analysis and design procedures. The results of each phase are presented using the terminology appropriate at that stage in the project. In particular, the text describing phase 1 (systems planning) references phases 2 (systems analysis) and 3 (general systems design) as future events. Likewise, the text describing phase 2 treats phase 1 in the past tense and phase 3 in the future tense.

Systems Planning

As outlined in the Phase 1 list of activities and tasks (see table 18), the investigator met with the three constituent groups to introduce the EIS project. Following these group meetings, individual interviews were conducted with administrators, middle managers, and administrative assistants. The definitions presented to the participant groups are shown in figure 1, while a sample of the interview format is shown in figure 2.

Definition of an Executive Information System

An executive information system (EIS) is an on-line computer system which involves the executive in data interpretation for decision making. This interpretation is done using the latest internal and external data, often using modeling tools and graphical presentations. The EIS typically is designed for a higher-level executive than traditional management information systems and therefore development of the EIS often emphasizes ease of use over economy. Information handled by the EIS is obtained from internal corporate databases, internal communications, external databases, and external communications.

Key characteristics of an EIS

There are four major characteristics of executive information systems:

1. *Executive Participation*
   The software which runs the EIS is designed for use by the executive. The software presents summarized information and provides any easy method for obtaining detailed information to support each piece of summarized information.

2. *Quick Access*
   The information presented in the EIS is current, and can be obtained rapidly. The executive does not have to wait for long processing runs. The information is available automatically; no manual effort is required to assemble the data.

3. *Analytical Tools*
   The software which underlies the EIS provides the executive with methods for recombining data into views and summaries which enhance the executive's ability to solve the problems at hand. This software includes the capability to view historical data and extrapolate future trends. Key to the analytical portion of the EIS is the ability to change underlying assumptions and examine the resulting projections.

4. *Management Impact*
   An executive information system must help the executives do a better job of managing the institution. While many data processing systems help employees managing daily operations, the focus of the EIS is on strategic planning and institutionally-defined critical success factors.

1 Definitions presented to participant groups

Interview format for Phase 1

Interviewee	Date

Objective

Determine requirements for executive information system (EIS)

Requirements to be determined

types of decisions for which information system support is appropriate
types of internal data required
types of external data required
timing of information requirements
presentation format requirements
analysis requirements

Interview outline

1. Thanks for participation
   Purpose of the interview

2. Review concept of executive information systems
   a. executive participation
   b. quick access
   c. analytical tools
   d. management impact

3. Do you have any initial comments or suggestions regarding the EIS project?

4. Let's do some brainstorming about the project. I have a few questions to get our discussion moving...

   a. What major decisions have you had to make recently?
   b. What internal data have you used recently?
   c. What external data have you used recently?
   d. Have you had any frustrations about information not being available?
   e. How do you see your involvement with the eventual EIS?

5. Invitation to submit follow-up materials

6. Are there particular subordinates who ought to be involved in the project?

2 Sample interview form used in systems planning phase

Based on the interviews conducted in the systems planning phase, and further discussion with Computer Services analysts, three reports were prepared: a system scope report, a feasibility report, and a strategic-factors report. Highlights from these reports are presented below.

System Scope Overview

Managing an organization with an annual budget over $20,000,000 is a serious task, requiring sound decisions based on accurate information. The installation of *CedarNet* has provided a vehicle for improving delivery of this information to administrators and middle managers. On the basis of interviews with all of the administrators and several managers, a preliminary systems concept has been formed.

System Scope Types of Decisions to be Supported

Since Cedarville College has been experiencing several years of growth, many of the major decisions facing the College administration are growth related: building facilities and hiring personnel. Major facilities currently under design include a new residence hall, a new chapel, and a new fine arts building. Discussions of facility and personnel recommendations consume large portions of Administrative Council meetings. (The Board of Trustees has legal authority for deciding these issues, but the Board depends heavily on the recommendations of the Administrative Council.)

Other major decisions made by Council members include development of budgets, setting employee benefit levels, reviewing major curricular offerings, and designing of capital campaigns.

System Scope Information Requirements

Administrators rely on both internal and external data to make major decisions. The tables below highlight the types of data most frequently cited in the interviews with the Administrative Council.

Table 24: Internal Data Used in Major Decisions

Type of Decision	Categories
Support requirements for new facilities (staffing, space, budget)	Personnel Budget
Cash activity and investment activity (cash flow, rate of return)	Budget

Table 24: Internal Data Used in Major Decisions	
Type of Decision	Categories
Trend analysis of employee benefits (health care, life insurance, disability insurance, workmen's compensation)	Personnel Budget
Historical pattern of prior capital campaigns (timing of pledges, completion ratio, sources of gifts)	Development
Yield and retention studies according to types and amounts of financial aid awarded	Enrollment Budget
Faculty load information (number of sections taught, credit hours generated, student/faculty ratio)	Personnel
Enrollment trends (bi-monthly status of applications, comparison of matriculation yields)	Enrollment
Housing summaries (number of students given permission to live off campus, number of students graduating in future terms, retention rates)	Enrollment

Table 25: External Data Used in Major Decisions	
Type of Decision or Comparison	Categories
Tuition comparisons with peer institutions	Budget Enrollment
Curricular comparisons with peer institutions	Curriculum
Financial compliance information (tax and reporting requirements, financial aid regulations)	Budget
Non-financial compliance information (safety regulations, employment policies)	Personnel
Financial aid comparisons with peer institutions	Budget Enrollment
Salary comparisons with other educational institutions	Budget Personnel
Student Services policies at peer institutions	Enrollment
Market investment rates	Budget
Foundation data (tax returns, recent grants, officers)	Development

System Scope Target Audience and Access Requirements

Two of the six administrators indicated that they would like direct interaction with an executive information system. The other four administrators indicated that their style would be to obtain information from their managers. For all of the vice-presidents, the respective managers would need access to the executive information system in order to provide effective support to the administration. In some cases, access to pre-planned charts and reports will meet the information requirements. In other cases, the administrator or manager will need the capability to explore the information to identify patterns and trends.

System Scope Summary

Interviewees have expressed a need for better access to information. Internal and external information requirements have been summarized into categories. A target audience (administrators and managers) has been identified.

Feasibility Overview

At this early stage in the analysis, the intent of a feasibility review is to demonstrate the general viability of the EIS project. Detailed cost/benefit comparisons are done during a later phase. The feasibility factors discussed in this section are derived from Adams, Powers, and Mills (1984).

Financial Feasibility

This researcher has begun acquiring evaluation copies of software for the development of a prototype executive information system. The software acquired to date carries purchase prices ranging from $695 (one-time purchase of Forest and Trees) to an annual license charge of $2,200 (SAS/EIS). While the financial impact of simultaneous-user licensing will not be known until a later project phase, the initial costs are comparable to other software which the College has purchased.

Operational Feasibility

One consideration which must be evaluated as part of a systems analysis project is the ability of personnel to implement and operate the proposed system. All members of the target audience (two vice presidents and the managers) have computers on their desks and make routine use of a variety of software packages. For example, electronic mail is a routine part of each working day for all of the personnel involved. If the executive information system can be implemented in a menu or graphical-user interface, the personnel should not have undue difficulty in learning to use the system.

Technical Feasibility

For a systems analysis project to succeed, the technology to implement the design must exist. In the case of an executive information system, technical requirements include ease of use and the ability to manipulate data in a variety of ways. Each of the software packages being reviewed provides a simple interface and powerful analysis tools. The existence of these packages not only confirms the technical feasibility, but also indicates that the system can be built using packaged software rather than being written totally in-house.

Schedule Feasibility

Major budgetary, facility, and personnel decisions for Cedarville College tend to be made during the last 2 or 3 months of a calendar year. To provide support for major decisions during the 1994-95 academic year, the executive information system would need to be in place by September of 1994. Assuming that one or more of the commercial packages being reviewed proves to be acceptable, the development of an executive information system during the next ten months seems reasonable. (Executive information systems are not static systems; development is iterative and continuous. The system which would be in place by September of 1994 would undoubtedly be enhanced frequently.)

Human Factors Feasibility

Being able to implement a system is good, but the system will still fail if the personnel cannot handle the psychological changes brought on by the new system. With an executive information system, there will be changes in work patterns as participants will be able to obtain information directly which previously required contact with other employees. Conversely, the system may introduce more direct contact between the information custodian and the manager--eliminating an intermediary who previously summarized the information. The open communication atmosphere of Cedarville College is one indication that the administrators and managers can handle this kind of change. Each of the administrators and managers has indicated a willingness to do whatever is necessary to improve the quality of information being delivered.

Summary of Feasibility

At this preliminary point in the analysis, there does not appear to be any major obstacle to continued development of an executive information system.

Strategic Factors Overview

Cedarville College places a great deal of emphasis on strategic planning. The annual planning cycle involves personnel from over 40 departments and culminates in the establishment of strategic priorities for the institution. Any major project to be undertaken must support these strategic priorities. Strategic planning priorities for 1993-94 include:

- Human resources
- Technology
- Institutional security
- Student priorities
- Facilities management
- Assessment

The proposed executive information system will provide direct support for all of the priorities except "institutional security." In addition to the direct support which is part of the EIS design, the improved flow of communication should aid administrators and managers in implementing all of the strategic priorities.

Another approach to the evaluation of strategic importance is to use a strategic review like the one presented by Burch (1992). Burch recommends evaluating strategic importance in the three categories described below.

Strategic Factors Productivity

One measurement of the strategic importance of a project is that project's impact on the volume and quality of work accomplished. The primary focus of the executive information system is on improving the quality of decisions made by administrators and managers. For executive personnel, decision making is productivity.

Strategic Factors Differentiation

Some projects are justified on the basis that the project will provide something unique which competitors do not possess. Data from CAUSE cited earlier in this dissertation indicate that 21% of the institutions responding to CAUSE's annual survey were currently using an executive information system. Implementation of an EIS at Cedarville College will position the institution with the minority who use this type of a tool, providing the College with a competitive edge.

Strategic Factors Management

Another measurement of the strategic importance of a systems project is its impact on management. Since the EIS is designed for managers, the management impact should be direct and immediate.

Strategic Factors Summary

The proposed executive information system supports the College's own strategic priority list and is supported by a popular measurement of strategic importance.

Systems Analysis

The systems analysis phase was designed to further define the scope of the executive information system by performing a more in-depth analysis of the system requirements which were identified during the systems planning phase. Several commercial packages were selected for investigation on the basis of their frequency of citation (see table 16) and on the basis of generally-accepted market leadership. Each of these commercial packages was examined to determine features and business applications which might be applicable to a Cedarville College executive information system. A summary of this "requirements definition" is presented below.

As mentioned in the "systems scope" report, there is a need within the College to support decision making related to the continued growth in enrollment. The view of data requirements in the systems scope report is still appropriate, but it is also profitable to look at data requirements in the context of an ordinary business operation. Based on the research done in phases 1 and 2, the requirements shown in the table below would also apply to a Cedarville College executive information system.

Table 26: Requirements Definition by Business Analogy

Business EIS Application	Cedarville College EIS Application
Routine financial accounting	The usual financial ratios (e.g., current, accounts receivable turnover) and financial statements (e.g., balance sheet, income statement) apply.
	In addition to the usual accounting ratios, the College tracks ratios like student/faculty ratio, average credit hours taken per student, and average credit hours generated per faculty member.

Table 26: Requirements Definition by Business Analogy	
Business EIS Application	Cedarville College EIS Application
Sales by region	The College "sales" are students recruited, hours sold, and gift income received. The regions would include types of high schools (public or private), region of the country, academic qualifications, transfer institutions, and sources of gifts.
Sales representative tracking	College sales representatives include the academic departments, admissions recruiters, advisors, and development staff.
Inventory control	Inventory which needs to be controlled includes sections offered, classrooms in use, residence hall rooms, and parking spaces.
Product sales by period and category	The College periods are the academic quarters and years. The categories would include academic departments, majors, and course levels. For development operations, categories would include designations (operating expense, capital campaign).

Table 26: Requirements Definition by Business Analogy	
Business EIS Application	Cedarville College EIS Application
Profit margin by item	Though the College typically has not used profit-margin analysis, some appropriate information might be provided. This information would include revenue and expense by major or by course.

Requirements Definition: Feature Requirements

Two general feature requirements have emerged from the research to this point:

- Viewing of existing reports from the administrative system
- Hands-on manipulation and cross-dimensional analysis of critical variables

Any EIS software selected for the project must provide the executive with easy access to standard reports currently produced on the administrative computer system. The viewing software should have scrolling capability for long reports, and should provide for local printing as desired.

For those occasions when standard reports do not fit the executive's needs, the selected EIS software must provide for "slicing and dicing" data across various dimensions. Key to this support is the ability to group information according to an appropriate time dimension and functional area. The identified time dimensions are shown in the table below. While detailed analysis of required data dimensions is not yet complete (this will be done in phase 3), more than 100 different candidate data variables have been identified to date.

Table 27: Time Dimensions for Cedarville College EIS	
Academic Division	Academic term and year
Business Division	Fiscal periods (month, quarter, year) for budgeting, annual reports, non-profit reporting Calendar periods (month, quarter, year) for employment reporting
Development Division	Calendar year (donor records, IRS reporting) Fiscal year (annual reports) Capital campaign (multi-year activity)

Requirements Definition: Economical and Effective

One of the goals of the EIS design project is to produce an economical system. Software acquisition costs help to determine the overall cost of the project, but software development costs must also be considered. The selected EIS package should be relatively easy for Computer Services staff to learn and use.

Another goal of the design project is to produce an effective system. For the system to be effective, it must meet the needs of the executives and be used by them (or their subordinates). Consequently, the selected EIS package needs to be easy to use and provide the flexibility required by the executives. Ease of use is enhanced if the product follows standard Windows conventions, since the executives are already familiar with Windows. Another ease-of-use factor is the effort required to perform data manipulations such as changing data dimensions or time intervals. The selected package should require minimal effort to maneuver through different views of the data.

Summaries of Software Packages

For each of the commercial EIS packages included in the review, a textual overview was prepared and the underlying data structures were investigated. The following pages contain the textual summaries and the results of the data structure analysis. The information presented on the commercial EIS packages was obtained from the literature cited in the summaries and from actual installation and operation of the five packages. The initial design proposal called for investigating some selected productivity software (Lotus Notes, QuattroPro, Paradox, WordPerfect, and WordPerfect Office) in addition to the commercial EIS packages. Textual summaries of these products are also shown below.

Summary of Commander

Product Identification

Commander (version 3.1.3.2)

Comshare, Inc.

3001 S. State Street

PO Box 1588

Ann Arbor, MI 48106

(313) 994-4800

(800) 922-7979

Overview of the Product

Commander provides:

- Easy management access to customized status reporting, information analysis, investigation, electronic mail, and external information sources
- High-resolution printing
- Graphical interface
- Data-driven screens for SQL-servers and other LAN and host databases
- Document-driven screens for non-database information

- Integration of data from multiple sources
- Drill-down
- Point-and-click interface and keyboard interface
- Application management functions for security and automation

  (Commander Info Pack, pages 1-2)

Standard Commander applications include:

- Briefing book
- News navigator
- Execu-View analysis and ad hoc investigation
- Redi-mail touch-screen interface to electronic mail
- Reminder calendaring application

Pricing (November, 1993)

$25,000 for a 50-user bundle (production version)

$1,440 for a 30-user research-only bundle

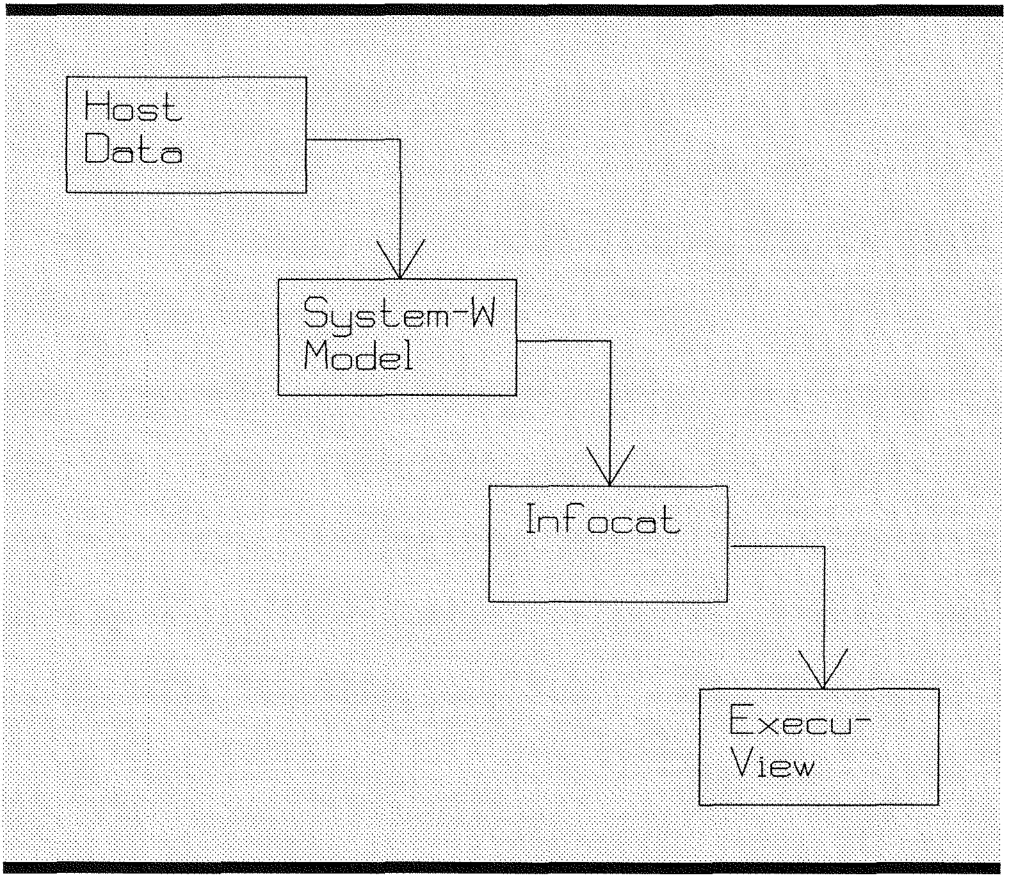
Data Access Method

Data from reports are incorporated as text files. Exception signaling (traffic-lighting) can be done on numeric areas of the reports. Any numeric area can be selected for graphical presentation.

The "Execu-View" application provides ad hoc investigation and analysis of host data and PC-based data. However, Execu-View requires the use of System W on the host or One-Up on the PC to transform the data into a model accessible by Commander. Execu-View provides tabular and graphical displays of data across various dimensions. The user can drill-down any of the dimensions. There is also a rotate command to change which variables are used for drill-down and which variables are used in the tabular display.

Information to be used within Desktop Builder (the briefing book application) originates as text report files from a host. These files are copied to the PC and then incorporated into a document database using Commander's batch administrative system. (Hot spot buttons can also manipulate documents via the underlying scripts.) Processing of the report data must be very explicit--at the level of specifying particular row and column numbers on the report.

Information to be used within Execu-View must already exist in a System W or One-Up model. Data from the model is extracted into a structure called an "infocat." The infocat is subsequently processed into a "modelmap" for manipulation by Execu-View. This three-step access to data is illustrated in figure 3.



3 Three-step Access Methodology Used by Commander

Software Organization

Commander is divided into five major functional areas:

- "Briefing Book" for electronic status reporting
- "Execu-View" for exploration of corporate models across multiple data dimensions
- "News Navigator" for interfacing with commercial news services like the Dow Jones stock reports
- "Redi-Mail" for sending and receiving electronic mail
- "Reminder" for scheduling appointments and forming tickler systems

Screens within the briefing book application are arranged in a hierarchical structure. The structure is traversed by means of hot spots. The software maintains a log of the current path through the screens, and provides the user with the option of backing up to any previous screen without having to view the intervening screens. Screens can be nested to a limit of 50 levels deep.

Feature List

The Briefing Book application (also called Desktop Builder) includes:

- Hot spot buttons

Buttons can be used to present a menu, activate a function, or branch to another screen.

- Scripting for hot spots
- Traffic lighting
- Drawing objects for use as hot spots or logos
- Charting

  Graphs can be drawn based on tabular sections of reports provided to Commander.

The Execu-View application includes:

- Multi-dimensional analysis
- Easy drill-down under the user's command
- User-changeable views of the data
- Charting

Execu-View provides an option for saving a particular view of the data. The view can be saved as an Execu-View file, as a "DIF" file for analysis by another program, sent to the printer, or sent to another person via electronic mail. Electronic mail interfaces are provided for:

- PROFS (IBM VM systems)
- Office Vision (IBM VM systems)
- All-in-1 (DEC VAX systems)

Commander itself provides batch and on-line facilities for accessing host data. Scripts can perform logon sequences and data transfers. Communications activities are under control of the MSEEK utility.

Miscellaneous Observations

Drawing three-dimensional buttons requires physically drawing all borders and then connecting the objects.

Scrolling end-user screens is accomplished via on-screen arrow buttons, rather than the traditional Windows scroll bars.

The "erase" tool erases any selected object (even an entire screen) without prompting for permission. There is no "undo" function.

Summary of Forest & Trees

Product Identification

Forest & Trees (version 3.0a)

Trinzic Corporation (formerly Channel Computing)

One Harbour Place, Suite 500

Portsmouth, NH 03801-3872

(603) 427-0444

Overview of the Product

"Forest & Trees is a Data Access and Reporting Tool (DART) that collects and combines data from a variety of sources and monitors the resulting information in order to track information at all levels from business vital signs to underlying detail." (Trinzic Corporation, 1992, Forest & Trees Reference Guide, p. 15)

The following features are included in Forest & Trees:

- data collection

  access host and PC databases (ASCII, SQL, dBASE, DDE)

- combining data

  numeric, text, date, time, and conversion functions

- presentation

  menus, push buttons, graphics

- action

  generating alarms and launching other applications (e.g., sending an e-mail message)

- reports

  customizable reports

- monitoring

  automatic updates of data views, automatic generation of alarms

- analysis

  graphs, cross-tabulations, history logs

- customizing

  changing look and feel of the product

- sharing data

  exporting to files, DDE links, Windows clipboard

- security

  enforce database security, optional F&T security

(Trinzic Corporation, 1992, Forest & Trees Reference Guide, pp. 16-17)

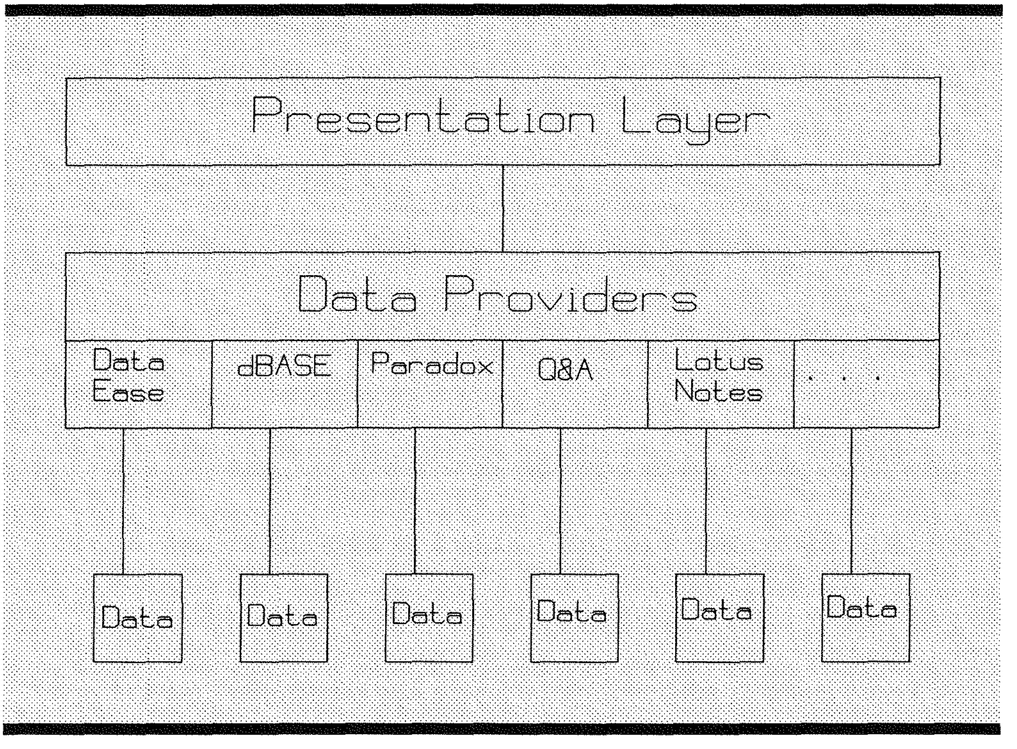
Pricing (November, 1993)

License Pricing for Forest & Trees			
	25 users	50 users	100 users
End-user volume (per-station license)	$420/copy	$365/copy	$290/copy
Concurrent users	$530/user	$445/user	$350/user

Maintenance Pricing for Forest & Trees			
	25 users	50 users	100 users
End-user volume (per-station license)		$99/copy	$79/copy
Concurrent users		$149/user	$129/user

Data Access Method

Forest & Trees supports a three-layer model of data access, as shown in figure 4. Data access is accomplished via Structured Query Language (SQL). If the data source supports SQL, Forest & Trees passes the SQL query directly. For other data sources, Forest & Trees uses an internal SQL engine called a "provider" to process the request.



4 Structure of Forest & Trees (Based on Information from Trinzic Corporation, 1992, Forest & Trees Standard Provider Guide)

Retrieved data is held in files called views. The views may be combined to form new views. This combination of data views gives Forest & Trees a natural information-tree structure. The software automatically places drill-down buttons on related views. By default, all of the views associated with a particular application are stored in a single view file. However, individual view files can be linked to form a more modular structure. Linking the view files provides for easier development (debugging small views rather than one large view) and also promotes re-use of existing views.

The presentation layer supports seven view types:

- standard result

  The standard result view performs data queries and displays results in a columnar format.

- cross-tabulation

  The cross-tabulation view performs data queries and displays results in a table or matrix. The particular domains for the matrix (i.e., categories to be displayed in the rows and columns) can be changed via mouse clicks after the data have been fetched.

- edit field

An edit field view can display text and obtain input from the user.

- list

  A list view displays a "pick list" for the user to select an item from the specified list.

- picture

  A picture view displays a bitmap, and can serve as a button for triggering other activities.

- button

  A button view looks like a standard Windows button, and serves to trigger other activities.

- hot spot

  A hot spot view serves as a transparent button, providing a means for displaying information and enabling clicks on the display area to trigger further action.

Feature List

Forest & Trees supports the following features:

- Data collection

  SQL-based access to PC and host-based databases

Dynamic Data Exchange (DDE) access

Forest & Trees files

- Combining data

    formulas and functions for combining existing data

- Presentation

    default display settings

    customizable via menus, panels with push buttons, and graphic images

- Action and monitoring

    routine scheduling of queries and calculations

    alarms

    e-mail notification

- Reports

    control breaks, calculated values

- Analysis

    graphs

    cross-tabulation

    history log for tracking changes in information

- Security

    enforcement of database internal security

    optional Forest & Trees additional security

(Trinzic Corporation, 1992, Forest & Trees Reference Guide, pp. 16-17)

Summary of LightShip

Product Identification

LightShip and LightShip Lens (version 3.0)

Pilot Software

40 Broad Street

Boston, MA 02109

(617) 461-5800

(800) 944-0094

Overview of the Product

LightShip is "...a PC-based visual information access and analysis system for managers and other decision makers at all levels within an organization" (Pilot Software, 1993). LightShip features include:

- Filtering
- Hot spots
- Drill-down
- Support for DDE (dynamic data exchange)
- Eight objects (draw, text, document, image, hot spot, menu, chart, format)

- Live connections to various databases (dBASE, DB2, Excel, Informix, Oracle, Ingres, Sybase, SQL Server, Netware SQL, Paradox, OS/400, Rdb, and 1-2-3)

Pricing (November, 1993)

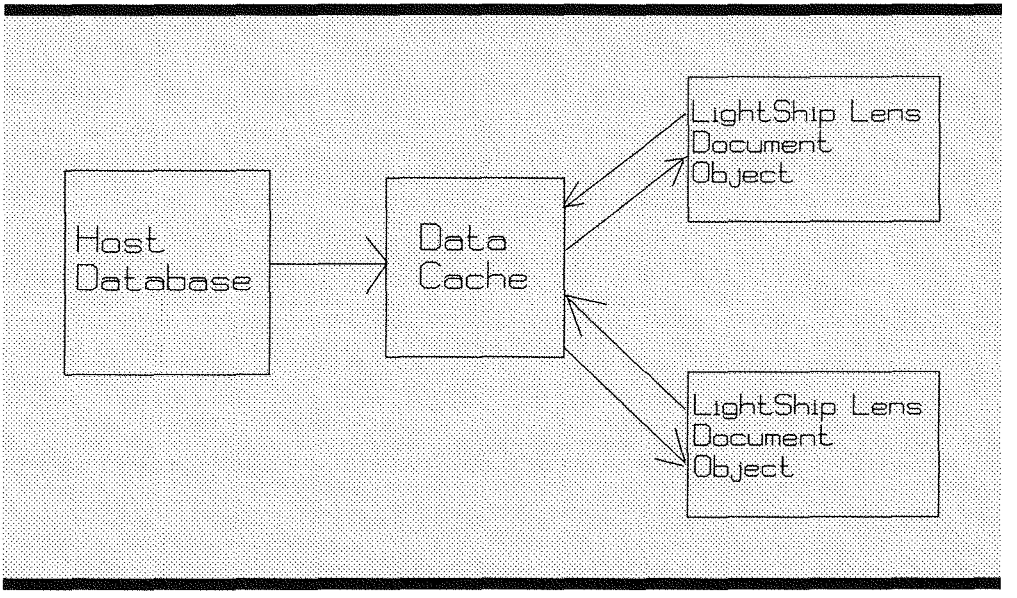
Pilot Software LightShip Pricing "Standard Lightship" list price $795/copy "Lightship Lens" list price $295/copy			
Number of users	Discount	LightShip Net cost per user	LightShip Lens Net cost per user
0-10	0%	$795	$295
11-20	10%	716	266
21-30	15%	676	251
31-50	20%	636	236
51-100	25%	597	222
100+	30%	556	207

Pilot Software LightShip Pricing "Professional"	
up to 100 users	$37,000
each additional user	$370

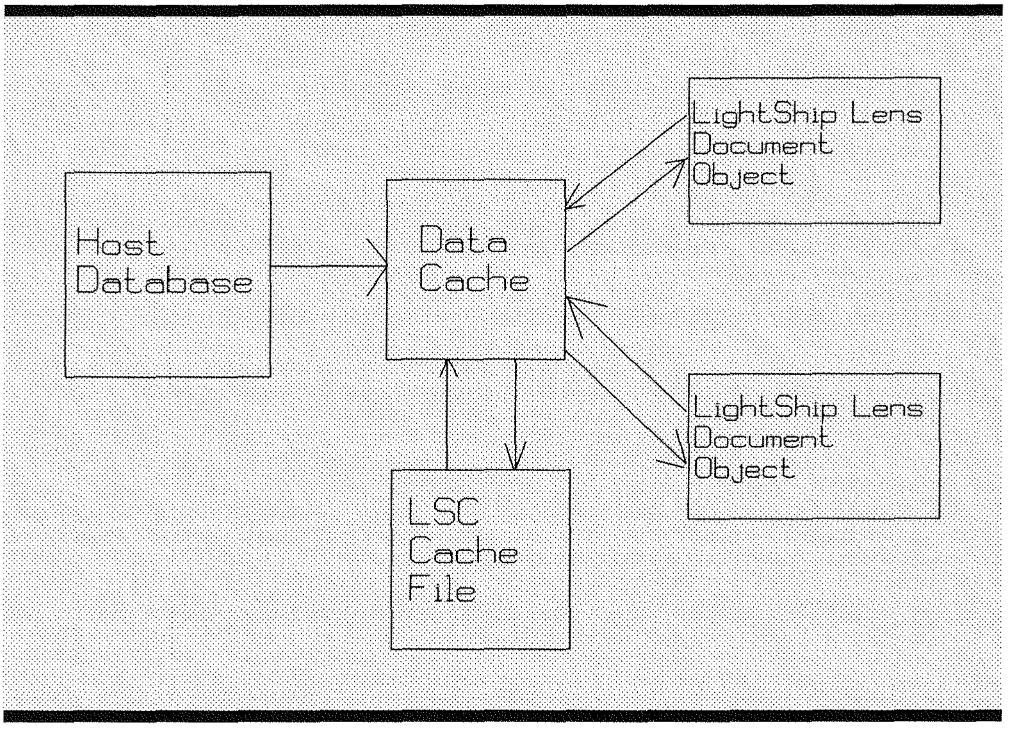
Structural Review of LightShip

Data Access Method

LightShip can access some types of data directly, such as ASCII text files. However, the principal data access method is via LightShip Lens. LightShip Lens extracts data from a database and forms an in-memory cache. The developer has the option of saving this in-memory cache to disk. Diagrams 5 and 6 below illustrate how the data cache is used.



5 LightShip Lens Structure Using In-memory Caching (Pilot Software, 1992)



6 LightShip Lens Structure Using File for Data Caching (Pilot Software, 1992)

The LightShip Lens data display is organized by columns, rows, and dimensions. Typically, a dimension field is a character or date field which describes the numeric data (e.g., branch name, employee name, product name, date of sale).

Software Organization

The following components are used to build a LightShip application:

- Screens

  Screens present data to the user. Screens can be linked via menu objects or hot spots.

- Objects

  Object types available in LightShip include document, chart, format (for formatting document objects and highlighting variances), image, hotspot, menu, text, and draw (for outlining or highlighting portions of the screen).

- Data sources

  Supported data sources include DDE links, DLL links, database systems (dBASE, SQL, and others), and Lotus Notes files.

- Actions

Actions are implemented via menus and hotspots. Many actions are pre-defined, but the developer can also implement external functions as actions.

- Variables

Feature List

Pilot LightShip includes drill-down, charting tools, reporting tools, and query tools. These capabilities are provided through the LightShip objects (see "Software Organization" above). LightShip capabilities include:

- Display of data from dBASE files, SQL servers, ASCII text files, and Microsoft Windows DDE applications
- Open data access with active software links
- Drill-down navigation through information
- Variance reporting
- Trend analysis

Summary of PowerPlay for Windows

Product Identification

PowerPlay for Windows (version 3.0d)

Cognos Corporation

67 South Bedford Street

Burlington, MA 01803-5164

(617) 229-6600

(800) 426-4667

Overview of the Product

"PowerPlay offers business analysis and reporting tools that:

- transform two-dimensional data into multi-dimensional information
- give...information users the power and flexibility to service their own reporting and analysis needs
- allow data to be analyzed and presented within a context that's relevant to its users, and through an interface that's easy to understand and use"

(Getting Started with PowerPlay, p. 2)

PowerPlay capabilities include:

- drill down
- vary graphics displays to present clear pictures of trends
- "slice-and-dice" data to look at a business from a variety of perspectives

(Learning PowerPlay, p. v.)

Pricing (November, 1993)

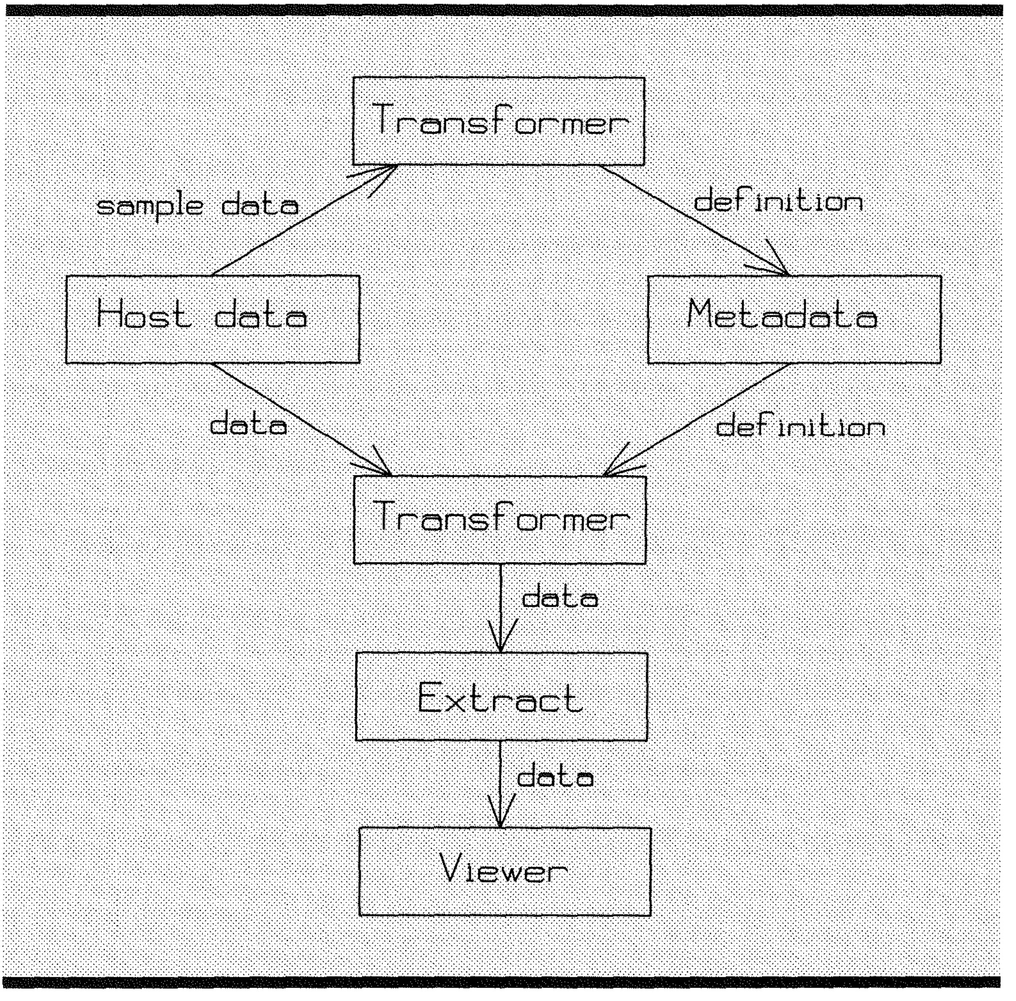
License and Maintenance Pricing for PowerPlay Individual Licenses				
	1-9 users	10-49 users	50-99 users	100+ users
License fee	$695/copy	$435/copy	$395/copy	$350/copy
Annual maintenance	$125/copy	$110/copy	$100/copy	$90/copy

License and Maintenance Pricing for PowerPlay LAN Pack (10-user) Licenses				
	10 users	20-40 users	50-90 users	100+ users
License fee	$4330/pack	$3935/pack	$3535/pack	$3090/pack
Annual maintenance	$1085/pack	$985/pack	$885/pack	$775/pack

Structural Review of PowerPlay

Data Access Method

The viewing and reporting portions of PowerPlay access data file extracts. These extracts are generated by the "transformer" portion of PowerPlay. The extract files contain metadata "dimensions" which provide basic naming of the data contained in the extract. The actual data are called "measures" in the PowerPlay environment. Extracts can be related to each other to form an information model for PowerPlay. The overall PowerPlay structure is shown in figure 7 below.



7 PowerPlay Data Access Model

Acquisition of data for the extracts is accomplished by using Impromptu, Cognos' query tool for Microsoft Windows. Once a query is defined within Impromptu, the query can be executed directly by the transformer module of PowerPlay. Impromptu functions in a point-and-click mode, where the developer can select data from an existing database. Impromptu automatically generates the SQL program corresponding to the selected fields and options.

Impromptu accesses databases through a "catalog." The catalog must be set up by the database administrator. It defines the name, location, and contents of the database. The catalog also controls access to the database(s), enforcing security restrictions set up by the database administrator. Impromptu supports access to dBASE, ODBC, Oracle, Paradox, SQL Server, and Sybase databases.

Software Organization

PowerPlay contains three basic modules:

- Transformer

  The "Transformer" is used for converting local databases into extract files which can be used by the Viewer and Reporter modules. Transformer can manipulate ASCII files only; other database formats must be processed via the Impromptu product. (Transformer is an integrated component of PowerPlay, whereas Impromptu is a separate product.)

- Viewer

  The "Viewer" portion of PowerPlay is designed to be used as a browsing tool. The Viewer allows the user to restrict or broaden dimensions, transpose dimensions, and perform other data manipulations.

- Reporter

  The "Reporter" module is designed for creating a standard report using the PowerPlay extract file as input. All of the features of the Viewer are available in the Reporter, and some additional commands are available, such as deleting a column and sorting by value.

Feature List

PowerPlay is designed with user-controllable cross-tabulations as the primary venue for relaying information. The user can easily change dimensions and cell contents. Graphs can be generating by highlighting appropriate columns, rows, or cells. The program can create simple bar graphs, stacked bar graphs, and pie charts. The current release of PowerPlay does not support menuing, display of external reports, nor display of external graphical objects.

Summary of SAS/EIS

Product Identification

SAS/EIS (version 6.08)

SAS Institute, Inc.

SAS Campus Drive

Cary, NC 27513

(919) 677-8000

Overview of the Product

SAS supports Dynamic Data Exchange (DDE) and Object Linking and Embedding (OLE). Audio and video can be incorporated into SAS applications. Data from various databases can be accessed directly. SAS/EIS "...provides a syntax-free environment for building user-friendly enterprise information systems." (SAS Institute, April, 1993). SAS/EIS features include:

- point-and-click menus
- pull-down windows
- access to native host applications such as electronic mail
- drill-down
- what-if analyses

- exception reporting
- graphical display of critical success factors
- business forecasting

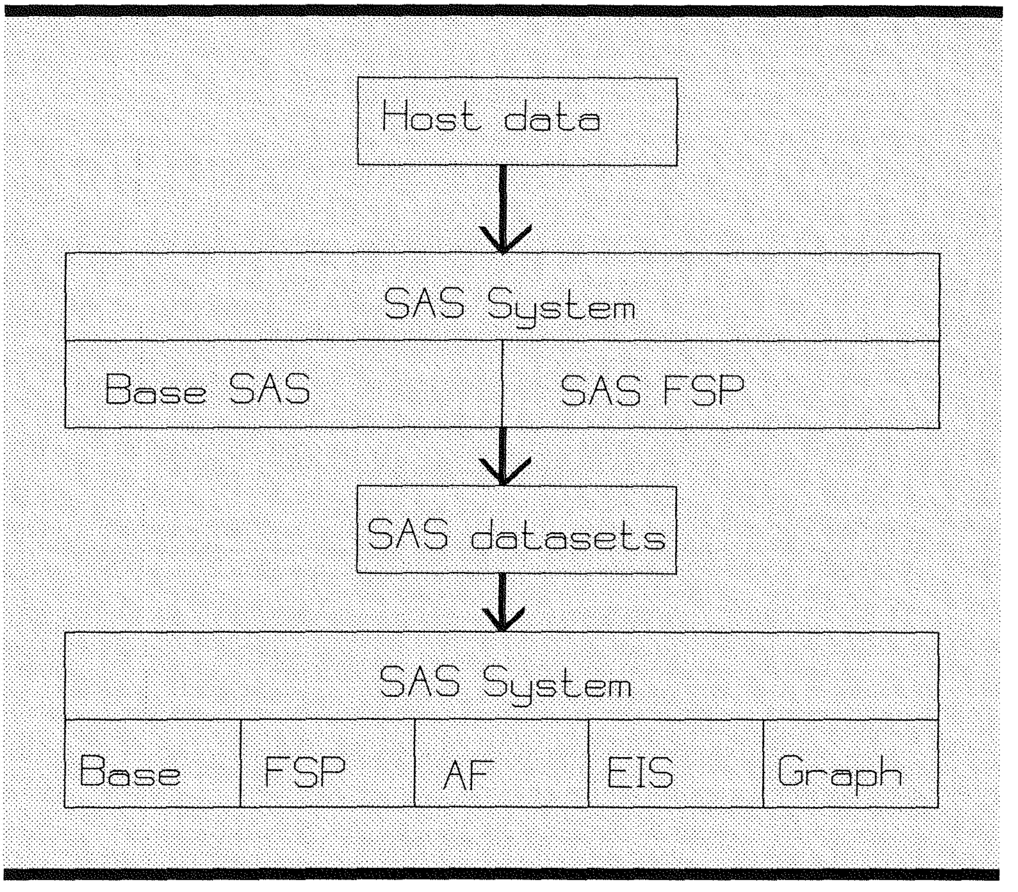
Pricing (November, 1993)

SAS Educational Pricing		
Number of Workstations	First-year Fee	Renewal-year Fee
5	$2,000	$1,500
10	$2,500	$2,000
25	$3,000	$2,500
50	$3,500	$3,000
100	$4,000	$3,500
200	$4,500	$4,000
300	$5,000	$4,500

Data Access Method

SAS/EIS uses a metabase, a "master SAS data set that stores information about the data. The metabase is used for specifying attributes for datasets and variables in your EIS applications." (SAS Institute, April, 1993). While most SAS applications require that data be located in SAS datasets, there is some support for direct access to external files (for browsing and minor editing). Applications like charting and forecasting require that the data exist in SAS data sets.

The metabase system is implemented with a series of data sets called "metalists" and several standard screen-control programs for manipulating the lists. One of the key datasets within the metabase system is the "attribute dictionary." The attribute dictionary contains attributes which are available for assignment to other objects in the metabase. Attributes are assigned to data through a process called "registration." The overall SAS structure is illustrated in figure 8 below.



8 SAS Data Access Structure

Software Organization

SAS/EIS is based on "object" packages of data and routines. Objects can be combined into "applications" which provide the actual business-information tasks of the executive information system. Standard objects within SAS/EIS include:

- AF: SAS/AF (Windows-style user interface to other SAS applications)
- BLOCK: block menus
- CALC: spreadsheets
- CHART: business graph charts
- CSF: critical success factors
- DESKTOP: graphics menu builder
- EDIT: edit SAS data set
- EXECUTE: execute a SAS program
- FILENAME: assign a file reference name
- FORECAST: simple forecasting
- GRAPH: graphics
- LETTER: letter application
- LIBNAME: assign a library reference name
- LISTMENU: list menu
- OUTPUT: output entry
- PLOT: business graphics plots
- PREDICT: what-if analysis
- RANGE: ranges
- REPORT: general reporting
- SASCMD: SAS commands
- SCRIPT: script of SAS/EIS applications

- SIGNON: remote connect
- SOURCE: source entry
- SYSCMD: host-system commands
- VARREP: variance report
- VIEWFILE: view an external file
- WELCOME: welcome window

SAS/EIS is not a standalone product; its use requires several other SAS modules:

- Base SAS

  Base SAS provides facilities for creating SAS datasets.
- SAS/AF

  SAS/AF is used for building and maintaining FRAME entries in the SAS catalog. FRAMES are used to build interactive SAS applications using the SAS control language (SCL). FRAME entries are members of object-oriented classes.
- SAS/EIS

  SAS/EIS is the principal SAS vehicle for delivering executive information using SAS. SAS/EIS includes tools for metadata design and actual data delivery.
- SAS/FSP

  SAS/FSP is used to create and modify SAS datasets.

- SAS/GRAPH

  SAS/GRAPH is used to create graphs from SAS datasets.

Feature list

SAS supports various typical EIS features:

- Charting

  (dynamically created graphs, stored graphs)

- Forecasts
- Report viewing

  (text reports, variance reports)

- What-if analysis
- Drill down
- Traffic lighting
- Hot spots
- Bookmarks for easy movement to specific windows
- Menus

(SAS Institute Getting Started with SAS/EIS Software, 1993, pp. 2-3).

SAS/EIS is part of a software family with strong mainframe roots. Parts of the software still show this heritage--most applications are run by forming a paragraph of source code and submitting the code to a batch processor.

SAS/EIS is designed to run on multiple platforms (Windows, OS/2, Unix), so the graphical user interface is a compromise between various styles. The buttons have a non-Windows look.

SAS/EIS has memory requirements which are larger than the other EIS packages reviewed in this dissertation. SAS/EIS requires a minimum of 10 MB RAM, with 14 MB recommended.

The SAS documentation set is the largest of the products reviewed in this dissertation. Fifteen manuals are provided as part of the SAS/EIS package (which includes several other required modules). Eight of these manuals are over 300 pages in length, with two manuals being over 1,000 pages long.

Summary of Lotus Notes

Product Identification

Lotus Notes (version 3.0)

Lotus Development Corporation

55 Cambridge Parkway

Cambridge, MA 02142

Overview of the product

Notes is "...an open platform for sharing knowledge and building business applications." (Lotus Development Corporation, 1993, Lotus Notes Means Business. Notes is "...a unique, secure client-server implementation of an open distributed document database with integral messaging transport and an environment for developing and deploying knowledge-sharing applications." (Lotus Development Corporation, 1993, Discovering Lotus Notes). "There is no product like Lotus Notes. It's a unique, secure client-server implementation of an open, distributed document database" (Lotus Development Corporation, 1993, Lotus Notes).

Features of Lotus Notes include:

- Database technology for storing documents
- Support for collaborative work

- Full-text search
- Pop-up and multimedia annotation
- Replication (selective, background)
- Automatic document versioning

Standard applications which ship with Notes include:

- Correspondence tracking
- Customer tracking
- Discussion groups
- Document library
- Meeting tracking
- News
- Reservation scheduler
- Service request tracking
- Status reports
- Things to do

Notes is designed for applications which involve large amounts of free-form material requiring access by a group of users. Some support is provided for mathematical calculations, but the product is not designed for real-time, spreadsheet-style applications.

Pricing (November, 1993)

Lotus Notes Academic Pricing	
Server (OS/2 or Windows)	$225
1 client	110
10 clients	1,000
20 clients	1,900
50 clients	4,500
100 clients	8,500

Summary of Paradox for Windows

Product Identification

Paradox for Windows (version 4.5)

Borland International

100 Borland Way

Scotts Valley, CA 95066-3249

(408) 431-1000

Overview of the Product

Paradox is a relational database management system that can be used either as a standalone system on a single computer or as a multiuser system on a network. Paradox includes support for:

- Context-sensitive "speed bar" buttons
- Desktop folders
- Table viewer, organized by primary key or secondary index
- Graphical query by example
- Form design tool
- Report design tool
- Access data in Paradox and dBASE formats

- SQL database access for InterBase, Oracle, Sybase, and Microsoft
- Use of OLE and DDE links

Pricing (November, 1993)

Pricing for Paradox for Windows	
List price	$795.95
Educational price	$69.95

Summary of QuattroPro

Product Identification

QuattroPro for Windows (version 5.0)

Borland International

100 Borland Way

Scotts Valley, CA 95066-3249

(408) 431-1000

Overview of the Product

QuattroPro for Windows includes:

- Notebooks (three-dimensional, multipage spreadsheets)
- Multiple windows
- Styles for formatting output
- Group-mode commands (applying same command to adjacent pages)
- Speed buttons
- Support for bit-mapped graphics and slide shows
- Dynamic data exchange (DDE and OLE)
- Add-in @-functions

Pricing (November, 1993)

Pricing for QuattroPro for Windows	
List price	$99.95
Educational price	$49.95

Summary of Word Perfect for Windows

Product Identification

Word Perfect for Windows (version 4.0)

WordPerfect Corporation

1555 N. Technology Way

Orem, UT 84057-2399

(801) 225-5000

Overview of the Product

WordPerfect for Windows is a full-featured word processing system. The current release supports:

- Columns and tables, including spreadsheet functions
- Dynamic data exchange (DDE)
- Equation editing
- Graphics (created within WordPerfect or imported)
- Mailing documents
- Merging
- Spell checking
- Spreadsheet and database importing and linking

Pricing (November, 1993)

Educational Pricing for WordPerfect	
List price for one copy (Schools are eligible for an 8-for-1 grant when buying WordPerfect. These licenses must be used on-campus only.)	$495
At-home license for full-time faculty, staff, and students	$135

Summary of WordPerfect Office

Product Identification

WordPerfect Office for Windows (version 4.0a)

WordPerfect Corporation

1555 N. Technology Way

Orem, UT 84057-2399

(801) 225-5000

Overview of the Product

WordPerfect Office is a comprehensive electronic-mail package. The system also includes a calendar and scheduler. Features of WordPerfect Office include:

- Personal and system mailing groups
- Appointment transactions
- Auto-date scheduling of appointments
- Delegation and forwarding
- Rule processing for incoming messages
- Information on outgoing messages (date and time of delivery, opening, deleting)
- Folders for sorting incoming and outgoing messages

- Proxy feature for allowing other people to read your mail
- Retraction of unread messages
- Routing slips

Pricing (November, 1993)

Educational Pricing for WordPerfect Office	
List price for server edition	$295
List price for client pack for 5 users (Schools are eligible for an 8-for-1 grant when buying WordPerfect. These licenses must be used on-campus only.)	$495

General Systems Design

The third and final phase of the project included a general systems design for the executive information system. The requirements were further refined to determine the supporting data elements needed. Once preliminary data stores were defined, a basic prototype structure was established and implemented. The prototype implementation was done using three commercial EIS packages (Pilot's LightShip, Trinzic's Forest & Trees, and Cognos' PowerPlay). While a detailed EIS design might include some use of the productivity packages, the initial prototype design focused on the commercial EIS software packages.

Attribute Identification

As part of the general systems design, this researcher developed a list of entities, attributes, and time dimensions which would be appropriate for the Cedarville College EIS. The entities were selected on the basis of decision making referenced by administrators and middle managers during the interview process, and on the basis of existing report specifications on the College's administrative computer system. Attributes and time dimensions were derived from the interviews and further analysis by this researcher. Tables 28 and 29 show the entities and attributes which were derived during this portion of the general systems design. Time dimensions which would be applied to these entities and attributes were shown in table 27.

Table 28: EIS Entities	
Academic Records (REG)	classroom course section faculty member student
Accounts Receivable (AR)	account
Admissions (ADM)	applicant institution prospect
Christian Ministries (CHR)	church mission team
Development (DEV)	campaign donor gift
Financial Aid (FA)	aid recipient

Table 28: EIS Entities	
General Ledger (GL)	account
Payroll (PAY)	employee
Student Services (SSO)	student

Table 29: Entity Attributes	
Academic Records (REG)	academic status (academic warning, probation, suspension) accounts receivable balance ACT score advisor at entry advisor current
	age (birth date) aid received (loans) aid received (scholarships) aid received (employment) application status

Table 29: Entity Attributes	
	church denomination church identification number citizenship class rank (college) class rank (high school)
	classroom size classroom utilization course credits attempted course credits completed course grades earned
	course section capacity course section enrollment courses required not yet completed dependent status (dependent on parents, independent) division at entry

Table 29: Entity Attributes	
	division current ethnicity full-time status (full-time, part-time) gender grade point average (college general education)
	grade point average (college major) grade point average (college overall) grade point average (high school) graduation year (college) graduation year (high school)
	major at entry major current placement score English placement score mathematics state of residence at entry
	state of residence current transfer institution transfer credits

Table 29: Entity Attributes	
Accounts Receivable (AR)	account type (student, staff, outside agency, telephone) balance current balance aged balance payment plan balance start of term
	balance end of term class (freshman, sophomore, junior, senior, other) full-time status residence current revenue source (A/R code)
	revenue amount revenue term
Admissions (ADM)	ACT score advisor application date application status application status date

Table 29: Entity Attributes	
	church denomination contact date contact code deposit date gender
	grade point average (college) grade point average (high school) institution code (high school) institution code (college) major
	sports interest state of residence
Christian Ministries (CHR)	church location church denomination church size church number of prospects church number of students

Table 29: Entity Attributes	
	church number of alumni church giving date church giving amount church contact date church contact type
	church contact results mission field goal mission field giving
Development (DEV)	agreement holder alumni class year alumni social organization alumni sport church denomination
	corporation type (church, high school, foundation, company) gift current source (alumnus, trustee, parent, friend) gift current designation gift current date gift current amount

Table 29: Entity Attributes	
	gift current matching gift last source gift last designation gift last date gift last amount
	gift last matching gift largest source gift largest designation gift largest date gift largest amount
	gift largest matching gift total amount to date gift total matching to date giving interests (capital campaigns, annual fund, specific departments) participant in special events (golf tournament, tours)

Table 29: Entity Attributes	
	phonathon response pledge balance pledge designation pledge date pledge amount
Financial Aid (FA)	ACT score aid type (government, private, institutional) aid type (scholarship, loan, employment) aid type (need-based, non-need-based) aid amount
	debt load family income grade point average (high school) grade point average (college) major

Table 29: Entity Attributes	
	matriculation date (yield studies)
	need index
	state of residence
	student type (full-time, part-time)
	student type (on-campus, off-campus, commuter)
	terms registered (retention)
	unmet need
General Ledger (GL)	balance year-to-date
	budget adjustment permanent
	budget adjustment temporary
	budget officer
	budget original
	budget year-to-date
	credit
	credit year-to-date
	debit
	debit year-to-date

Table 29: Entity Attributes	
	general ledger department general ledger detail (type of expense) general ledger fund (general, restricted) opening balance responsible vice-president
Payroll (PAY)	classification (secretarial, technical, administrative, trades) dependents employee full-time status (full-time, part-time) employee staff status (faculty, staff) employee student status (student, non-student)
	exempt status (exempt, non-exempt) hire date hourly status (hourly, salaried) life insurance eligibility medical plan (single, couple, family)

Table 29: Entity Attributes	
	salary amount salary general ledger source pension plan eligible date rank (professor, associate, assistant, instructor) termination date
	tuition remission amount
Student Services (SSO)	chapel cuts class (freshman, sophomore, junior, senior, other) enrollment deposit amount enrollment deposit date ethnicity
	gender health insurance plan major current marital status pre-registration month

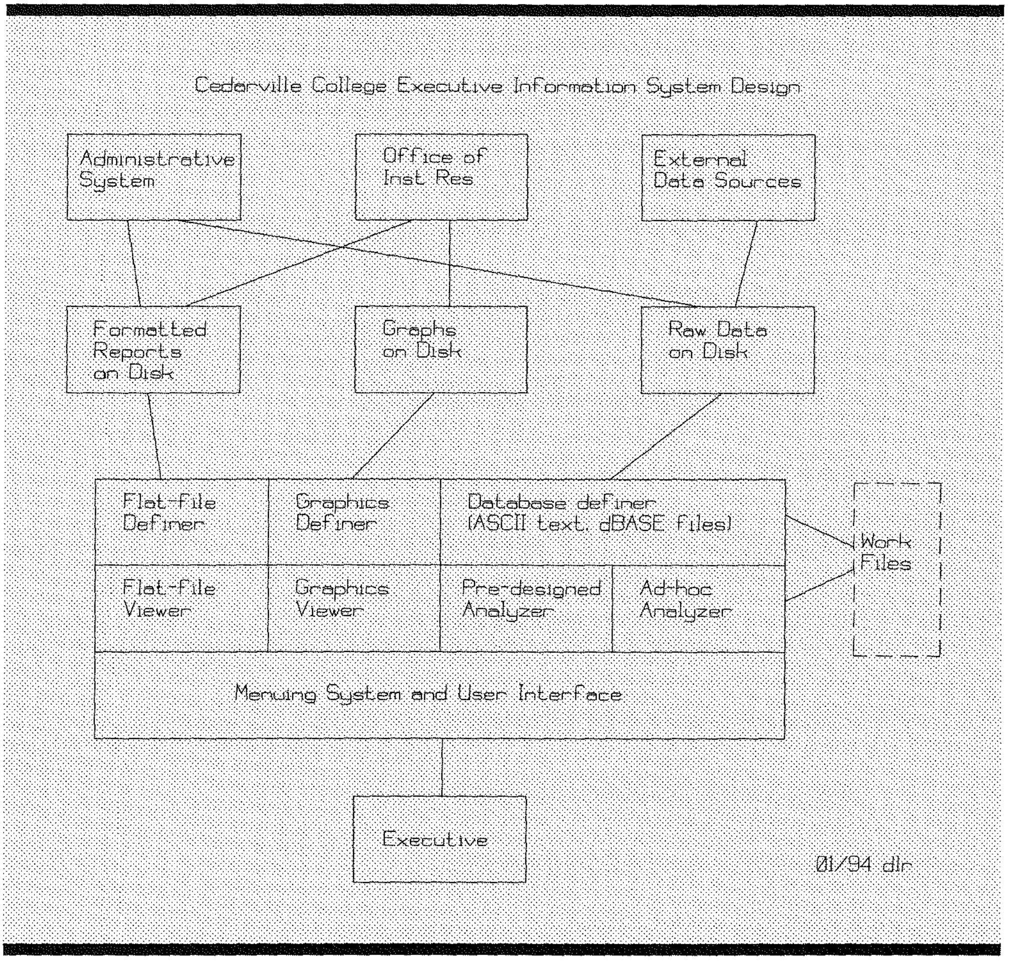
Table 29: Entity Attributes	
	pre-registration year residence anticipated (on-campus, off-campus, true commuter) residence current (on-campus, off-campus, true commuter) residence hall anticipated residence hall current
	residence hall current advisor residence hall current director third-world status (third-world resident)

Data Definition

The entities, attributes, and time dimensions which were identified in the previous activity were then combined into data store definitions which would form the basic file structure for the EIS. The data store definitions are shown in appendix A and the corresponding central data dictionary is shown in appendix B. The data stores were designed so as to be suitable for processing by the commercial EIS software. This design limitation precluded the use of normalized data stores, as the EIS packages are generally incapable of performing logical joins on local data. (The EIS development for Cedarville College is based on using local copies of administrative data rather than directly accessing the data. Direct access via the EIS software packages requires structured query language (SQL) on the host, but SQL is not available on the College's current administrative system.)

Modeling

Once the data dictionary items were in place, this researcher developed a diagram to illustrate the required structure for the Cedarville College EIS. That structure is shown in figure 9 below.



9 Logical structure for Cedarville College EIS

As can be seen from the structure diagram above, the Cedarville College EIS requires access to external data in digital format. Two major sources of this external data have been identified. These sources and the types of data provided are described in table 30.

Table 30: Potential Sources of External Data	
Quantum Research Corp. 7315 Wisconsin Ave., 631W Bethesda, MD 20814 "Caspar" ($350)	R&D Expenditures Survey (NSF Survey of Scientific and Engineering Expenditures at Universities and Colleges)
	Federal Support Survey (NSF Survey of Federal Obligations to Universities, Colleges, and Selected Nonprofit Institutions)
	Graduate Student Survey (NSF-NIH Survey of Graduate Science and Engineering Students and Postdoctorates)
	S&E Personnel Survey (NSF Survey of Scientific and Engineering Personnel Employed at Universities and Colleges)
	Earned Degrees (NCES IPEDS Survey)
	Opening Fall Enrollment (NCES IPEDS Survey)
	Faculty Salaries, Tenure, and Fringe Benefits (NCES IPEDS Survey)

Table 30: Potential Sources of External Data	
	Financial Statistics on 151 Variables (NCES IPEDS Survey)
	Tuition (NCES IPEDS Survey)
	Doctorate Records (National Research Council)
	Doctorate Program Ratings (National Research Council)
John Minter Associates 2400 Central Ave., Suite B-2 Boulder, CO 80301	Rankings by revenue contribution ratios, expenditure allocation ratios, fall enrollment, recruitment statistics, tuition and other institutional charges, student financial aid, unrestricted revenue statistics, unrestricted expense statistics ($200)
	Tuition and other student charges, 1992-93 ($50)
	16-year trends in undergraduate tuition and fees ($55)

Table 30: Potential Sources of External Data	
	Student financial aid expenditure ratios by source of aid ($50)
	College Board survey of student financial aid ($65)
	Management ratios for colleges and universities, 1990-91 ($65)
	Operating costs of higher education, 1990-91 ($65)
	Financial statistics and ratios for colleges and universities, 1990-91 ($65)
	Financial ratio trends for independent colleges and universities, 1981-1991 ($65)
	10-year trends in revenue and expenditure ratios, 1982-1991 ($55)
	IPEDS reports ($40 per section for sections A, B, E, K, G, H, I)

A major part of the general systems design phase was the development of prototypes of the Cedarville College EIS. This researcher developed a prototype design of approximately 20 screens. These screens were selected to cover both financial and student records, and to illustrate various capabilities of executive information systems. The screen designs and the associated EIS features they illustrate are shown in table 31. This design was presented to the three participant groups along with the descriptions shown in table 32.

Table 31: EIS Prototype Screen Designs

Source Screen	Text/Title	Options/Contents	Dest. Screen	Technique
1000	Cedarville College Executive Information System	Financial System	2000	Menus
		Student System	3000	
		Exit	NA	
2000	Financial System	Revenue	2100	Menus
		Expense	2200	
		View Report	2300	
		Return	1000	
		Exit	NA	

Table 31: EIS Prototype Screen Designs

Source Screen	Text/Title	Options/Contents	Dest. Screen	Technique
2100	Revenue	By year/month	2110	dBASE access
		By department	2120	
		By detail	2130	Traffic lighting
		Return	2000	
		Exit	NA	Drill-down
2200	Expense	By year/month	2210	
		By department	2220	User-controllable
		By detail	2230	cross-tab
		Return	2000	
		Exit	NA	
2300	View Report	Actual report	NA	View external text
		Return	2000	report
		Exit	NA	

Table 31: EIS Prototype Screen Designs				
Source Screen	Text/Title	Options/Contents	Dest. Screen	Technique
3000	Student System	Demog Analysis GPA Predictors View Graph Return Exit	3100 3200 3300 1000 NA	Menus
3100	Demographic Analysis	Applic Status Birth year Gender Return Exit	3110 3120 3130 3000 NA	Charts (single variable; bar and pie)
3200	GPA Predictors	ACT Score High Schl GPA Return Exit	3210 3220 3000 NA	Charts (two variables; bar)
3300	View Graph	Actual Graph Return Exit	NA 3000 NA	View external graphical object

Table 32: Description of EIS Techniques in Prototype Design

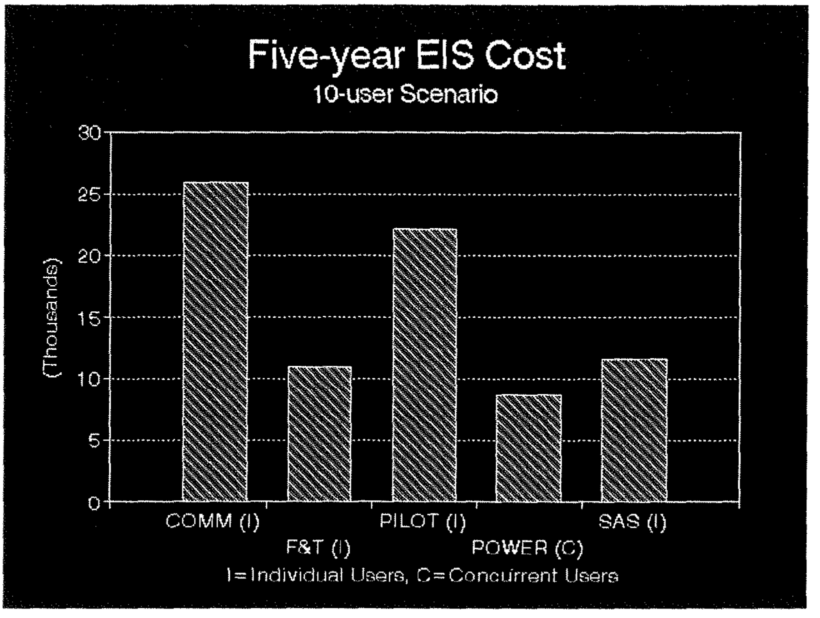
dBASE access	Use the EIS software package to access data which is stored in a dBASE IV database file.
drill-down	Obtain supporting detail which supports a particular numeric value displayed on the screen. For example, if the screen shows departmental expenditures of $875, a drill-down would display each type (general ledger object) of transaction and corresponding expenditure which generated the $875 total.
traffic-lighting (stop-lighting)	Use color to highlight numeric values which fall outside of a pre-determined range. Typically, a value on one extreme is colored red and a value on the other extreme is colored green. Traffic-lighting is used to help visualize a variance or exception condition.

Table 32: Description of EIS Techniques in Prototype Design	
User-controllable cross-tab	Present an array of rows and columns where the user can select the categories to be used for the rows and columns and the values to be displayed in the corresponding cells. For example, the user might be able to select general ledger pieces for the rows and columns: fund, department, detail, year, quarter, month. The cell options might include dollar amounts: revenue, expense, budget.
View external text report	Provide a scrollable on-screen representation of a text-based report. Typical use for this technique would be viewing reports which have been copied from the administrative host to the microcomputer (rather than receiving the printed output).
View external graphical object	Provide an on-screen image using a graphics file produced by some other software package. This technique is particularly useful in presenting charts that have been prepared using a spreadsheet program.

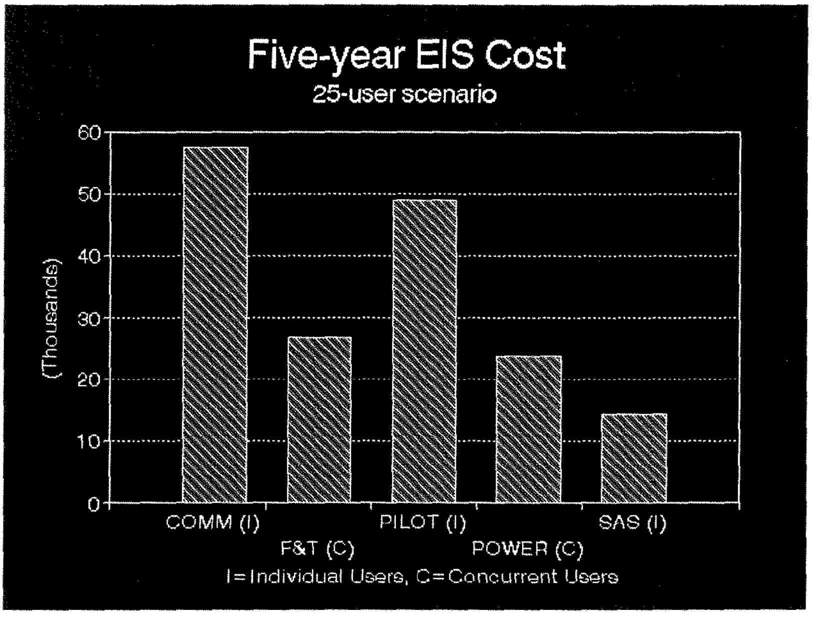
Once the prototype design was complete, it was necessary to select one or more of the commercial EIS packages for implementing the prototype. As an aid in the selection process, this researcher estimated the number of people who would be accessing the software. One estimate was prepared under the assumption that use of the EIS would be used by a fairly limited group of people (the vice-presidents and a few middle managers). A second estimate assumed that the EIS would be used by all of the middle managers. These estimates are shown in table 33. Based on the estimates of the number of users, projected five-year costs were calculated. These costs reflect two scenarios (10 users and 25 users). Both scenarios include initial software cost and annual software maintenance, but the cost estimates do not include any hardware costs or labor costs for developing the EIS application. The two cost charts are shown in figures 10 and 11 below. On the basis of the cost estimates, Comshare's Commander was eliminated from the prototype process.

Table 33: Estimated User Counts				
Potential user base	Count	Running Total	Concurrent Users	
			EIS Only	EIS+ Other
Administrative council	6	6	3	3
Middle managers	40	46	10	15
Faculty	130	176	20	50
Staff	150	326	25	60
Students	2,300	2,626	NA	100

Note: The EIS products could be used for EIS-only delivery, or for delivery of other information. If other information is delivered, users may stay on the system longer, requiring more concurrent licenses.



10 Cost estimates, 10-user EIS



11 Cost estimates, 25-user EIS

The remaining four packages were considered for development of a prototype. However, consideration for faithfulness to the Windows paradigm and estimated development effort eliminated SAS/EIS from consideration. The SAS/EIS package has an interface which uses different buttons and controls from standard Windows applications. The SAS/EIS package is also labor-intensive, as it requires mastery of several separate modules prior to implementing the EIS portion. These observations regarding SAS/EIS are confirmed in a recent article by Robert Moran (January 10, 1994).

Elimination of SAS/EIS left the researcher with three products to use in developing the prototype:

- Trinzic's Forest & Trees
- Pilot's LightShip
- Cognos' PowerPlay

Full prototypes were successfully developed and demonstrated using Forest & Trees and using LightShip. The PowerPlay product provided a comprehensive user-controllable cross-tab capability, but did not provide any of the other features specified in the prototype design. Several of the actual screens developed in the prototypes are shown in appendices C, D, and E. A summary of the features implemented in each prototype is shown in table 34.

Table 34: Techniques Implemented in Prototypes	
Forest & Trees	menus
	dBASE access
	drill-down
	view external report
	view external graphic object
	single-variable bar chart
	single-variable pie chart
	two-variable bar chart
	user-controllable cross tab
LightShip	menus
	dBASE access
	traffic lighting
	drill-down
	view external report
	view external graphic object
	single-variable bar chart

	single-variable pie chart
	two-variable bar chart
PowerPlay	delimited-file access
	user-controllable cross-tab

The Forest & Trees prototype was implemented without major incident. The program took approximately 5 minutes to load all 1884 records of the general ledger database. Drill-down was achieved in two different ways. In one method, each row of a view became a hot-spot for updating another view with the detail for that line. In the second method, two views were linked together in a parent-child fashion. With the parent-child link in place, Forest & Trees automatically generated the drill-down and drill-up icons. Forest & Trees does not have a built in file viewer, so the file-viewing was accomplished by invoking the Windows "notepad" program. One limitation of Forest & Trees is that there is no obvious way to enter text on the screen. The method which is documented in the Forest & Trees reference manuals is to import a bit-map file. This researcher generated text by placing an edit-list view on the screen and then removing all borders and buttons. Viewing existing graphical objects within Forest & Trees is limited to Windows bitmap files (.BMP) and icon files (.ICO). No support is provided for PCX or other popular digital formats.

The LightShip prototype was implemented with two major difficulties. The first problem related to loading data via LightShip Lens. LightShip was faster than Forest & Trees in loading data, as the 1884 records of the general ledger database were loaded within 10 seconds. However, an attempt to process all of the fields generated an error message indicating that too much text had been generated, and that the number of fields needed to be reduced. In order to make the general ledger data accessible, this researcher had to omit three fields (budget officer, opening balance, and fund) from the sample data. The second difficulty encountered with the LightShip prototype involved the implementation of drill-down. The concept of drill-down is described briefly in the reference manuals, but no instructions are given for implementing it. Drill-down can be implemented in LightShip in one particular situation: If a particular document object has a fixed number of rows, a hot-spot can be created for each row and these hot-spots could then invoke detail screens. This drill-down implementation relies on separate development of each of the detail screens.

PowerPlay's "Transformer" does not provide an interface to dBASE files, so data were loaded from ASCII text files. Loading the 1884 records in the general ledger ASCII file took only 5 seconds. However, Transformer did not correctly handle the "fiscal year" and "fund" fields of the input data.

Even with several attempts to force Transformer to recognize these fields as dimensions, the resulting model did not include them. Also, none of the other dimensions were provided with any categories. For example, the "month" dimension should have had 12 categories (month 01, month 02, etc.), but Transformer did not generate any of these categories. The resulting extract would provide only one grand total for each measure (opening balance, budget, debit, credit). No drill-down was possible with this arrangement. A smaller general ledger file which had only yearly totals rather than monthly totals was successfully loaded, creating the appropriate categories in each dimension. One problem which was encountered during this data loading process is Transformer's control over file names. When creating extract files, Transformer does not allow the developer to specify the name of the extract file. Instead, the name is generated from the name of the source file. This makes generating multiple extracts from the same source file difficult. (Transformer will generate sequentially-numbered extract files, but the developer has no control over the numbering or naming.) Transformer loaded the student demographic data successfully, and even automatically inferred a relationship between division, major, and advisor.

The "Viewer" portion of PowerPlay is designed for active manipulation and exploration of data. The drill-down capabilities are easily accessible from a "dimension line." The user can click on a particular dimension and select the drill-down level for that dimension. Viewer also includes a "power bar."

Using the power bar, the display can be changed from the default cross-tabulation view to a graphical view. The power bar can also be used to change the contents of rows and columns (changing the dimensions which are shown, changing the display from raw values to percents, and swapping rows and columns). These drill-down capabilities are easily implemented and easily accessed. However, Viewer does not have any menuing or branching capabilities. To provide a set of pre-determined views, the developer needs to create the corresponding view files. The end-user must call up these view files one at a time. The developer, therefore, would need to provide documentation as to the names and contents of the view files. The Viewer does have an option to export data from a particular view. This feature would be useful for a manager who wanted to use another tool (e.g., a spreadsheet) to perform other analyses on the data being displayed by PowerPlay. Some results using the "Reporter" module of PowerPlay were difficult to explain. A cross-tabulation of "application status" and "gender" showed 199 females with an application status of "A1," even though there were only 160 students in the entire sample data set.

Evaluation of the Design

The design which resulted from the three phases was evaluated as a means of verifying the design's appropriateness. The evaluation procedure included an internal review within the College and a review by external experts. The internal review was conducted by the three participating groups, while the external review was conducted by three information systems managers from colleges which use the Datatel Colleague software package and by the director of marketing and product development for Datatel. Details of the review are provided below.

A synopsis of the requirements document and the proposed design was prepared and distributed to the evaluators. An evaluation instrument accompanied the synopsis. The evaluation instrument focused on EIS features described in chapter 2: executive participation, quick access, analytical tools, management impact, and ease of use (from the section on historical and functional contrasts). The actual evaluation instrument is shown in figure 12, and the evaluation results are presented in table 35. Reviewer comments are shown in table 36.

Evaluation of the Cedarville College EIS Design

The following characteristics are generally considered to be important in supporting executive information systems (EIS). Please rate the proposal for Cedarville's EIS using a scale of 1 (strongly agree) to 5 (strongly disagree).

1.	The proposed design will encourage executives to actually use the system.	1 2 3 4 5 SA SD
2.	The proposed design will deliver the required information as fast or faster than current methods.	1 2 3 4 5 SA SD
3.	The proposed design includes tools which will help executives perform strategic analyses.	1 2 3 4 5 SA SD
4.	The proposed design will contribute to the mission and competitive position of the institution.	1 2 3 4 5 SA SD
5.	The proposed design will help the institution achieve its critical success factors.	1 2 3 4 5 SA SD
6.	The proposed design will help give executives access to internal information.	1 2 3 4 5 SA SD
7.	The proposed design will help give executives access to external information.	1 2 3 4 5 SA SD
8.	The proposed design will aid the executives in predicting long-term trends in higher education.	1 2 3 4 5 SA SD
9.	The proposed design will aid the executives in planning for long-term curricular changes.	1 2 3 4 5 SA SD
10.	The proposed design will be easy to use.	1 2 3 4 5 SA SD
11.	The proposed design makes appropriate use of graphics.	1 2 3 4 5 SA SD

Evaluator's position:

_____ Cedarville College administration
_____ Cedarville College middle-management
_____ Cedarville College systems analyst
_____ Other

12 EIS Evaluation Instrument

Table 35: Evaluation Results		
Item	Internal Rating	External Rating
1. The proposed design will encourage executives to actually use the system.	1 SA **** 2 *** 3 ***** 4 5 SD *	1 SA * 2 *** 3 4 5 SD
2. The proposed design will deliver the required information as fast or faster than current methods.	1 SA ******** 2 *** 3 * 4 5 SD *	1 SA *** 2 * 3 4 5 SD
3. The proposed design includes tools which will help executives perform strategic analyses.	1 SA **** 2 ******* 3 * 4 * 5 SD	1 SA ** 2 ** 3 4 5 SD

Table 35: Evaluation Results

Item	Internal Rating	External Rating
4. The proposed design will contribute to the mission and competitive position of the institution.	1 SA ** 2 ******** 3 *** 4 5 SD	1 SA ** 2 * 3 * 4 5 SD
5. The proposed design will help the institution achieve its critical success factors.	1 SA *** 2 ****** 3 ** 4 ** 5 SD	1 SA * 2 ** 3 * 4 5 SD
6. The proposed design will help give executives access to internal information.	1 SA ******* 2 ****** 3 4 5 SD	1 SA **** 2 3 4 5 SD

Table 35: Evaluation Results		
Item	Internal Rating	External Rating
7. The proposed design will help give executives access to external information.	1 SA *** 2 *** 3 ***** 4 ** 5 SD	1 SA * 2 * 3 ** 4 5 SD
8. The proposed design will aid the executives in predicting long-term trends in higher education.	1 SA *** 2 ***** 3 **** 4 * 5 SD	1 SA ** 2 * 3 * 4 5 SD
9. The proposed design will aid the executives in planning for long-term curricular changes.	1 SA **** 2 ******** 3 4 5 SD *	1 SA * 2 ** 3 * 4 5 SD

Table 35: Evaluation Results		
Item	Internal Rating	External Rating
10. The proposed design will be easy to use.	1 SA **** 2 ******* 3 4 ** 5 SD	1 SA 2 *** 3 * 4 5 SD
11. The proposed design makes appropriate use of graphics.	1 SA ****** 2 ****** 3 * 4 5 SD	1 SA * 2 3 ** 4 * 5 SD
Note: The internal results shown above are based on 13 evaluation instruments returned, representing an 92% return rate on the 14 instruments which were distributed to individuals within the College. The external results shown above are based on 4 evaluation instruments returned, representing a 100% return rate on the 4 instruments which were distributed to individuals outside the College.		

Table 36: Reviewer Comments
Internal Reviewers (Three of the 14 internal reviewers made comments.)
Will this system really provide data to quicker [sic]? My understanding is that most of the data available would be updated on a weekly basis. In many cases, this would not be current enough.
What about all the various statistics that must be massaged before they are released due to adjustments that are not current or easily tracked by the administrative system?
Will the utility of such a system justify the additional costs, which could be significant?
Which would be better supported by such a system, strategic or operational decisions? I would think that the system could be better justified on an operational basis versus a strategic decision making basis.
I liked what I saw today. The real question hinges on its ability to economically deliver needed information to the decision maker in a timely fashion.

Table 36: Reviewer Comments
Regarding item 1 [encourage executive use of the system]...if you mean **personally** [my rating is a 3]. I believe that they [the executives] would have their secretaries use it often.
The graphics are less than spectacular.
External Reviewers (Three of the four reviewers supplied comments.)
The front-end menu needs more development. [The] ability to drill down to specific menus is needed. I suspect you do it, you just didn't show it.
I strongly favor graphical presentations to support numbers. The graphs, though, need to show the numbers they represent, at least in some cases.
Are you considering offering a comparison to other departments, schools, etc. in detail or in summary to assist in the analysis?

Table 36: Reviewer Comments
We might more strongly agree with this statement [item 5] if it had said ...design is an important tool to help... The way it is worded, we questioned what the critical success factors are and what other designs not stated must be in place for this piece (the proposed design) to have a significant impact. For example, we assume enrollment management is one critical success factor. How will this tool make a significant difference over current tools already in place?
We did not more strongly agree [with item 7] in part based on lack of knowledge about the format of external data. Will it be present in the same format as internal data? Will one be able to do comparison reports on internal and external data?
Over all, we "agree" to "strongly agree" with the entire proposal.
How does the EIS retrieve and compile data from the Prime [administrative computer system] quickly?
Page 7 shows formatted reports on disk, graphs, and raw data, what produces these and where are they stored?
How often are they [reports, graphs, and raw data] updated or are you going to deal with real-time data?

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How does the EIS retrieve and compile data from the Prime [administrative computer system] quickly?
Page 7 shows formatted reports on disk, graphs, and raw data, what produces these and where are they stored?
How often are they [reports, graphs, and raw data] updated or are you going to deal with real-time data?

Table 36: Reviewer Comments
How easy is it to enhance the system and does it provide flexibility for future growth or portability?
What are the costs for development time and management related to this system?
If question 2 is read from the perspective of system staff rather than end-users, we would have the following questions: Not knowing your system capacity or design or the time constraints or capabilities of your staff, our question [is] what about packages such as Visual Basic at $140 or Visual C++...why Forest & Trees or Pilot LightShip? Could you do the job in-house as fast or faster and more cheaply than this proposal?
Is the administrative system providing data to the EIS on a "real-time" basis? We believe that the answer to this question has to be "yes." The failure of most EIS systems has been the lack of timeliness of the data. Executives want the answer to their questions to reflect up-to-the-minute data.

Table 36: Reviewer Comments
Are your internal "attributes" restricted to ones currently available in Colleague [the administrative software package]? There are several other critical attributes being included in the next few releases of Colleague that would benefit Cedarville. These include far more extensive personnel information and data on the goods and services buying characteristics of your institution. Also, we will be releasing a pooled investment program that will help measure your institution's investment performance.
How will you enter and maintain the external data? I expect that the external data is [sic] in a variety of formats, is very dated, and is unavailable in any form of computer media. I also wonder if an executive will really want to believe the data on a peer institution. Usually, they believe that differences between institutions obscure the lessons that can be learned from the data.
As you may know, we have been using Forest & Trees to develop our EIS. We are awaiting the next release of SQL from UniData to finish the first phase of the project. Our brief experience with our prototype suggests that using a graphical presentation for the top level of presentation, with the ability to drill down to the actual supporting data, is the preferred method of operation. Most systems elect to use the exact opposite technique.

Table 36: Reviewer Comments
The one area that seems to be missing from your design is any data on faculty. We see a strong desire from executives in higher education to look at more extensive data on their faculty. The demands of more cost-effective use of personnel resources are driving this requirement. Also, the new accreditation investigations that will evolve over the next few years will dictate the need for current and historical faculty information.
Another evolving requirement is the need to satisfy FASB SFAS number 117. Datatel will introduce new software to calculate the financial "ratios" specified in this requirement. The financial ratios defined by this specification will introduce some excellent peer institution data that can be used in an EIS. Also, the ongoing NACUBO benchmark project includes a variety of peer institution information.

Summary

This chapter has presented the results of executing the activities outlined in chapter 3. In particular, this researcher conducted a systems planning activity, performed a systems analysis, and developed a general systems design. These activities included a requirements analysis, data definition activities, and the development of three prototype executive information systems. The EIS design and prototypes were then evaluated by internal and external reviewers. The entire project was designed to demonstrate the feasibility of accomplishing the problem statement:

Design an effective, economical

executive information system

for Cedarville College.

Chapter 5 Discussion

Success of the Design Effort

Success of a systems analysis design effort can be measured in at least two ways: conformance to the design objectives and acceptance by the end-users. For the Cedarville College executive information systems project, the phases were conducted according to plan and (in the sense of producing the planned product) were successful. Acceptance by the end-users was measured by an evaluation instrument. End-user acceptance of an EIS is critical (if the end-users do not like it, they will not use it), so an item-by-item review of the evaluation results is in order. The discussion below highlights those evaluation items where this researcher has identified a discrepancy between internal and external reviewers or where internal (end-user) acceptance is suspect.

Encourage Executives to Actually Use the System

All of the external reviewers rated the "encourage executive use" item towards the "strongly agree" end of the rating scale. However, four of the internal reviewers gave a neutral rating and one gave a "strongly disagree" rating. This overall lack of enthusiasm by internal reviewers may be an indication that the EIS design is not addressing a felt need.

Deliver Required Information as Fast or Faster

A similar disparity in ratings was obtained on the "deliver information faster" item. One of the internal reviewers gave this item a neutral rating and one gave it a "strongly disagree" rating. This hesitancy about the speed of delivery may indicate a problem in the design (e.g., frequency of updates), confusion about the frequency of updates, or the success of current delivery methods.

Tools for Strategic Analyses

The majority of internal reviewers rated the "strategic analyses" item between "strongly agree" and "neutral." One of the reviewers suggested that the information being presented was more appropriate for operational decisions rather than strategic ones. The presentation materials did not define "strategic" for the reviewers; perhaps the provision of a definition would have garnered greater agreement on the strategic analyses item. Another issue to be considered relating to strategic analyses is the concept that managers sometimes make judgments based on feelings rather than facts. For a manager who makes decisions this way, provision of more information--even though it is good and relevant information--may not improve the strategic analyses.

Contribute to Mission and Competitive Position

Corporate mission is very important to Cedarville College. Every new faculty member discusses the mission statement with the College president prior to being hired. Strategic planning and budgeting decisions are based on the mission statement. Only one internal reviewer held a strong view that the proposed EIS would aid the mission and competitive position. Perhaps this is because the College is currently enjoying good success (record enrollments in 14 of the last 15 years) and many strategic issues are related to problems of rapid growth. However, a successful EIS must deliver **perceived** value if it is to be used.

Access to External Information

Comments by internal and external reviewers indicate some confusion regarding the accessibility of external information. This researcher evidently did not do an effective job of communicating what information would be available. For example, one of the reviewers questioned whether any external data would be available in electronic form...even though the two major sources of external data cited in the report do provide their data in electronic form.

One of the external reviewers commented that comparative data are generally suspect, yet that same reviewer pointed with anticipation to using new ratios being defined by NACUBO (National Association of College and University Business Officers). However, interviews conducted with Cedarville administrators indicate that access to existing comparative data is valuable. The administrators felt that timeliness was not an issue for external data.

Planning for Long-term Trends and Curricular Changes

Both internal and external reviewers gave these two items a spread-out rating. The EIS design included substantial historical data which could be used for predicting long-term trends. One possible reason the reviewers did not have a stronger impression of this aspect of the EIS is that other factors (outside the scope of the EIS) may be perceived as having a stronger influence on trends in higher education and curriculum design.

Easy to Use

Two of the internal reviewers rated ease-of-use between neutral and "strongly disagree." Evidently, these two people did not think the software interface was intuitive. Since several of the vice-presidents and the president are not frequent computer users, this evaluation may be a reflection of general computer skill rather than a specific concern over the EIS design. During the interview process, these same administrators indicated a preference for obtaining information from their subordinates. It appears that most of the subordinates would find the software easy to use.

Effective Use of Graphics

The external reviewers and some of the internal reviewers were not impressed with the graphics in the prototypes. This impression may be related to the quantity of graphics or the quality of them. This researcher also had concerns that the quality of graphics produced by the EIS packages as the prototypes were being developed. Other software products like spreadsheets can produce more attractive graphics and offer greater customization potential.

Overall Evaluation of the Design

While there were some "strongly disagree" ratings submitted, most of the ratings were "strongly agree" or between neutral and "strongly agree." These ratings and some of the reviewer comments indicate general acceptance of the EIS design.

Concerns and Alternatives

The overall hesitations mentioned by the reviewers reflect a concern that there may not be a need for the EIS type of information delivery; there may be some systems/performance issues; and that there might be a better method for delivering the information. These suggestions are explored below.

Need for Information Delivery

Four of the executives who were interviewed in the requirements analysis activity indicated their reliance on subordinates for meeting data needs. These executives do not have a felt need for improving information access, though their subordinates might. Some questions were raised during the prototype demonstrations as to the need for direct data manipulation (as in the user-controllable cross-tabulation). It seems that several of the Cedarville executives are satisfied with current information delivery methods.

Another factor which continues to haunt EIS development efforts is the unpredictable nature of information requirements. Some executive decisions are one-time affairs: there is a sudden, pressing need for information on a given topic but once the decision has been made, the decision makers are no longer interested in that information. Anticipating these requirements in the design of an EIS is difficult; convincing a prospective user that future information requirements are covered by the EIS is also difficult.

Systems Concerns

This researcher developed some systems concerns while working on the prototypes:

- Can the commercial EIS packages handle sufficient volumes of data to be useful? One of the packages could not successfully load the 1884 items in a test general ledger dataset. This test dataset represented only 2 departments out of 1,000 defined in the general ledger.
- What is the cost of development compared with the cost of delivery? The existence of a campus-wide network has made delivery of the EIS fairly economical. However, there is a great disparity in the amount of time required to learn various EIS packages. The SAS/EIS package was eliminated from the prototype process for this reason. Even the simpler-to-use products require professional manpower from the information systems area of the organization. There may be times when developing a canned report may be more cost-effective than learning how to deliver the same information via an executive information system.
- How will security be handled? For those packages that use Structured Query Language (SQL), some of the security can be handled by the host which responds to the queries. Relying on the host query, however, means that separate datasets will be provided to users with different security levels. This proliferation of files may result in considerable duplication of data and use of processing cycles on the host system. A related problem (for now) is that the current administrative system does not support SQL access.

Alternate Methods of Information Delivery

As the project proceeded, several suggestions arose regarding alternate delivery of the executive information:

- **Windows "help" system**

  One prominent feature of EIS software is the drill-down capability. This same functionality can be implemented using the hypertext features of the Windows help system. Compilers are readily available to assist developers in creation of the Windows help files. One possible use of this type of system would be an electronic version of the "Fact Book" currently produced in hardcopy form by the Office of Institutional Research.

- **Use of Asymmetrix Toolbook**

  The "Toolbook" program is designed to present multimedia materials in a point-and-click environment. Toolbook could also be used for presenting the "Fact Book." One advantage of using Toolbook would be dynamic access to tables and graphs, so that the end user would always view the most recent data.

- **Creation of ASCII files and provision of network access**

  Computer Services already provides some registration-related text-based files in shared directories on the campus network. This service could be expanded to include financial information.

- **E-mail delivery of various text-based reports**

  The Admissions Office has started delivering its monthly applicant report via electronic mail. Other information could be provided in this fashion. (However, several of the executives and middle-managers indicated that one problem with information access is finding historical information. E-mail delivery would make historical access difficult, unless the recipient developed a personal filing system for the information.)

Implications for Cedarville College

The entire project described in chapters 3 and 4 was intended to demonstrate the feasibility of the problem statement:

Design an effective, economical
executive information system
for Cedarville College.

Before concluding the dissertation, it would be appropriate to review some definitions from chapters 1 and 3 to see if, in fact, the feasibility of the problem statement has been demonstrated and what the next course of action should be for Cedarville College.

Executive Information System

The definition of **executive information system** (EIS) presented in chapter 1 is:

> An executive information system is an on-line computer system (Gray, King, McLean, and Watson, 1989) which involves the executive in data interpretation for decision making (Lukesh, 1988). This interpretation is done using the latest internal and external data (Kador, 1991), often using modeling tools and graphical presentations (Graham and Freely, 1991). The EIS typically is designed for a higher-level executive than traditional management information systems and therefore development of the EIS often emphasizes ease of use over economy (Legatt, 1991; Emery, 1987). Information handled by the EIS is obtained from internal corporate databases, internal communications, external databases, and external communications (Thierauf, 1991).

The prototype design which was developed did, in fact, include several of the features mentioned in the definition: on-line access, use of internal and external data, modeling tools, and graphical presentations. The design focused on ease-of-use, insisting on an icon-selectable menuing system.

Economical EIS

The definition of **economical** which was presented in chapter 1 is: An economical EIS is one whose benefits can be justified, or--when formal cost/benefit analyses are not performed--at least not place the corporation in a detrimental financial position. (Yeh, Zave, Conn, and Cole, 1984).

The projected out-of-pocket costs of the EIS ranged from $5,000 per year to $10,000 per year. This low cost is achievable in large part due to the existence of a campus-wide computer network and appropriate hardware on executive desks. Some concern was raised, however, about the labor costs involved in developing the EIS applications.

Effective EIS

Referring again to chapter 1, the definition of an **effective** EIS is: An effective EIS produces demonstrable benefits for the strategic planning process and for the routine management of the institution. (Frank and Lesher, Fall, 1991)

The strategic effectiveness of the EIS design was emphasized in item 3 of the evaluation instrument. All of the external reviewers rated the strategic effectiveness as "strongly agree" or between neutral and "strongly agree." Eleven of the 13 internal reviewers also rated strategic effectiveness at this level. One internal reviewer rated the strategic effectiveness as neutral, and one gave a rating between neutral and "strongly disagree." While the ratings may not be as high as this researcher would have liked, the ratings are positive in regards to the effectiveness of the EIS design.

For Cedarville College

Several questions were raised in chapter 3 regarding the specific orientation of the EIS to Cedarville College:

> Does the EIS design meet the needs of a small college (limited financial resources, intense competition for students)? Does the EIS design support the comprehensive, liberal-arts nature of the institution (emphasis on instruction rather than research, broad range of executive interests and responsibilities)? Does the EIS design reflect the Christian orientation of the college (extensive support for service and missionary opportunities, spiritual tone of operations)?

The EIS design which was presented does reflect the broad range of interests and responsibilities of the administrators. As members of the administrative council, these people are concerned not only with their particular areas of the organization but also with more general trends. The EIS design, therefore, presented a broad array of information without regard to the specific administrative duties of the user. The design is oriented to small institutions, minimizing content in areas such as teaching load (since these areas are easier to manage in a small institution). The EIS design also provides support for Cedarville's Christian orientation with its provision of several data elements from the Christian ministries department and inclusion of church-related demographic data.

Course of Action

This researcher is recommending that some alternative methods of delivery be explored prior to committing funds for a commercial EIS package. Testing alternative delivery methods would enable the College administrators to gain many of the benefits of an EIS without a substantial expenditure of funds. This recommendation is based on the concerns raised previously and a recent announcement that the College's major software provider (Datatel, Inc.) intends to deliver an executive information interface based on the Forest &

Trees product. It would be wise for the College to postpone acquisition of a commercial EIS product until the Datatel offering is available and has been evaluated.

Recommendations for Future Research

This researcher has presented a design for an effective, economical executive information system for Cedarville College. While the EIS design meets the criteria outlined in chapter 3 of this dissertation, the reviewers have raised some issues which should be explored. One issue is the quality of graphics provided by the commercial EIS packages: do the commercial EIS packages provide sufficient graphical tools to be acceptable in the executive office? Another issue is the lack of enthusiasm for the EIS by the executives. Is this typical of small, liberal arts colleges? Is this an attitude which should be changed or do the executives obtain sufficient information via other methods? A third issue is the use of personnel in developing executive information systems. The five packages which were reviewed in this dissertation required widely varying amounts of development time,especially as it relates to learning how to use the products. Can a successful EIS be developed using a package which minimizes development effort?

This dissertation has presented a great deal of material about executive information requirements, systems design, and commercial executive information systems. The material shared in this document should enable future researchers to move higher education further along the road to appropriate executive information delivery.

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Appendix A Data Stores

Academic Records (REG)		
Data Store	Entity	Attributes
classroom	classroom	building room academic term
		day time capacity
		utilization
course section	course section	academic term section number capacity
		enrollment course credits
faculty	faculty member	faculty id academic term course section
		enrollment

Academic Records (REG)		
Data Store	Entity	Attributes
student demographic	student	student id ACT score advisor at entry
		application status birthyear citizenship
		class rank (high school) division at entry ethnicity
		gender grade point average (high school) graduation year (college)
		graduation year (high school) major at entry placement score English

Academic Records (REG)		
Data Store	Entity	Attributes
		placement score mathematics state of residence at entry transfer institution
		transfer credits grade point average (college general education)
		grade point average (college major) grade point average (college overall)
student term	student	student id academic term academic status
		accounts receivable balance advisor current age
		aid received (loans) aid received (scholarships) aid received (employment)

Academic Records (REG)		
Data Store	Entity	Attributes
		church denomination church id class rank (college)
		courses required not yet completed dependent status division current
		full-time status grade point average (college general education) grade point average (college major)
		grade point average (college overall) major current state of residence current
		residence type {all student demographic fields, either by logical join or actual data elements}

Academic Records (REG)		
Data Store	Entity	Attributes
student section	student	student id academic term course section
		course credits attempted course credits completed course grade earned
		{all student demographic fields, either by logical join or actual data elements}
student needed	student	student id course required not yet completed {all student demographic fields, either by logical join or actual data elements}

Accounts Receivable (AR)		
Data Store	Entity	Attributes
AR account term	AR account	AR account id academic term account type balance current balance 30-day
		balance 60-day balance 90-day balance payment plan balance start of term balance end of term
AR revenue	AR account	AR account id academic term source amount

Admissions (ADM)		
Data Store	Entity	Attributes
applicant demographic	applicant	applicant id ACT score advisor application year application month church denomination deposit year deposit month gender grade point average (college) grade point average (high school) institution code (high school) institution code (college) major sports interest state of residence SAT score

Admissions (ADM)		
Data Store	Entity	Attributes
applicant status	applicant	applicant id start term application status year
		application status month application status {all applicant demographic fields, either by logical join or actual data elements}
applicant contact	applicant	applicant id start term contact year
		contact month contact code {all applicant demographic fields, either by logical join or actual data elements}

Christian Ministries (CHR)		
Data Store	Entity	Attributes
church demographic	church	church id church location church denomination
		church size
church year	church	church id academic year church number of prospects
		church number of students church number of alumni {all church demographic fields, either by logical join or actual data elements}
church giving	church	church id church giving year church giving amount

Christian Ministries (CHR)		
Data Store	Entity	Attributes
		{all church demographic fields, either by logical join or actual data elements}
church contact	church	church id church contact year church contact type
		church contact results {all church demographic fields, either by logical join or actual data elements}
mission	mission field	mission field id calendar year mission field goal
		mission field giving

Development (DEV)		
Data Store	Entity	Attributes
donor demographic	donor	donor id agreement holder alumni class year
		alumni social organization alumni sport church denomination
		corporation type (church, high school, foundation, company) gift last source gift last designation
		gift last year gift last month gift last amount
		gift last matching gift largest source gift largest designation

Development (DEV)		
Data Store	Entity	Attributes
donor demographic	donor	donor id agreement holder alumni class year
		alumni social organization alumni sport church denomination
		corporation type (church, high school, foundation, company) gift last source gift last designation
		gift last year gift last month gift last amount
		gift last matching gift largest source gift largest designation

Development (DEV)		
Data Store	Entity	Attributes
		gift largest year gift largest month gift largest amount
		gift largest matching gift total amount to date gift total matching to date
		giving interests participant in special events phonathon response
gift	gift	donor id gift current source give current designation
		gift current year gift current month gift current amount

Development (DEV)		
Data Store	Entity	Attributes
		gift current matching {all donor demographic fields, either by logical join or actual data elements}
pledge	pledge	donor id pledge balance pledge designation
		pledge year pledge month pledge amount
		{all donor demographic fields, either by logical join or actual data elements}

Financial Aid (FA)		
Data Store	Entity	Attributes
aid recipient demographic	aid recipient	aid recipient id ACT score grade point average (high school)
		matriculation year matriculation month SAT score
aid	aid recipient	aid recipient id academic term aid type (source)
		aid type (scholarship, loan, employment) aid type (need-based, not) aid amount
		debt load family income grade point average (college)

Financial Aid (FA)		
Data Store	Entity	Attributes
		major need index state of residence
		student type (full-time) student type (residence) unmet need
		{all aid-recipient demographic fields, either by logical join or actual data elements}

General Ledger (GL)		
Data Store	Entity	Attributes
GL account year	GL account	GL account fiscal year balance ytd
		budget officer budget original budget ytd
		credit ytd debit ytd general ledger department
		general ledger detail general ledger fund opening balance
		responsible vice-president
GL account month	GL account	GL account fiscal year fiscal month

General Ledger (GL)		
Data Store	Entity	Attributes
		budget adjustment permanent budget adjustment temporary credit
		debit {all GL account year fields, either by logical join or actual data elements}

Payroll (PAY)		
Data Store	Entity	Attributes
employee demographic	employee	employee id hire year hire month
		pension plan eligible year pension plan eligible month termination year
		termination month
employee year	employee	employee id fiscal year classification
		dependents employee full-time status employee staff status
		employee student status exempt status hourly status

Payroll (PAY)		
Data Store	Entity	Attributes
		life insurance eligibility medical plan salary amount
		salary general ledger source rank tuition remission amount
		{all employee demographic fields, either by logical join or actual data elements}

Student Services Office (SSO)		
Data Store	Entity	Attributes
SSO student demographic	student	student id enrollment deposit amount enrollment deposit year
		enrollment deposit month ethnicity gender
		third-world status
SSO student term	student	student id academic term chapel cuts
		major current class health insurance plan
		marital status pre-registration year pre-registration month

Student Services Office (SSO)		
Data Store	Entity	Attributes
		residence anticipated residence current residence hall anticipated
		residence hall current residence hall current advisor residence hall current director
		{all SSO student demographic fields, either by logical join or actual data elements}

Element name	Primary Area	Format	Description
academic status	REG	X(5)	code to indicate student's academic status (honors, warning, probation, suspension)
academic term	REG	X(5)	portion of the academic year used for instruction
academic year	REG	9(2)	last two digits of the calendar year during which the fall academic term begins
account type	AR	9(2)	type of receivable account (student, staff, outside agency)
accounts receivable balance	AR	9(7)V99	dollar amount owed to the Cedarville College

Element name	Primary Area	Format	Description
ACT score	REG	9(2)	composite score earned on the American College Testing Service exam (or an approximation based on the SAT score if the student did not take the ACT test)
advisor	REG	X(7)	faculty member assigned to a particular student for the purposes of academic advising
advisor at entry	REG	X(7)	advisor assigned when the student first matriculated
advisor current	REG	X(7)	advisor assigned to the student for the current term
age	REG	9(2)	age at the start of the academic term
agreement holder	DEV	X	yes/no flag to indicate whether or not the donor is also an agreement holder (annuity, living trust, other estate planning option)

Element name	Primary Area	Format	Description
aid amount	FA	9(7)V99	amount of financial aid given to the aid recipient
aid received	FA	9(7)V99	amount of financial aid received by the aid recipient during a particular academic term
aid received (employment)	FA	9(7)V99	that portion of aid received with requires work by the aid recipient (includes Federal College Work Study and employment paid by institutional funds)
aid received (loans)	FA	9(7)V99	that portion of aid received with requires repayment by the aid recipient
aid received (scholarships)	FA	9(7)V99	that portion of aid received which does not require repayment or work by the aid recipient

Element name	Primary Area	Format	Description
aid recipient id	FA	X(7)	identification number for the aid recipient (system id from the administrative computer system)
aid type (source)	FA	X	code for source of aid money (governmental, private, institutional)
aid type (need)	FA	X	code to indicate whether the aid received is need based or not
alumni class year	DEV	9(2)	graduating-class year claimed by the donor (may be different than actual graduation year)
alumni social organization	DEV	X(5)	code for the donor's social organization while enrolled at Cedarville
alumni sport	DEV	X(5)	code for the donor's sport while enrolled at Cedarville

Element name	Primary Area	Format	Description
applicant id	ADM	X(7)	identification number for the applicant (system id from the administrative computer system)
application month	ADM	9(2)	calendar month during which final application materials were received from the applicant
application year	ADM	9(2)	calendar year during which final application materials were received from the applicant
application status	ADM	X(2)	code to indicate status of the application (accepted, pending, denied)
application status month	ADM	9(2)	calendar month during which the application status was assigned
application status year	ADM	9(2)	calendar year during which the application status was assigned

Element name	Primary Area	Format	Description
AR account	AR	X(7)	identification number for the account (system id from the administrative computer system)
balance 30-day	AR	9(7)V99	total of all accounts receivable items for this account which are more than 30 days past due
balance 60-day	AR	9(7)V99	total of all accounts receivable items for this account which are more than 60 days past due
balance 90-day	AR	9(7)V99	total of all accounts receivable items for this account which are more than 90 days past due
balance current	AR	9(7)V99	total of all outstanding accounts receivable items for this account
balance end of term	AR	9(7)V99	"balance current" as of the end of the academic term

Element name	Primary Area	Format	Description
balance payment plan	AR	9(7)V99	amount remaining to be paid via payment plan for the current academic term
balance start of term	AR	9(7)V99	"balance current" as of the start of the academic term (after billing for the term)
balance ytd	GL	9(9)V99	available funds for this GL account (budget+credits-debits)
budget adjustment permanent	GL	9(9)V99	change in budget for a general ledger number, where the change will be carried into future years
budget adjustment temporary	GL	9(9)V99	change in budget for a general ledger number, where the change will not be carried into future years
budget officer	GL	X(7)	code for the individual who has responsibility for this general ledger account

Element name	Primary Area	Format	Description
budget original	GL	9(9)V99	budget as of the start of the fiscal year for this general ledger account
budget ytd	GL	9(9)V99	budget as of today's date (including all adjustments)
chapel cuts	SSO	9(2)	number of unexcused absences from chapel for a student during a particular academic term
church contact month	CHR	9(2)	calendar month during which contact was made with the church
church contact year	CHR	9(2)	calendar year during which contact was made with the church
church contact results	CHR	X(4)	code to indicate the church's response to a contact (favorable, neutral, unfavorable)
church contact type	CHR	X(5)	code to indicate the type of contact (speaker, singing team, other team)

Element name	Primary Area	Format	Description
church denomination	CHR	X(4)	code to indicate the denominational affiliation of the church
church giving month	CHR	9(2)	calendar month during which the church made a gift to the College
church giving year	CHR	9(2)	calendar year during which the church made a gift to the College
church giving amount	CHR	9(8)V99	dollar amount of the church gift
church id	CHR	X(7)	identification number for the church (system id from the administrative computer system)
church location	CHR	X(5)	zip code for the church
church number of alumni	CHR	9(4)	number of alumni who are members of the church
church number of prospects	CHR	9(4)	number of prospective students (for the next two academic years) who are members of the church

Element name	Primary Area	Format	Description
church number of students	CHR	9(4)	number of students (for a particular academic term) who are members of the church
citizenship	REG	X(5)	code to indicate the student's country of citizenship
class	REG	X(2)	code to indicate the student's class (freshman, sophomore, junior, senior, other)
class rank (high school)	REG	9(2)	student's rank in high school graduating class (expressed as a percentile)
class rank (college)	REG	9(2)	student's rank in Cedarville graduating class (expressed as a percentile)
classification	PAY	X(4)	code to indicate the employee's job classification (clerical, technical, professional)

Element name	Primary Area	Format	Description
classroom size	REG	9(2)9(2)	official human capacity for the room
classroom utilization	REG	9(2)9(2)	number of students assigned to the classroom for a particular time of day, day of week, and academic term
contact code	ADM	X(3)	code to indicate the type of contact made with a prospective student
contact month	ADM	9(2)	calendar month during which contact was made with prospective student
contact year	ADM	9(2)	calendar year during which contact was made with prospective student
corporation type	DEV	X(3)	code to indicate the type of corporation (church, high school, foundation, commercial business)

Element name	Primary Area	Format	Description
course credits attempted	REG	9(2)V9	number of credits attempted for a particular course section by a particular student
course credits completed	REG	9(2)V9	number of credits earned for a particular course section by a particular student
course grade earned	REG	X(2)	grade earned by a particular student in a particular course section
course section capacity	REG	9(2)9(2)	maximum number of students who may enroll in a particular course section
course section enrollment	REG	9(2)9(2)	actual number of students enrolled in a particular course section
course required not yet completed	REG	X(8)	course which is required for graduation but has not yet been completed by the student

Element name	Primary Area	Format	Description
credit	GL	9(9)V99	dollar amount credited to the GL account during specified month
credit ytd	GL	9(9)V99	total dollar amount credited to the GL account so far during the year specified
debit	GL	9(9)V99	dollar amount debited to the GL account during specified month
debit ytd	GL	9(9)V99	total dollar amount debited to the GL account so far during the year specified
debt load	FA	9(7)V99	outstanding financial aid loans for this aid recipient
dependent status	FA	X	code to indicate the aid recipient's dependency status in relation to parents (dependent, independent)
dependents	PAY	9(2)	number of dependents for this employee

Element name	Primary Area	Format	Description
deposit month	ADM	9(2)	calendar month during which the applicant's enrollment deposit was received
deposit year	ADM	9(2)	calendar year during which the applicant's enrollment deposit was received
division	REG	X(2)	code for academic division which offers a particular course or major
division at entry	REG	X(2)	the student's division as of the matriculation term
division current	REG	X(2)	the student's current division
donor id	DEV	X(7)	identification number for the donor (system id from the administrative computer system)
employee full-time status	PAY	X(2)	code to indicate whether employee is considered full-time or part-time

Element name	Primary Area	Format	Description
employee hourly status	PAY	X	code to indicate whether employee is paid hourly or via salary
employee id	PAY	X(7)	identification number for the employee (system id from the administrative computer system)
employee full-time status	PAY	X(2)	code to indicate employee's full-time or part-time status
employee staff status	PAY	X(2)	code to indicate employee's status (staff member, faculty member)
employee student status	PAY	X(2)	code to indicate whether employee is considered to be primarily a student or primarily an employee
enrollment deposit amount	SSO	9(6)V99	amount of money received from applicant as an enrollment guarantee
enrollment deposit month	SSO	9(2)	calendar month in which enrollment deposit was received

Element name	Primary Area	Format	Description
enrollment deposit year	SSO	9(2)	calendar year in which enrollment deposit was received
ethnicity	REG	X(2)	code for the ethnic background claimed by the student
exempt status	PAY	X	code to indicate employee's exemption from Federal overtime laws
family income	FA	9(8)	total family income as reported on the free application for financial aid
gender	REG	X	code for student's gender (F=female, M=male)
GL account	GL	X(10)	identification number for the general ledger account (comprised of fund, department, and detail)
GL department	GL	X(5)	departmental budget identifier
GL detail	GL	X(4)	type of revenue or expense
GL fund	GL	X	fund designator

Element name	Primary Area	Format	Description
gift id	DEV	X(12)	identification number for the gift (system id from the administrative computer system)
gift current	DEV	---	current gift record (i.e., gift currently being processed)
gift largest	DEV	---	largest gift given to the College by this donor
gift last	DEV	---	most recent gift given to the College by this donor
gift (current, largest, last) amount	DEV	9(8)V99	amount of the gift
gift (current, largest, last, designation	DEV	X(3)	code for the gift's intended use (general fund, scholarships, capital campaign)
gift (current, largest, last) month	DEV	9(2)	calendar month during which gift was received

Element name	Primary Area	Format	Description
gift (current, largest, last) year	DEV	9(2)	calendar year during which gift was received
gift (current, largest, last) matching	DEV	9(8)V99	amount of money to be received from a matching employer or foundation
gift (current, largest, last) source	DEV	X(3)	FISAP designator for source of the gift (alumnus, trustee, friend)
gift total amount to date	DEV	9(8)V99	total amount of the donor's giving to the College
gift total matching to date	DEV	9(8)V99	total amount of matching funds received from this donor's gifts
giving interests	DEV	X(3)	code for the donor's giving interests
grade point average (college general education)	REG	9V9999	grade point average earned in Cedarville College general education courses
grade point average (college major)	REG	9V9999	grade point average earned in courses within the student's major

Element name	Primary Area	Format	Description
grade point average (college overall)	REG	9V9999	grade point average earned in all Cedarville College courses
grade point average (high school)	ADM	9V9999	grade point average earned in all high school courses
graduation year (college)	REG	9(4)	year of graduation from Cedarville College
graduation year (high school)	ADM	9(4)	year of graduation from high school
health insurance plan	SSO	X	code for the health insurance plan selected by the student
hire month	PAY	9(2)	calendar year in which employee was hired
hire year	PAY	9(2)	calendar year in which employee was hired
institution code (college)	REG	X(6)	code for the last collegiate institution attended by the student

Element name	Primary Area	Format	Description
institution code (high school)	ADM	X(6)	code for the last high school attended by the applicant
life insurance eligibility	PAY	X	code to indicate the employee's eligibility for College-provided life insurance
major at entry	REG	X(5)	code for the student's major as of the matriculation term
major current	REG	X(5)	code for the student's current major
marital status	REG	X	code for the student's marital status
matriculation month	REG	9(2)	code for the calendar month in which the student matriculated
matriculation year	REG	9(2)	code for the calendar year in which the student matriculated
medical plan	PAY	X(2)	code for the health insurance plan used by the employee
mission field giving	CHR	9(7)V99	total amount of gifts received for this mission field

Element name	Primary Area	Format	Description
mission field goal	CHR	9(7)V99	dollar goal for total giving for this mission field
mission field id	CHR	X(7)	identification number for the mission field (system id from the administrative computer system)
need index	FA	9(7)V99	relative measure of need for financial aid (PELL index)
opening balance	GL	9(8)V99	balance in the GL account at the start of the fiscal year
participant in special events	DEV	X(4)	code to indicate donor's participation in special campus events (golf tournament, concerts, drama, tours)
pension plan eligible month	PAY	9(2)	calendar month in which employee became eligible for pension plan participation

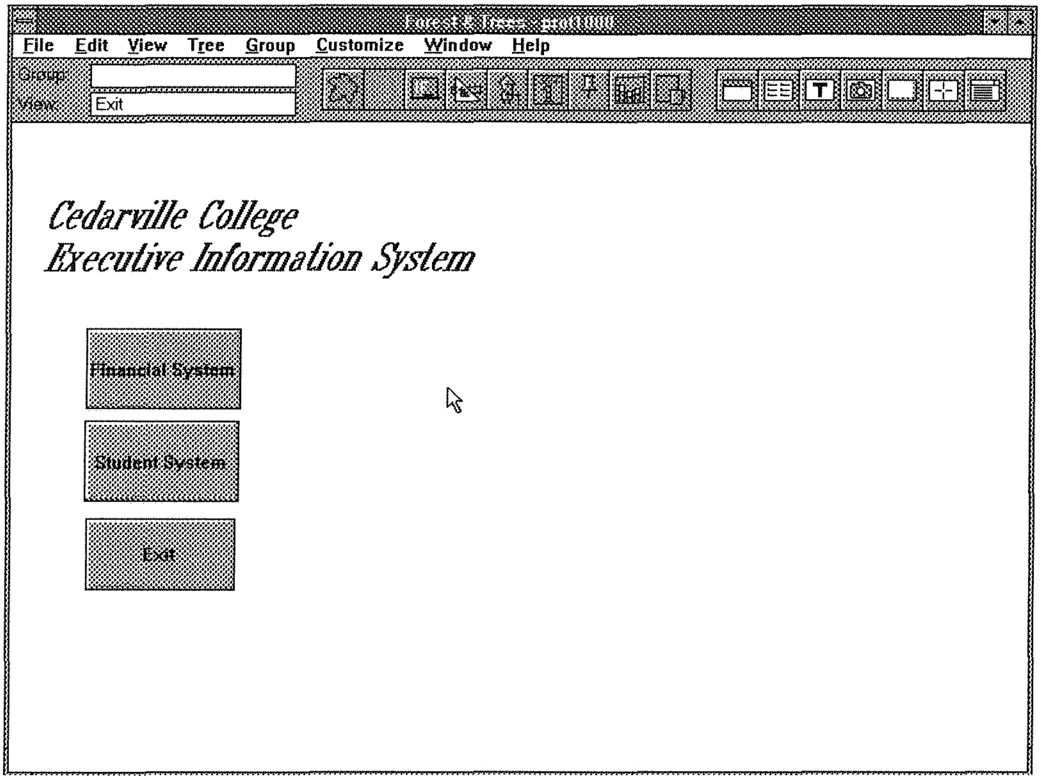
Element name	Primary Area	Format	Description
pension plan eligible year	PAY	9(2)	calendar year in which employee became eligible for pension plan participation
phonathon response	DEV	X(2)	code to indicate response to phonathon request (pledged, refused, no decision)
placement score English	REG	9(2)	score earned on Cedarville College English placement exam
placement score mathematics	REG	9(2)	score earned on Cedarville College mathematics placement exam
pledge amount	DEV	9(8)V99	dollar amount of the pledge
pledge balance	DEV	9(8)V99	amount not yet received from donor's pledge
pledge month	DEV	9(2)	calendar month in which donor's pledge was received
pledge year	DEV	9(2)	calendar year in which donor's pledge was received

Element name	Primary Area	Format	Description
pledge designation	DEV	X(3)	code for the pledge's intended use (general fund, scholarships, capital campaign)
pledge id	DEV	X(10)	identification number for the pledge (system id from the administrative computer system)
pre-registration month	REG	9(2)	calendar month in which the student pre-registered for an academic term
pre-registration year	REG	9(2)	calendar year in which the student pre-registered for an academic term
rank	PAY	X(2)	code to indicate professorial rank
residence anticipated	SSO	X	code to indicate student's intended residence (on-campus, off-campus, commuter)
residence current	SSO	X	code to indicate student's residence for the academic term (on-campus, off-campus, commuter)

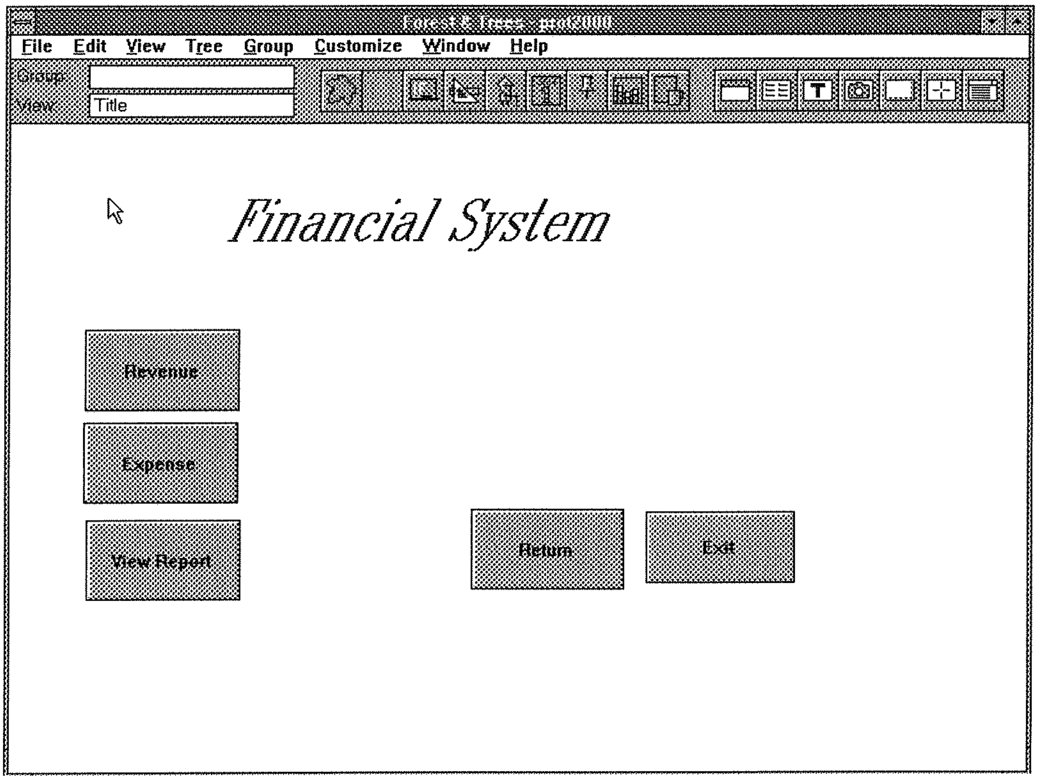
Element name	Primary Area	Format	Description
residence hall anticipated	SSO	X(3)	code for student's anticipated residence hall
residence hall current	SSO	X(3)	code for student's residence hall for the academic term
residence hall current advisor	SSO	X(7)	identification number for the student's student supervisor (system id from the administrative computer system)
residence hall current director	SSO	X(7)	identification number for the student's staff supervisor (system id from the administrative computer system)
responsible vice-president	GL	X(7)	identification number for the vice-president responsible for the GL account (system id from the administrative computer system)
revenue amount	AR	9(8)V99	dollar amount of revenue generated by the AR transaction

Element name	Primary Area	Format	Description
revenue source	AR	X(3)	code for source of AR revenue (tuition, fees, room, board, other)
revenue term	AR	X(5)	academic term during which revenue was realized
salary amount	PAY	9(7)V99	dollar amount of the employee's salary
salary general ledger source	PAY	X(10)	general ledger number which funds the employee's salary
sports interest	ADM	X(3)	code to indicate the applicant's primary sports interest
state of residence at entry	REG	X(2)	student's state of residence as of the matriculation term
state of residence current	FA	X(2)	student's state of residence for the current academic term
student id	REG	X(7)	identification number for the student (system id from the administrative computer system)

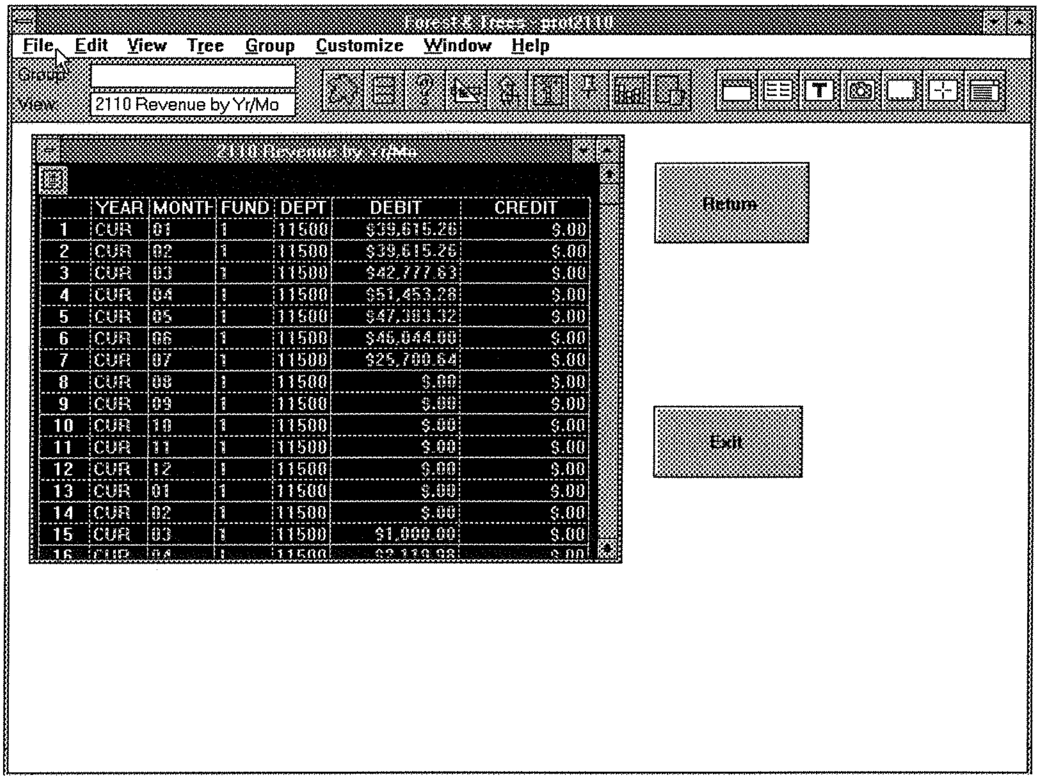
Element name	Primary Area	Format	Description
termination month	PAY	9(2)	calendar month during which the employee was terminated
termination year	PAY	9(2)	calendar year during which the employee was terminated
third-world status	REG	X	code to indicate the student's third-world status (resident of third-world country, missionary child)
transfer credits	REG	9(3)V9	number of course credits transferred from other institutions
transfer institution	REG	X(6)	code to indicate the institution from which the credits were transferred
tuition remission amount	PAY	9(7)V99	dollar amount of tuition forgiven an employee or relative of an employee
unmet need	FA	9(7)V99	dollar amount of financial aid need which has not been covered by financial aid awards



1 Forest & Trees, PROT1000 (main welcome screen)

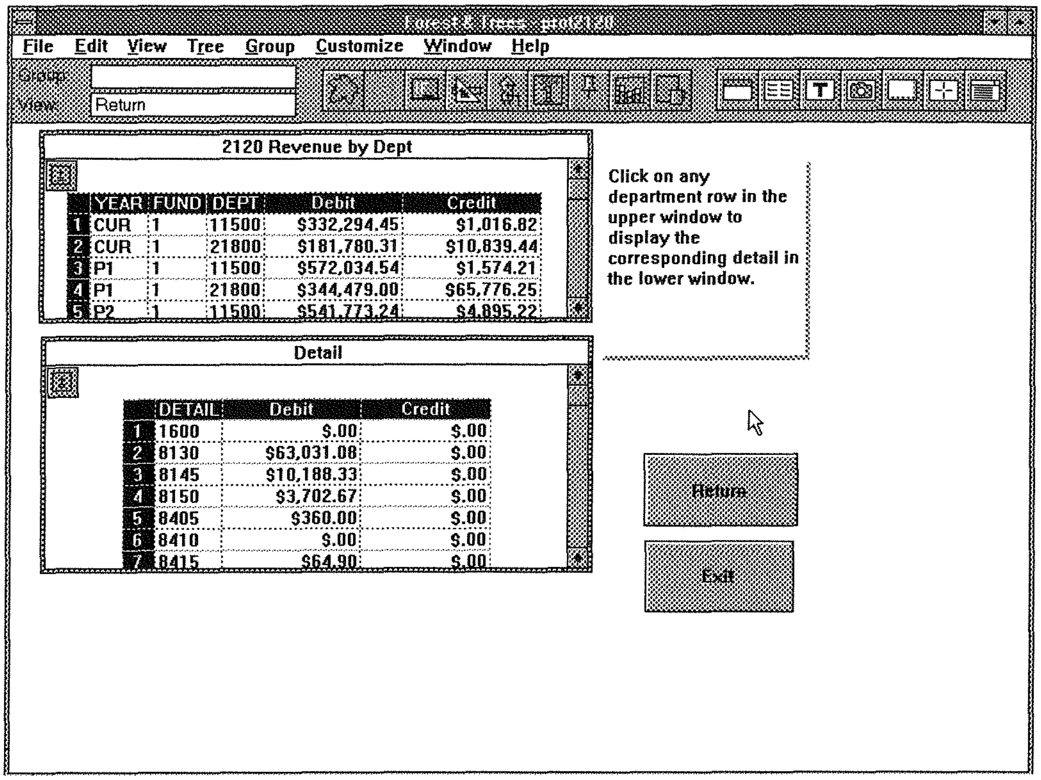


2 Forest & Trees, PROT2000 (typical menu screen)

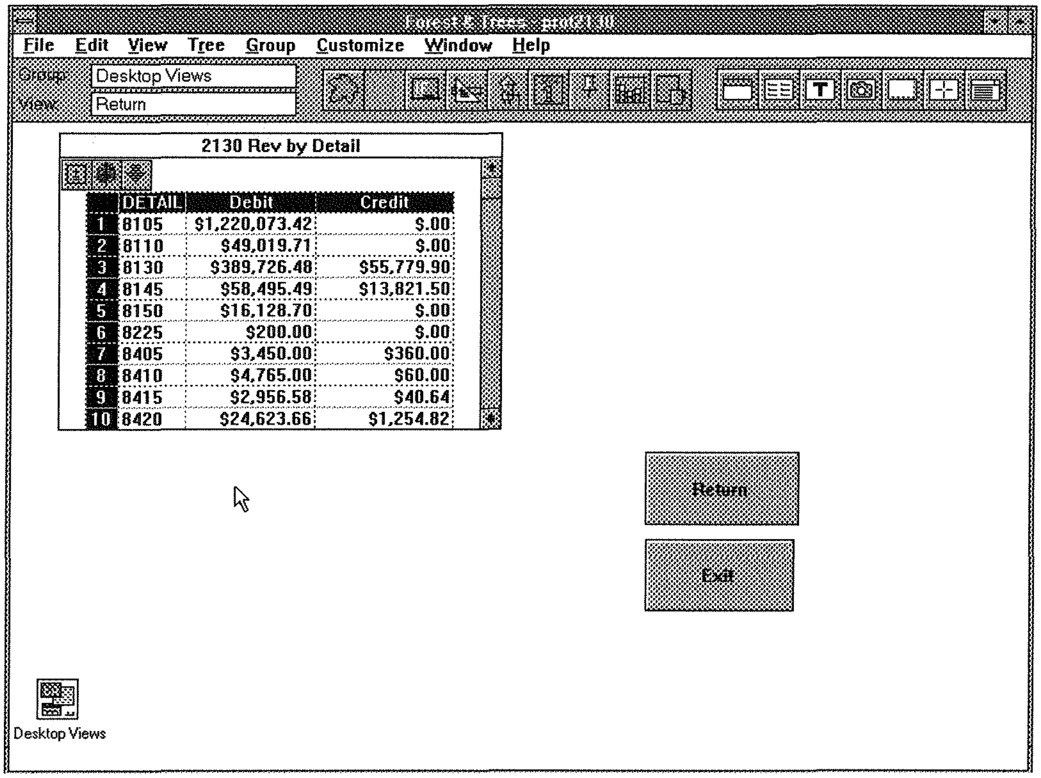


	YEAR	MONTH	FUND	DEPT	DEBIT	CREDIT
1	CUR	01	1	11500	$39,615.26	$.00
2	CUR	02	1	11500	$39,615.26	$.00
3	CUR	03	1	11500	$42,777.63	$.00
4	CUR	04	1	11500	$51,453.28	$.00
5	CUR	05	1	11500	$47,383.32	$.00
6	CUR	06	1	11500	$46,044.00	$.00
7	CUR	07	1	11500	$25,700.64	$.00
8	CUR	08	1	11500	$.00	$.00
9	CUR	09	1	11500	$.00	$.00
10	CUR	10	1	11500	$.00	$.00
11	CUR	11	1	11500	$.00	$.00
12	CUR	12	1	11500	$.00	$.00
13	CUR	01	1	11500	$.00	$.00
14	CUR	02	1	11500	$.00	$.00
15	CUR	03	1	11500	$1,000.00	$.00
16	CUR	[illegible]	1	11500	[illegible]	$.00

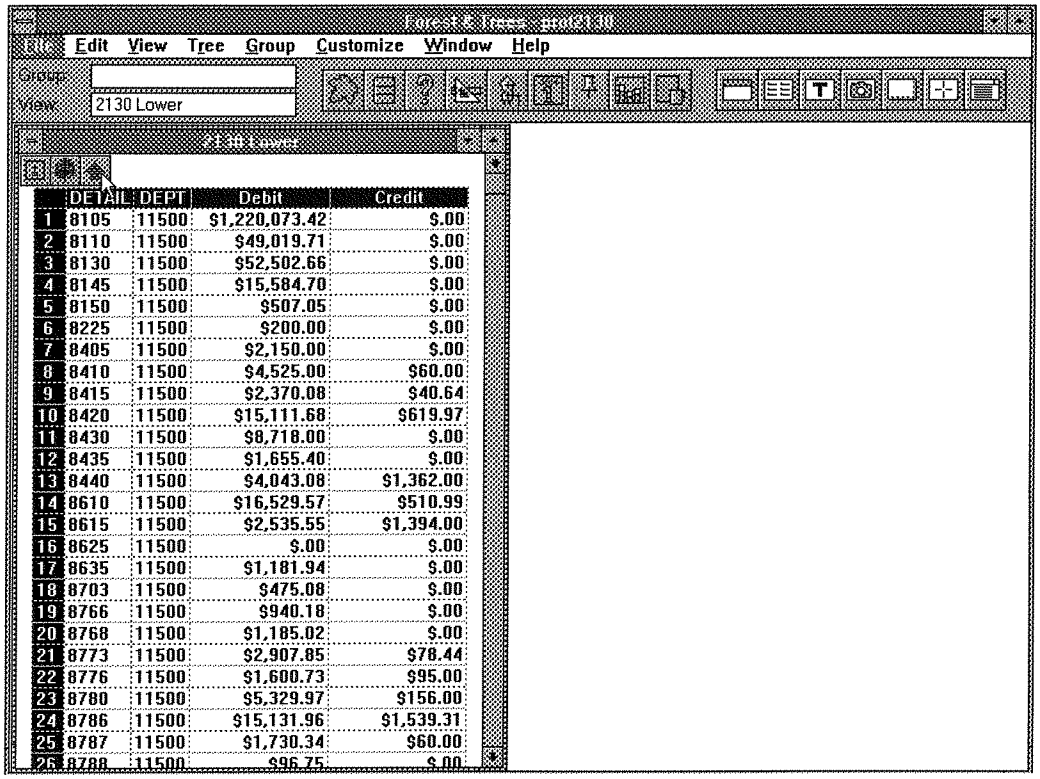
3 Forest & Trees, PROT2110 (revenue by year and month)



4 Forest & Trees, PROT2120 (revenue by department, with hot spots)

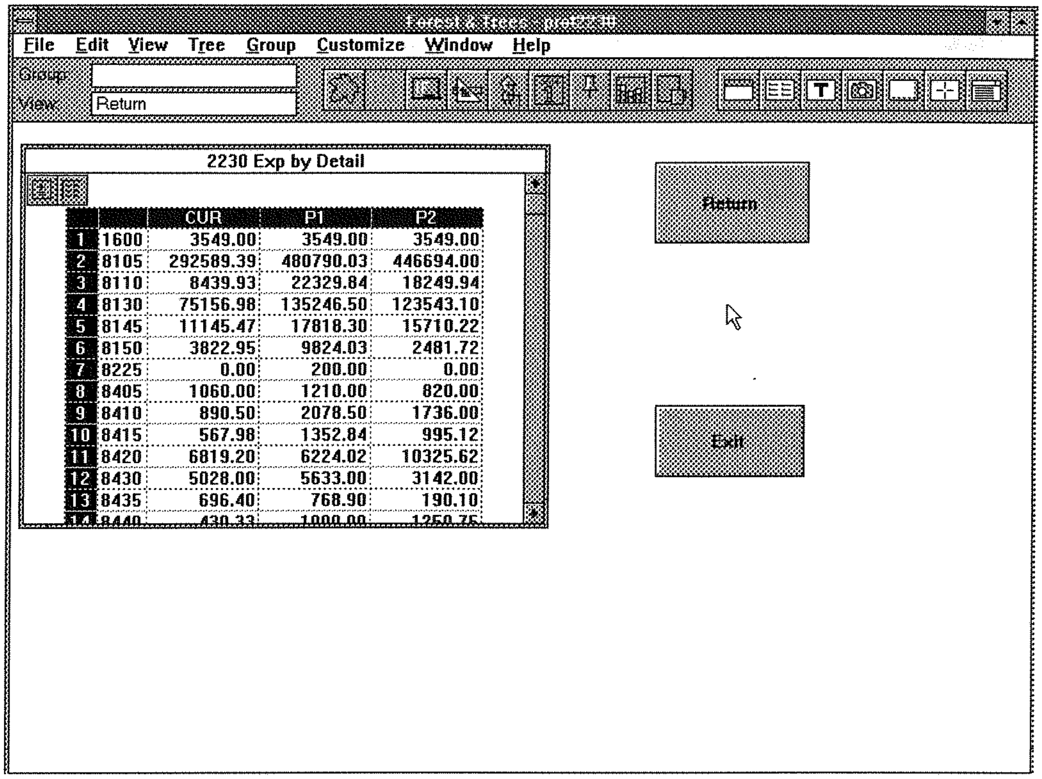


5 Forest & Trees, PROT2130 (upper level of drill-down screen)

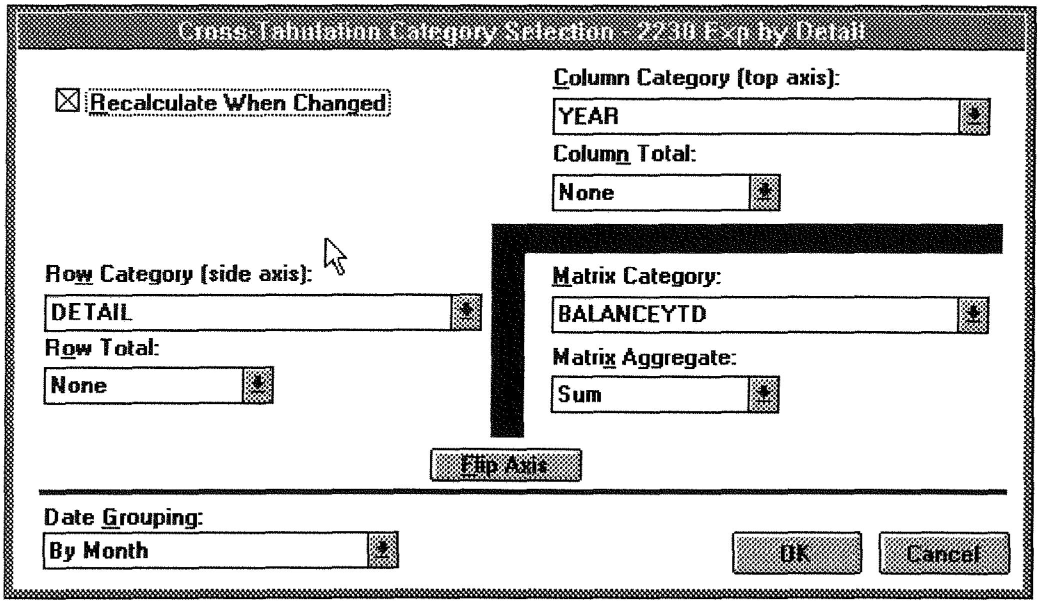


	DETAIL	DEPT	Debit	Credit
1	8105	11500	$1,220,073.42	$.00
2	8110	11500	$49,019.71	$.00
3	8130	11500	$52,502.66	$.00
4	8145	11500	$15,584.70	$.00
5	8150	11500	$507.05	$.00
6	8225	11500	$200.00	$.00
7	8405	11500	$2,150.00	$.00
8	8410	11500	$4,525.00	$60.00
9	8415	11500	$2,370.08	$40.64
10	8420	11500	$15,111.68	$619.97
11	8430	11500	$8,718.00	$.00
12	8435	11500	$1,655.40	$.00
13	8440	11500	$4,043.08	$1,362.00
14	8610	11500	$16,529.57	$510.99
15	8615	11500	$2,535.55	$1,394.00
16	8625	11500	$.00	$.00
17	8635	11500	$1,181.94	$.00
18	8703	11500	$475.08	$.00
19	8766	11500	$940.18	$.00
20	8768	11500	$1,185.02	$.00
21	8773	11500	$2,907.85	$78.44
22	8776	11500	$1,600.73	$95.00
23	8780	11500	$5,329.97	$156.00
24	8786	11500	$15,131.96	$1,539.31
25	8787	11500	$1,730.34	$60.00
26	8788	11500	$96.75	$.00

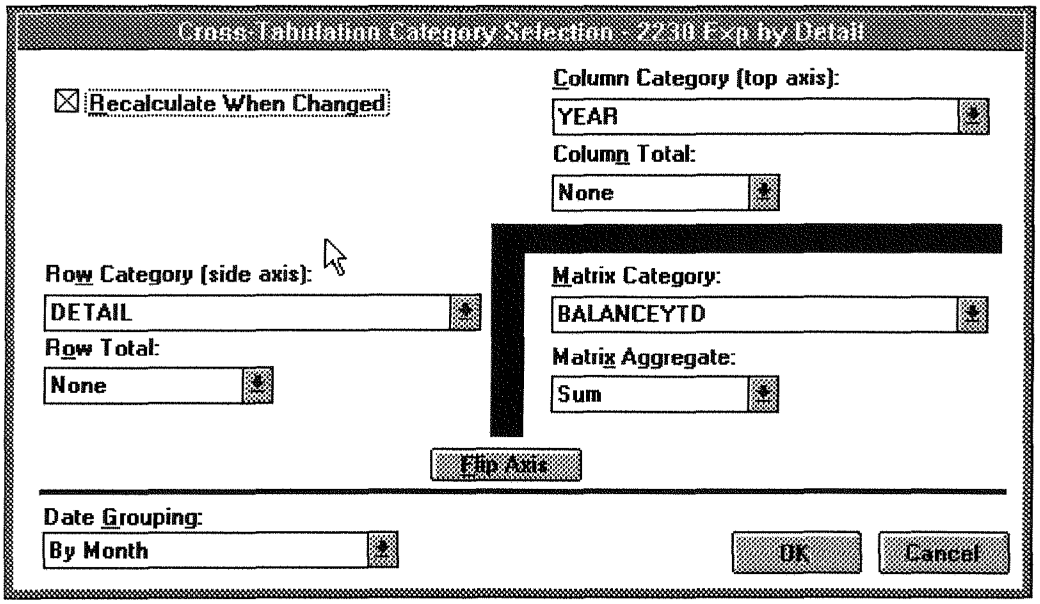
6 Forest & Trees, PROT2131 (lower level of drill-down screen)



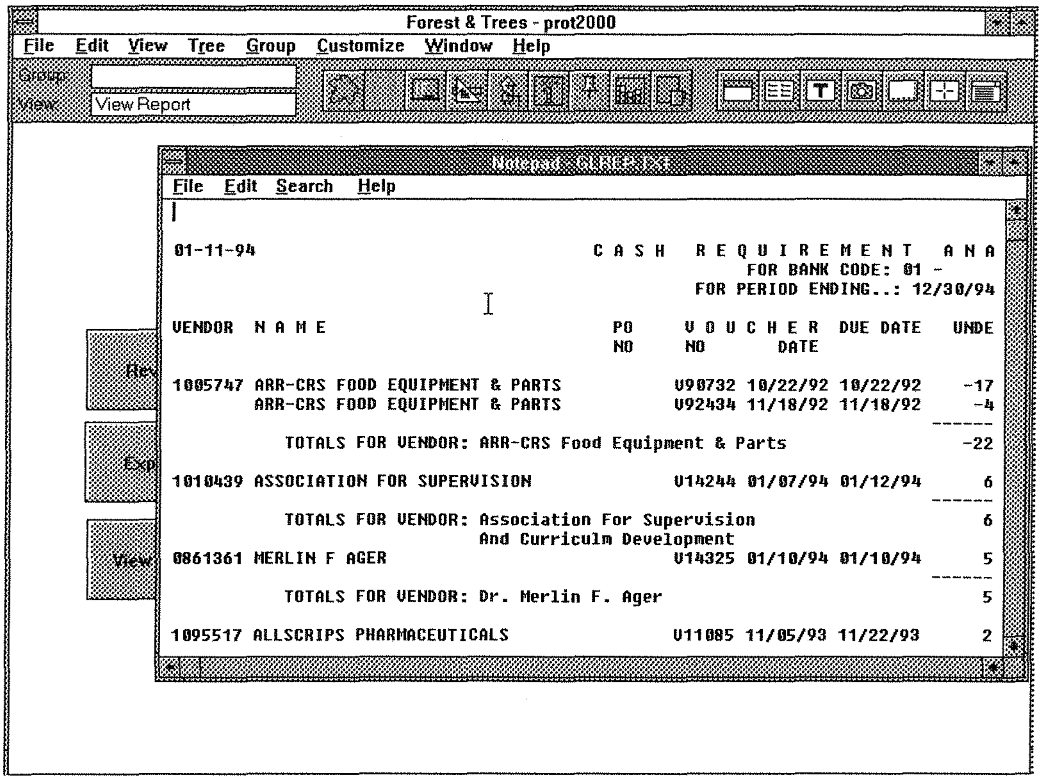
7 Forest & Trees, PROT2230 (use-controllable cross-tab)



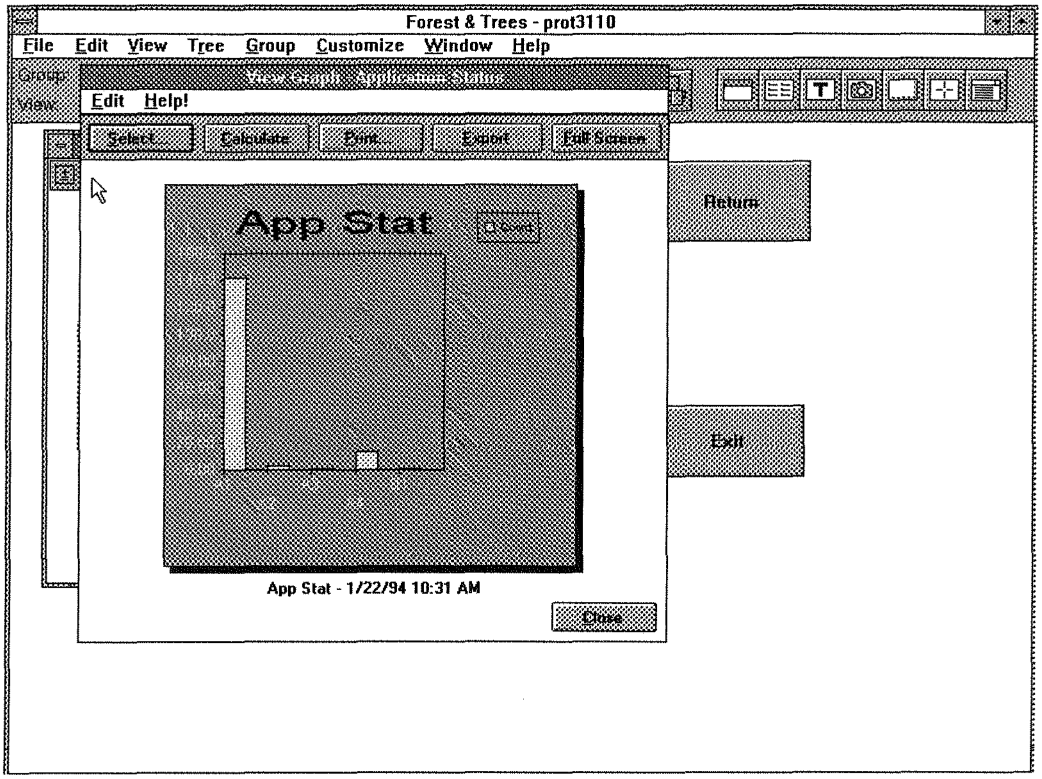
8 Forest & Trees, PROT2231 (activating user-controllable cross-tab)



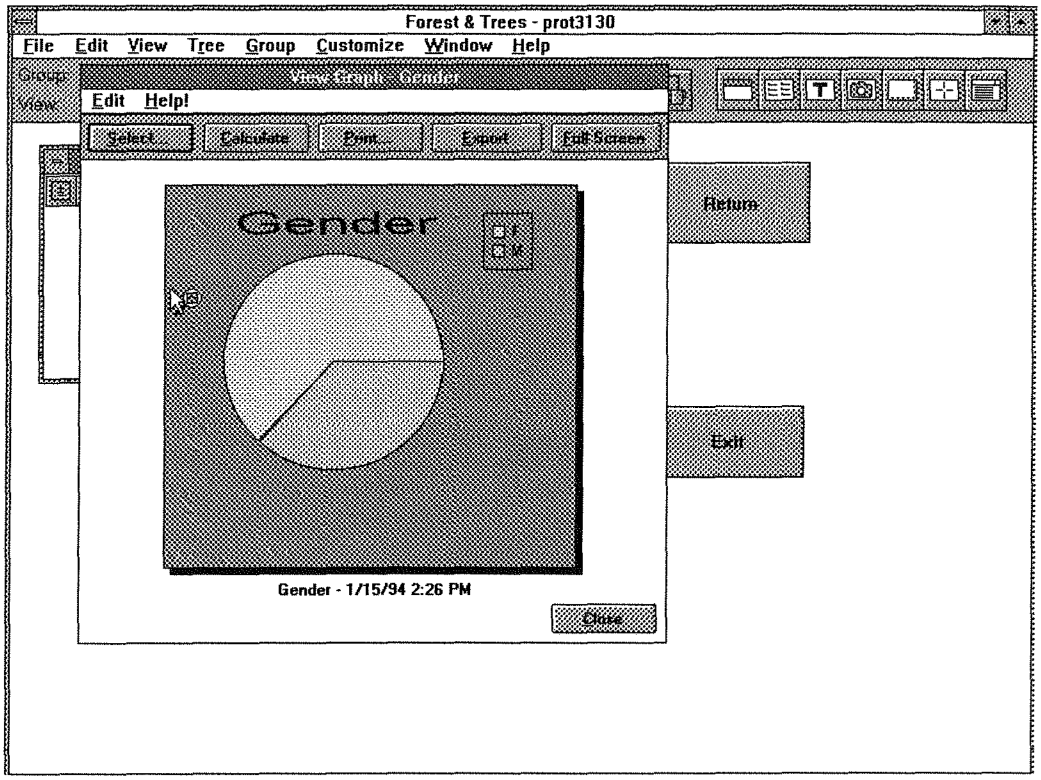
8 Forest & Trees, PROT2231 (activating user-controllable cross-tab)



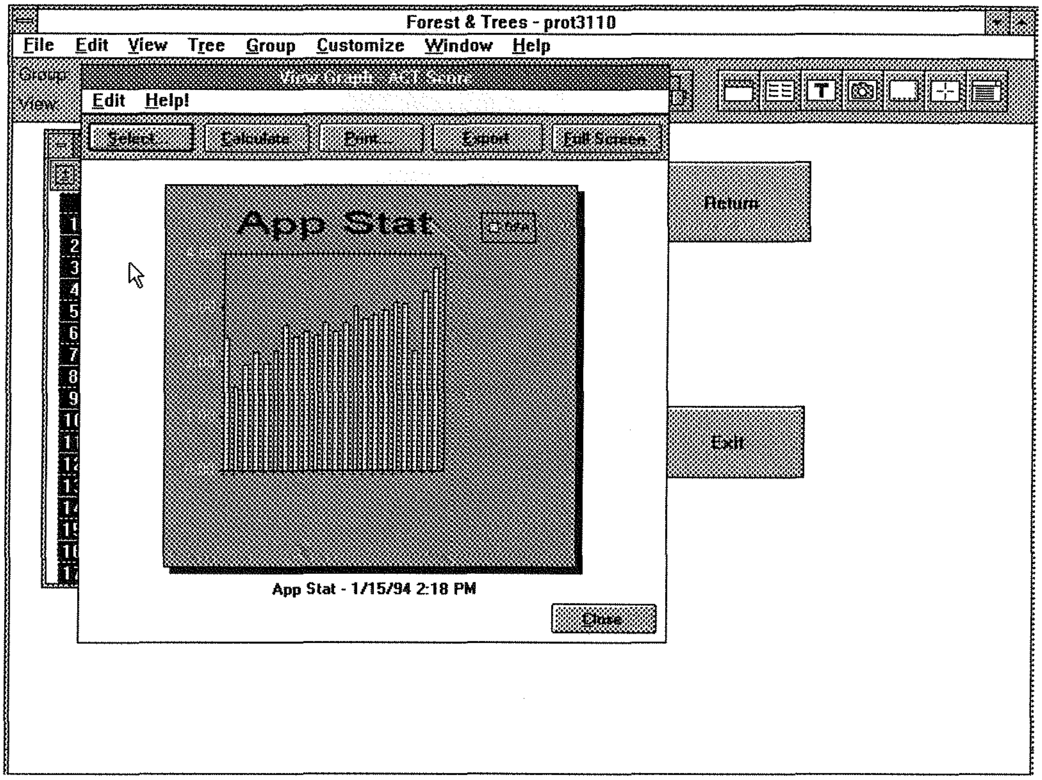
9 Forest & Trees, PROT2300 (view text report)



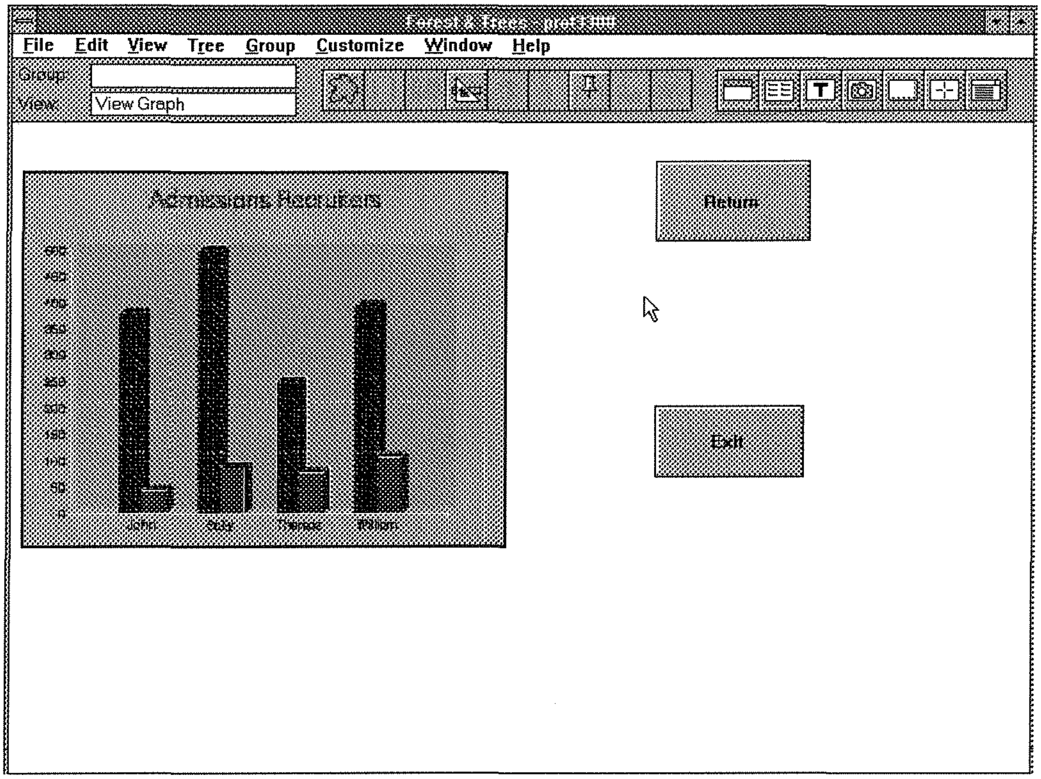
10 Forest & Trees, PROT3110 (one-variable bar chart)



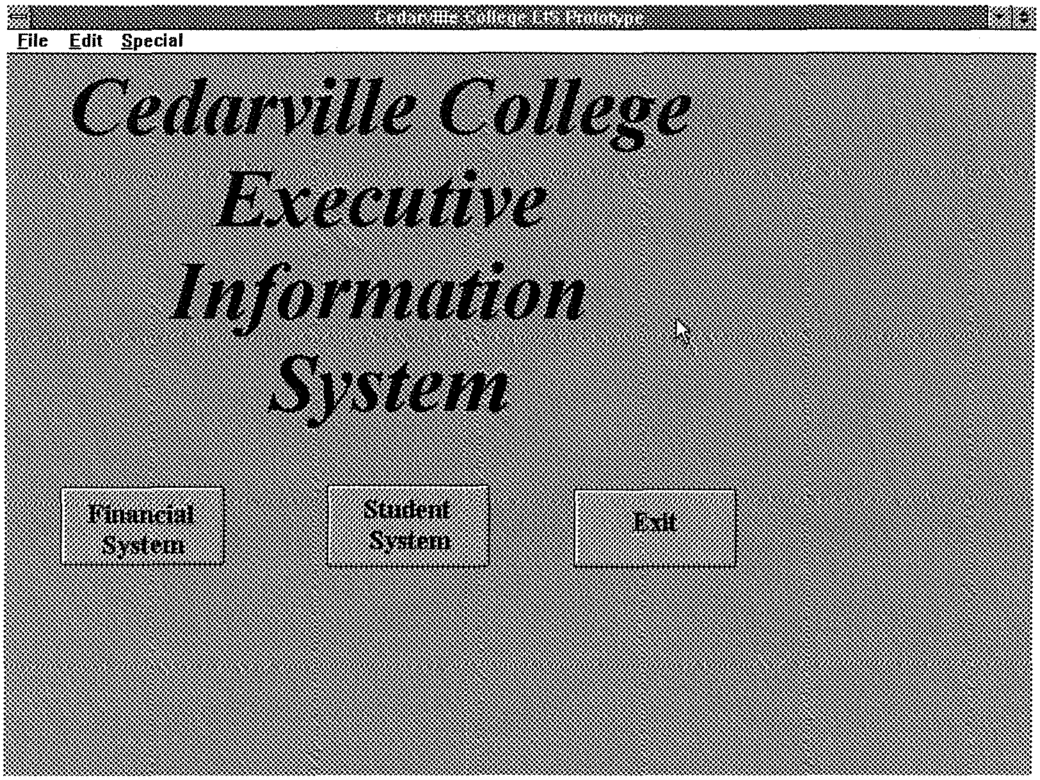
11 Forest & Trees, PROT3130 (one-variable pie chart)



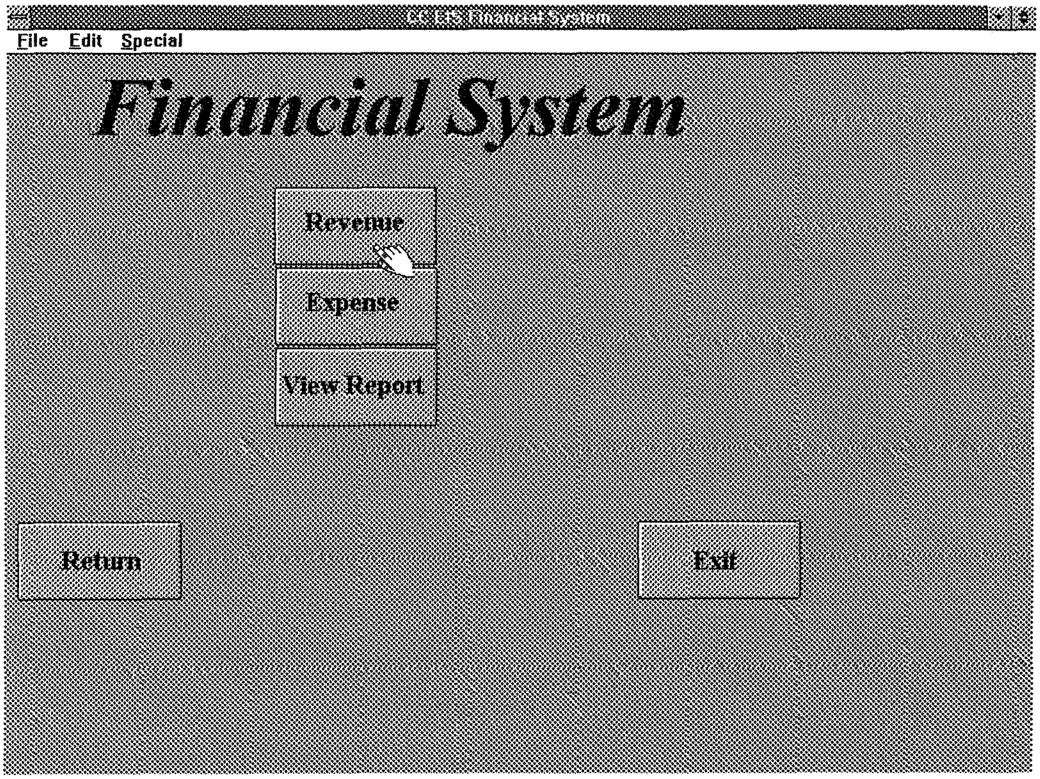
12 Forest & Trees, PROT3210 (two-variable bar chart)



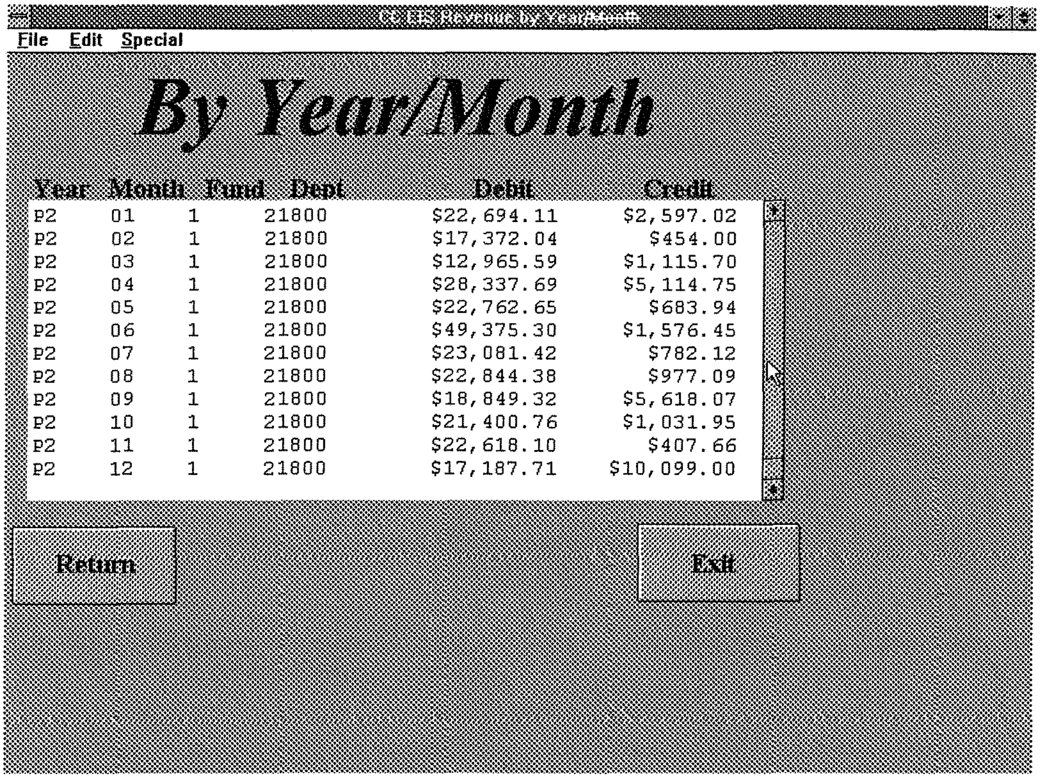
13 Forest & Trees, PROT3300 (view external graphical object)



14 Pilot LightShip, PROT1000 (main welcome screen)



15 Pilot LightShip, PROT2000 (typical menu screen)



CC EIS Revenue by Year/Month

File Edit Special

By Year/Month

Year	Month	Fund	Dept	Debit	Credit
P2	01	1	21800	$22,694.11	$2,597.02
P2	02	1	21800	$17,372.04	$454.00
P2	03	1	21800	$12,965.59	$1,115.70
P2	04	1	21800	$28,337.69	$5,114.75
P2	05	1	21800	$22,762.65	$683.94
P2	06	1	21800	$49,375.30	$1,576.45
P2	07	1	21800	$23,081.42	$782.12
P2	08	1	21800	$22,844.38	$977.09
P2	09	1	21800	$18,849.32	$5,618.07
P2	10	1	21800	$21,400.76	$1,031.95
P2	11	1	21800	$22,618.10	$407.66
P2	12	1	21800	$17,187.71	$10,099.00

Return Exit

16 Pilot LightShip, PROT2110 (revenue by year and month)

CC EIS Revenue by Year/Month

File Edit Special

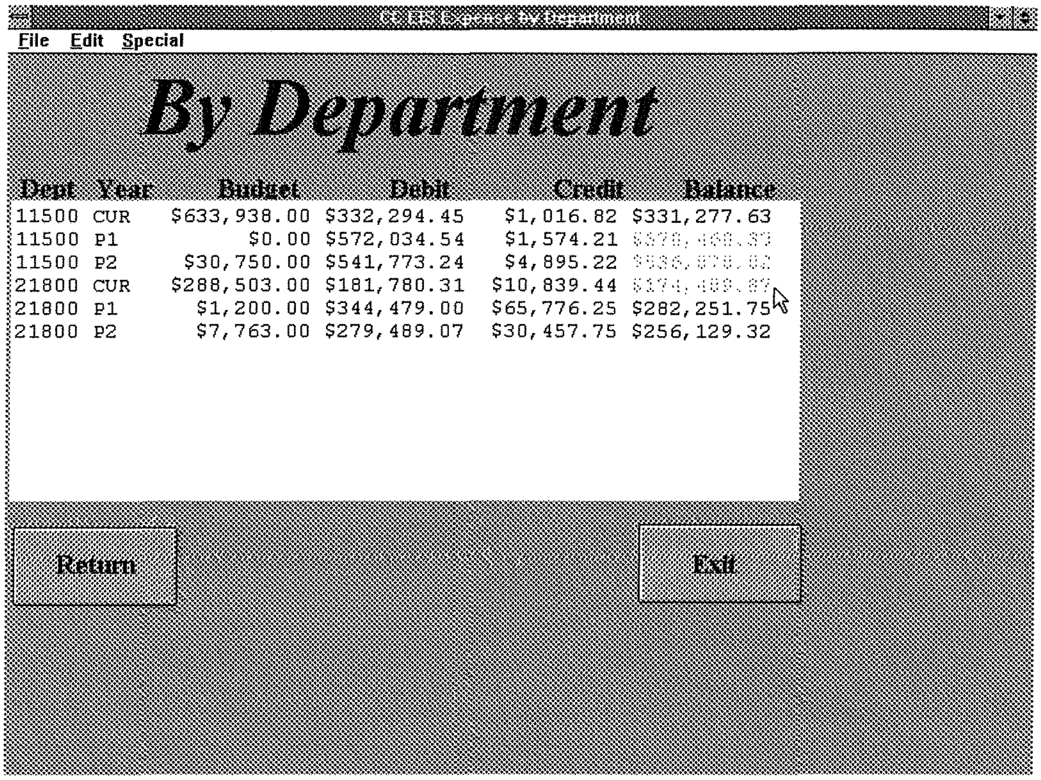
By Year/Month

Year	Month	Fund	Dept	Debit	Credit
P2	01	1	21800	$22,694.11	$2,597.02
P2	02	1	21800	$17,372.04	$454.00
P2	03	1	21800	$12,965.59	$1,115.70
P2	04	1	21800	$28,337.69	$5,114.75
P2	05	1	21800	$22,762.65	$683.94
P2	06	1	21800	$49,375.30	$1,576.45
P2	07	1	21800	$23,081.42	$782.12
P2	08	1	21800	$22,844.38	$977.09
P2	09	1	21800	$18,849.32	$5,618.07
P2	10	1	21800	$21,400.76	$1,031.95
P2	11	1	21800	$22,618.10	$407.66
P2	12	1	21800	$17,187.71	$10,099.00

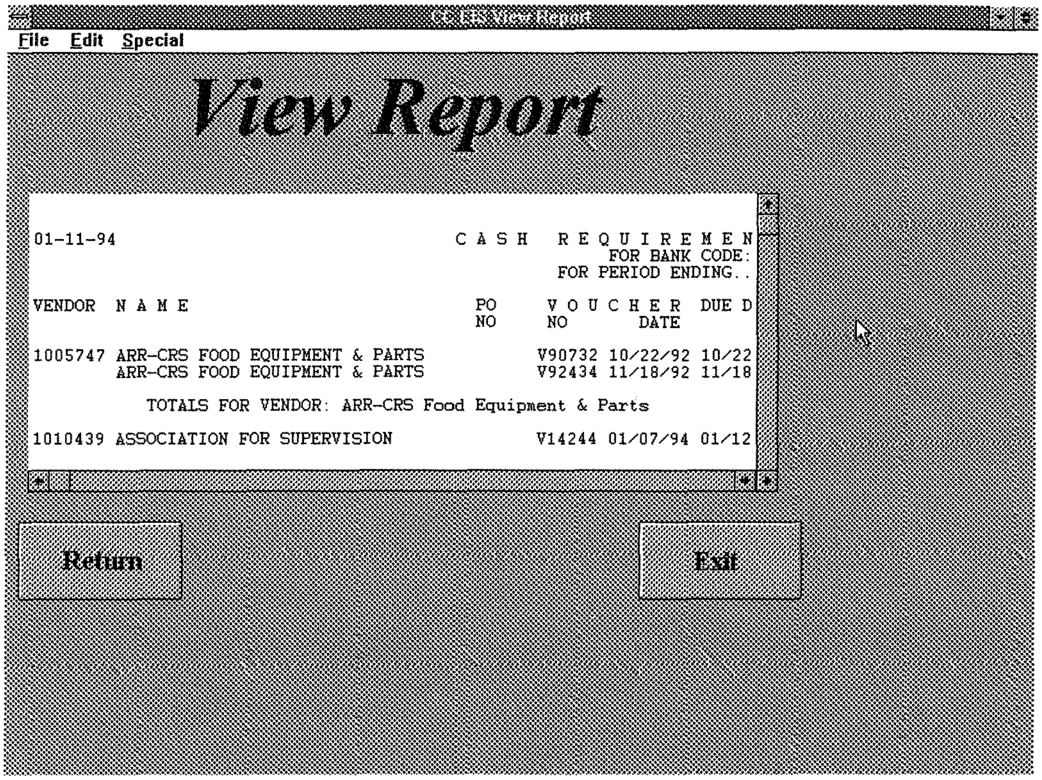
Return

Exit

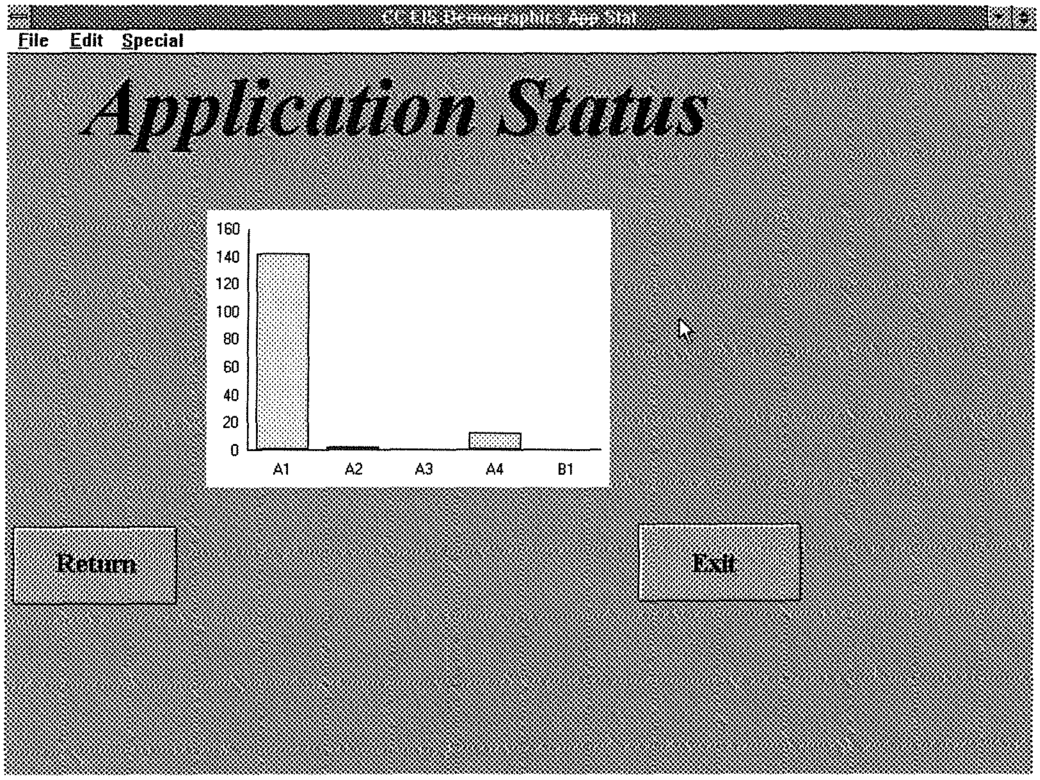
16 Pilot LightShip, PROT2110 (revenue by year and month)



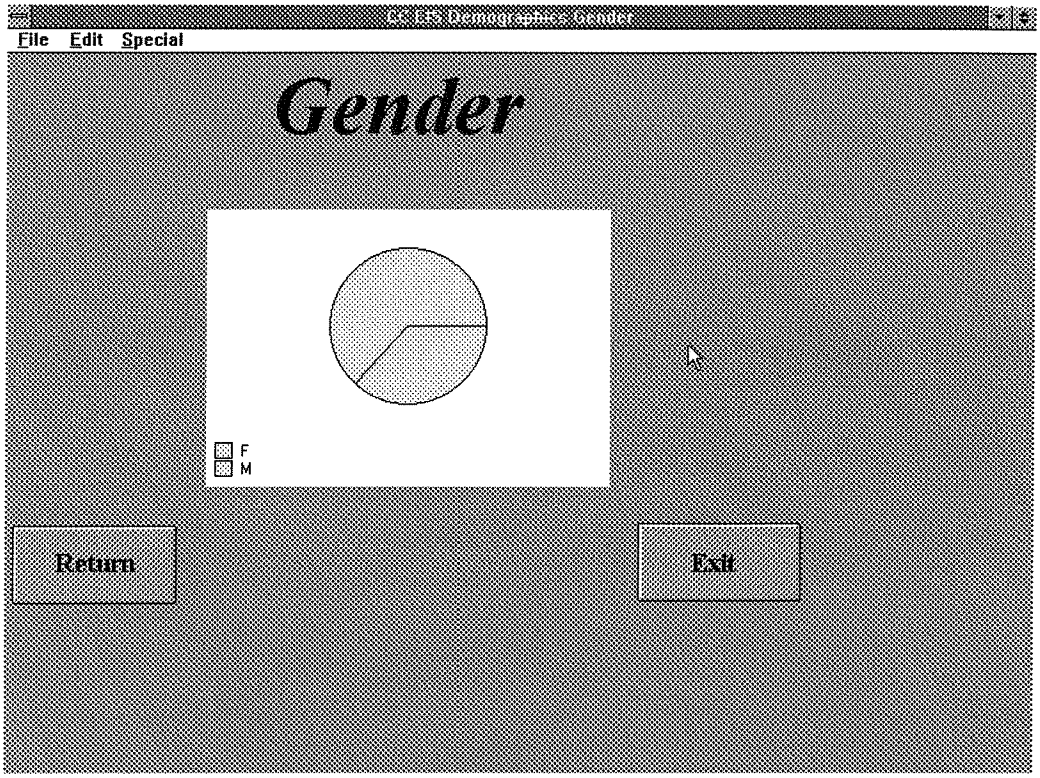
17 Pilot LightShip, PROT2220 (traffic lighting)



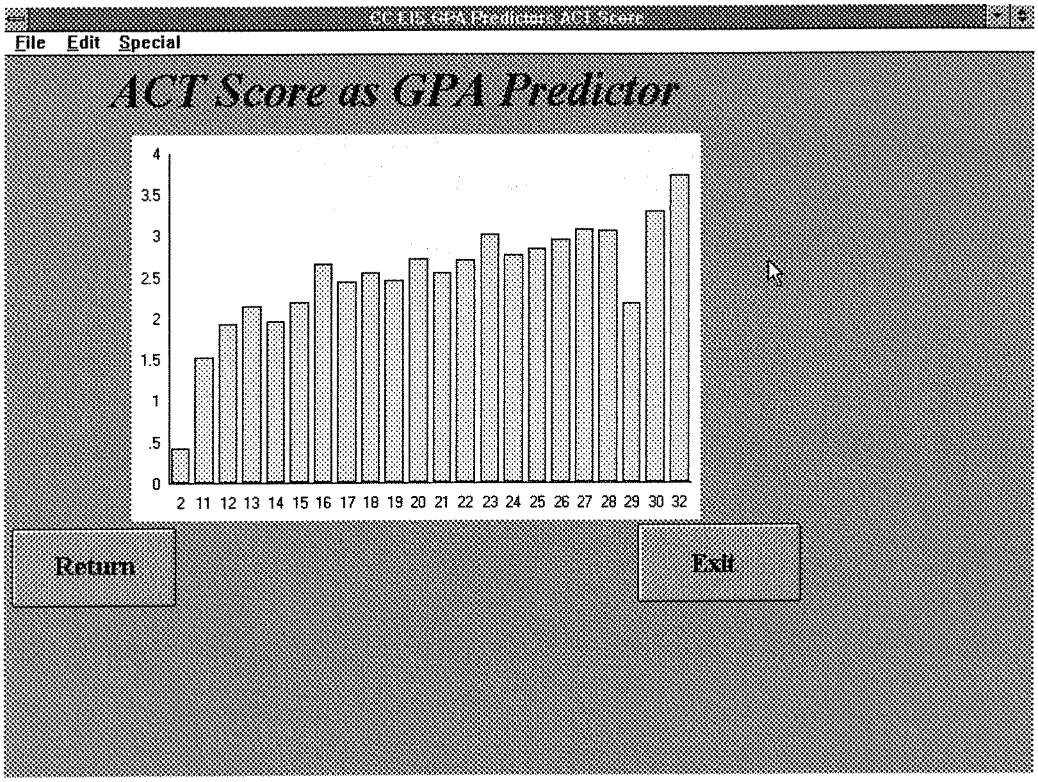
18 Pilot LightShip, PROT2300 (view text report)



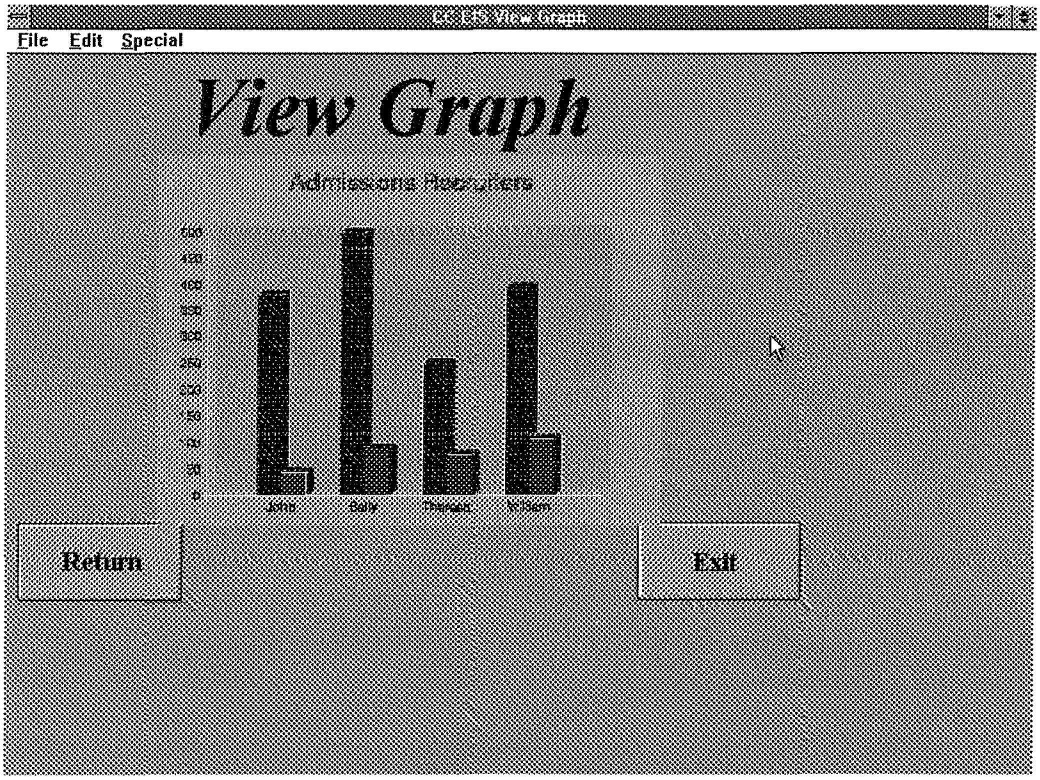
19 Pilot LightShip, PROT3110 (one-variable bar chart)



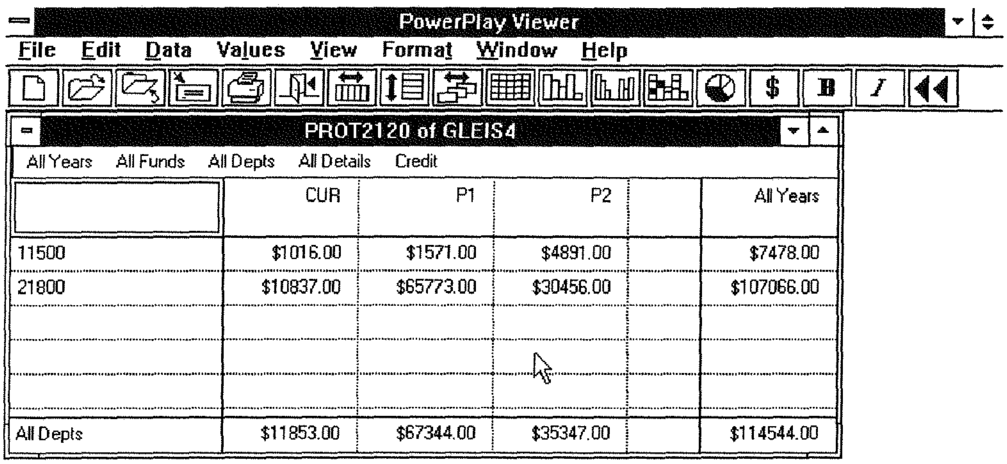
20 Pilot LightShip, PROT3130 (one-variable pie chart)



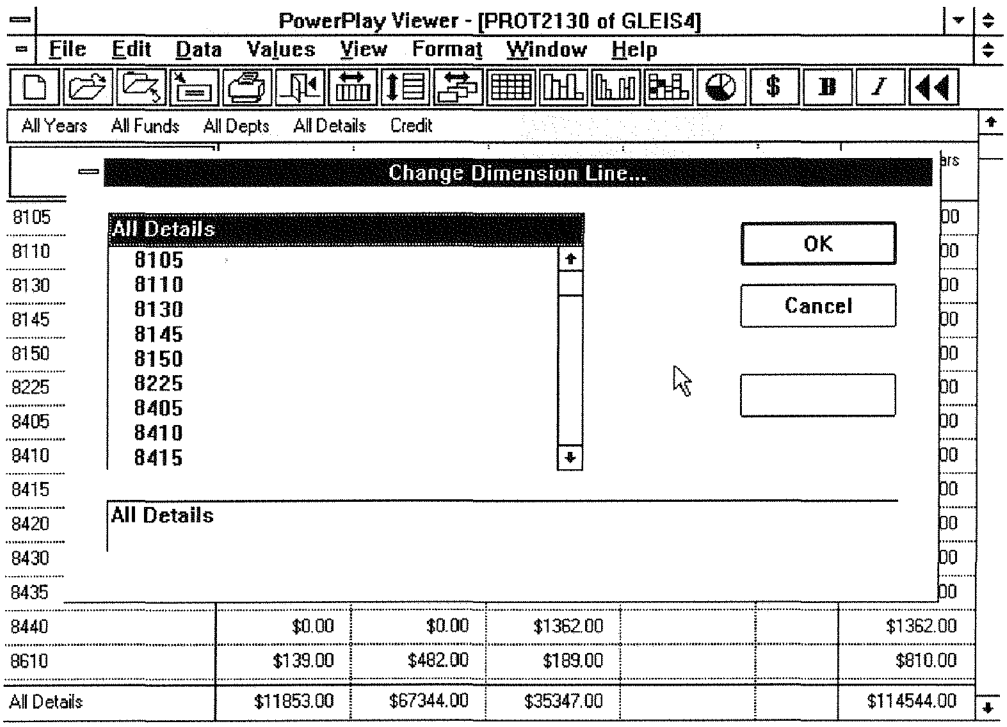
21 Pilot LightShip, PROT3210 (two-variable bar chart)



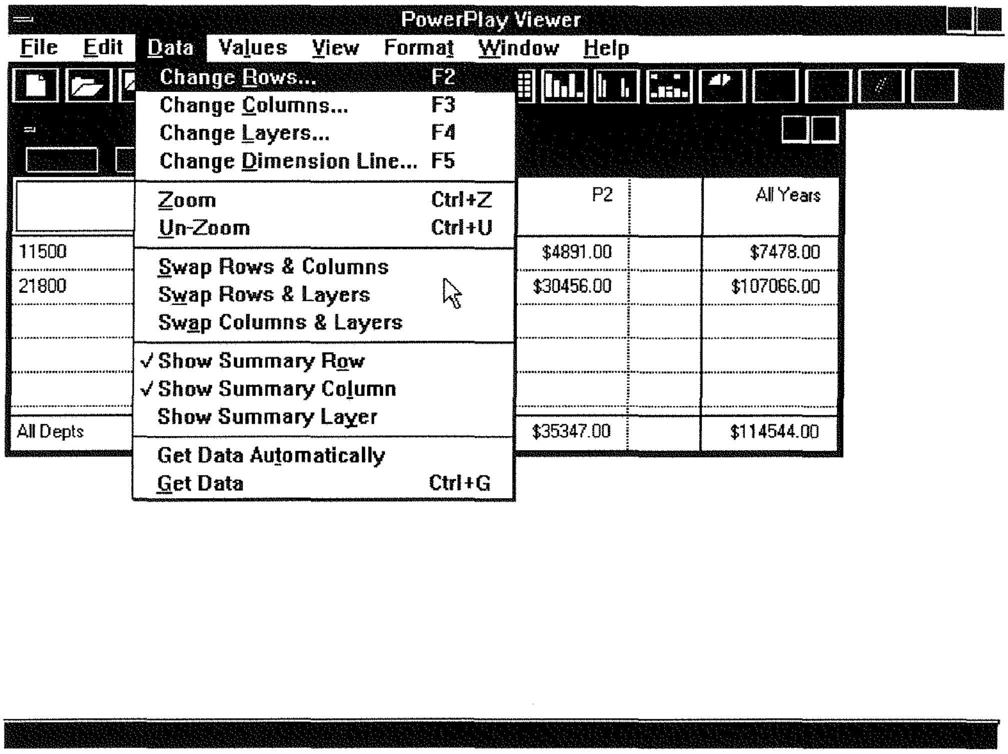
22 Pilot LightShip, PROT3300 (view external graphical object)



23 PowerPlay, PROT2120 (delimited-file access)



24 PowerPlay, PROT2130 (user-controllable cross-tab from the "dimension" line)



25 PowerPlay, PROT2220 (user-controllable cross-tab via pull-down menu)

Biographical Sketch

David L. Rotman received his B.S. in mathematics education from Taylor University (Upland, IN) in 1968 and his M.A.T. in mathematics from Indiana University (Bloomington, IN) in 1972. He received his Certificate in Data Processing (CDP) in 1981. Mr. Rotman taught mathematics and computer programming in public and private secondary schools from 1968 through 1979. He served as an adjunct instructor in computer science for Indiana University (South Bend, IN) from 1973 through 1984. Mr. Rotman was Lead Programmer and then Director of Computer Services for Indiana University at South Bend from 1979 through 1984. In 1984, Mr. Rotman assumed a position as assistant professor of computer information systems at Cedarville College (Cedarville, OH). In 1986, Mr. Rotman became Director of Computer Services for Cedarville College. Since that time, he has been actively involved in promoting technology on the Cedarville campus. A principal accomplishment during this time period was the installation of a campus-wide computer network, including the placement of college-owned computers in three-fourths of the residence hall rooms. Mr. Rotman's professional activities include participation in CAUSE and the Colleague Users Group (customers of Datatel, Inc.). Mr. Rotman has served on the technical advisory board of the Colleague Users Group and has made numerous presentations at the group's semi-annual meetings. Mr. Rotman has also served as a consultant on administrative computing and campus networking for several colleges and universities.