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Executive Information Systems For Providing Next Generation Strategic Information

An Evaluation of EIS Software and Recommended
Applicability Within the FAA Computing Environment

DISTRIBUTION STATEMENT A

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MiTech
INCORPORATED

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16. Abstract Commercially-available Executive Information System (EIS) software products are evaluated. Their performance is analyzed against criteria approved by the FAA. Criteria include functionality and ease of use, ease of design and development, hardware and software issues, and maintenance. Data transmission and mainframe storage options within the FAA are identified and evaluated. A recommendation for complete EIS implementation within the FAA is provided.			
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This work was supported in part, by the Federal Aviation Administration Technical Center, Atlantic City International Airport, New Jersey.

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1.0 EXECUTIVE SUMMARY AND RECOMMENDATION

1.1 Method of Evaluation

In accordance with FAA Technical Center contract DTFA03-88-C-00064, MiTech, Inc. has completed a technical and functional evaluation of commercially-available Executive Information Systems (EISs). Not only have the performance and capability of the systems been evaluated: their suitability to the Management Information System (MIS) computing environment at the FAA has also been considered. The primary concern in this evaluation, however, was identifying each system's ability to support top FAA executives in meeting management objectives and to respond to changing information needs.

Ten commercially available EIS products were initially selected for evaluation. Four of these appeared capable of meeting FAA's minimum requirements for an Executive Information System on their own, and three more were judged capable of meeting these requirements if enhancements from other products were added. These seven alternatives were evaluated in depth according to criteria developed by MiTech and approved by FAA/MIS Technical Program Office. These areas included functionality and ease of use for the end-user, ease of design and development including the speed at which the initial prototype could be installed, hardware and software constraints, and system maintenance issues. In addition, the scope of work required to design, develop and install each of the systems was estimated and is provided in this report. A quantitative method of scoring each of these areas was used in order to avoid as much as possible a subjective evaluation of these products.

The installation and implementation of each system within the FAA environment were also evaluated, and optimum implementation strategies for each of the systems were designed, in cooperation with FAA and contractor personnel from the Office of Management Systems (World Computers and AMS-300). Available FAA mainframe computer resources were also identified, and alternatives to FAA mainframe utilization such as timesharing and computer leasing were considered.

Cost issues were also pursued with each of the systems that were considered to have met 70% of the FAA EIS criteria. Mainframe and PC software costs were identified and totaled. In addition, cost estimates were made for system design and development above the baseline, as well as the consulting and training required with each system. Total costs (excluding baseline estimates for system design and development) were estimated for the next five years, through the acquisition of the Computer Resource Nucleus (CORN) equipment, anticipated by 1992.

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Executive Summary

The Federal Aviation Administration (FAA) is developing and implementing a Management Information System (FAAMIS) which has several major components. One of them is the implementation of an Executive Information System (EXIS). The FAA Technical Center, FAAMIS Technical Program Office, with support from MiTech Incorporated, an SBA 8(A) firm located in Washington, DC conducted an evaluation of EIS software and recommended applicability within the FAA.

The objective of the evaluation was to analyze the performance of the products against criteria approved by the FAAMIS Technical Program Office and recommend an implementation strategy suitable for the FAA. Criteria includes functionality and ease of use, ease of design and development, hardware and software issues, and maintenance (Appendix B shows the detailed FAA criteria). The primary concern in this evaluation, however, is in identifying each system's ability to support top FAA executives in meeting management objectives and in responding to changing information needs. Data transmission and mainframe storage options within the FAA are also identified and evaluated.

Numerous commercially available EIS products were evaluated. Some of these appeared capable of meeting FAA's minimum requirements for the EXIS on their own, and others were judged capable of meeting these requirements if enhancements from other products were added. These alternatives were evaluated in depth according to criteria referenced above. Detailed results of this evaluation are described in Section 2.

A recommendation for complete FAA EXIS implementation is provided, as follows (reference Section 1.2 for details):

Software Recommendation. Information Resources, Inc.'s mainframe and microcomputer software products EXPRESS/pcEXPRESS (Section 1.2.1.1) are recommended primarily due to its multidimensional database management capability on the PC and the ability to implement in a phased PC stand-alone-to-mainframe approach.

Connectivity Recommendation. The long-term solution takes advantage of the FAA's Administrative Data Transmission Network (ADTN) to provide connections between PCs and the EXIS mainframe. In the short term, a virtual disk capability utilizing a minicomputer will be tested as a means for EXIS distribution (Section 1.2.2).

Hardware Recommendation. Due primarily to the costs associated with timesharing alternatives, leasing a dedicated mainframe computer is recommended for the EXIS. However, if DOT/FAA resources can be found at nominal costs, they should be utilized.

The recommended implementation strategy will enable the FAA to begin early development of a prototype system in a PC environment. This approach provides the FAA with maximum capability at minimum cost, first year costs approximately \$100,000. In the long term, as the EXIS evolves from a PC based system through conversion to CORN, the total costs, excluding application development, will be approximately \$982,000 (Section 5).

1.0 BACKGROUND SUMMARY AND RECOMMENDATION

1.1 Method of Evaluation

In accordance with FAA Technical Center contract DTFA03-88-C-00064, MiTech, Inc. has completed a technical and functional evaluation of commercially-available Executive Information Systems (EISs). Not only have the performance and capability of the systems been evaluated: their suitability to the Management Information System (MIS) computing environment at the FAA has also been considered. The primary concern in this evaluation, however, was identifying each system's ability to support top FAA executives in meeting management objectives and to respond to changing information needs.

Ten commercially available EIS products were initially selected for evaluation. Four of these appeared capable of meeting FAA's minimum requirements for an Executive Information System on their own, and three more were judged capable of meeting these requirements if enhancements from other products were added. These seven alternatives were evaluated in depth according to criteria developed by MiTech and approved by FAA/MIS Technical Program Office. These areas included functionality and ease of use for the end-user, ease of design and development including the speed at which the initial prototype could be installed, hardware and software constraints, and system maintenance issues. In addition, the scope of work required to design, develop and install each of the systems was estimated and is provided in this report. A quantitative method of scoring each of these areas was used in order to avoid as much as possible a subjective evaluation of these products.

The installation and implementation of each system within the FAA environment were also evaluated, and optimum implementation strategies for each of the systems were designed, in cooperation with FAA and contractor personnel from the Office of Management Systems (World Computers and AMS-300). Available FAA mainframe computer resources were also identified, and alternatives to FAA mainframe utilization such as timesharing and computer leasing were considered.

Cost issues were also pursued with each of the systems that were considered to have met 70% of the FAA EIS criteria. Mainframe and PC software costs were identified and totaled. In addition, cost estimates were made for system design and development above the baseline, as well as the consulting and training required with each system. Total costs (excluding baseline estimates for system design and development) were estimated for the next five years, through the acquisition of the Computer Resource Nucleus (CORN) equipment, anticipated by 1992.

1.2 Recommendation

1.2.1 Software Recommendation

The seven EIS systems which were closely evaluated include Pilot's Command Center, Comshare's Commander, Execucom's Executive Edge in a full-capacity system, Execucom's Executive Edge in a partial-capacity system paired with ORACLE as the DBMS, Information Resources' EXPRESS/pcEXPRESS, and Computer Associates' (CA) product Stratagem paired in one option with CA's Tellagraf and the Southern Electric Company's CADET, and Stratagem paired in the other option with Interactive Image's product EASEL. Each of these systems is discussed in detail in Section 2 of this report.

1.2.1.1 Recommended Selection

All the evaluated systems have mainframe database management capability with varying levels of additional processing performed at the executive PC. Of these, EXPRESS/pcEXPRESS was judged to be superior to the other systems for the following reasons:

Flexibility for the User. pcEXPRESS provides a database management system on the PC. All of the other systems have only file serving capability (or less) on the PC, limiting the executive user to a choice of static screens of information. With pcEXPRESS, the user is provided with dynamic access to the data at his PC, and can choose to view any information in his database in any format he chooses at any given time. With the other systems, the executive is limited to the reports created for him in advance by analysts and developers -- an electronic version of the Performance Indicators report.

Ease of Use. pcEXPRESS has an automatic link to mainframe EXPRESS, the major storehouse of EIS data. Whenever data is not accessible on the smaller database stored on the PC, pcEXPRESS can be programmed to access the EXPRESS database on the mainframe automatically and retrieve the requested data, all without the executive knowing that this process is taking place. Other systems provide access to their mainframe database, but require the user to back out of their static, "Briefing Book" type of interface to access the mainframe. Thus, users must know where their data resides, whether it is on the PC or on the mainframe and the executive must learn two separate methods of accessing the data. With EXPRESS/pcEXPRESS, the executive need not be aware of any difference.

Lower Maintenance Effort. Since the executives can define their own reports as needed, EIS developers do not need to concentrate their efforts on designing screens and reports for executive users. Rather, the development effort can concentrate solely on automating the inclusion of new data into the central EIS database.

1.2.1.1

Recommended Selection (Continued)

Phased Implementation at Lower Initial Costs.

EXPRESS/pcEXPRESS is the only system which can be designed, developed and used entirely at the PC level (either alone or in a Local Area Network) and then transported to a mainframe computer as the system grows. All other systems require a mainframe computer from the initial stages of the system.

Fast Response Time. Because most of the data needed by a given executive will reside on his PC, the response time will be that of a PC rather than that of a PC accessing a mainframe computer. Queries to the mainframe database will be needed only when needed data is not already stored on the PC.

EXPRESS/pcEXPRESS does have a serious drawback in its user interface and graphic presentation capabilities, which are comparatively primitive and not designed for use by high-level management. However, with the toolkit provided by EXPRESS/pcEXPRESS and in cooperation with Information Resources, Inc., MiTech believes that these limitations can be overcome within the required timeframe.

These advanced features of the EXPRESS system allow the fastest possible response to changing executive information needs: no new Briefing Book reports need to be designed and downloaded by developers and analysts behind the scenes while the executive waits for information -- or looks elsewhere. Thus, the product most suited to provide superior performance to FAA executives both functionally and technologically is Information Resources' EXPRESS/pcEXPRESS. This product is also cost-competitive, especially during its initial prototype phase. (See Section 5.0 for an exact breakdown of costs.)

1.2.1.2

Deficiencies of Alternatives

Pilot's major drawback is that it is completely mainframe-based. Executive users receive all data in interactive sessions with the mainframe. Because of its slow response time and intensive prime-time utilization of mainframe resources, which necessitates a much larger and more powerful mainframe than is required for the other systems, Pilot was judged to be unsuitable for the FAA. Its lack of decision support tools and its current inability to run in an IBM MVS operating system (the most widespread operating system within FAA) were also factors in its elimination.

1.2.1.2

Deficiencies of Alternatives (Continued)

Comshare Commander, Executive Edge (in either configuration), and Stratagem (in either configuration) all fall within a middle group of EISs. Each has a mainframe-based database which produces flat file reports; these reports are then downloaded in batch mode (usually overnight) to the executive user's PC. The user has the capability to call up and view these documents (in a static Briefing Book or slideshow type of interface). If executives wish to perform ad hoc queries interactively against the mainframe database, all of these products (except Stratagem with CADET) provide the capability. However, in order to do so, they must be aware of what information resides on the mainframe database and what data is already contained in their Briefing Book of reports. Stratagem with CADET has only the capability to produce flat file reports to be downloaded to the PC; no interactive querying capability for the executive user is possible in this configuration.

The biggest drawback to this group of systems is the rigidity of their reporting mechanisms. If the executive would like to "drill down" further into the details of a summary-level report, only limited capability can be provided within the PC "Briefing Book" architecture. Instead, the executive must usually access the mainframe, find the same data as in the Briefing Book report, and then continue the drill down, using a different interface than used while viewing his Briefing Book.

If executives need new areas of data, or they would like to see the same data presented in a different way, they cannot do it at the PC, EVEN IF THE DATA IS ALREADY IN THE MAINFRAME DATABASE. In order for the data to be added to his Briefing Book, the report must be ordered by the executive and then designed and coded by developers and analysts and finally added to the Briefing Book display. MiTech concluded that FAA executives will not be willing to wait that long for the answers to their questions and will turn away from using the system.

Both Stratagem options and especially the Executive Edge paired with ORACLE option will require a great deal of extra development work and time beyond that needed for the other options. Also, Stratagem does not have many of the EIS-oriented enhancements that the other products have, including EIS templates, and advanced data loading and summarization capabilities. Comshare Commander and the full-system Executive Edge are very similar; of the two, Executive Edge was judged to be slightly superior to Comshare in its portability to other products (IFPS), its decision support capability, and its service to its customers. Executive Edge also has a lower cost of the two. Comshare, however, is currently the industry leader in EIS systems and has a superior, iconic user interface; Execucom has a large base of decision support customers and has only recently entered the EIS market.

1.2.1.2

Deficiencies of Alternatives (Continued)

In general, EIS systems which rely on a static set of reports as their main method of information delivery require too much human intervention in report preparation to be a truly dynamic source of executive information. Information Resources' EXPRESS and pcEXPRESS have overcome the limitations of this EIS approach. Their products are functionally and technologically superior to the flat-file, "Briefing Book" approach to executive information. EXPRESS combines the flexibility of queries found in Pilot with the fast response time of PC-based Comshare and Executive Edge. In EXPRESS, data is collected and stored on a mainframe computer, but instead of downloading flat file reports to the PC, EXPRESS actually downloads a subset of the entire database, still in database form, to its counterpart pcEXPRESS. pcEXPRESS provides database management capability at the PC: thus, executive users and their staff are not limited to PC-based flat file reports, but can actually perform ad hoc queries at the PC. This allows maximum flexibility of use by the executives and their staffs.

1.2.2

Connectivity Recommendation

With regard to connectivity, two implementation strategies were considered. The first implementation strategy takes advantage of the Administrative Data Transmission Network (ADTN) directly. Executive users at FAA headquarters and the regions would be connected directly to a Packet Assembler/Disassembler (PAD) which would become a node on the ADTN. Hardwiring and installation of the PADs would be performed by the ADTN contractor, Telenet, and costs would be borne by the ADTN program office. This strategy results in no reduction in functionality to any of the EIS systems. In addition, this method provides a method for other executives to access the EIS as the user community grows and the information requirements reach remote regions and centers.

In the second option, PC-based software would be installed on a partitioned virtual disk of several Wang VS 300 minicomputers in FAA headquarters and on the virtual disks of the Data General MV 15000 computers at the regional headquarters. These computers would be linked to the ADTN, receiving downloaded information from the mainframe computer where the EIS mainframe database resides. The executive's Wang (and other) PCs, working in their DOS mode, would access information from the virtual disk. The advantage to this implementation strategy is its use of the Wang and Data General virtual disks for mass storage. All of the major vendors support this implementation to some degree; some may not allow the users the capability of interactive queries to the mainframe. Further tests of this option with the selected vendor may be required.

This second option could have significant disadvantages, however, especially when considering a long-term solution. New users beyond the initial prototype would have to be supported by use of additional Wang minicomputers or via direct connection to the EXIS mainframe over the ADTN. In the still longer term, porting the database from the Wang to CORN and OATS environments would probably require some recoding, given the extremely proprietary nature of Wang's telecommunications protocols. A significant amount of performance degradation is also expected with usage of the Wang virtual disk when five or more users are accessing data from the disk. Finally, use of the Wang virtual disk will not permit interactive queries to the EXIS mainframe for all the EIS vendor systems. Most of the systems are supported to some extent, but can only support batch downloads to the Wang virtual disk. Use of this method would therefore mean a reduction in functionality to the EIS.

For these reasons, connectivity through the Wang VS 300 virtual disk is not recommended. The preferred implementation option uses the ADTN directly.

1.2.3

Hardware Recommendation

The following mainframe hardware options were considered: use of DOT-owned computers, use of timesharing computers, and lease of a mainframe computer from IBM or Digital Equipment Corporation. For cost reasons alone, leasing a dedicated mainframe is the preferred solution. A mainframe capable of supporting the FAA EXIS needs through the CORN timeframe can be leased for as little as \$13,000 per month with a 36-month lease. Timesharing costs, by conservative estimates, would be at least twice that figure by the project's second year, and would probably be six times that figure by the project's fourth year. No FAA-owned mainframe computer is currently capable of supporting the FAA EXIS needs. (See Section 4.2, "Mainframe Hardware Options," for further information in this area.) Other government-owned mainframes (such as those owned by the Transportation Systems Center and the Transportation Computer Center) would charge rates at least comparable to the best timesharing option available.

1.2.4

Full Implementation Strategy

A phased implementation strategy would take advantage of EXPRESS/pcEXPRESS's ability to support a small EIS without the need for a mainframe computer. Thus, neither the mainframe acquisition nor the connection to the ADTN would delay the development of the initial three to six month prototype phase of the EIS. Following the prototype, the database developed on pcEXPRESS could be ported to mainframe EXPRESS with minimal redesign and recoding. If necessary, the database could be ported temporarily to the timesharing service provided by Information Resources, which supports mainframe EXPRESS. The database could be then ported without difficulty to the mainframe provided by FAA for the EXIS project, and finally to the CORN environment.

1.3 Summary: Advantages and Disadvantages

1.3.1 Option 1: Pilot

1.3.1.1 Advantages (Pilot)

Product line dedicated solely to EIS use.

Database not distributed between mainframe and PC's: no repetition of data and guarantee of data integrity.

Mature EIS product.

Modifications simple because of single template for each application.

1.3.1.2 Disadvantages (Pilot)

Requires 100% of queries to be interactive to the mainframe. Response time can be unsatisfactory unless large capacity mainframe is available. 400+ users will require very large machine.

No Decision Support System (DSS) (e.g., modeling, forecasting) capability.

Closed software architecture makes connection to other systems/applications difficult.

Does not work on IBM MVS machine.

Does not have code-generation capability at present, although it has announced some for the future. Currently, products are supplied only with sample applications to copy.

No data summarization capability for loading Pilot database.

1.3.2 Option 2: Comshare Commander

1.3.2.1 Advantages (Comshare Commander)

Fast response time for Briefing Book use.

All data need not be entered into the System W database; reports which do not lend themselves to database format or which are already being prepared in another media (such as PC word processing or spreadsheets) can be loaded directly into the Workstation Manager for inclusion in the Briefing Book.

1.3.2.1 Advantages (Comshare Commander) (Continued)

Colorful, iconic interface.

Single integrated EIS/DSS capability (modeling, forecasting, analysis) integrated with System W.

Data input and summarization tool (DATMAN) very strong. Some SQL data pipelines.

1.3.2.2 Disadvantages (Comshare Commander)

Rigid "Briefing Book" interface does not allow executive user to modify report format or content as needed.

Comshare does not have its own electronic mail, nor can it provide a front-end to any other e-mail.

Ad-hoc analysis capability with Execu-view is separate from Briefing Book, i.e., user must leave one to use the other.

Comshare is not as flexible in its Builder's EASEL as EASEL itself would be.

PC updates are time-consuming and dependent on PC batch commands. Mainframe can only note problems with updates; it cannot ensure that they are performed.

1.3.3 Option 3a: Executive Edge (Full system)

1.3.3.1 Advantages (Full Executive Edge)

Executive Edge is the most portable of the systems evaluated. The complete IFPS/Plus runs on IBM MVS/TSO, IBM VM/CMS, DEC VAX, Burroughs, Hewlett Packard, Honeywell, Prime, Sperry, and Wang.

Provides a single integrated EIS/DSS capability.

The AI-based artificial intelligence EXPLAIN feature directs drill-down.

Customer comments highly complimentary of both products and services.

Has its own electronic mail.

1.3.3.2

Disadvantages (Full Executive Edge)

Rigid "Briefing Book" interface does not allow executive user to modify report format or content as needed.

Data collection and storage functionality is weak.

No code-building tools are provided, only sample applications written in their 4th generation language.

Training beyond the initial session would not be local; classes offered only in Texas, New York, Chicago.

ESS product (Vantage Point and templates) new this year.

PC product (Vantage Point) actually owned by third-party vendor, Candle Corporation.

PC updates time-consuming and dependent on PC batch commands. Mainframe can only note problems with updates; it cannot ensure that they are performed.

1.3.4 Option 3b: Executive Edge (Partial system supplemented by Oracle)

1.3.4.1

Advantages (Partial Executive Edge)

Executive Edge is the most portable of the EIS systems. IFPS runs on IBM MVS/TSO, IBM VM/CMS, DEC VAX, Burroughs, CDC, Data General, Hewlett Packard, Honeywell, Prime, Sperry, and Wang. Oracle is also extremely portable.

1.3.4.2

Disadvantages (Partial Executive Edge)

Rigid "Briefing Book" interface does not allow executive user to modify report format or content as needed.

Partial system does not include multidimensional database storage and retrieval.

IFPS not integrated with Oracle database. Flat files must be created in Oracle and shipped over to IFPS. Oracle would act as a data buffer only, with limited use of its selection capability.

1.3.4.2

Disadvantages (Partial Executive Edge) (Continued)

Data is being stored in mainframe at least twice: in Oracle database and in flat files reports created by Oracle and accessible by IFPS.

No EXPLAIN feature with limited capacity system.

PC emulation of Data General terminals may prove to be a problem if Data General is used as mainframe.

No code-building tools are provided, only sample applications written in their 4th generation language.

Training beyond the initial session would not be local; classes offered only in Texas, New York, Chicago.

ESS product (Vantage Point and templates) new this year.

PC product (Vantage Point) actually owned by third-party vendor, Candle Corporation.

PC updates time-consuming and dependent on PC batch commands. Mainframe can only note problems with updates; it cannot ensure that they are performed.

Poor vendor support from ORACLE, based on customer comments.

1.3.5

Option 4: Information Resources EXPRESS

1.3.5.1

Advantages (EXPRESS)

Dynamic user querying of PC-based database possible (although pre-designed reports can also be programmed if desired).

Single, seamless user interface for data on PC or data on mainframe.

EIS can be built in a phased implementation, starting on a PC and moving to a mainframe as the EIS database grows.

Powerful data dictionary capability allows automatic maintenance of database tables.

1.3.5.1

Advantages (EXPRESS) (Continued)

Lower maintenance for developers, since predesigned reports need not be created for users.

Fast response time.

Provides a single, integrated EIS/DSS capability.

1.3.5.2

Disadvantages (EXPRESS)

PC updates time-consuming and dependent on PC batch commands. Mainframe can only note problems with updates; it cannot ensure that they are performed.

No code-generating capability with application development tools.

Automated iconic interface not yet part of EIS toolkits. Icons can be built, but with difficulty.

No electronic mail capability.

1.3.6

Option 5a: Stratagem/Tellagraf/CADET

1.3.6.1

Advantages (Stratagem/Tellagraf/CADET)

Superior graphics capabilities are provided.

Produces standardized reports automatically: once generated these could continue to be produced automatically.

Powerful data dictionary integrated with application development.

1.3.6.2

Disadvantages (Stratagem/Tellagraf/CADET)

Significant programming effort required to build user interfaces, monitoring capability, audit trails (verification of updates), and other functions which come automatically included with other EIS products.

Executive user interface limited to "slide show" capability only: no drill-down or ad hoc queries possible.

Requires two different menuing interfaces be built for executive and analyst users.

1.3.6.2

Disadvantages (Stratagem/Tellagraf/CADET) (Cont.)

More than one vendor supplying software and support.

Coding in 3rd generation language such as COBOL or FORTRAN required to read data from large files into Stratagem database; no built-in capability supplied.

Stratagem does not have automatic data summarization "staging area" and loading capability. Instead, non-summarized data must be loaded into database and then summarized.

Printing graphs requires use of third party software package such as Technographics.

CADET implementation requires graphs to be downloaded, displayed and captured on PC -- an extremely awkward and error-prone procedure.

PC updates time-consuming and dependent on PC batch commands. Mainframe can only note problems with updates; it cannot ensure that they are performed.

Due to integration of multiple vendor products, the time to initial application (and all subsequent) will be slower than with vendors who supply completely integrated products for all EIS needs.

Computer Associates did not develop Stratagem or Tellagraph; they were acquired by purchase of the developing corporations. Products are a conglomeration rather than being designed together to meet EIS needs.

Vendor support inconsistent.

1.3.7 **Option 5b: Stratagem/EASEL**

1.3.7.1

Advantages (Stratagem/EASEL)

Extremely user-friendly iconic (pictures) interface.

Graphics created at PC from scripts.

1.3.7.1

Advantages (Stratagem/EASEL) (Continued)

Code-generating tools are provided in addition to 4th generation language sample applications.

Powerful data dictionary integrated with application development.

1.3.7.2

Disadvantages (Stratagem/EASEL)

More than one vendor supplying software.

Coding in 3rd generation language such as COBOL or FORTRAN required to read data from large files into Stratagem database; no built-in capability supplied.

Stratagem does not have automatic data summarization "staging area" and loading capability. Instead, non-summarized data must be loaded into database and then summarized.

PC updates time-consuming and dependent on PC batch commands. Mainframe can only note problems with updates; it cannot ensure that they are performed.

Due to integration of multiple vendor products, the time to initial application (and all subsequent) will be slower than with vendors who supply completely integrated products for all EIS needs.

Computer Associates did not develop Stratagem or Tellagraph; they were acquired by purchase of the developing corporations. Products are a conglomeration rather than being designed together to meet EIS needs.

Vendor support inconsistent.

Significant programming effort required to build user interfaces, monitoring capability, audit trails (verification of updates), and other functions which come automatically included with other EIS products.

1.4 Summary of Performance Against Criteria

Each of the systems was evaluated based on a set of criteria approved by FAA prior to beginning the evaluation. Only those vendors which received a rating of 70% or higher against these criteria were considered in the final evaluation. Five of the seven evaluated vendors received a score of 70% or above. Scoring was based on the following areas: functionality and ease of use, ease of design and development, hardware and software limitations and requirements, maintenance issues, and product/company history. The highest scoring system was EXPRESS/pcEXPRESS, with a score of 81%. The partial Executive Edge system paired with ORACLE and the Stratagem/Tellagraf/CADET option received less than 70%, and were eliminated. See Table 1-1 for a summary of the scores in each of the major areas. Appendix A contains a complete breakdown of the individual scores and a list of the criteria approved by FAA.

Product Scores vs. FAA Criteria

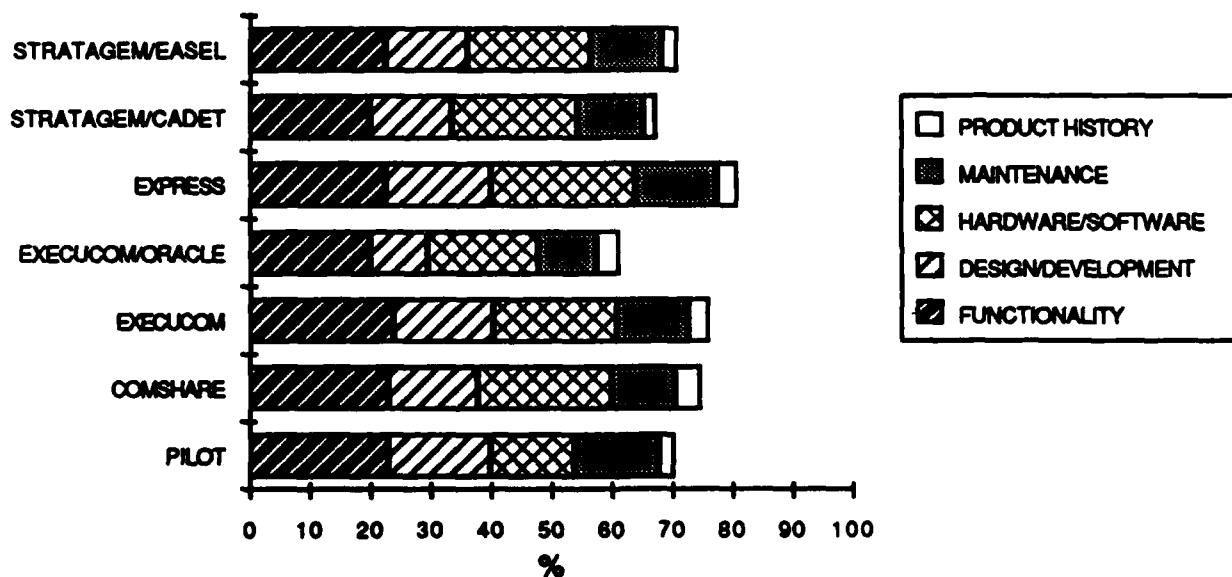


Diagram 1-1

1.5 Differentiating Features

The following summary of major features helps discriminate between systems and identify the critical features of the FAA EIS. See Diagram 1-2 for a pictorial representation of these features.

Key to Options

P - Pilot
 C - Comshare
 E - Execucom (full system)
 EO - Execucom (with ORACLE)
 Ex - EXPRESS
 SC - Stratagem/Tellagraf/CADET
 SE - Stratagem/EASEL

<u>List of Features</u>	<u>System Options</u>						
	<u>P</u>	<u>C</u>	<u>E</u>	<u>EO</u>	<u>Ex</u>	<u>SC</u>	<u>SE</u>
No additional development	Yes	Yes	Yes	No	Yes	No	No
Decision support capability provided	No	Yes	Yes	Yes	Yes	Yes	Yes
Not mainframe intensive	No	Yes	Yes	Yes	Yes	Yes	Yes
Works in IBM MVS	No	Yes	Yes	Yes	Yes	Yes	Yes
Dynamic information retrieval	Yes	No	No	No	Yes	No	No
Single vendor support	Yes	Yes	Yes	No	Yes	No	No
Low ongoing maintenance	Yes	No	No	No	Yes	No	No
Fast prototyping possible	Yes	Yes	Yes	No	Yes	No	No
Single interface for all executive data	Yes	No	No	No	Yes	No	No
Fast response time for majority of queries	No	Yes	Yes	Yes	Yes	Yes	Yes
Total "Yes" Answers (out of 10):	6	7	7	4	10	4	4

EIS FEATURE COMPARISON

PILOT	COMSHARE	EXECUCOM	EXECUCOM ORACLE	EXPRESS	STRATAGEM TELLAGRAF CADET	STRATAGEM EASEL
NO ADDITIONAL DEVELOPMENT	NO ADDITIONAL DEVELOPMENT	NO ADDITIONAL DEVELOPMENT	DECISION SUPPORT	NO ADDITIONAL DEVELOPMENT	DECISION SUPPORT	DECISION SUPPORT
DYNAMIC INFO. RETRIEVAL	DECISION SUPPORT	DECISION SUPPORT	NOT MAINFRAME INTENSIVE	DECISION SUPPORT	NOT MAINFRAME INTENSIVE	NOT MAINFRAME INTENSIVE
SINGLE VENDOR	NOT MAINFRAME INTENSIVE	NOT MAINFRAME INTENSIVE	WORKS IN IBM MVS	NOT MAINFRAME INTENSIVE	WORKS IN IBM MVS	WORKS IN IBM MVS
LOW MAINTENANCE	WORKS IN IBM MVS	WORKS IN IBM MVS	SINGLE VENDOR	FAST PROTOTYPE	WORKS IN IBM MVS	FAST RESPONSE TIMES
FAST PROTOTYPE	SINGLE VENDOR	SINGLE VENDOR	FAST PROTOTYPE	SINGLE USER INTERFACE	FAST RESPONSE TIMES	FAST RESPONSE TIMES
SINGLE USER INTERFACE	FAST PROTOTYPE	FAST PROTOTYPE	FAST RESPONSE TIMES	FAST RESPONSE TIMES		

DIAGRAM 1-2

1.6 Cost Summary

The software, additional development above the baseline, and hardware costs for each of the vendors which met the minimum FAA functional requirements are identified below. Diagram 1-3a shows the full five year costs of each of the systems through the CORN acquisition; Diagrams 1-3b and 1-3c show the costs for each of the first two fiscal years, respectively. See Section 5.0, "Costs," for further details on this information.

	Five Year Costs (in \$K)				
	Pilot	Comshare	Execucom	EXPRESS	Stratagem/ EASEL
Software	166	548	323	483	526
Additional Development	25	25	25	25	218
Hardware (Lease)	1,086	474	474	474	474
TOTAL	1,277	1,046	822	982	1,217

	First Year Costs (FY 89) (in \$K)				
	Pilot	Comshare	Execucom	EXPRESS	Stratagem/ EASEL
Software	112	139	91	95	163
Additional Development	25	25	25	25	218
Hardware (Lease)	366	126	126	0	126
TOTAL	503	290	242	120	507

	Second Year Costs (FY 90) (in \$K)				
	Pilot	Comshare	Execucom	EXPRESS	Stratagem/ EASEL
Software	13	83	56	277	90
Hardware (Lease)	360	156	156	162	156
TOTAL	373	239	212	439	246

5 Year Costs

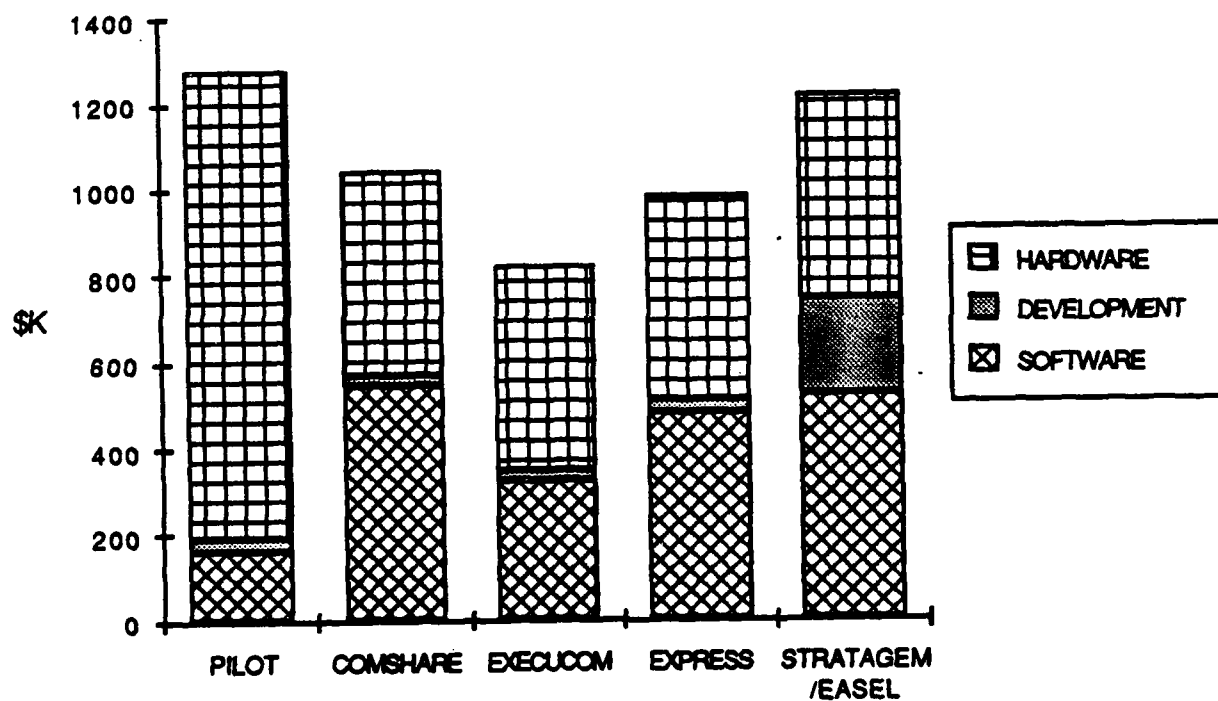


Diagram 1-3a

First Year Costs (FY 89)

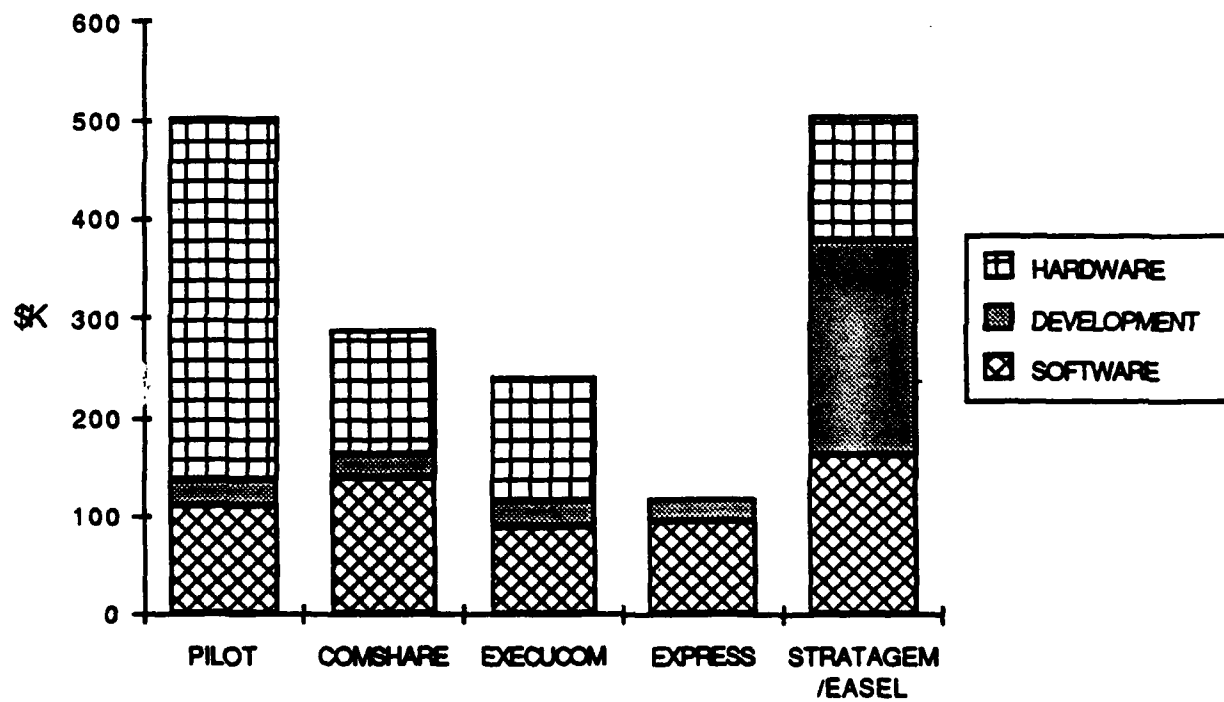


Diagram 1-3b

Second Year Costs (FY 90)

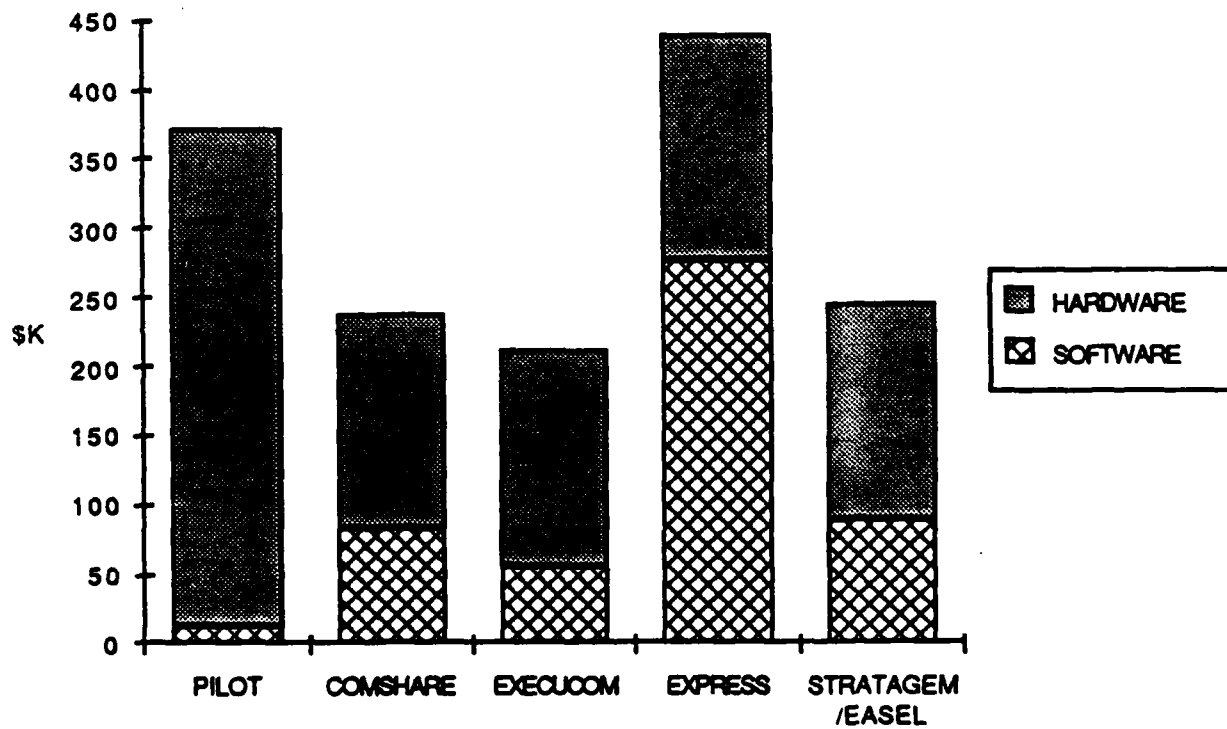


Diagram 1-3c

2.0 SOFTWARE

2.1 Pilot Executive Software

2.1.0 Product Overview

Pilot Executive Software is an integrated system, having most of the components of an EIS: a centralized database, analysis tools, presentation and graphing capability, and a user interface method. Its only missing piece is in the area of decision support: Pilot does not have the capability to perform sophisticated analysis such as forecasting and modeling, and because it is a closed system, this component cannot be integrated directly.

Pilot is a mainframe-based system. Its multidimensional database is created on a host mainframe, and all user queries are done in interactive sessions with the mainframe database. The PC workstation takes care of graphics, report formatting and presenting the information for its user. (See Diagram 2-1.) The PC also performs RAM data caching of each user's most commonly requested data to minimize mainframe CPU utilization and retransmission time.

In addition to the Command Center "kernel," Pilot supplies three tools for building user interfaces (for an additional charge). These are:

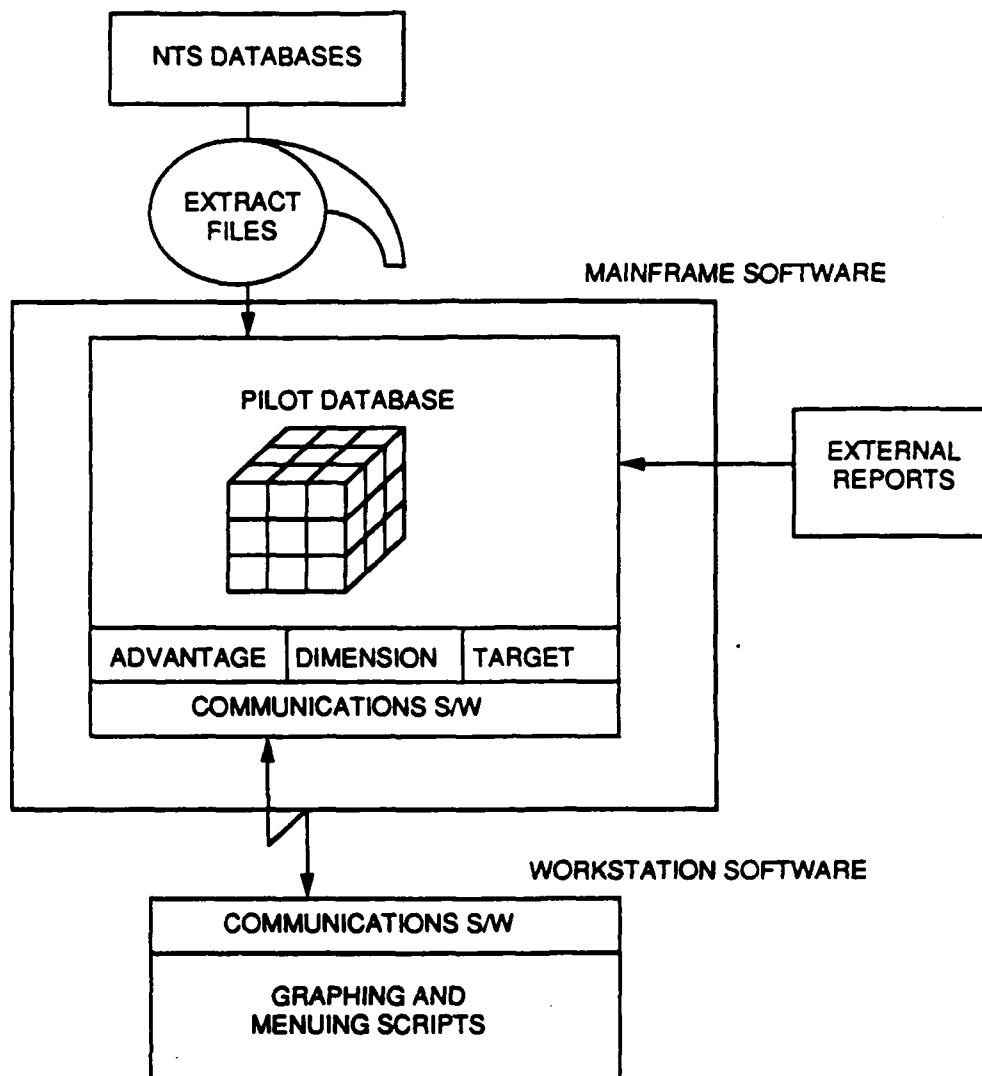
(1) Advantage: Views data hierarchically. Uses "drill-down" techniques allowing user to view greater levels of detail. Produces exception reports, trends, cumulative totals. Works via pre-planned menus and screens.

(2) Dimension: Views data relationally. Intuitive ad hoc queries made by viewers allow the same data to be viewed from different perspective (e.g., over time, across regions, etc.). Takes advantage of multidimensionality of database.

(3) Target: Project status-oriented. Geared toward schedule and cost information.

Pilot has been in production since 1985, and it has quickly become one of the two industry marketing leaders in EIS.

PILOT



ADVANTAGE

DIMENSION

TARGET

PILOT DATABASE

- Tool to allow user to view data in database hierarchically
- Tool to allow user to view data in database relationally
- Tool for showing project schedule and cost information
- Multidimensional, relational database

Diagram 2 - 1

2.1.1 Functionality and Ease of Use Score: 77/100

2.1.1.1 User-Friendly Access Score: 14/15

The system is menu-driven, and almost no training is required for the user. Each user's menu can be customized to meet his own needs with Pilot's menu library. When using applications designed using the "Advantage" tool, managers may select for viewing any of several previously designed reports. (The difference between Pilot and some other systems -- notably Comshare's -- is that each report is not actually generated until the executive selects it.) "Dimension" allows ad hoc "data driven" queries to the database. Since these are particularly easy to perform an executive user could reasonably be expected to perform his own analyses. Customized on-line help is available.

2.1.1.2 Data Manipulation Score: 10/15

Like many of the other EIS products, Pilot has a multidimensional/relational database for collecting and manipulating data. Pilot emphasizes the time-series aspect of its data, claiming that any piece of data has a time-series associated with it. However, with its Dimension tool, data can be viewed from any perspective, not just by time. The database can store and present textual, numeric, historical and timeseries information. Pilot's database is optimized for data retrieval, rather than balanced between data retrieval and data input. This is an important design consideration which gives greater value to the Pilot database product. Because it only has a database for storing information, textual reports which do not lend themselves to a database format present something of a problem. Pilot's answer is to store the report in a database format of some kind.

Pilot's drill-down functions are performed using the "Advantage" application tool. Calculator functions, worksheet capabilities, and a Lotus 1-2-3 interface allow executives to do ad hoc analysis/comparisons of information with any Pilot applications. Executives or their support staff can build a virtually unlimited number of ad hoc reports using the "Dimension" tool with no sacrifice in response time. The results of queries can be stored at the user's workstation and can also be sent to other users -- with comments appended -- via electronic mail. Pilot can produce a system-wide exception report, listing only those items which are out of line with the goals and objectives set. The user can change the trigger points which define the achievement of goals and objectives.

Pilot's products are specifically designed for EIS use and therefore do not support "what-if" modeling or other "decision support" capabilities. This limitation is a serious drawback and one of the primary reasons Pilot is not recommended.

2.1.1.3

Security

Score: 9/10

Pilot's Command Center has a variety of security features. Prime among them is the role of the user profile which defines applications and subsystems available to each user. User ID's and password protection of applications and files are fully supported. The nature and the extent of security for each application is definable by the application developer.

2.1.1.4

Operations

Score: 6/10

Pilot's ability to support up to 400 users is limited by the hardware constraints of the CPU(s) on which the EIS operates. Pilot claims that a response time of less than 10 seconds for each query is possible due to their software optimization. However, GSA has experienced response times of several minutes. Animal and Plant Health Service (APHIS) is already experiencing this with their Management Support System running in a MicroVax environment. A dedicated large mainframe will be necessary if Pilot is selected. A large number of active users will probably slow the system. Four hundred users will require a powerful multiprocessing computer totally dedicated to EXIS.

Pilot claims that because the mainframe is not producing all the EIS reports, graphics, analysis, etc., and then sending the entire set of finished products to the PC, their system requires less CPU utilization and less transmission time than systems which develop a "Briefing Book" set of canned reports. However, this is less of an advantage than it might appear, since most standard report generation and mass PC updates would take place during off-peak hours.

Pilot does occasionally lock out users from data access, depending on what mainframe operating system is being used. A Digital VAX machine would not lock out users; an IBM might.

Mainframe CPU utilization is optimized in that only data manipulation is performed there; data formatting and presentation (graphics) functions take place at the PC.

2.1.1.5

Data Sources/Input

Score: 6/10

The Pilot database will accept input from flat files (ASCII, EBCDIC, certain COBOL strings) only. It has no direct interface to any transactional-type DBMS systems, nor does it have an automatic summarization capability, such as DATMAN in Comshare or the Data Reader programs in pcEXPRESS. When using Pilot, raw files from transactional databases would need to be summarized by some additional external tool prior to being loaded into the Pilot database. It does have a Lotus 1-2-3 interface at the PC level.

2.1.1.6

Data Integrity

Score: 9/10

This is one of Pilot's strengths. The existence of a single, shared database ensures that all executives are provided with consistent data. The lack of PC databases to update also ensures that the freshest data is always being accessed. There are no constraints on the frequency of data updates.

One problem is the amount of control that data "owners" (such as the Office of Primary Interest, or OPI) can have over their data. Subsystems can be built that allow for the review and presentation of data to "owners" in order to receive their approval prior to the general entry of data into the database tables. Alternately, in time-sensitive applications, some Pilot customers have color coded newly released or "unblessed" data in the database. The color reverts to normal when the "owner" has approved or verified the data for release.

2.1.1.7

Presentation

Score: 8/10

Pilot supports a mouse and touchscreen interface, as well as a keyboard. They recommend at least a mouse. Color graphic capabilities are supplied, and color coding to indicate problem areas can and is typically used. Text and several graphs can be displayed simultaneously on the same screen. Each executive user can choose his own display formats and graph types needed for each query, as he feels appropriate. The executive can send the results of his query directly to be printed, or save them to a file to be re-examined later.

The graphic functions are the usual ones: 2-dimensional pie charts, bar charts, and line graphs. The graphs can be scaled automatically. Graphs can be printed to a file or directly to a printer. Printed reports can be generated automatically.

2.1.1.8

Monitoring Functions

Score: 8/10

Pilot Command Center has audit features which allow the tracking of application/system use by each executive user. These systems help direct the attention of limited system development and maintenance resources.

2.1.1.9

Additional Functions

Score: 7/10

Electronic mail interfaces to PROFS, Vaxmail and All-In-1 are provided with the system. To front-end Wang mail will take some customization. Pilot does not have its own mail service; however, that feature is currently in development.

Pilot provides a user-friendly front-end interface to the Dow Jones news reporting and retrieval service. News items can be collected in the EIS database or the executive can access Dow Jones directly, depending on the development approach.

Data can be exported to and imported from Lotus 1-2-3 and ASCII files only on the PC level. Pilot could provide a front end to word processing capabilities.

2.1.2 Design/Development Issues Score: 84/100

2.1.2.1 System design/build

2.1.2.1.1 Tools or 4GL language for EIS user interface development Score: 12/15

One of Pilot's advantages is that it has a "data driven" menuing structure: a standard report template, including scripts for both graphic and textual information, can control the presentation format for an entire application. This means that once the template has been designed, changes in the database structure or in the data itself will automatically be picked up when reports are generated. Unlike other products, where each screen or report must be prepared individually, a single Pilot template can handle literally hundreds of screens and reports.

Pilot provides Command Center, essentially an intermediate EIS language (4GL/RDBMS) applications development environment. The ease of use in deploying the language as a development tool for EIS has been enhanced by embedding the language into "visual programming" modules. This environment is helpful in developing specific report types as defined by requirements. The Command Center environment may be used to create complex menus and graphics, depending on the overall system design. Sample EIS templates are provided as models.

Pilot provides application generators or off-the-shelf applications to be used to model the generation of the user interfaces. These application generators include "Advantage," for hierarchical user interface; "Dimension," for relational user interface; and "Target," for schedule and cost information. Pilot provides functional building blocks that increase productivity of developers and Pilot will continue to upgrade these products to make development easier.

2.1.2.1.2 Database building and manipulation Score: 13/15

The basic architecture of the Pilot system is the use of the centralized database with heavy emphasis on speed in data retrieval. Since this is the key distinguishing factor between Pilot and the other vendors they have concentrated on this aspect of the EIS (building the database and retrieval speed). Pilot uses advanced indexing and access schemes to optimize speed of data retrieval.

2.1.2.1.2 Database building and manipulation (Continued)

Time-series data are handled as a native data type. This is an advantage of this system because it keys on time-based data which is important in an EIS. Within the Pilot database are stored not only low-level data but also aggregates, which are dynamically added to the database structure itself as they are calculated. This optimizes retrievals at the summary level.

Another important optimization feature of the Pilot database is that all fields are dynamically resized to fit the data; database design requires a minimum of up-front specification. This allows the addition of new fields to records without rebuilding the database.

2.1.2.1.3 Easy installation of first application

Score: 15/20

Pilot's use of a centralized database and the availability of sample templates for all phases of implementation will make it possible for the first application to be developed and implemented in about 1-3 months.

2.1.2.2 Easy installation of enhancements and modifications

2.1.2.2.1 Adaptability to change

Score: 18/20

One of the advantages of Pilot is its dynamic menu technology. Once a template is created for an application any change in data structures (for example, adding or deleting new fields, resizing fields) done to the database will automatically be reflected in the menuing structure. One problem with the system is the limited graphic capabilities.

2.1.2.2.2 Transparency to User

Score: 10/10

A separate log-in workspace is defined for each user. Therefore, an area may be defined for development where new menu templates and data structures can be designed, developed, tested and integrated with no effect on users until the new application is completely installed.

2.1.2.3 Ease of Portability

Score: 8/10

Pilot software is fully transferable between the IBM and DEC mainframe and operating systems that they support. It does not run on the IBM MVS operating system.

2.1.2.4

Quality of Vendor Support

Score: 8/10

Under Pilot's maintenance contract technical assistance and upgrades are provided. Pilot makes available developer/user hotline between 8 a.m. and 6:30 p.m. One advantage to Pilot is an on-line customer report which allows the technical support consultant to receive a comprehensive technical and historical profile of each customer site, helping Pilot provide quick answers to customer queries. Pilot also offers a bulletin board feature which may be used to receive product information. Pilot offers extensive consulting services to help in all phases in the implementation of the EIS.

Pilot offers a three day training course which is included in the initial fee. Pilot training emphasizes hands on training which may be beneficial in the learning curve. Pilot also offers a user group and user newsletter.

2.1.3 Hardware/Software Issues Score: 46/100

2.1.3.1 Efficiency of product operation Score: 8/15

Pilot is a mainframe-based system, so efficiency is based on mainframe availability and telecommunication limitations. Within the Command Center Pilot has retrieval-oriented indexing scheme and many features specifically designed to speed performance, including the storage of aggregations as separate data elements. Use of this technique makes overall product operation relatively efficient; however, the enormous drain on mainframe resources is a serious drawback.

2.1.3.2 Application Size limitations Score: 9/10

There are no limits to the size of the EIS database because it is a mainframe based system. Limitations are based upon the size and power of the mainframe and performance limitations of large applications/files.

2.1.3.3 Utilization of Hardware Resources

2.1.3.3.1 PC Requirements Score: 6/10

Pilot software will operate on a 100% IBM compatible machine with the following required and optional capabilities.

Disk Space	640K RAM recommended (512K minimum)
Ports	Asynchronous serial communications port to VAX, or Ethernet connection using DEC/NET DOS version 1.2 LAT protocol.
Monitors	5153 monitor and 256K memory with a 5154 monitor
touchscreen (optional)	MicroTouch System Inc. PCC-OTI Interaction Systems, Inc. Series 3000
mouse (optional)	MICROSOFT mouse and accompanying software

2.1.3.3.1

PC Requirements (Continued)

Color printers	ACT II Chromajet Ink Jet Seiko D-scan color hardcopier Model CH-5201B and 5301 IBM Personal Computer Color Printer Model 5182001 IBM Color Ink Jet Printer Model 2
B&W Printers	Hewlett-Packard Laserjet + Model 2686A (option 200, 210,1 or 300) Hewlett-Packard Laserjet Model 2686A or other requested printers.
plotters	No plotters are supported as of now but Pilot will custom build printer drivers on a consulting basis, as needed
modem	2400 baud asynchronous error correcting modem recommended
other P.C. based software	Lotus, WP, and other products

2.1.3.3.2

Mainframe requirements

Score: 6/10

Pilot is a mainframe based system with
workstations connected off it. Pilot operates on IBM and DEC
mainframes only.

available models	IBM 9370, 43XX, 308X and 3090 series DEC VAX series Processors
operating system	IBM - VM/SP Release 4.0 or 5.0, VM/XA/SP, Release 1.0 or VM/IS, Release 5.0 PL/1 Transient Libraries (part 5734-51M) (MVS not yet supported) DEC VMS version 4.4 or higher
memory	IBM 4 Megabytes user virtual address space (6 Megabytes recommended) DEC 6 Megabytes minimum

2.1.3.3.2 Mainframe requirements (Continued)

workspace per user DEC VAX 8000 Pages/User
 minimum

2.1.3.3.3 Wang VS 300 Score: 0/10

Pilot cannot be used at all with the Wang VS 300
minicomputer.

2.1.3.3.4 Timesharing Provided Score: 3/10

Pilot does not offer timesharing options directly
but can work out an arrangement with a company to provide this
service.

2.1.3.4 Networking Capability Score: 6/10

Since Pilot is a mainframe system networking is
critical to its success. Pilot supports several industry
standard communications architectures and is currently developing
many additional networking tools including local area networking.

2.1.3.5 Portability to CORN Score: 8/20

Pilot runs on the two basic platforms of IBM and
DEC. However, at present Pilot does not run in the IBM MVS/TSO
operating system, the most utilized operating system within FAA.

2.1.4 Maintenance Issues Score: 92/100

2.1.4.1 Ease of Maintenance

2.1.4.1.1 Modifications to System Score: 24/25

Since Pilot's EIS is completely oriented to its mainframe multidimensional database, changes to the database structure are automatically carried throughout the system, without need for major modification of other files, reports and data structures. Changes to the database structure itself are easily accomplished, using Pilot's menu-driven flat file data reading tool.

Changes to reports are all driven by template structures which are powered by the data structure of the database itself. Thus, any changes to the database are automatically incorporated into the templates and thus to the end-user reports. Menus are maintained on the mainframe along with the user ID for each user; changes to the menus are made at a single point for all users.

2.1.4.1.2 Updates Score: 19/20

Updates to the mainframe database can be done automatically. Once script files have been generated containing the data structure of the input extract files, the Pilot database can be loaded and refreshed with new data as often as needed.

2.1.4.2 Distribution of Data Score: 25/25

Once Pilot's host-based database is updated, all users have simultaneous and instantaneous access to the latest information. Data is never out of sync from one workstation to the other, since data is never downloaded to individual PC's until it is requested interactively by the user.

2.1.4.3 Nightly backup and recovery facility Score: 8/10

Backup and recovery are fully supported in Pilot environments by using operating system level tools and procedures in both VM and VMS. No additional mainframe Pilot backup procedure is possible. PC backup is not applicable.

2.1.4.5 Automated Configuration Management Tools Score: 16/20

Pilot does not contain a data dictionary system. However, Pilot does offer Command Center Tables that act as a substitute data dictionary. The table approach to the database design offers both a compact data description, while still offering data integrity and retrieval flexibility.

2.2 Comshare Commander

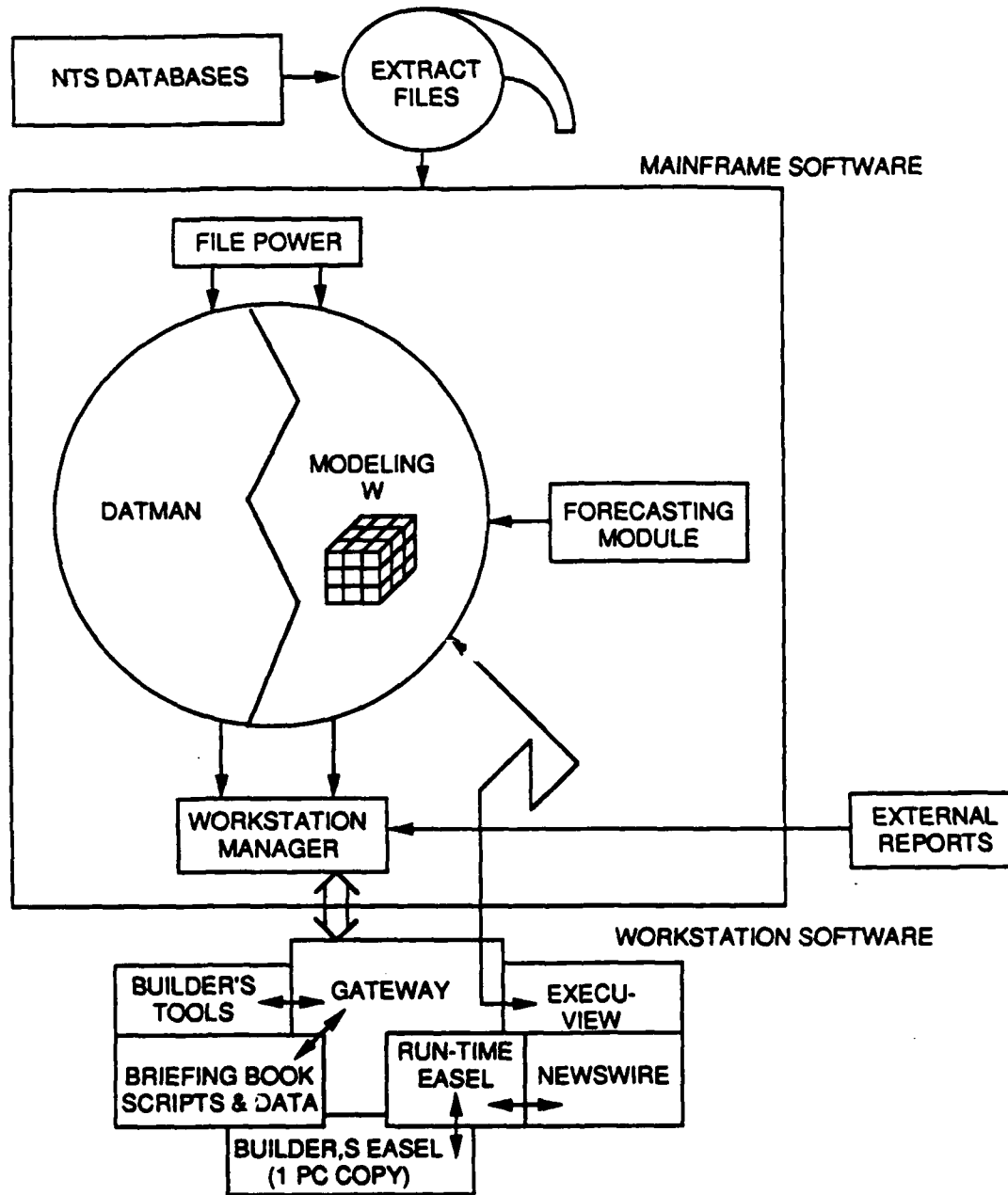
2.2.0 Product Overview

Comshare's Commander falls into the mainstream group of EIS products: data is stored and manipulated on a mainframe computer and then selected pieces are periodically downloaded to the executive user's PC hard disk. Comshare has titled the downloaded data reports "The Briefing Book," an apt title since the data is downloaded as a series of pre-formatted reports. Comshare believes that 80% of users' needs are satisfied with these Briefing Book reports. To satisfy the remaining 20%, Comshare allows its users to dial up the mainframe and direct any ad hoc queries to its "multidimensional" mainframe database (Modeling W, which provides the Comshare "Execuvue" and Decision Support (such as forecasting) features).

Data is collected and loaded into the mainframe using a product called File Power. Data collected through File Power can be loaded directly into Modeling W, a multidimensional DBMS which supports powerful modeling and decision support capabilities. Otherwise, the data can be loaded into the staging relational DBMS Datman for data summarization and consolidation before being passed to Modeling W. Data for Briefing Book reports are prepared by analysts logged into the mainframe (over a 3270 link) utilizing W's reporting functions. Report files are generated and sent using the W Control Language (WCL), a menu- or command-driven mainframe control language, to the mainframe Workstation Manager, mainframe software for document storage, administration, distribution, and PC-to-mainframe communications. Flat-file reports from other sources can also be loaded into the Workstation Manager. Analysts who prepare the final formatted reports for the Briefing Book log on to the Workstation Manager at a Comshare executive workstation and, using Builder's Tools or Builder's Easel, tie screens together and build graphs. (See Diagram 2-2.) In the future, Comshare plans to move its Modeling W capability to a PC accessed by a Local Area Network.

Comshare has been in business since 1966. It has 780 employees, and did a gross business during its most recent fiscal year of \$78.8 million. It has been marketing its EIS product since 1986, and according to industry surveys is one of the industry leaders in Executive Information Systems and Decision Support Systems.

COMSHARE COMMANDER



FILE POWER

DATMAN

MODELING W

FORECASTING

WORKSTATION MANAGER

GATEWAY

BUILDER'S TOOL

BUILDER'S EASEL

EXECUVIEW

- Mainframe software for reading data in "flat files" and loading the data into DATMAN or MODELING W
- Provides relational data storage, summarization and manipulation using SQL-like language
- Multidimensional analysis and data storage. Modeling and decision support. Tightly integrated w/DATMAN
- Mainframe software for statistical analysis and forecasting of data in W.
- Mainframe software for document storage and distribution and for mainframe communication
- PC communications software
- Builds screens and graphs for BRIEFING BOOK
- Develops graphical interfaces to mainframe systems such as E-MAIL
- PC software for on-line queries to MODELING W

Diagram 2 - 2

2.2.1 Functionality and Ease of Use Score: 81/100

2.2.1.1 User-Friendly Access Score: 13/15

Comshare uses graphical icons (pictures) for their user menus. These icons were built partially using Interactive Images' product EASEL. A Comshare customer thus receives a copy of run-time EASEL with their PC software; however, he does not receive EASEL building tools and access to EASEL's compiler; rather, a Comshare developer is limited to the applications (though not the images) that Comshare has developed using EASEL. The user interface is entirely menu-driven via these icons, built by the developers using Builder's Tools. In theory, each user's menu can be entirely customized. The reports in the "Briefing Book" are readily accessible, appearing after only a few menu choices. The format of reports in the Briefing Book cannot be directly modified by the user; instead, he must submit a request to developers or analysts who will then prepare a new report for him (and other users) to be added to the Briefing Book. However, he can query the mainframe database directly using Execuvue, a procedure which is also guided for him using the iconic interface. The user's ad hoc queries to the mainframe database can be saved, allowing him to repeat often-needed queries with minimal effort. A customized on-line "help" feature is available and can be added by the developers. The only major problem with the user interface is that the user must know where the information he needs resides, on his PC (in the Briefing Book) or on the mainframe (accessed via Execuvue). This dichotomy also requires the user to learn two separate interfaces, and to back entirely out of one selection before he can move into the other. Conversely, if the Briefing Book is properly designed, movement from one system to another would be minimized.

2.2.1.2 Data Manipulation Score: 14/15

Commander's multidimensional database representation and storage is done in System W. It can store and present textual, numeric, historical and timeseries information, using multiple links which allow the user to view the same information in several different ways, or "views." In addition, the user is not limited to a database structure for storing information; reports containing data not stored in the main database are readily stored with other Briefing Book reports at the Workstation Manager on the mainframe, and either downloaded to the executive's Briefing Book on the PC or accessed interactively. The system has limited drill-down capability (depending on design) in the Briefing Book and a full capability in Execuvue, controlled in an ad hoc manner by the user. Standard mathematical calculations and database aggregations can be performed by the System W database. Comshare also sells decision support tools with the System W database which can be used to perform sophisticated trending, analysis and modeling functions.

2.2.1.2

All performance data can be compared to goals and objectives; the user can reset the parameters indicating problems. A complete "exception report" summarizing all indicators out of bounds can be prepared as a separate report.

2.2.1.3

Score: 9/10

The system can be set up to require user ID and password protection, and data which resides on the PC is encrypted to prevent manipulation of files. User access to specific pieces of data can be restricted, depending on the levels of clearance given each user. This function is performed by the Workstation Manager at the mainframe. Individual workstations can be set to timeout after a certain amount of non-use; they would be reactivated by the executive typing in a combination. This can be set for both the Briefing Book and Execuvew.

Data analysts and "owners" (or "providers" in Comshare's terms) can be given more control over reports issued via the Briefing Book than data which is catalogued and stored in the System W database, simply because it is impractical to allow several offices to act as database administrators for the entire EIS database. On the other hand, reports sent to the Briefing Book can be prepared in their final format by the data owners, who may, if desired, be given access to the system as well, in order to prepare and submit reports to the Briefing Book.

2.2.1.4

Score: 8/10

Although 400 users can be accommodated on the Comshare EIS system in theory, in practice only a few installations have more than 100 users, and most have even fewer. User response time with the Briefing Book will of course be very fast, since the data resides on each user's PC. (The tradeoff for this speed comes in the difficulty of guaranteeing the currency of the data; see the section 2.2.4 on Maintenance.) The response time for queries to the mainframe via Execuvue will depend on several factors, including the number of other queries, the CPU power of the mainframe, and the number of other applications the mainframe must support. The database has not been optimized for data retrieval or for data input. All graphing functions take place at the PC, for both Execuvue and the Briefing Book.

Users cannot access the Briefing Book while it is being updated (updates would likely be set to occur during low-use periods after hours); however, users are not locked out of Execuvue while the main database is receiving updates.

2.2.1.5

Data Sources/Input

Score: 8/10

Comshare has pipelines which can import data directly as needed from several leading commercial DBMS systems, including FOCUS (MVS only), IMS, SQL/DS, VSAM, DB2, IDMS, and Easytrieve Plus, as well as DBASE II and III from a PC. In addition, it will accept flat files in several formats using its File Power product. Comshare emphasizes the robustness of its data transfer software, claiming it is the key to eliminating manual rekeying of data.

After source data files have been translated into a Comshare-readable format, Datman performs another important function: it summarizes, selects and sorts data, repackaging status information acquired from the transactional systems into the form required for executive reporting. This data may then be put into the multidimensional database, Modeling W, or it may be left in Datman, where it is still accessible by W.

Data owners and analysts who need to provide reports to executives through the EIS thus have two options: they can produce their reports in some text-file format that can be sent directly to the Workstation Manager on the mainframe for inclusion in the Briefing Book (useful when source data is not included in the EIS database or for rapidly-changing information such as daily reports), or they can be given access to the data in the database and use it to create their own reports, either directly using Comshare's tools (graphical and other) or with exact specifications for the report relayed to a more computer-oriented developer. If the analysts are given access to the system itself, this would require greater than 400 users and additional training provided.

2.2.1.6

Data Integrity

Score: 3/10

This is one of Comshare's weakest areas, one which it shares with all other systems that maintain data in two separate locations. Updates to the user's Briefing Book information can be blocked by any number of events, including the user's PC not being turned on when the data update (which must be initiated by the PC, although not necessarily through human intervention) is scheduled to take place. Thus, although data accessed interactively on the mainframe will be current and consistent among all users, there is no guarantee that all users will receive all batched updates simultaneously. The time required to perform updates to the PC is also a factor. Data verification is performed by the data owners and, at a gross level, by system administrators.

2.2.1.7

Presentation

Score: 8/10

The system can utilize a keyboard, a mouse, or a touchscreen interchangeably. It uses color to highlight information significance, e.g., green for good, red for trouble. Although the parameters for these judgments can be selected by each user, he does not have any on-line flexibility in the Briefing Book in choosing a format to view his data or the type of graph (pie, bar, etc.) which accompanies the data. (These choices are made in advance by the data owners or the database administrator, theoretically with input from the executive user.) This lack of flexibility does make the system very simple to use, but less able to respond quickly to evolving executive needs.

The standard types of graphs are available to the developer: pie, bar, stacked bar, 3D bar, double bar, line charts, etc. Automatic scaling of graphs is provided, and it can be overridden. The color palette includes the ability to fill in with solid color, horizontal lines, vertical lines, crosshatching, diagonal lines, weaving, etc. The system can present several graphs on the same page, or present text simultaneously with graphs.

Graphs can be sent from the screen directly to a printer, but they cannot be sent to a file for later printing at an off-site printer. The system can be set to generate printed reports automatically for an executive.

2.2.1.8

Monitoring Functions

Score: 10/10

The system can monitor usage by each user to determine the frequency of each application's use.

2.2.1.9

Additional Functions

Score: 5/10

Comshare cannot yet provide a front end to other applications, such as E-mail, or word processing. It does not provide its own word processor or E-mail. It does provide an EASEL-based front-end to the Dow Jones news service, and developers could build a similar front end to their own mainframe electronic mail or word processing, using Builder's Easel's 4GL. Data can be stored at the user workstation into a ".DIF" file for later viewing or for exporting into other PC programs which accept this format, such as Lotus 1-2-3.

2.2.2 Design/Development Issues Score: 73/100

2.2.2.1 System design/build

2.2.2.1.1 Tools or 4GL language for EIS user interface
 development Score: 12/15

Commander offers a variety of excellent tools for the designer to develop applications and to interface with existing 4GL's and other software products. They are easy to use and some are menu or mouse driven. These tools, combined with Commander Executive workstation software and Workstation Manager for mainframe and minicomputers completes the EIS.

Commander comes with a development language that can be used to create customized color graphics generated on a PC. It uses interactive, easy-to-understand color icons, pop-up menus, and window management. The PC-based graphics allow for fast graphic generation and display. This configuration also frees up the host resources for other tasks and cuts down on graphics data transmission costs. The menu and mouse capabilities suggest an increase in development ease with a decrease in development time. The developer can build interfaces to access external and internal data sources without the necessity of knowing complex computer syntax and procedures.

To create the Briefing Book from already-existing reports, the developer or analyst would use Builder's Tools on the PC. To identify mainframe reports in the Workstation Manager, create graphs, and use the tools takes very little time, once the menu-selections have been created by the developers. Creating a graph can be done by selecting an option with a mouse, selecting colors from a menu, selecting the size and the position of the graph and identifying the data to be associated with the graph -- a very simple set of procedures. Creating the data file for the reports from the mainframe databases W and Datman requires the use of a command file created with a text editor and knowledge of the W Control Language; thus, it is probably a job for developers rather than analysts.

2.2.2.1.2

Database building and manipulation

Score: 12/15

Modeling software, Modeling W, can define the structure of entities in a multidimensional view. Up to 12 criteria at 9 levels of detail can be defined. Historical information in particular can be retained. This is useful in generating trend analysis reports and statistical comparisons. The multidimensional database can be built from data accessed either through Datman or through File Power.

Another way Commander makes developing easier is with File Power to read extracts produced by DBMSs and external data sources. Only the data needed for the DBMS is extracted and then summarized as it is put into Datman. Additionally, a command language interface can be used to automate repetitive procedures, such as routine update and maintenance processes. Programmable command files would be built to perform these functions using the W Control Language (WCL). Access to the command files is vital to this system due to the extremely high maintenance required.

Execu-view applications can be built using menu selections from the Execu-view Builder tool accessing the mainframe. This is a fairly time-consuming task, requiring step-by-step responses from the developer. This program is totally menu driven with a full screen editor.

2.2.2.1.3

Easy installation of first application

Score: 15/20

Comshare believes that the first working application can be put up in 45-60 days, with 30 days for each additional application. This timeframe for the first application includes developer training. The installation of the mainframe Workstation Manager software is done by Comshare consultants for an additional fee. The Executive Commander software resident on the PC is installed via floppy.

2.2.2.2

Easy installation of enhancements and modifications

2.2.2.2.1

Adaptability to change

Score: 10/20

Incorporating changes in the data or reports used by the user is a lengthy and repetitive process. It may not be successful if a user's PC is not operational. If a report is altered it must be recompiled and distributed to all the users. Automatic updates to the user's PC are risky at the PC end. The user's PC must be operational and must have a procedure executed at update time which calls the host, asks for the appropriate updated reports and then disconnects. If the users PC is non-operational there is a risk that out-of-date reports are accessible to the user.

2.2.2.2.2

Transparency to User

Score: 8/10

All work done by the developer is done on the development workstation where it can be tested, validated, verified and then finally placed on the mainframe for distribution to end-users. When the end-user logs into the system he will be notified of any updates and be prompted to update his system, if these updates have not been taken care of automatically.

2.2.2.3

Ease of Portability

Score: 8/10

To move the application from one mainframe to another, regardless of model, the application reports must be copied onto magnetic tape in a format that is acceptable to the second computer. No recompilation of report or screen formats is required. The only effort involved is in altering any operating system dependent commands imbedded in the application or automated process scripts to the commands required by the other mainframe.

2.2.2.4

Quality of Vendor Support

Score: 8/10

Five sets of documentation are included with the initial system purchase. Additional copies can be purchased from Comshare as required. The documentation is good quality, complete and accurate. Training is available at group rates. Professional services for development assistance are also available at an additional cost. A maintenance contract is available (for a 15% charge). Under this contract technical assistance and upgrades are provided. Comshare makes a developer/user hotline available from 8 a.m. to 8 p.m. Since Comshare is a large company many consultants are available to aid in development.

2.2.3 Hardware/Software Issues Score: 74/100

2.2.3.1 Efficiency of product operation Score: 10/15

The speed of execution of the Briefing Book is extremely fast, since it retrieves reports from the PC hard disk, but the maintenance problems and time spent preprocessing data, updating, and recompiling reports may be a major problem with this system.

2.2.3.2 Application Size limitations Score: 9/10

The data structure is limited to 9 dimensions (levels) of detail with a maximum of 12 keys (criteria) for queries in each dimension. The space needed for each user's model depends on each model's dimensions.

2.2.3.3 Utilization of Hardware Resources

2.2.3.3.1 PC Requirements Score: 8/10

The PC software for this system can work on any PC that is IBM-compatible, including the Wang 240 and 280 workstations in DOS mode. The minimum requirements for the PC are as follows:

Disk Space	10 MB
RAM	640 K
Ports	1 com port, printer port, mouse port (optional)
Monitors	IBM EGA with expansion (high resolution 640x350) and an Enhanced Color Display
touchscreen/mouse	PC Mouse by Mouse Systems Logimouse by Logitech, Inc. Manager Mouse by Torrington Co. Microsoft Mouse by Microsoft Corp.
keyboard	standard

2.2.3.3.1 PC Requirements (Continued)

Printers/plotters

PostScript Laser (high resolution black and white)

HP Paint Jet for medium resolution color

HP Plotters (and compatibles) 7475, 7550

HP Laser Jet, Laser Jet Plus, Series/2

IBM Graphics Printer

communications

Asynchronous

Hayes Smart Modem or compatible

Protocol converter or coax communications for Workstation Manager and Execu-View

other P.C based software

Terminal emulation package (VT100, IBM 3101, etc)

2.2.3.3.2 Mainframe Requirements

Score: 12/15

The Comshare Commander software is available to run on two different types of mainframes, IBM and DEC VAX machines. These computers are two of the most popular types used in the computer industry today. Minimum requirements are as follows:

available models

IBM 9370 series and above or exact compatibles

Micro VAX II, Micro VAX 3000 series, VAX 11/780 and above, including 8000 series

operating system

IBM: MVS/TSO VS2 3.8, SP 1.0 or higher, or XA 2.1 or higher; or VM/CMS version VM/SP 2.0 or higher, or VM/SP/HPO 3.0 or higher. GDDM release 1.4 or 2.1

2.2.3.3.2

Mainframe Requirements (Continued)

operating system (cont)	DEC VAX: VMS version 4.5 and above, Graphics Kernel System version 2 or higher installed on the host.
memory	IBM: (VM/CMS) 3 + 4 MB DASD: 4 MB minimum using minidisks A-C, Product disk with 4 MB. (MVS/TSO) 2 started tasks pr 2 batch jobs, DASD: Product disks with 5 MG, 2MB permanent storage, min., 2 MB working storage, min. VAX: shared image 1 global section, 165 global pages. Privileged shared image-3 global sections, 10 global pages + 36,273 blocks, DASD: 570 blocks product disks, 4000 blocks permanent storage, min.
workspace per user	IBM: (VM/CMS) 3 MB virtual memory (MVS/TSO) 2.5 MB TSO region VAX: 400 blocks working set quota, min.
peripherals	IBM: host graphic display: IBM 3279/G or /3G color terminals. Hardcopy via host: IBM 3287 or compatible printers. Tape Drive VAX: VT125 or VT240 terminals. Tape Drive

2.2.3.3.3

Wang VS 300

Score: 8/10

Comshare Commander appears capable of working with the Wang VS 300 minicomputer's virtual disk, with full capabilities.

2.2.3.3.4 Timesharing Provided Score: 10/10

Comshare is a time share company and can offer timeshare service if needed.

2.2.3.4 Networking Capability Score: 5/10

The commands for logon and dial up (via modem) must be programmed. Comshare can make use of the ADTN. Only text files are passed; graphics are handled at the PC end. Comshare cannot work in a LAN environment; however, this capability is currently in development.

2.2.3.5 Portability to CORN Score: 12/20

Comshare is available on two platforms: IBM and DEC VAX. Although these are the most popular mainframe operating systems, this may limit Comshare's future portability.

2.2.4 Maintenance Issues Score: 72/100

2.2.4.1 Ease of Maintenance

2.2.4.1.1 Modifications to System Score: 13/25

Changes to the structure of the two databases, Datman and Modeling W, affect the entire system, but the changes are not automatically reflected in the other system components. For example, changes to the Modeling W database require the developer to make corresponding changes to the database Information Catalog and the ModelMap, a list of the fields available for relational querying from Execu-view. These files, Information Catalog and ModelMap, are not automatically updated when changes to the Modeling W database occur, but must be updated by the developer or database administrator for each change.

Two separate sets of script files (at the mainframe for report generation and at the PC for report format) are required to build a textual/graphical report for the Briefing Book. A change to either one of these script files necessitates a change in the other; changes must be performed separately to each file. Changes to the PC menuing structure only require changes to the PC menu files.

2.2.4.1.2 Updates Score: 19/20

Updates to the mainframe database are done by extracting data from the NTS databases and loading flat files into Datman or Modeling W for summarization, manipulation and analysis, using the Comshare product File Power. Once in the databases, reports can be generated and flat files put into the Workstation Manager for retrieval by the PCs. This entire process can be automated once the initial structure of the various input and output files has been determined.

2.2.4.2 Distribution of Data Score: 14/25

Updates to the PCs are done thru the Workstation Manager, used for mainframe communication and mainframe file storage. The Information Gateway at the PC retrieves files from the Workstation Manager and makes them available for the Briefing Book application. This process can be time-consuming, depending on the application size, the number of files, and the communication setup. Further, the PC is otherwise unusable during the update period; thus, updates must usually take place during off-peak hours, such as overnight. Close monitoring of PC-initiated updates is necessary, since automated processes at the PC can be easily disrupted. This PC availability coordination is a serious drawback to the use of Commander.

2.2.4.3

Nightly backup and recovery facility

Score: 7/10

System backup procedures for the mainframe system are usually dependent on the operating system backup procedures. Further backup procedures can be added to the Comshare system. Backups to the PCs must be handled on an individual basis.

2.2.4.5

Automated Configuration Management Tools

Score: 18/20

Comshare contains an on-line error and consistency checking tool. There is also an active data dictionary that provides information about existing data structures. An application definition language for application developers allows data manipulation and calculation. The audit trail facility allows for validation of data transfers, system transfers, system usage and successful application updates. This facility also provides notification of unsuccessful updates to the PCs, extremely important for maintaining data integrity system-wide.

2.3 Executive Edge

Two sets of evaluations and scores are provided for Executive Edge: one for a fully functional system and one for a system which is partially functional. Some mainframes support Executive Edge completely; these includes IBM and DEC machines. Other mainframes, such as the Data General and the Wang, only partially support Executive Edge. To use Executive Edge on these machines therefore also requires the use of a relational DBMS for optimum performance. For the purpose of this evaluation, the partially functional Executive Edge is paired with ORACLE, since ORACLE is already resident on the FAA Technical Center's Data General MV 15000.

2.3.0 Product Overview

Execucom's Executive Support System (ESS) software, together called Executive Edge, comes in several pieces:

IFPS/Plus, a mainframe analysis system which is composed of (1) an application development language for performing decision support analysis such as modeling, forecasting, etc; (2) an integrated multidimensional/relational database called "Dimension"; and (3) a "filing cabinet" storage capability for keeping flat file reports, documents, and memos. Data needed for IFPS calculations is retrieved either directly from the integrated "Dimension" database or from flat files in the filing cabinet. (The limited-capacity systems do not include "Dimension," the multidimensional/relational database; a substitute DBMS such as Oracle would be required to output flat files of data for IFPS to use.)

CL/Vantage Point, the PC component used to build and maintain the formats of user interface and the graphics templates. Data to drive the templates is supplied by IFPS/Plus, either directly from the database or from the results of IFPS analysis.

Executive Edge templates, sample EIS-specific applications for both CL/Vantage Point and IFPS/Plus, including a menu-driven Briefing Book, a Variance Reporting application, Ad Hoc relational database query, Dow Jones news retrieval access, and basic electronic mail capabilities. (The "Executive Edge extension" includes both CL/Vantage Point and the set of templates, along with consulting and training.)

In the full-blown system, the executive user has a choice of two types of interfaces, the "Briefing Book" and the "Interactive Review." In the first, the executive user is given access to standard reports which have been created by analysts, developers and data owners using IFPS on the mainframe and which then have been downloaded to his PC. These reports tend to show the results of sophisticated modeling and trending analyses.

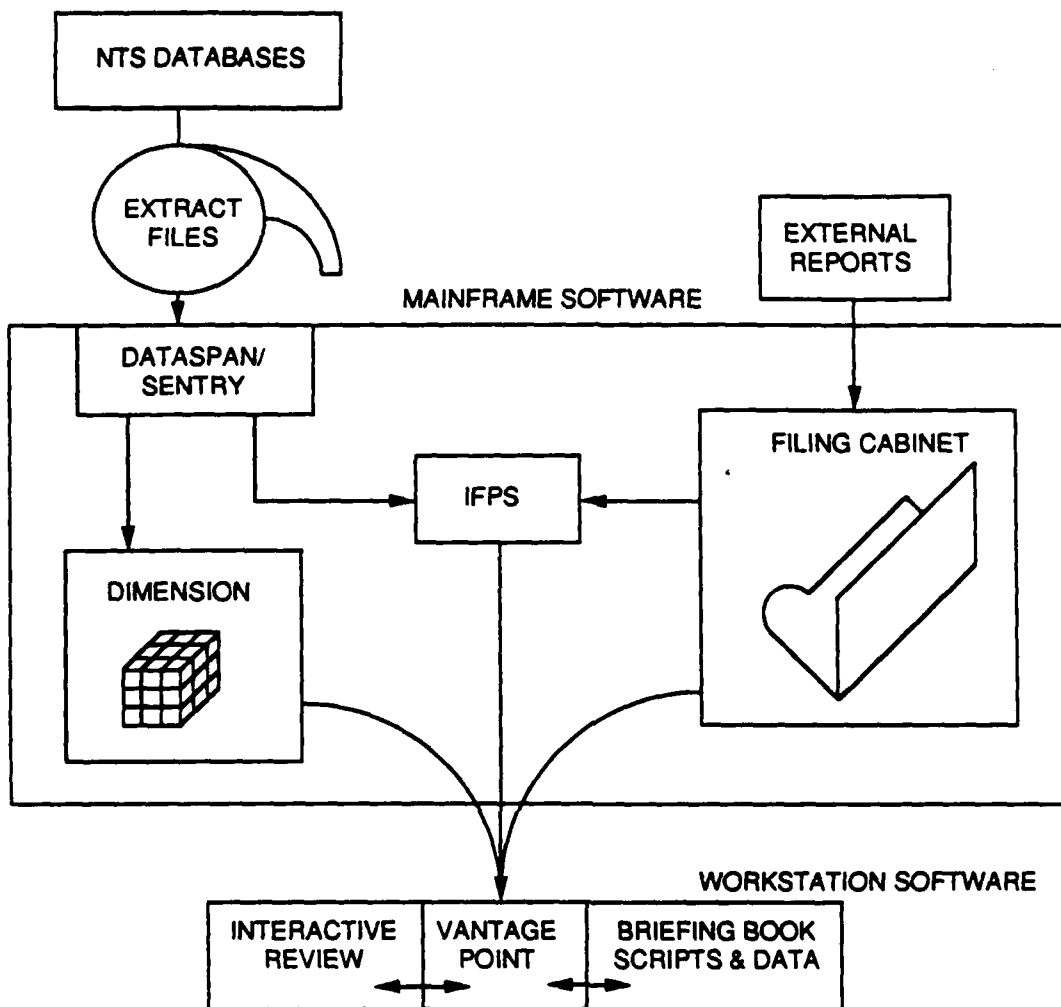
2.3.0 Product Overview (Continued)

Executives do not query the database interactively. In the second type of interface, the executive does access data interactively on the mainframe. They can access reports in the "filing cabinet" database, or he can access the multidimensional database, and can use tools in IFPS/Plus to perform advanced trending and modeling functions if desired. The Interactive Review against the multidimensional database is only available in a full-capacity system. See diagram 2-3a and 2-3b.

In addition to its basic system, Execucom offers some additional tools. Its "Data Transfer" extension imports files into IFPS. Its "Analysis" extension, OPTIMUM, does extremely high-powered decision-support analysis beyond what is provided with IFPS which allow situation modeling while varying many variables simultaneously. The "Presentation" extension, IMPRESSIONIST, is an additional boardroom-quality graphics package which would enhance the graphical capabilities supplied with the PC/Vantage Point. Unfortunately, there is no direct interface from Impressionist back to Vantage Point, although Execucom indicates an integrated capability could be developed within the next six to twelve months.

Execucom has been selling systems for fifteen years and IFPS is a DSS industry standard. Most of its customers are in the decision support arena. Execucom only moved into EISS (or Executive Support Systems, as they prefer to call it, emphasizing their company's emphasis on DSS tools) marketplace in June 1988. There are no local Executive Edge ESS installations in the local Washington area; Execucom has only a total of four ESS clients, although it has many DSS customers.

EXECUTIVE EDGE (FULL CAPACITY SYSTEM)



DATASPAN AND SENTRY - Part of DATA TRANSFER EXTENSION for loading and verifying data from "flat files" into DIMENSION or IFPS

DIMENSION - Multidimensional relational database, integrated with IFPS

IFPS - FORECASTING and MODELING language

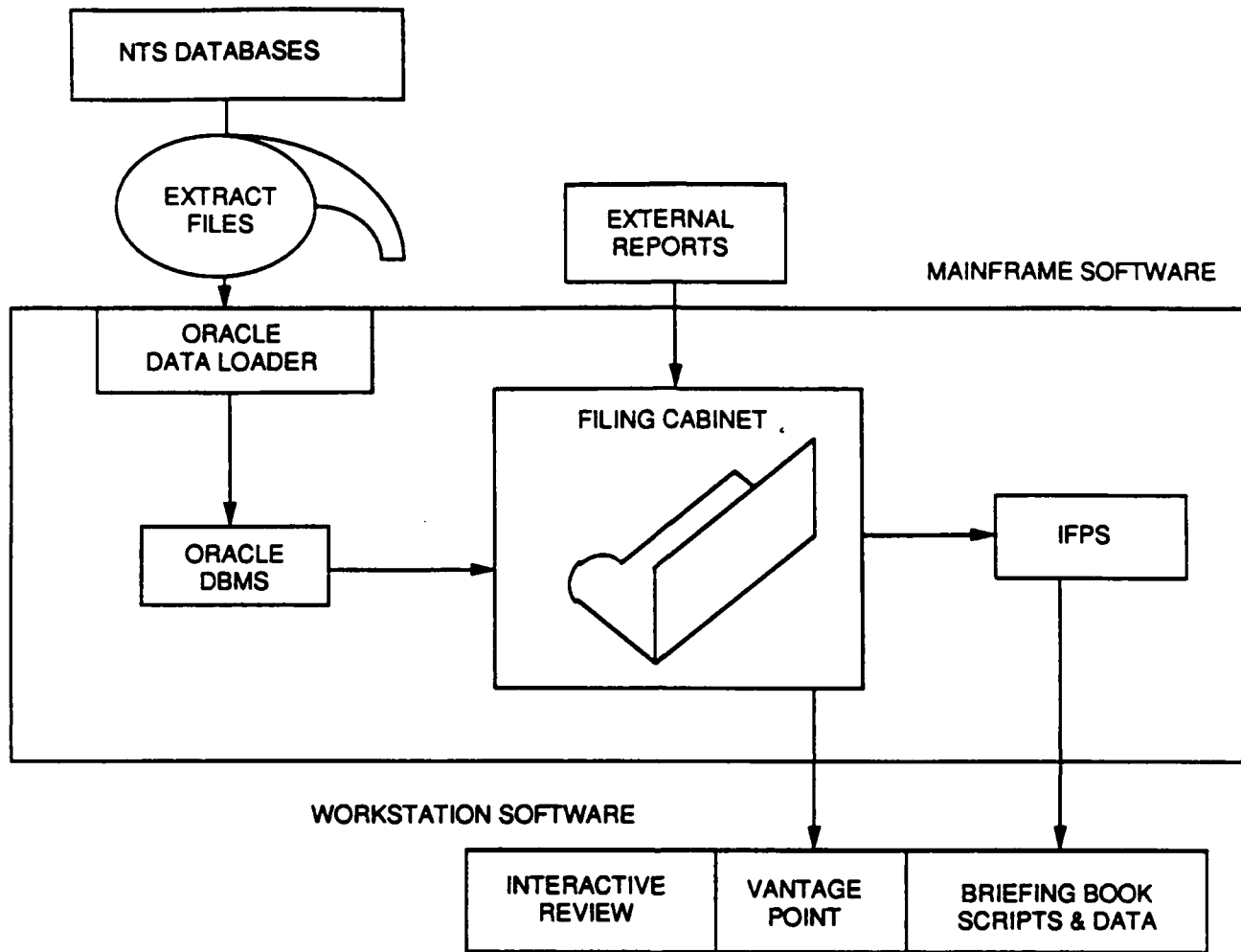
FILING CABINET - Storage area for test file reports. Readable by IFPS.

VANTAGE POINT - Communication, graphics- and menu-creation software at PC

INTERACTIVE REVIEW - PC software for on-line queries to DIMENSION, IFPS, and FILING CABINET

Diagram 2-3a
2-31

EXECUTIVE EDGE (PARTIAL CAPACITY SYSTEM WITH ORACLE)



IFPS

- FORECASTING and MODELING language

FILING CABINET

- Storage area for text file reports. Readable by IFPS.

VANTAGE POINT

- Communication, graphics and menu-creation software at PC

INTERACTIVE REVIEW

- PC software for on-line queries to IFPS and FILING CABINET

Diagram 2 - 3b

2.3.1 Functionality and Ease of Use

Full system score: 80/100
Partial System with Oracle: 66/100

2.3.1.1 User-Friendly Access

Full system score: 12/15
Partial system with Oracle: 12/15

ESS templates supplied with the ESS extension can create an intuitive menu-driven user interface, requiring only minimal training on the part of the executive. The system is entirely menu-driven. However, the user must learn two different methods of accessing data, one for the Briefing Book and one for the Interactive Review. The user is also required to know whether the data needed resides on his PC (in the Briefing Book) or on the mainframe (accessed via the Interactive Review). Data in the Briefing Book is easily accessed; retrieving data in interactive sessions with the database is not as simple, although menu querying is supplied. Executive Edge user interfaces to IFPS/Plus can access mainframe data via simple menus and fill-in-the-blank forms. Templates for this user interface are provided with the system. Built-in options within Executive Edge allow guided ad-hoc querying of data in the mainframe databases. Pop-up windows provide options allowing the executive to customize the display. The options may include graph or report type, colors, data sources, variance limits, etc. These pop-up windows are defined by the developers.

Customized menus and reports are available for each individual user. At the mainframe level, an application profile is maintained for each user. From this profile, a menu is generated that determines the applications/data the user can access. At the PC level, additional menus can be customized for/by each user using the CL/Vantage Point fill-in-the-blanks form.

The developer has full control over what the executive user can see when he presses the HELP key. Help screens can be designed for each particular user, depending on his/her level of expertise.

IFPS/Plus consists of a mainframe analysis system composed of (1) an application development language for performing decision support analysis such as modeling, forecasting, etc; (2) an integrated multidimensional/relational database called Dimension; and (3) a "filing cabinet" storage capability for keeping flat file reports, documents, and memos. Data needed for IFPS calculations is retrieved either directly from the integrated Dimension database or from flat files in the filing cabinet.

The IFPS/Plus database, Dimension, has the capability to store and present textual, numeric, historical and timeseries information. Ad hoc queries to the database are supported through the Interactive Review. Ad hoc queries to the database can be saved, or made a permanent query option by the user. The multidimensional database is limited to 100,000 records; thus it is not suited for transactional data the way an Oracle DBMS, for example, might be. However, Dimension has the ability to summarize data before actually storing it in the database.

The relational database component of the IFPS/Plus language can perform ratios, percents and averages and other management functions, using a SQL-based query language. The modeling language component provides functions to perform statistical correlations on database data, including planning, forecasting, model building, interrogation, ad hoc and multi-dimensional problem solving. What-if queries, goal seeking commands, forecasting routines including simple regressions and multiple linear regressions, Monte Carlo simulations, and multi-dimensional consolidations are all supported by IFPS/Plus. An on-line help facility is provided to explain IFPS/Plus commands.

To create new reports for the Briefing Book, analysts would perform analyses using IFPS, and create reports based on the results. Alternatively, reports containing selected data from the database itself would be created. They would then use Vantage Point's graphic capability to produce a graphics script, menus and user messages to accompany the report. The script would also contain an indication of where to receive updates of the data. The script and data files are saved separately, so that new data or changes to the script can occur independently.

Execucom's drill-down capability is provided by its "EXPLAIN" feature. This AI-based feature gives a verbal explanation of trends and anomalies, where causes are buried deep within the supporting detail information. It works by finding the variables that make up the top 85% of a change, eliminating searches through detail to find the cause of trends. This is an especially attractive feature of the Execucom product line.

2.3.1.2

Data Manipulation (Continued)

If a mainframe which supports only the partial Executive Edge system is selected, DBMS capability would be greatly reduced. The limited-capacity systems do not include "Dimension," the multidimensional/relational database; a substitute DBMS -- in our scenario, Oracle -- would be required to output flat files of data for IFPS to use. Thus when Oracle (or any other database without a direct pipeline to IFPS) is used for the relational DBMS instead of Executive Edge's own "Dimension" database, the ease of modeling capability and data manipulation is greatly reduced. Data must be output from the Oracle database into flat file reports which are then read by IFPS. This has several disadvantages in terms of modifications to the system and overall design. For example, if new types of data are required from the Oracle database, a new Oracle flat-file report must be designed and generated; an IFPS command alone would not suffice to retrieve the new data. This setup also has implications for data integrity and consistency. The same data would be stored at least twice in the mainframe: once in the Oracle database itself and once in the flat file reports which are accessible by IFPS. Data updates would take more time and processes to filter all the way through the system.

The limited system scenario also prevents the user from the capability of doing interactive queries against the mainframe database; the executive would be limited to reports created for him by analysts in advance and shipped to the mainframe. Executive Edge's "Explain" feature is also not available with the limited system.

2.3.1.3

Security

Full system score: 9/10
Partial system with Oracle: 6/10

At the mainframe level, an application profile is maintained for each user. From this profile, a menu is generated that determines the applications/data the user can access. The application profile for each user could also describe the types of accounts that the user should see and the level of detail to access. In addition to being compatible with whatever native security is installed on the host computer, layers of password protection can be designed within the ESS system to restrict access of data. Executive Edge provides the ability to prompt the executive for a userID and password, based on an initial entry screen. Additional password protection could also be provided at the mainframe level if desired. The underlying DSS engine is also protected by password protection on the databases and by file encryption.

2.3.1.3 Security

Data owners and analysts (within the FAA, Office of Primary Interest), can maintain responsibility over data in a variety of ways. For example, they could be involved in the creation of formats and screens for the Briefing Book. For data accessed via the Interactive Review of the mainframe database, data could be held in a central repository on the mainframe which gives access only when the data owner has released it. Executive Edge would then attempt to retrieve data from that location.

2.3.1.4 Operations

Full system score: 8/10
Partial system with Oracle: 8/10

Because of the PC component of the system, there is no limit to the number of Briefing Book users to Executive Edge. Response time for the Briefing Book on the PC will also be fast. Response time and limits on the number of interactive users will depend on the size of the mainframe. Only user-requested data is processed by the mainframe during the Interactive Review. More data is downloaded to the PC than will probably be used; however, because this is a batch process which takes place during off-peak periods, this should not be a problem. Updates to the database may or may not lock out interactive mainframe users, depending on which machine and operating system is being used.

Reports for the Briefing Book are not fully created until they are requested. Data needed for these reports is downloaded to the PC, along with scripts needed to access that data. When the user requests to see a particular screen, only at that moment is the data fully integrated with the instructions and a graph or table produced.

2.3.1.5 Data Sources/Input

Full system score: 9/10
Partial system with Oracle: 7/10

Executive Edge can import data from other PC sources using the ASCII file format. In addition, it can front-end any mainframe application which can be accessed interactively via a terminal. Executive Edge acts as a terminal (VT100, IBM 3101, or PC3270) to capture data from the PC screen buffer. This has the advantage of being able to retrieve any mainframe data which can be brought to an emulation screen, regardless of its underlying format. Direct interfaces to IFPS/Plus are available through its Data Transfer Extension, which is composed of Dataspan for reading flat files, Sentry for data validation, and pipelines to the following DBMS systems: FOCUS, SAS, McCormack & Dodge G/L, DB2, SQL/DS, Rdb, and Lotus 1-2-3. Direct access to Oracle is not available.

2.3.1.5 Data Sources/Input (Continued)

The multidimensional database and the Executive Edge Data Transfer Extension are not available on the Data General. For the limited system option being evaluated, Oracle's data transfer capabilities are limited to flat file access using Oracle's Data Loader, which can read flat files and populate the Oracle database.

2.3.1.6 Data Integrity Full system score: 6/10 Partial system with Oracle: 4/10

As with the other EIS systems where the central database source on the mainframe provides updates to the PC, the PC is responsible for its own updates which is a weakness inherent in the PC/mainframe relationship. Executive Edge provides a DOS-based Periodic Processor program (PERP.COM) which initiates a CL/Vantage Point script at a selected time. The developer can create a command-driven script which initiates information updates as often as hourly without human intervention. Because data must be kept both in Oracle and in files accessible by IFPS analysis routines, it will be much more difficult to guarantee data integrity in the partial-system configuration.

2.3.1.7 Presentation Full system score: 9/10 Partial system with Oracle: 9/10

Execucom supports mouse, touchscreen, and keyboard interfaces, as well as a special Execucom infrared remote-control device.

The following standard color graph formats can be created with CL/Vantage Point: line graph, bar chart (three dimensional), area fill, pie chart, table, variance, mixed bar/line table. In addition, some variations of these allow for exploded pie slices, bar stacking, data annotation, and others. Text, graphics and numeric charts can appear on the screen at the same time. There are no restrictions on the placement of these elements within the display area. Graphs can be automatically scaled to fit the data. Reports and graphs can be sent directly to a printer; alternatively, the SAVE DATA key (F2) saves the current screen display to a disk. The optional boardroom graphics module, Impressionist, can work on IBM-compatible PC's and some mainframes (IBMs TSO and CMS, DEC VAX, and Prime); however, this graphics product is not yet integrated with Executive Edge.

2.3.1.8 Monitoring Functions Full system score: 7/10
Partial system with Oracle: 6/10

Using the IFPS command language, a command file could be built on the mainframe which would provide the capability for tracking usage by application area and by user. A command file would also need to be built in Oracle to keep track of updates which occurred to the Oracle database.

2.3.1.9 Additional Functions Full system score: 8/10
Partial system with Oracle: 8/10

An electronic mail system is included in Executive Edge which can be used on a standalone basis or can link to any electronic mail system which already resides on the mainframe. A powerful feature of the built-in electronic mail is its ability to send and receive Executive Edge created reports (text and graphic). It can also front-end PROFS mail. A menu-driven Dow Jones template is available. Users can access news retrieval, stock quotes, and earnings statements. Company comparisons and trending can also be performed.

Executive Edge can read and write files to the standard spreadsheet PRN files as well as to a generic ASCII file.

2.3.2 Design/Development Issues

Full system score: 81/100
Partial system with ORACLE: 49/100

2.3.2.1 System design/build

2.3.2.1.1 Tools or 4GL language for EIS user interface development

Full system score: 12/15
Partial system with ORACLE: 7/15

Executive Edge offers an object orientated language to develop menus, graphics and interfaces to existing systems. The development language can operate in two modes. The first mode is called "easy" mode which is a menu driven simplified process. The second mode is called "power" mode which is direct 4GL language programming. A compiler is provided for developers to utilize as they become more efficient in writing Executive Edge code. The interface between the mainframe software and the end-user is done using CL/Vantage Point. CL/Vantage Point is a PC-based software tool that can access and front-end virtually any mainframe or microcomputer. Vantage Point offers a graphical interface to aid in development of reports and database queries. Extensive online, context-sensitive help in all modes of development is provided at both the PC and the mainframe level. All tools for application generation are menu-driven. Another feature of Executive Edge is the "choice" key. The choice key is used in developing a menu or graph by making available the next logical choice.

Executive Edge also provides a template library which containing pre-written models which include applications for building a menu-driven briefing book, a variance report application, ad hoc relational database query access, and access to other external data sources (Dow Jones, etc.), which should serve as a starting point to build the EIS.

The report generator in ORACLE is not menu-driven, nor are there any EIS-type report examples provided.

2.3.2.1.2 Database building and manipulation

Full system score: 12/15
Partial system with ORACLE: 5/15

Executive Edge offers a variety of tools to aid in the building of the IFPS/Plus model. The full system offers a "multidimensional database" which will interact with the IFPS/Plus model, making data immediately accessible for sophisticated analysis (what-ifs, modeling, AI). Tools are available to load the Dimension database from a variety of sources with a menu-driven scripting tool. Executive Edge provides models to help in the loading of the Dimension database,

2.3.2.1.2 Database building and manipulation (Continued)

from which all necessary DBMS functions may be performed. Since the multidimensional database is used, time-based data may be incorporated. To load data into the Dimension database from flat files, Executive Edge has a file reader program called Dataspan/Sentry. In addition, it may be used to retrieve any mainframe application which can be accessed interactively via a terminal.

The use of ORACLE as the DBMS would limit the system's data storage and retrieval efficiency. ORACLE could only provide flat file reports which could then be accessed either by IFPS for modeling or by Vantage Point for direct inclusion in the Briefing Book. ORACLE would not be able to utilize all its relational capabilities and would act primarily as a pass-through and summarization tool for IFPS. The ORACLE database would be loaded by the ORACLE data loader. All code needed for this process would need to be written in the ORACLE command language. A direct interface between ORACLE and IFPS does not exist so the use of an intermediate "filing cabinet" of flat files would be necessary.

2.3.2.1.3 Easy installation of first application

Full system score: 15/20
Partial system with ORACLE: 8/20

Executive Edge provides the basic templates to accelerate the development of the first prototype. These templates include templates in CL/Vantage Point, complete IFPS/Plus applications for producing a menu driven briefing book, Variance Reporting application, Ad Hoc relational database query, Dow Jones news retrieval access and basic electronic mail capabilities.

In the ORACLE option the installation of the first application will be more difficult. Effective database design and file management using ORACLE will take significantly more time than with the full system, since ORACLE lacks Execucom's multidimensional reporting and retrieval capabilities. See section 3.0, "Scope of Development and Schedule," for further information.

2.3.2.2 Easy installation of enhancements and
modifications

2.3.2.2.1 Adaptability to change

Full system score: 15/20
Partial system with ORACLE: 8/20

Since Executive Edge is an object-orientated system, end-user PC scripts can be modified independently of the data. Changes in a data structure in the IFPS multidimensional model will be directly incorporated into IFPS procedures.

To make modifications to the ORACLE/Execucom option, changes must occur in three different areas. The ORACLE database, the ORACLE report writing procedures, and the IFPS file reader all may need modifications. In addition to being prone to errors, this process will require additional time to provide new or modified reports.

2.3.2.2.2 Transparency to User

Full system score: 10/10
Partial system with ORACLE: 7/10

Executive Edge provides the developer with tools to access actual data to test, validation, and verification of new procedures on the mainframe, but any updates to the PC must be performed while the system is inactive.

2.3.2.3 Ease of Portability

Full system score: 8/10
Partial system with ORACLE: 8/10

Executive Edge software is the most portable of any EIS software. The mainframe EIS is done with a straight copy done with any media available to the mainframe. The Execucom/ORACLE option is also very portable, with minimal recoding needed to move to a new platform.

2.3.2.4 Quality of Vendor Support

Full system score: 9/10
Partial system with ORACLE: 6/10

Execucom offers a very strong customer support system; each project has a dedicated consultant. They also provide a customer hotline from 8 am to 8 pm. They provide extensive training both to the developer and to the end-user. Three levels of training for developers are offered: basic fundamentals, intermediate development, and advanced/optimum use of Executive Edge products.

ORACLE support has been consistently poor. Courses for developers are available for all levels of development but none are specific to an EIS need. Documentation is provided but is generally poor and sometimes incorrect.

2.3.3

Hardware/Software Issues

Full system score: 68/100
Partial system with ORACLE: 60/100

2.3.3.1

Efficiency of product operation

Full system score: 10/15
Partial system with ORACLE: 5/15

The mainframe portion of the full system Execucom would operate at maximum efficiency because of the direct link between the multidimensional database and IFPS. In addition, all queries generated from the Interactive Review portion of Vantage Point could directly query the database, the IFPS model, or the filing cabinet. The repetition of report files in the mainframe and on the PC causes some reduction in efficiency at the PC.

The Execucom/Oracle option would not operate at nearly the same efficiency. Data stored in the filing cabinet would also be stored in the ORACLE database. This configuration would be inefficient and would put a bigger strain on mainframe storage resources.

2.3.3.2

Application Size limitations

Full system score: 8/10
Partial system with ORACLE: 8/10

The full system option uses a "multidimensional" database to manage data and provides networking capabilities to handle as many users as allowed by hardware limitations. The database works most efficiently with summary-level data; masses of data found in typical transaction-level systems would be best summarized before its inclusion.

There is no physical limitation to the ORACLE option but as application size and concurrent users increase product efficiency will decrease. ORACLE is more suited to handling large amounts of data.

2.3.3.3

Utilization of Hardware Resources

2.3.3.3.1

PC Requirements

Full system score: 8/10
Partial system with ORACLE: 8/10

Executive Edge will operate on a 100% IBM-compatible PC, with the following additional requirements or options.

Disk Space	2 Meg bytes
RAM	640K bytes

2.3.3.3.1 PC Requirements (Continued)

Ports	Asynchronous serial communications port
Monitors	EGA graphic monitor
mouse	supports standard "mouse"
touchscreen	"mouse" compatible touchscreen supports an infrared remote control device.
printers	black and white and color Quadram Quadram (QJ9000) IBM Color Jetprinter Epson JX-80 EX-1000 with the color option Hewlett Packard LaserJet Plus or LaserJet series II

2.3.3.3.2 Mainframe Requirements

Full system score: 12/15

Partial system with ORACLE: 4/15

The full Execucom Executive Edge system can operate on the following mainframe computers and operating systems: IBM's TSO and CMS, DEC VAX, Prime, SUN and Apollo operating environments. Complete requirements are supplied for the IBM and DEC environments.

available models	IBM 370X, 303X, 3090, 43xx, 9370 and compatibles AMDAHL, CDC OMEGA, CAMBEX, CITEL, ITEL, MAGNUSON, NAS DEC VAX 11/725, 730, 780, 782, 785, 8200, 8300
operating system	IBM MVS/SP, MVS/XA, VM/370, VM/SP, VM/SP-HPO, VM/XA Fortran library is required DEC VAX VMS version 4 or higher Fortran library is required

2.3.3.3.2

Mainframe Requirements (Continued)

memory	IBM Initial space to read tape - 10.4 M bytes Load Module - 2.7 blocks DEC VAX Initial space to read tape - 10668 Load Module - 3103 pages
workspace per user	IBM Load Module size - 2.1 M bytes DEC VAX Load Module size - 3103 pages
peripherals	IBM 9-track tape drive DEC VAX TK50 Cartridge tape 9-track tape

Execucom's partial Executive Edge system, with IFPS only, can be operated on the following mainframes in addition to those listed above: Burroughs, Honeywell, Sperry, CDC, Data General, Wang, and Hewlett Packard. Complete additional requirements are supplied for the Data General and the Wang, ORACLE is portable to most available platforms.

available models	Data General MV 15000 Wang VS Series+
operating system	Data General AOS/VS 1.5 or later Fortran is required Fortran 77 Rev 2.0 or later Wang VS 5.3 or later Fortran is required Fortran 77 Rev 2.0 or later
memory	Data General Initial space to read tape - 1.19 M bytes Load Module - 870 bytes Wang Initial space to read tape - 3.3 M bytes Load Module - 715 1K blocks

2.3.3.3.2 Mainframe Requirements (Continued)

working space memory	Data General 60K words Wang 75K words
peripherals	Data General Tape Drive Wang all systems must have a 9-track tape drive and at least 1 megabyte of real memory

2.3.3.3.3 Wang VS 300

Full system score: 6/10
Partial system with ORACLE: 6/10

Executive Edge should be able to utilize the Wang VS 300 minicomputer's virtual disk, at least in batch mode.

2.3.3.3.4 Timesharing provided

Full system score: 4/10
Partial system with ORACLE: 4/10

Execucom does not provide its own timesharing facilities, and does not suggest that timesharing would be a good option for their product.

2.3.3.4 Networking Capability

Full system score: 5/10
Partial system with ORACLE: 5/10

CL/Vantage Point is able to support a variety of communication protocols, including direct-connect, dial-up, synchronous and asynchronous protocols. Vantage Point is not supported in a Local Area Network configuration.

2.3.3.5 Portability to CORN

Full system score: 15/20
Partial system with ORACLE: 20/20

Executive Edge complete systems are available in IBM's TSO and CMS, DEC VAX, Prime, SUN and Apollo operating environments. Additionally, the less-functional option, IFPS with ORACLE, runs on Burroughs, Honeywell, Sperry, CDC, Data General, Wang, and Hewlett Packard. ORACLE is portable to a comparable variety of systems.

- 2.3.4 Maintenance Issues
Full system score: 80/100
Partial system w/Oracle: 63/100
- 2.3.4.1 Ease of Maintenance
- 2.3.4.1.1 Modifications to System
Full system score: 20/25
Partial system w/Oracle: 16/25

Changes to the structure of the Dimension database on the mainframe and changes to the IFPS models must be done separately; changes to one are not automatically incorporated in the other. Data loading can be streamlined since the Dimension database has the capability to summarize data before storing it. The IFPS/Plus application language is used for central maintenance of ESS menus for analysis, new information and decision support applications. IFPS can be accessed directly using a command interpreter or a menu-driven interface can be used. PC Briefing Book creation and maintenance is object-oriented: modification of a single graph, menu or script does not require any other objects to be changed, only the object in question, which in turn shortens maintenance time. Changes in data format would require modifications to Briefing Book script files.

In the limited Execucom configuration, changes to the Oracle database structure are more difficult to incorporate. Changes in the database structure would also necessitate changes in the SQL*Forms flat file output used by IFPS 46s separate changes in IFPS. The Oracle data loader capability is limited in comparison with the menu-driven Execucom approach. Modifications to Oracle data loading procedures are more labor-intensive. Modifications to the PC portion of the EIS would be the same as for the full system.

- 2.3.4.1.2 Updates
Full system score: 18/20
Partial system w/Oracle: 10/20

Data is loaded from flat files into the Dimension database using Dataspan and Sentry. This process can be automated once the data structure of the input files has been defined.

Data updates to the Oracle/Execucom system are extremely complicated. Not only does the Oracle database itself need to be updated, but also the output files accessible by IFPS must be newly generated. This has serious implications for data integrity and currency, since each additional process is additionally time-consuming.

2.3.4.2

Distribution of Data

Full system score: 18/25
Partial system w/Oracle: 18/25

Updates to the PCs are done thru the Filing Cabinet, used for mainframe communication and mainframe file storage. The PC retrieves files from the Filing Cabinet and makes them available for the Briefing Book application. This process can be time-consuming, depending on the application size, the number of files, and the communication setup. Further, the PC is otherwise unusable during the update period; thus, updates must usually take place during off-peak hours, such as overnight. Close monitoring of PC-initiated updates is necessary, since automated processes at the PC can be easily disrupted.

Distribution of data to the PC using the Oracle/Execucom system would be the same as with the full Execucom system.

2.3.4.3

Nightly backup and recovery facility

Full system score: 9/10
Partial system w/Oracle: 7/10

System backup for both Execucom and Oracle are usually dependent on the operating system backup procedures. Additional backup procedures can be added to the full Execucom system but not to the Execucom/Oracle option. Backups to the PCs must be handled on an individual basis.

2.3.4.5

Automated Configuration Management Tools

Full system score: 15/20
Partial system w/Oracle: 12/20

There is a limited active database-specific data dictionary within the mainframe component of the Executive Edge. The "limited active" data dictionary refers to two IFPS/Plus commands. The first is LISTREL command which gives the user a list of all available relations. The second is the LISTFLDS command which gives the user a list of all active fields or dimensions. Executive Edge does not have an audit trail to check update receipt.

Oracle has a data dictionary for documentation purposes only. Changes to the data dictionary are not automatically reflected in the database, and vice versa.

2.4 EXPRESS/pcEXPRESS

2.4.0 Product Overview

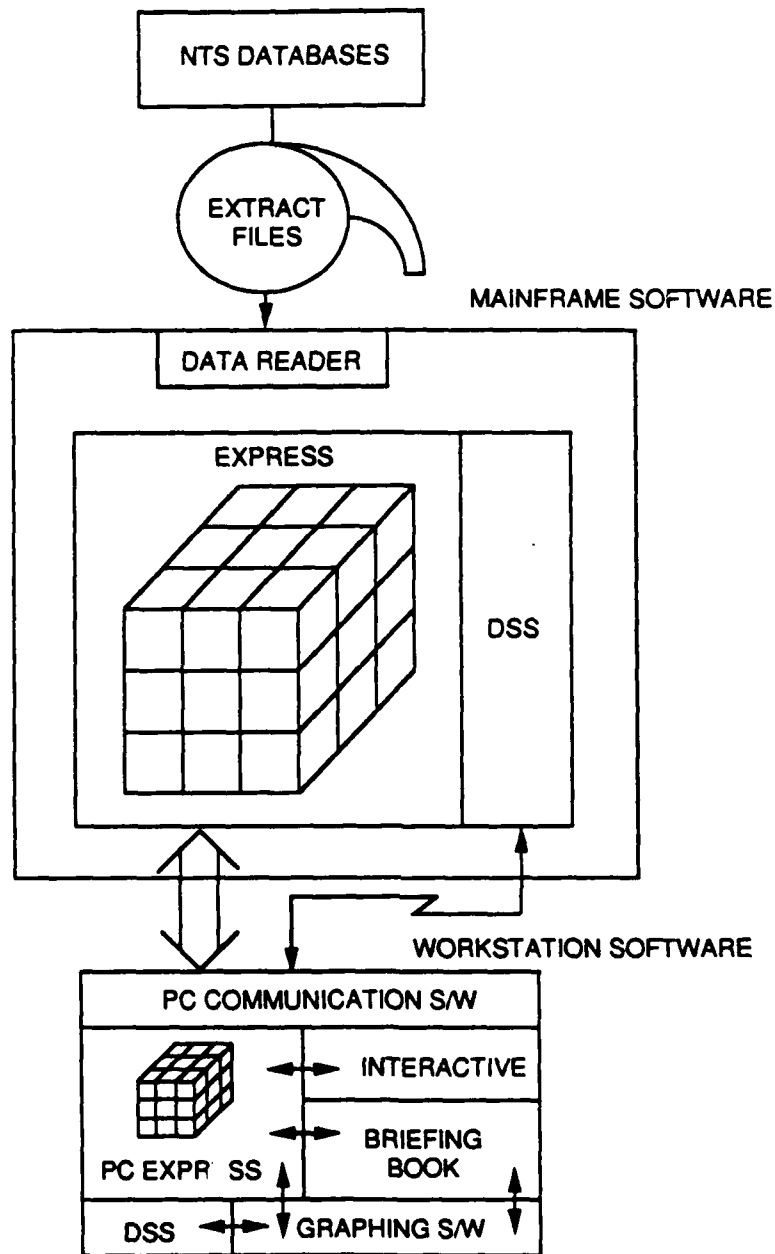
EXPRESS/pcEXPRESS also falls into the mainstream group of EIS products in that data is stored and manipulated on a mainframe computer and then selected pieces are periodically downloaded to the executive user's P.C. hard disk. However, this product has some unique features which appears to make it superior to many of the other similarly structured products. Rather than downloading finished reports, EXPRESS downloads a portion of the actual database to a database manager on the PC. The executive user actually queries the PC database rather than requesting to see specific, pre-generated reports. Further, if the query needs data not on the PC, the system can automatically access the mainframe database for the information, without the user being aware that this is occurring. These two features supply added flexibility and simplicity for the user -- strong points of a mainframe-only system -- without sacrificing the fast response time which is the inherent advantage of a PC-based system.

EXPRESS/pcEXPRESS has another advantage over the other evaluated systems: it is the only product which can work entirely in a standalone PC or LAN environment and then be moved to a mainframe computer as the database grows and exceeds the storage limits of the PC. This flexibility would allow a prototype EIS to be designed and developed without being affected by delays in procuring a dedicated mainframe computer or by delays in linking the mainframe to the Administrative Data Transmission Network (ADTN).

The most serious drawback of EXPRESS/pcEXPRESS is in their user interface and graphical display capabilities. In these areas, it is probably the most primitive of the systems being evaluated. Future enhancements to the product should improve these capabilities.

Information Resources, Inc. is a well-established decision-support and software development firm which has only recently entered the Executive Information System market. Their decision support tools are considered to be particularly strong in the DSS market.

EXPRESS/PC EXPRESS



DSS - Decision Support (MODELING, FORECASTING) System

Diagram 2-4

2.4.1 Functionality and Ease of Use Score: 81/100

2.4.1.1 User-Friendly Access Score: 8/15

Unlike many of the other mainframe/PC products, EXPRESS/pcEXPRESS does not require the user to know whether his data is on the mainframe or the PC. When a query is posed, the system first checks the PC for the data and if it is not found, automatically goes out to the mainframe to query the database there. The user need not be aware that this process is taking place.

"EasyEXPRESS," an interface provided with pcEXPRESS, provides a list-driven user interface for the novice user. An advanced user interface includes menus, forms, windows, choice lists, and action buttons to deliver a self-explanatory, easy-to-use system. The system is menu-driven, but has no icons. Menus can be customized for each user, although the menu-generation product was not considered very useful by the users interviewed at Bolling AFB. EasyEXPRESS is not a suitable tool for EIS executive users; developers would need to design additional, simpler user interfaces. On-line help is provided for the user to guide him through the menus; the help is better on the PC than on the mainframe. Developers can create customized on-line help.

New tools being provided by EXPRESS will probably aid greatly in developing a highly user-friendly interface. However, there even with these tools it will be difficult to build an interface as intuitive and graphically attractive as EASEL and others.

A "slide show" of canned reports can also be built, although every query could go against the database, either at the PC or on the mainframe. An EIS "toolkit" is currently being developed for EIS applications of EXPRESS. This toolkit will allow limited icons to be built, with some degree of difficulty. The toolkit also controls colors, box and bar menus, default graphics, reports, scrolling, paging, zooming, and changes of orientation, notes, and ad hoc graphics. Some of these capabilities are not yet part of the toolkit. Ad hoc query reports can be saved by the user and made part of his menu structure for future use.

2.4.1.2 Data Manipulation Score: 13/15

EXPRESS can store and present textual, numeric, historical, and time series data in its database. Like most of the other EIS products, EXPRESS also touts its multidimensional relational variables and database, which allow the representation of many dimensions in a single model, thus allowing multiple views of the same data, depending on the user's current interests. Changes and enhancements to the database are easily

2.4.1.2 Data Manipulation (Continued)

added. New fields automatically become part of the active data dictionary: no dumping and reloading of the database is required. The DEMS can also perform such analytic functions as aggregations (averaging, totaling), numeric calculations, (logarithms, standard deviations), time series (lag, lead, percent change), forecasting, financial, and regression. Data from multiple tables can be compared and correlated. Both system-wide and individual triggers for performance indicators can be set. "Classic" EXPRESS has more sophisticated analysis capability than MDB, the newer and more portable version of the mainframe EXPRESS software. EXPRESS and pcEXPRESS also have sophisticated decision support modeling and analysis capabilities.

The user has great flexibility in performing ad hoc queries to the database. The capability to drill down or "zoom" (in EXPRESS terms) to greater levels of detail is provided for each user, the levels of detail varying depending on the pre-determined needs of each user. The user has the ability to save data and files in temporary storage locally on his individual workstation.

2.4.3 Security

Score: 9/10

The use of user ID's and password protection is supported by EXPRESS. Both PC and mainframe EXPRESS have the ability to restrict access of files, programs and even data down to the cell level. Each user may have his own customized EIS system and within that be allowed access to varying levels of information. Timeouts after a certain amount of non-use can be set in by the developers.

2.1.4.4 Operations

Score: 8/10

400 users could be accommodated by EXPRESS, although the vendor notes that 20 to 50 simultaneous users accessing the mainframe is probably the maximum for a "comfortable" response time. However, EXPRESS points out that response may vary due to baud rate, size of the database, database design, CPU processing speed, etc. Information Resources consultants can suggest design considerations that maximize response. Graphing functions can take place either at the PC or at the mainframe, if both EXPRESS and pcEXPRESS have been purchased.

Users cannot access the database during data updates, either at the PC or at the mainframe.

2.4.1.5

Data Sources/Input

Score: 7/10

EXPRESS can accept data from virtually any source, as long as it is put into a sequentially-delimited file. pcEXPRESS can import and export 1-2-3, Symphony, DIF or PRN files. Both PC and Mainframe EXPRESS (Classic and MDB) have an automated Data Reader that will accept data from any flat file. "Classic" EXPRESS has a direct interface to SAS, IFPS, and FOCUS while MDB currently has a direct interface to SAS. Data reader programs can summarize data from flat files as they are being read.

2.4.1.6

Data Integrity

Score: 8/10

Like all systems with a severable PC/mainframe link, the currency and integrity of the data is a weak point, since the mainframe central database can contain information more current than that on the PC. In most EISs, if a PC misses its update schedule then data could potentially be inconsistent across the user community. With pcEXPRESS, automated updates of the PC database are possible, and can include error checking. Large databases can be updated overnight and an audit trail indicating unsuccessful updates can be programmed in.

2.4.1.7

Presentation

Score: 8/10

The data can be presented in report, table or graphical formats, which can be chosen by the users. A mouse interface is supported but not required. Color graphics support includes scatter plots, line graphs, stacked and clustered bar charts, pie charts. The system can work with both printers and plotters. Automatic scaling based on the data is the default situation. Text can only be displayed with graphs using the DRAW command for each particular graph. There is no way to save a graph to a print file.

2.4.1.8

Monitoring Functions

Score: 8/10

pcEXPRESS and the Mainframe EXPRESS EIS can monitor time and usage by user via an audit trail. Such audit trails are typically handled by the system Database Administrator (DBA) who will additionally monitor updates and refreshes to the database at the mainframe and the PC.

2.4.1.9

Additional Functions

Score: 6/10

Users can provide a user front-end access to applications outside of pcEXPRESS such as Dow Jones news service, E-mail, word processing, etc. No finished user interfaces are provided, however. pcEXPRESS can import and export 1-2-3, Symphony, DIF or PRN files. pcEXPRESS does not support its own word processing or E-mail.

2.4.2 Design/Development Issues Score: 86/100

2.4.2.1 System design/build

2.4.2.1.1 Tools or 4GL language for EIS user interface development Score: 13/15

System builder tools for application development include 4GL programming language and interface building tools. These tools are all menu-driven with online help. One helpful feature is the recall window which may be used to retrieve, cut and paste commands of previously written modules. EXPRESS provides a tool kit of utilities and program templates which would provide models for all aspects of the EIS. The tool kit contains models of micro-mainframe scripts, data entry screens, and sample report generation with both graphic and text.

Among pcEXPRESS tools provided there is a menu/form generator which makes the creation and changing of menus/forms a simplified process. The generator consists of a menu-driven application with context specific help screens.

2.4.2.1.2 Database building and manipulation Score: 14/15

EXPRESS provides a data retrieval capability which imports data from nonstandard formats once they have been converted to sequentially-delimited flat files. In the data retrieval program, EXPRESS takes the data from the transaction databases and with a menu-driven tool loads it into a worksheet format. This worksheet format is where all aggregates and calculations will take place. After the worksheet has calculated all possible combinations it is given a variable name and then loaded into the EXPRESS main database. Data may also be read directly from 1-2-3, Symphony, DIF and PRN standard reports. The database may be updated through an automated procedure at night or when appropriate.

The EXPRESS database is a multidimensional and relational model with a maximum of 6^6 dimensions. The multidimensional aspect of the database is helpful in accessing the data for modeling and advanced analysis procedures. The relational features are used for queries for standard analysis of data. One feature that makes the EXPRESS database simple to modify is the flexibility of changing field definitions and adding fields.

2.4.2.1.3 Easy installation of first application Score: 15/20

With the use of IRI's consulting services and the predefined scripts provided, building an initial prototype typically takes one to three months.

2.4.2.2 Easy installation of enhancements and modifications

2.4.2.2.1 Adaptability to change Score: 19/20

Since EXPRESS uses their data dictionary to manage the multidimensional relational DBMS, developers can change any decision structure or data structure without dumping or reloading the database. Any new data added to the database will be made available with the execution of the automatic refresh process. Because no static screens of information are prepared for the executive user, once the database has been reformatted, the new data is available for executive use without further development effort on the part of the system administrator.

2.4.2.2.2 Transparency to User Score: 9/10

An advantage to EXPRESS is that it provides the facility for testing and debugging a new module. It will be transparent to the user until fully developed and implemented.

2.4.2.3 Portability Score: 8/10

The system is ported between available platforms with a straight copy onto magnetic media available at the mainframe. However, the communications application portions may have to be modified to handle the changed platform.

2.4.2.4 Quality of Vendor Support Score: 8/10

IRI provides training in all aspect of the EIS for end-users and developers at one of 20 offices worldwide. Documentation is good and includes a specific manual for all aspects of development with a quick reference booklet. EXPRESS also provides computer-aided training modules. IRI has a consulting group available for any level of technical consulting, implementation and development of systems. EXPRESS also provides a hotline and an extended support agreement for new releases and extended hotline assistance. In addition, there is a growing group of private consultants who can provide support to EXPRESS installations at more competitive rates.

2.4.3 Hardware/Software Issues Score: 80/100

2.4.3.1 Efficiency of product operation Score: 14/15

EXPRESS is a mainframe/PC-based system which first queries its own database stored on its hard drive. If the information is not located on the PC, the system can be programmed to automatically log into the mainframe and download additional information. This process makes product efficiency dependent only on telecommunications limitations, and the size of the database stored on the PC. The increased flexibility of executive user access to an actual database of information rather than only to predeveloped reports is unique among the products evaluated and therefore makes it an attractive product line.

2.4.3.2 Application size limitations Score: 10/10

One of the advantages of EXPRESS is the unlimited restrictions to the size of the multidimensional database tables. The amount of simultaneous mainframe use will be dependent on hardware limitations.

2.4.3.3 Use of Hardware Resources

2.4.3.3.1 PC Requirements Score: 8/10

A 100% IBM-compatible machine running DOS version 3.0 or higher is required for the PC workstation. In addition, pcEXPRESS has the following requirements or options:

Disk space	2-4 MB
RAM	640 K RAM EXPRESS will take advantage of up to 2 MEG extended RAM.
Ports	asynchronous
Monitors	EGA monitor or VGA monitor with cards
mouse	Standard "mouse"
keyboard	standard
printers	Epson; IBM graphics printers IBM color graphics printer Okidata, Toshiba, Hewlett-Packard models.

2.4.3.3.2

Mainframe Requirements

Score: 10/15

EXPRESS can operate within IBM, DEC, Prime and Hewlett-Packard environments. Specific requirements are as follows:

available models

IBM
Prime
Hewlett Packard
DEC Vax

operating system required

IBM - MV, MVS
Prime - Primos
Hewlett Packard -
MPE/XL
DEC Vax - VMS

memory

IBM: for a very large system and 20 - 30 simultaneous users, 8 Meg memory is needed. For 40 - 70 simultaneous users, 16 meg is needed.

2.4.3.3.3

Wang VS 300

Score: 7/10

EXPRESS and pcEXPRESS can be supported using the Wang VS 300 minicomputer's virtual disk capabilities, although interactive connection between the user and the mainframe is not possible via the Wang virtual disk because of Wang's proprietary communications protocols.

2.4.3.3.4

Timesharing Provided

Score: 10/10

Information Resources was originally a timesharing vendor and can provide timesharing facilities with their product if necessary.

2.4.3.4

Networking Capability

Score: 8/10

EXPRESS is a mainframe-driven system and will support a cluster of several PC's or mainframes acting as a single place where data resides. EXPRESS supports a fully configurable synchronous (3270) and asynchronous communication protocol, as well as several local area networks.

2.4.3.5

Portability to CORN

Score: 13/20

EXPRESS supports IBM mainframes running VM or MVS, Digital minicomputers running VMS, Prime minicomputers running PRIMOS and Hewlett Packard minicomputers running MPE/XL, making it more portable than the many of the other EIS products.

2.4.4 Maintenance Issues Score: 90/100

2.4.4.1 Ease of Maintenance

2.4.4.1.1 Modifications to System Score: 24/25

Modifications to EXPRESS's database are accomplished with the EXPRESS active data dictionary. As changes to any object in the dictionary are made, or as new objects are added, the integrity of existing objects remains intact. Because the dictionary remains active, enhancements and modifications to existing applications are facilitated. As changes to one object are made, those changes are cascaded to all related objects. The active data base dictionary plays a major role in supporting the prototyping development methodology. Developers are able to quickly iterate application designs; adding, modifying, and deleting objects in the database without impacting working portions of an application.

2.4.4.1.2 Updates Score: 18/20

Updates to mainframe EXPRESS are done by extracting files from the NTS databases and loading the data into the EXPRESS database, using the EXPRESS Data Reader. The mainframe EXPRESS database can be refreshed as often as necessary through automated updates that do not necessarily require human intervention. The Data Reader does contain an error checking device for updates. For large databases, the updates are normally done overnight.

2.4.4.2 Distribution of Data Score: 21/25

Data is distributed to PC users in two ways. First, a subset of the mainframe database is downloaded automatically to the PC DBMS which is part of pcEXPRESS, using the IMPORT and EXPORT commands. When a user performs a query, pcEXPRESS looks first in its own database for information. If the data is not on the PC, pcEXPRESS queries the mainframe database automatically, using EXPRESS-Mate, an active data link to mainframe EXPRESS. Time to download the entire database to the PC could be a problem, but this process would usually occur at night. If the EIS is designed such that the content of the PC database is specific to each user or each group of users, data distribution becomes more efficient.

2.4.4.3 Nightly backup and recovery facility Score: 8/10

In addition to the standard backup procedures of the mainframe operating system, EXPRESS has a backup and recovery facility that is an automated procedure.

2.4.4.5

Automated Configuration Management Tools

Score: 19/20

EXPRESS has an extensive list of automated configuration management tools and database administration features such as:

- o An active data dictionary
- o On-line and printed documentation
- o Error trapping

Auditing of EIS usage is handled at the PC. Data updates and refreshes are done at the mainframe, and can be monitored by the system-wide database administrator.

2.5 Stratagem/Tellagraf/CADET and Stratagem/EASEL

Because Computer Associates (CA) does not market a front-end EIS user interface which is integrated with its mainframe EIS products, two different Computer Associates' product options are being considered for the FAA EIS which utilize third party front-end software. The first option uses CA's products Stratagem and Tellagraf together with an Arthur Young/Southern Electric Company product called CADET, while the second option uses Stratagem along with EASEL, a product from Interactive Images. In the first option Stratagem would perform the database and analysis functions and create menus for analyst-users, while CA-Tellagraf on the mainframe would produce graphic output which would be delivered to the PC by CADET. The second option uses Stratagem to perform database and analysis functions, while EASEL handles all menuing and graphing functions. Each option has advantages: the use of Tellagraf for graphics takes advantage of the integrated interface between Stratagem and Tellagraf, while the use of EASEL eliminates the need for separate interfaces for executive and analyst users and reduces the computing load on the mainframe since graphics are produced at the PC. See Diagram 2-5a and 2-5b.

2.5.0 Product Overview

Computer Associates (CA) sells a range of integrated business application tools which allow EIS developers to pick and choose which pieces are best suited for a particular application. Most of these tools are mainframe based. The two CA tools best suited for an EIS application are CA-Stratagem, a multidimensional data storage system with sophisticated modeling capabilities, and CA-Tellagraf, a powerful and flexible mainframe graphing tool. Computer Associates does not make or market a PC front-end executive user interface product. Thus, developers of the FAA EXIS would have to find or build a compatible front-end user interface which can be integrated with these CA products if selected.

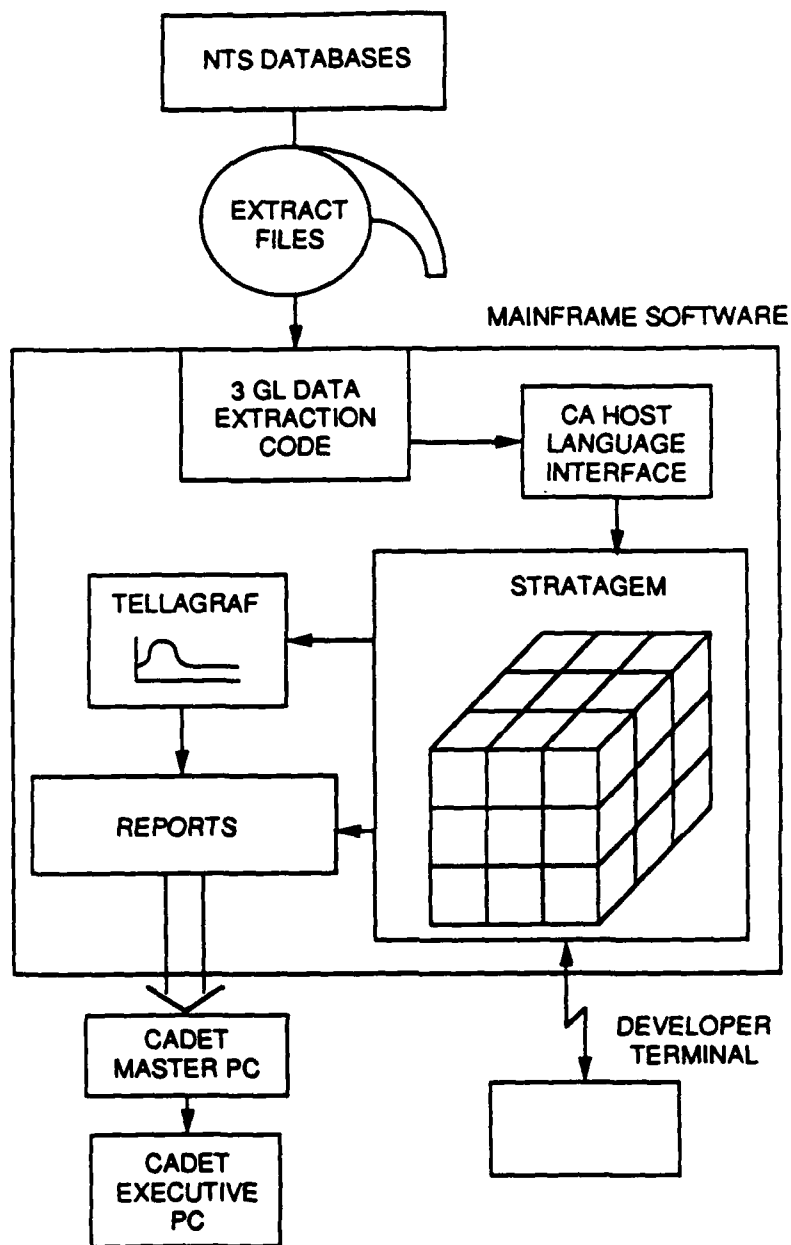
Stratagem has been on the market since 1982 when it was marketed by ISSCO, whom Computer Associates since bought out. Stratagem has multidimensional data management capabilities, financial and statistical modeling and trending analysis capability, a custom report generator, limited build-in graphics capability and a transparent interface to CA-Tellagraf and other CA products. It is somewhat of a concern that there are numerous graphics products available from Computer Associates for use with Tellagraf -- Cuechart, Tellagraf Menus, Data Connection, Superchart, SuperImage and IVISS Manager -- each with slightly different capabilities. Any new graphical requirement may necessitate buying more graphics software.

2.5.0 Product Overview (Continued)

Interactive Image's product, EASEL, is an extremely flexible PC front-end user interface whose strength lies both in its adaptability and in its graphical and iconic display capability. It provides a visually attractive front-end which sends masked keystrokes (like a macro) to any back-end system. It receives a textual response and displays it as directed by previously programmed commands. It also works as a graphics tool, producing graphic output in accordance with received data. As a tool, it is remarkably easy to program, having code-producing tools and access to the actual 4th generation language which is produced. EASEL has been on the market since 1983.

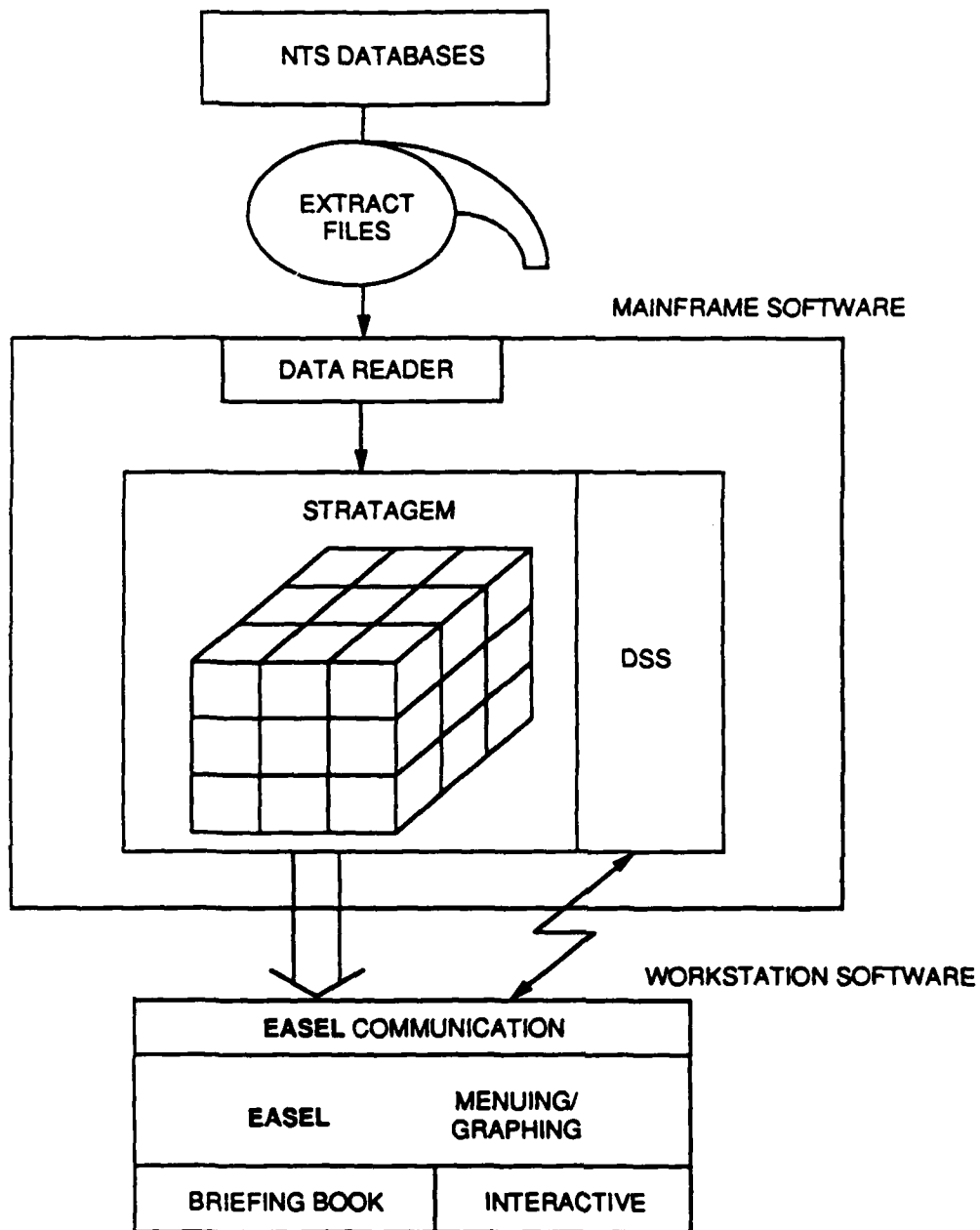
The Southern Electric Company's product, CADET, works as a PC menuing and delivery system. Graphs created by another product, such as Tellagraf, can be captured on a PC screen and saved for delivery to PCs connected via a local area network. CADET requires some machine, usually an IBM PC or compatible, to act as a file server for machines linked within any NET BIOS compatible network. CADET cannot produce graphs itself, nor does it allow dynamic drill-down capability or interactive communication with the mainframe. CADET has been marketed for two years as an EIS front-end delivery tool, with approximately twenty-one corporate customers.

STRATAGEM/TELLAGRAF/CADET



- CADET - Data screen capture, store, and display software: includes menuing software
- STRATAGEM - Multidimensional data analysis and data storage
- TELLAGRAF - Mainframe graphics software

STRATAGEM/EASEL



- STRATAGEM - Multidimensional data analysis and data storage mainframe software
- EASEL - PC communications, graphing, and menuing software

Diagram 2-5b

2.5.1 Functionality and Ease of Use

Stratagem/Tellagraf/CADET Score: 67/100

Stratagem/EASEL Score: 75/100

2.5.1.1 User-Friendly Access

Stratagem/Tellagraf/CADET Score: 8/15

Stratagem/EASEL Score: 13/15

Building user-friendly access to the system would require more initial and ongoing development effort than the other EIS systems being evaluated. Like the other products, extensive training in the system's 4th generation language is required in order to address queries directly to the mainframe database; unlike the others, no user-friendly menuing interface is provided with the system. Although Stratagem does come with a full-screen on-line help and tutorial for users (probably development users), this is of little help to executive and non-computer programming analyst users. Rather, system developers would be required to build a menu-structured user interface for both analyst and executive users. In the Stratagem/EASEL implementation, the menuing capability would be built with EASEL. In the Stratagem/Tellagraf/CADET implementation, menu interface capability for analyst-users would be built using the Stratagem and Tellagraf 4th generation language. For executive users accessing data through CADET, ad hoc and drill-down queries on the mainframe data would be impossible. They would be limited to a set of pre-developed screens, accessible through menus.

It is difficult to evaluate the user-friendliness of the system, since this would depend on the programming done by the development team. Depending on the intuitiveness of the menus designed by the developers, executive users and their analysts would probably require some amount of training in the system, especially during the early prototype stages before menus could be prepared. (This lack of intuitiveness for non-computer users could also slow down the addition of new EIS application areas.) The Stratagem/EASEL implementation would have a clear advantage here, due to EASEL's easy-to-design user-friendly iconic (pictures) interface and its business graphics capability. Executive users in either the CADET or the EASEL implementation could have customized menus. Analyst users could not use CADET (since it prevents on-line communication with the mainframe database); due to the programming effort involved in customizing menus, analysts would probably all have the same menu, at least initially.

Stratagem and Tellagraf's strength is in its production of standardized reports: once generated these could continue to be produced automatically.

2.5.1.2

Data Manipulation

Stratagem/Tellagraf/CADET Score: 12/15

Stratagem/EASEL Score: 13/15

Stratagem's "multidimensional" data management structure is created by using arrays with an unlimited number of positions. Stratagem does not have automatic data summarization "staging area" and loading capability like Execucom, Comshare, and EXPRESS. Instead, non-summarized data must be loaded into the database and then summarized when it is needed.

Stratagem can store and present textual, numeric, historical and timeseries information and perform mathematical calculations (such as ratios, percents, averages) and aggregations of data and to sort and store the results. It allows ad hoc queries of the database and can save these queries in a report file for automatic re-generation. Given a sufficiently user-friendly front end interface, the executive user could perform these queries. Data from multiple arrays can be compared and correlated. Drill-down capability from higher to lower levels of information is not present as such; however, it can be programmed in. Like the other multidimensional database products, the same data can be presented in multiple "views." In addition to simple database aggregations, Stratagem's more sophisticated modeling and analysis tools contain built-in financial and statistical functions and allow what-if, trending, goal-seeking and Monte Carlo analyses. A system-wide exception report can be programmed; however, menus must be built to allow the user to set his own goals and objectives against performance.

EASEL comes with "Manager's Portfolio," which includes EASELView, a module containing libraries of routines with capabilities for drill-down, exception reporting, scrolling and a commentary attachment. Manager's Portfolio also includes EASEL OrgChart, StockWatch (an interface to Dow Jones News Service), and EASEL Spreadsheet Access, which provides an interface to Lotus 1-2-3. EASEL's drill down capability could provide a user friendly front end which masks commands sent either to the PC or to the mainframe for drill-down information.

2.5.1.3

Security

Stratagem/Tellagraf/CADET Score: 7/10

Stratagem/EASEL Score: 7/10

In addition to ID and password protection security, users can be restricted to pieces of data. Up to 16 classes of users for each application can be identified, allowing different levels of access for each. There is also read and write security to differentiate between analyst users (with limited read and write privileges) and executive users (with read privileges only).

2.5.1.4

Operations

Stratagem/Tellagraf/CADET Score: 4/10

Stratagem/EASEL Score: 8/10

The use of Tellagraf for graphic production does not seem to be an optimal use of resources. Tellagraf does its graphic production on the mainframe, in contrast with the other EIS vendors who produce their graphs cheaper and faster on the PC. Downloading graphics files also takes more transmission time, a significant factor when the large number of potential graphs is considered. In addition, transmission of graphical characters often requires special communications resources. Because of this intensive drain on mainframe and communications resources, Tellagraf graphs are usually produced in batch mode and shipped down to PC's during off-peak hours. The drawback to this solution is that graphs must be created in advance and cannot be created by the user on the fly at his PC. Computer Associates counters that Tellagraf is much more flexible than a PC product, giving as an example the capability of putting numbers on the tops of bars. They also cite the increased resolution which allows at least 50 graphs per page. However, they concede that there are many functions which PC products can do which a mainframe product like Tellagraf cannot, such as rotate a diagram on the screen. They usually suggest that Tellagraf be sold in conjunction with a PC-based product, such as their Superimage.

In addition to these issues associated with Tellagraf, the use of CADET for capturing the graphs for the PC requires that each and every graph and report created by the EIS be downloaded to the PC, displayed at the PC, and then captured by CADET and stored. In addition to the time involved, especially when frequent updates are possible, the robustness of PC-controlled batch jobs is highly questionable. This is a serious drawback with the Stratagem/Tellagraf/CADET application.

CADET guarantees a user response time of 3 seconds or less, as long as a separate PC or a partitioned virtual disk is used as the file server. EASEL can perform multitasking under DOS, allowing simultaneous receipt of mainframe data and performance of PC tasks. Both PC products have no restrictions on the number of users who can be serviced, either in terms of physical location or response time. Local storage of data is possible with both products.

2.5.1.5

Data Sources/Input

Stratagem/Tellagraf/CADET Score: 3/10

Stratagem/EASEL Score: 3/10

Stratagem is clearly the weakest of all the evaluated products in the area of loading the database with input from the transactional systems. Its automatic sequential-delimited file reader (called "File Read") only works with files of only up to 500 records. For larger files, a parsing routine must be written in a 3rd generation language such as C, COBOL, PL/I, or Assembler, and fed to Stratagem's "Host Language Interface." Stratagem can directly access data files in DB2 only.

2.5.1.6

Data Integrity

Stratagem/Tellagraf/CADET Score: 9/10

Stratagem/EASEL Score: 8/10

A single database with multiple views avoids duplication of data. Stratagem's lack of a front-end delivery system means that any update issues must be addressed during development and design of the delivery vehicle. CADET has a program which automatically checks when the master PC containing the data files was updated; one could be built using EASEL. In addition, because only the master PC receives data updates when using CADET (individual user PCs request data interactively from the master PC), there is much less risk of data inconsistency among users than with systems where each individual user PC must be updated. EASEL can be installed either in a LAN configuration or on individual PCs. Analysts and data owners in either of the two evaluated options would be given direct access to the mainframe data manipulation capabilities in order to prepare reports and verify data.

2.5.1.7

Presentation

Stratagem/Tellagraf/CADET Score: 8/10

Stratagem/EASEL Score: 8/10

Because Stratagem and Tellagraf are mainframe products only, they do not utilize a touchscreen or a mouse. EASEL can take advantage of a mouse or a touchscreen or the keyboard interchangeably. CADET can work with a mouse.

Tellagraf can produce color two-dimensional charts of the standard variety: pie, exploded pie, bar, stacked bar, and line charts. The color palette is extremely varied, offering up to 1,400 colors. Charts and graphs can be automatically scaled and reformatted. Graph and text can be displayed simultaneously on the same screen, and color flags can be used to indicate problems. Graphs can be printed to almost any printer as well as to files which can be spooled to printers. From CADET, almost any printer is supported, but no plotters.

2.5.1.7 Presentation (Continued)

Business Graphics is an EASEL module which allows input data to be converted into ten kinds of graphs: standard line graph, surface line graph, high-low-close graph, pie graph, standard bar graph, 3-D bar graph, overlapping bar graph, 3-D overlapping bar graph, stacked bar graph, and 3-D stacked bar graph. The following can also be optionally specified: labels for the graph, axes, legend, ticks, and pie wedges, automatic or manual axis boundaries, number of ticks on the Y axis, colors used for titles, plotted data, and pie wedges, footnotes, axis grid lines, fonts and colors for titles, labels, footnote, and legend.

2.5.1.8 Monitoring Functions

Stratagem/Tellagraf/CADET Score: 9/10
Stratagem/EASEL Score: 8/10

Because Stratagem lacks the front-end delivery capability, it cannot monitor the actual usage of each EIS application. CADET does produce reports that show the number of times each report is viewed and by whom. Statistics are also available on the number of accesses by day and by hour. EASEL could be programmed to perform this function, utilizing either PC capabilities or built-in mainframe file control capabilities.

2.5.1.9 Additional Functions

Stratagem/Tellagraf/CADET Score: 7/10
Stratagem/EASEL Score: 7/10

Computer Associates has no E-Mail product which is compatible with Stratagem and Tellagraf, nor do they have the capability to front-end other E-mail products. EASEL can front-end other products such as PROFS 2.0, but does not have its own database. EASEL also supports the importing and exporting of ASCII-format files from DOS or any other source, such as a remote database. EASEL does come with a built-in capacity to access the Dow Jones news and stock service. CADET does not have its own mail system, nor does it have the capability to front-end another one. CADET can import reports from any other other PC program, due to its screen capture capability. It can provide a menu choice to other computer applications such as LOTUS 1-2-3, Dow Jones News Retrieval, and office automation systems. Computer Associates does market a product called Microgem, which allows data to be imported and exported from Stratagem into Lotus 1-2-3 and SuperCalc.

2.5.2 Design/Development Issues
 Stratagem/Tellagraf/CADET Score: 66/100
 Stratagem/EASEL Score: 68/100

2.5.2.1 System design/build

2.5.2.1.1 Tools or 4GL language for EIS user interface development
 Stratagem/Tellagraf/CADET Score: 9/15
 Stratagem/EASEL Score: 10/15

On the mainframe, report generation from data in the multidimensional database can be done in the Stratagem command language or with menu-driven tools that are provided, depending on the user's expertise. All modes of development make use of context sensitive help. Stratagem provides a toggle switch between modes of development. If Tellagraf is used for graphic presentation, limited mainframe menuing capability as well as interaction with the command interpreter is possible. The flexibility of the Tellagraf graphic engine allows it to meet many application requirements and to mold graphics to meet the requests of management. The Tellagraf system stands apart from all others in the extensiveness of features it makes available, from the simplest to the most sophisticated output. Tellagraf offers an English-like command mode for the more experienced user and basic commands with built in defaults for the new user. Prewritten modules are available with Tellagraf as a separate product called CA-CUECHART. CA-CUECHART uses a library of boardroom quality predesigned charts. The language used to call these charts is English-like and very easy to use. Tellagraf is completely integrated with Stratagem, and can retrieve data from a Stratagem database directly.

CADET is used as a delivery tool to the end-users (executives) at the PC. After logging into the mainframe database and using the commands to create the graph and the textual report, these screens are captured in CADET. After being captured in CADET, they may be organized via CADET commands into a menu structure and made available to the executive. The CADET commands are very easy to learn and can be executed interactively or in the batch mode.

EASEL software comes in three parts, EASEL development software, EASEL Layout, and business graphics. EASEL development software is the engine behind all graphics and interfaces created. EASEL provides the developer with the 4GL code to write interfaces. EASEL layout is a tool to help in the quick and easy creation or modification of graphical objects on the PC screen.

2.5.2.1.1 Tools or 4GL language for EIS user interface development (Continued)

Developers can select from EASEL Layout's built-in library of patterns and shapes or can quickly create their own customized shapes, such as logos, with interactive ease. Once a screen is created with EASEL layout it automatically generates the EASEL code to describe that screen. EASEL Business Graphics saves development time by allowing developers to quickly convert tables of number into many kinds of full color business graphs. The business graph utility is very helpful in the creation of the graph. It uses the windowing capability to view the data and create the graph on the same screen. This is an extremely helpful feature in first-time creation of graphics.

2.5.2.1.2 Database building and manipulation

Stratagem/Tellagraf/CADET Score: 12/15

Stratagem/EASEL Score: 12/15

For data extraction and loading of the database Stratagem uses a file read command for a variety of external files into the Stratagem database. However, the file read command is good for small amounts of data (500 - 600 records). For loading large files Stratagem provides an interface to 3GL languages (COBOL, FORTRAN, etc) which force the developers to write extraction code in one of these languages before being accessible by Stratagem.

The flexibility and ease of database manipulation is one of the strongest features of Stratagem. Stratagem stores all data in arrays, a collection of individual labelled storage cells. These are easy to create and maintain and make all database queries more efficient. Stratagem is not only a database, but a tool for advanced analysis. This is done using some of the same utilities and commands for database creation and makes use of all benefits available. These tools are used to perform all DBMS functions (aggregations, calculations including ratios, percentages, averages, and statistical correlations). These tools are natural-language driven but can be built to work with limited menuing capability.

2.5.2.1.3 Time to install first application

Stratagem/Tellagraf/CADET Score: 10/20

Stratagem/EASEL Score: 12/20

In both situations the piecing together of two separate software packages could slow installation of the first application. In addition, no EIS models or templates are provided with Stratagem; EASEL does provide an EIS toolkit with templates. See Section 3.0 "Scope of Development and Schedule," for more information in this area.

2.5.2.2 Easy installation of enhancements and
modifications

2.5.2.2.1 Adaptability to change

Stratagem/Tellagraf/CADET Score: 10/20

Stratagem/EASEL Score: 10/20

One of the advantages of the Stratagem database is the ease in changing the data structure. Changes, additions, deletions of field, record, and file definitions can all be handled by the data dictionary. Since Stratagem uses defined arrays for data storage, modifications to data structures are much simpler than with a true relational database.

Changes to the format of reports delivered to the users must be done at the mainframe in the Stratagem/Tellagraf/CADET scenario, a process almost guaranteed to be more cumbersome than format changes done at the PC, as in the Stratagem/EASEL scenario. Changes to the menu structures in CADET are relatively straightforward.

EASEL is a non-procedural, event-driven language. The language consists of program blocks and statements which send messages to each other. This configuration makes incorporating changes simplified. All attributes of icons and windows can be changed by using action statements. Changes may be incorporated in real time, since they are embedded in action statements.

As with all EIS systems which rely on a static set of reports as their main method of information delivery, this this configuration requires too much human intervention into information presentation to become a truly dynamic source of executive information.

2.5.2.2.2 Transparency to User

Stratagem/Tellagraf/CADET Score: 8/10

Stratagem/EASEL Score: 8/10

A developer workspace within Stratagem is defined by the system administrator which would allow all modifications to be validated, verified and then implemented to the system without interfering with the user community. CADET and EASEL have similar capabilities.

2.5.2.3

Ease of Portability

Stratagem/Tellagraf/CADET Score: 10/10

Stratagem/EASEL Score: 9/10

CADET can operate in a DOS format, DEC VAX, or the VM/CMS operating system, set up in a network with a file server. This configuration is portable to many platforms. Tellagraf is one of the oldest mainframe graphics tool available and is able to run in the most of the platforms available; no recoding is required. EASEL is a PC-based system and is portable in the IBM 100% compatible mode; some Wang-specific commands might have to be recoded during a port to another system.

Stratagem runs in the IBM MVS/XA VM, DEC Vax VMS, and the Prime Primos. Stratagum has developed a routine to transfer between IBM and DEC Vax platforms called Deckdump. With execution of this routine the application will be dumped to tape and ready for transfer to other platform.

2.5.2.4

Quality of Vendor Support

Stratagem/Tellagraf/CADET Score: 7/10

Stratagem/EASEL Score: 7/10

Computer Associates provides documentation, training (3-day course for developers for each segment), and customized application support. CA also provides a 24 hour hotline for developers. Because of the company's size and its decision not to assign a single consultant to an individual project, vendor support may not be of as high a quality as with smaller firms.

Interactive Images offers a 4-day class for training of the use of EASEL. EASEL offers consulting for during the three to ten days after purchase to help with initial installation. Southern Electric provides 3 days of consulting and training with the initial installation of CADET. Additional on-site training is available for a fee. Southern Electric also provides an 8 a.m. to 5 p.m. support hotline. A specific analyst assigned to each application.

2.5.3

Hardware/Software Issues

Stratagem/Tellagraf/CADET Score: 69/100

Stratagem/EASEL Score: 67/100

2.5.3.1

Efficiency of product operation

Stratagem/Tellagraf/CADET Score: 8/15

Stratagem/EASEL Score: 9/15

Stratagem's use of arrays and linked lists for data storage is more efficient than a relational database would be. However, using CADET to capture Tellagraf's graphic output to the PC would require that each graph be downloaded to the PC, displayed briefly, and then captured to the CADET-format file. When doing a large group of updated reports, this could be both time-consuming and risky, given the chance of interruption at the PC. Graphic transmission would consume more transmission time than systems requiring only data transmission.

2.5.3.2

Application size limitations

Stratagem/Tellagraf/CADET Score: 10/10

Stratagem/EASEL Score: 10/10

Stratagem's use of array technology for data storage set no limitations on size of application. The use of an array header to describe the information held in the array makes the queries and database manipulation efficient. The PC-based products CADET and EASEL are limited to the size of hard disk storage on the PC.

2.5.3.3

Utilization of Hardware Resources

2.5.3.3.1

PC Requirements

Stratagem/Tellagraf/CADET Score: 8/10

Stratagem/EASEL Score: 6/10

CADET is the use the PC for the delivery of information and runs on the IBM 100% compatible machines. It has the following additional requirements or options:

Disk Space	minimum 360K
RAM	640K are moving towards use of extended memory
Ports	communications port
Monitors	recommended EGA for high resolution of graphics
touchscreen	not supported

2.5.3.3.1 PC Requirements (Continued)

mouse	standard "IBM compatible" mouse
printers	supports screen prints from PC with the intervention of 3rd party vendors
plotters	same as printers
communications software	DDCP Dos to Dos Communications Program DCA fastlink Trailblazer Any Net Bios network
modem	packet switching high speed modem

EASEL is a PC-based delivery tool and graphic tool which runs on the IBM 100% compatible machines. It has the following additional requirements or options:

Disk Space	10 Meg
RAM	512 KB
Monitors	EGA monitor and board
mouse	supports standard "mouse"
touchscreen	"mouse" compatible touchscreen
printers	Andex, DataProducts, Diablo, Epson, Gemini, Hermes, Hewlett-Packard, IBM, Mannesman, Okidata, Toshiba, and Quadram
plotters	All Hewlett-Packard models

2.5.3.3.1 PC Requirements (Continued)

communications software	Asynchronous communications board, DCA's IRMA board or IBM's 3278/79 Emujlation Adaptor (required for 3270/EASEL)
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2.5.3.3.2 Mainframe Requirements

Stratagem/Tellagraf/CADET Score: 11/15
Stratagem/EASEL Score: 11/15

Stratagem is a mainframe based application which runs on the IBM, DEC Vax, and the Prime platforms. It has the following additional hardware requirements:

available models	IBM DEC Vax Prime
operating system required	IBM MVS/XA; MVS/TSO; VM DEC VAX VMS Prime Primos
memory	IBM MVS/XA, VM to load the application 3 Meg to run developer applications/ad- vanced users 4 Meg DEC Vax VMS 1.5 Meg to load system Prime Primos 3 Meg to load machine WS quota 512K
peripherals	Tape drive TP monitor

2.5.3.3.2 Mainframe Requirements (Continued)

CA-Tellagraf is a mainframe-based application, which operates on a wide variety of mainframes. A complete list was not available from Computer Associates. The following is a list of the additional requirements necessary for running Tellagraf on an IBM or a DEC VAX.

available models	IBM/CMS IBM/MVS VAX/VMS
operating system required	IBM/CMS VM/SP or VM/XA SP VS FORTRAN ver 1 release 4 or higher compiler and library GDDM 1.4.0 or higher IBM/MVS MVS/SP or MVS/XA SP VS FORTRAN ver 1 release 4 or higher compiler and library GDDM 1.4.0 or higher VAX/VMS VMS 4.2 or higher FORTRAN 4.4 or higher FORTRAN Runtime library
memory/installation	IBM/CMS May be installed as discontiguous saved segment (DCSS) for more efficient use IBM/MVS installed in overlay structures Compiling with VS FORTRAN 1.4.0 optimization level 3 Compiling with the VS FORTRAN 1.4.0 reentreancy option VAX/VMS installed as a VAX shareable image

2.5.3.3.3

Wang VS 300

Stratagem/Tellagraf/CADET Score: 9/10

Stratagem/EASEL Score: 9/10

Both Stratagem configurations appear to be fully supportable using the Wang VS 300 minicomputer virtual disk.

2.5.3.3.4

Timesharing Provided

Stratagem/Tellagraf/CADET Score: 2/10

Stratagem/EASEL Score: 1/10

Computer Associates does not provide timesharing facilities, nor were they able to provide a list of timesharing vendors who had already installed Stratagem. Tellagraf is provided by many popular timesharing vendors.

2.5.3.4

Networking Capability

Stratagem/Tellagraf/CADET Score: 8/10

Stratagem/EASEL Score: 8/10

CADET is designed to be used in a local area network configuration; several popular LANS including Novell are supported. The EASEL/Stratagem system uses the EASEL software to front-end the Stratagem database; EASEL supports most popular protocols.

2.5.3.5

Portability to CORN

Stratagem/Tellagraf/CADET Score: 13/20

Stratagem/EASEL Score: 13/20

Because both configurations use Stratagem for the DBMS, portability is directly dependent on platforms available to Stratagem. Stratagem is portable between the IBM VM and MVS, DEC Vax VMS, and the Prime Primos platforms.

2.5.4 Maintenance Issues
 Stratagem/Tellagraf/CADET Score: 73/100
 Stratagem/EASEL Score: 79/100

2.5.4.1 Ease of Maintenance

2.5.4.1.1 Modifications to System
 Stratagem/Tellagraf/CADET Score: 19/25
 Stratagem/EASEL Score: 20/25

CA-Stratagem uses arrays for its multidimensional data storage facility rather than the traditional tables of a relational database. The data is tracked by a very active data dictionary. Modifications to the data dictionary are directly reflected in the array structure of the data storage. New data structures are easily added to the system: if the data dictionary has been set to "active" mode, changes made in the data structures are only incorporated when they become part of the data dictionary. In general, Stratagem provides great flexibility in setting up the arrays. There are no restrictions on the structure or shape of the array, on the number of dimensions the array may have, or on the choice of positions the developer may want to include along each dimension. Although the array data storage structure is easily modified, the data input facility is not. Changes to the input data file format are not handled within the Stratagem 4GL environment, but instead require changes to the 3GL code which was necessary to read in the data initially.

In the Stratagem/Tellagraf/CADET configuration, all report generation is done at the mainframe using either Stratagem or Tellagraf or a combination of the two. Their command files written for report generation must be modified to change the appearance of reports. Both Tellagraf and Stratagem allow the developer to write these command files either using a menuing interface or with direct natural language commands. CADET is used as the PC delivery tool to the end-user. Cadet has a very flexible format for creating and modifying user menu structures, which can be modified on a system-wide level or user-specific level. System-wide changes are simple to make; user-customized menus will require ever-increasing levels of maintenance.

In the Stratagem/EASEL configuration, EASEL is used as the front end for the mainframe report generator and as the PC graphics and delivery tool. Thus, menus need be written only using EASEL, unlike the Stratagem/Tellagraf/CADET option, in which menus would be written both in Stratagem and in CADET. PC graphs and textual reports are treated as separate objects within EASEL; changes to one would not necessarily require changes to the other.

2.5.4.1.2 Updates

Stratagem/Tellagraf/CADET Score: 18/20
Stratagem/EASEL Score: 18/20

Data updates or refreshes to the main data storage facility are handled through the 3GL extraction programs that have been developed by the system administrator. This process may be automated; once the data has been updated, Stratagem (and Tellagraf) reports reflecting the new data also may be automatically generated in batch mode.

2.5.4.2 Distribution of Data

Stratagem/Tellagraf/CADET Score: 13/25
Stratagem/EASEL Score: 18/25

Static reports created on the mainframe using Stratagem (or Tellagraf, if applicable) are downloaded to the PCs in batch mode, usually during off-peak hours. When CADET is used, each graph or textual report must be displayed briefly on CADET's master PC in order for CADET to capture the display in its own format. This will be an extremely time-consuming and error-prone procedure, because of the increased transmission time required to download graphical data and because of the PC capture time required for each EIS graph and report. The EASEL configuration would be much less risky and time-consuming, since only data reports are downloaded to the PC. In the EASEL configuration, data can also reach the users using an icon-driven, user-friendly interface which allows ad hoc queries to the Stratagem database.

2.5.4.3 Nightly backup and recovery facility

Stratagem/Tellagraf/CADET Score: 5/10
Stratagem/EASEL Score: 5/10

Stratagem does not have its own backup utilities. All of Stratagem's data is stored in "Gem-Files," which are included among the files backed up using the operating system backup routine.

2.5.4.5 Automated Configuration Management Tools

Stratagem/Tellagraf/CADET Score: 18/20
Stratagem/EASEL Score: 18/20

Stratagem has a data dictionary that is very easy to modify. Some of the data dictionary features are

- o Built in relational capability
- o Hierarchical consolidations along multiple paths
- o Label storage for reporting

2.5.4.5

Automated Configuration Management Tools (Continued)

A user can define a dictionary which can include relationships and descriptive labels. The defined dimension is used to aid in array creation. One of Stratagem's built-in menus (data definition and relationships) allows for creating, modifying and editing arrays, defining and relating dimensions, as well as providing longer position labels. Stratagem does not contain audit trails to track updates to the user; CADET cannot perform this function, but EASEL could be built to do so, utilizing either PC capabilities or built-in mainframe file control functions.

CADET has a configuration tool that is called the "biography screen," which is similar to a data dictionary. The biography screen reveals who is responsible for the specific data on the CADET master PC.

2.6 Other Systems

The following systems were found to be unsuitable to FAA's needs after an initial evaluation. Reasons for their lack of further consideration are supplied.

2.6.1 Metapraxis' Resolve

Resolve is an entirely PC-based system. It can only be used on a PC after downloading part of an IBM (hosted) database. Downloads are made as an aggregate, eliminating ad hoc queries, and reducing data currency and the frequency of updates. Further limitations to this system are as follows.

(1) IBM mainframe ties make it hardware and database limited.

(2) The reporting screens are highly inflexible. No new menuing structure can be developed, nor can menus be customized for individual users.

(3) No mouse or touchscreen interface is available; infrared keypads and the keyboard are the only interface possible.

(4) The size of the database would be limited by the size of the PC, reducing drill-down capability.

2.6.2 Ferox Microsystems' Encore! Plus

Encore is primarily a financial management system, and does not appear to be well-established in EIS sales or in contractor support at this time. Other factors reflecting on its suitability for the intended use are listed below.

(1) Encore is entirely PC-based, with the associated limitations on data capacity and upkeep. It is a standalone system.

(2) Its language is advertised as "financial modeling language," which may limit its applications for general management uses.

(3) Encore operates mostly with its own database, which consists of a binary matrix file and an ASCII (text) file. It has the capability to import Lotus 1-2-3 and "flat" (comma delimited) files. This would severely limit Encore's ability to work with other data types and database structures.

2.6.3

Metaphor

Metaphor is essentially a data base management system; its use by a database administrator is stressed. In addition, the following related points limit its suitability to the FAA's specific application.

(1) The DBMS must operate with relational structured databases only. In addition, it requires a data dictionary from the associated databases for proper operation.

(2) Extensive hardware purchases would be required, including mainframe file-servers and workstations or PC workstation modifications. In addition to defining the hardware for the FAA EIS without a selection process, the cost of the hardware upgrades to the PCs alone is \$5000 per PC.

(3) Analysis capabilities are limited to those of a standard PC spreadsheet.

(4) Queries are made in the form of shortened SQL commands and would require a knowledge of the data and the database structure.

3.0 SCOPE OF DEVELOPMENT AND SCHEDULE

The principle reason for selecting an off-the-shelf Executive Information System (EIS) for use on the EXIS project is to save time and money. (The alternative to using a commercially available EIS is to select a data base management system such as ORACLE or INGRESS and develop the necessary graphic data output and man-machine interface software, an alternative which is prohibitively expensive.)

The primary objective of the EXIS project is to provide the FAA executives with a management support tool as soon as possible with a tentative schedule for a preliminary capability as early as March, 1989 and an operationally useful capability by June, 1989.

Four of the seven commercially available EISs that were evaluated will require essentially the same initial development efforts for user interface, graphic output, application software, data extraction, and system integration and start-up. These four are Pilot, Comshare, Execucom (full system without ORACLE) and EXPRESS. The Execucom/ORACLE alternative, however, requires a significant amount of effort for data base design and system integration, while the Stratagem/CADET and Stratagem/EASEL alternatives require more time than is available for data base loading, analysis software development, user interface development and integration and start up.

The major problem with using the Execucom/ORACLE system is the lack of multidimensional data capabilities. The competition in this industry provides multidimensional data base capabilities because of the flexibility and long term advantages. A multidimensional design from the start greatly reduces the life-cycle system enhancement costs by providing the ability for growth and change as the data base matures. Multidimensional data storage is open-ended and the system response performance is optimized. In a multidimensional environment the designer can define a data array for a data entity such as "person" to include name, sex, geography (eg. region), date hired, skill category (eg. controller), and any number of other dimensions. The designer doesn't have to restrict the design of this entity to records that include a finite amount of information as has been the case with relational database design in the 1970's and early 1980's. The principle advantage is the ability to define any number of relationships for analysis.

3.1 Execucom/ORACLE EIS

3.1.1 Design and Implementation of Data Entities

In order for ORACLE to be made to simulate the functions of a multidimensional database, a great deal of additional effort will be required over the baseline products which already have this capability. There is also some additional effort involved to load an ORACLE database from flat files, in contrast with other systems whose file definition and data loading processes are menu-driven. Further development effort will also be required when writing SQL*Forms report generation processes to move data from the ORACLE database into flat files accessible by IFPS. This additional work will require 12-18 man-months of effort over the four more competitive systems.

3.1.2 Integration of multiple-vendor products

Integrating software products from different vendors is also a challenge. Given the disappointing customer support supplied by ORACLE, system integration is expected to be extremely difficult. Additionally, enhancements to either product may eventually make them incompatible with one another, leaving the choice of not growing with improving technology or an ongoing intensive development effort. In addition to the potential risk of incompatibility this integration start-up effort would require an additional 6 man-months of effort.

3.2 Stratagem/Tellagraf/CADET, Stratagem/EASEL

The use of the Stratagem/Tellagraf/CADET or Stratagem/EASEL EIS would add a considerable risk and schedule difficulty. Design and loading of the database would require an additional 6 man-months over the four competitors, while analysis software, user interface development, and integration start-up would require an additional 10-15 man-months.

3.2.1 Data Extraction and Loading

Loading the Stratagem database from flat extract files is not done using system 4GL code or menus, as in the four more competitive EIS systems. Instead, data parsing code must be written in a third generation language such as FORTRAN, C, or Assembler, and then integrated with the Stratagem Host Language Interface for loading into the Stratagem database. In addition, no sample EIS application templates are provided with the system, in contrast to all other evaluated EIS vendors.

3.2.2

Analysis and Presentation Software

Because no EIS example templates are provided with the system, writing even simple forecasting and analysis routines will require more time and effort. Equally as important, Stratagem has no menu-driven interface for performing modeling and analysis, unlike all the other EIS analysis tools. Thus, developers must either write each modeling routine separately in 4GL code or they must spend time writing menuing functions to expedite the process of building models. Although a set of predone graphs is provided with Tellagraph's product Cuechart, when developers require different types of graphs than those provided they must move from a menu-driven interface to working with a command interpreter. This will require more training and time on the part of the developers.

3.2.3

User Interface Development

All user menus at the mainframe must be written by the developers, again without aid of EIS templates. CADET has a menuing capability for the PC already included; Stratagem (for the mainframe) does not. The Stratagem/EASEL alternative has some advantages over the Stratagem/CADET alternative in the area of user interfaces. All user interfaces, both menus and graphs, and both at the PC and at the mainframe, can be written using EASEL to provide a single iconic interface for all processes. EASEL is provided with a set of EIS templates.

3.2.4

Integration of multiple-vendor Products

Integrating CADET with Tellagraf and Stratagem has been accomplished before, by CADET's original designers, but integration within FAA's specific environment is expected to take additional effort. The risks of integration of products from multiple vendors are discussed in the Execucom/ORACLE section of this document.

4.0 IMPLEMENTATION STRATEGIES

4.1 Connectivity Strategies

4.1.1 Direct connect to Packet Assembler/Disassembler (PAD)

In this implementation, executive user PCs would be hardwired into a PAD on the Administrative Data Transmission Network (ADTN). Data would be stored on the EXIS mainframe and on the local users PC hard disks. See Diagram 4-1 for a schematic representation of this implementation.

There are several major advantages to this implementation. Full functionality of all EIS systems is guaranteed. As the number of users grows, both in FAA headquarters and in remote regions and centers, executive users are easily provided with direct access to the system. In addition, no costs would be incurred by the EXIS project for links to the ADTN: all ADTN costs including hardware are borne by the ADTN program office. (For information purposes only, the cost of a PAD for the ADTN is approximately \$20-25,000 for 25 to 30 users at FAA headquarters. Pricing information is found in modification number 8 to the ADTN contract. A proposed configuration will be needed to price this out accurately, e.g., cabling involved, LDMS needed.) For these reasons, this implementation is the preferred one.

CONNECTIVITY OPTION #1

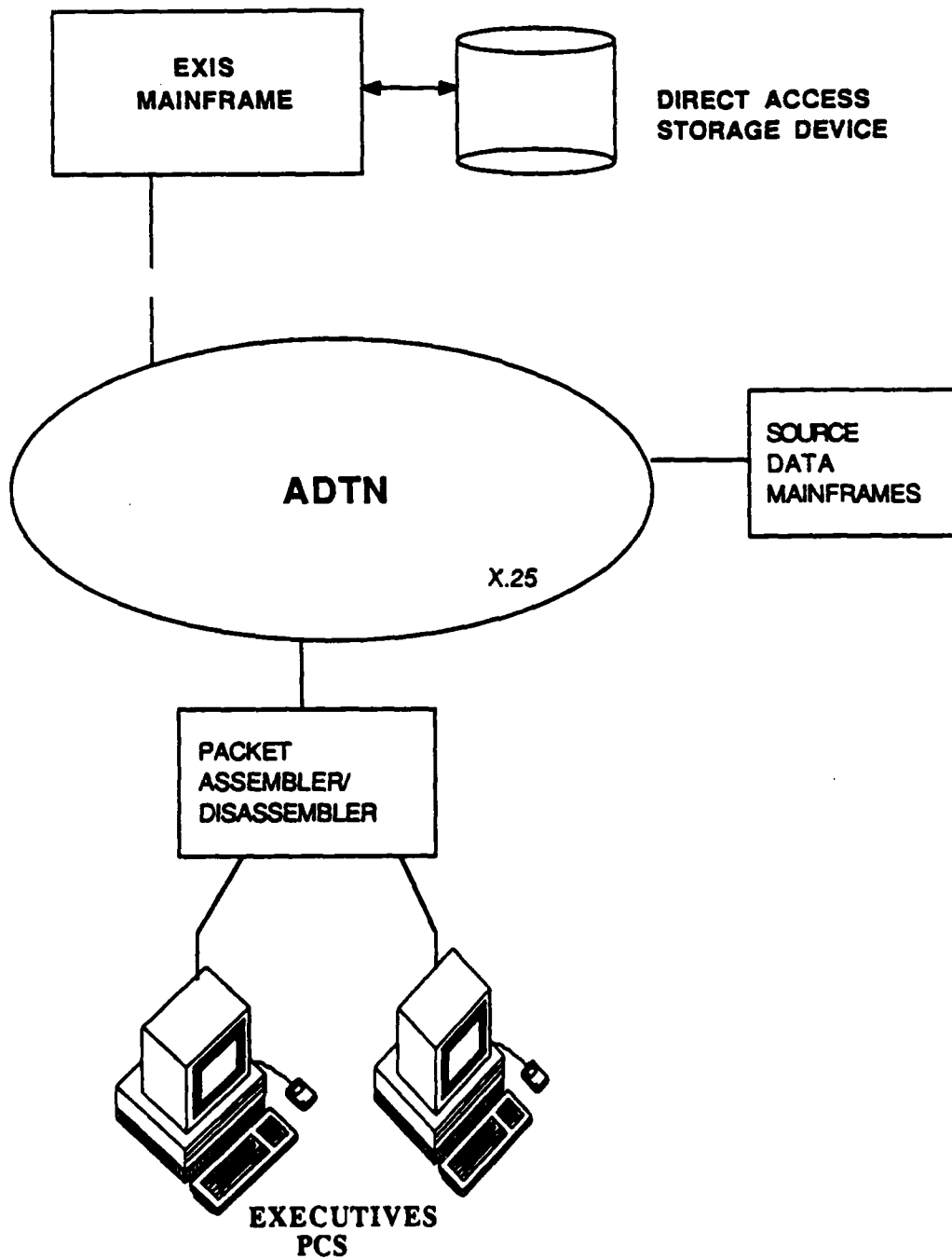


Diagram 4-1

4.1.2

Via Wang/DG Minicomputers

In this implementation, executive user PCs at each site would be connected to the EXIS mainframe via Wang VS 300 (at FAA headquarters) or Data General MV 15000 (at regional HQs) minicomputers linked to the ADTN. Data would be stored on the EXIS mainframe and on the minicomputer's virtual disk, taking advantage of its mass storage capability and its ability to support a local area network implementation. See Diagram 4-2 for a schematic representation of this approach.

This implementation could have significant disadvantages, however, especially when considering a long-term solution. EXIS usage at FAA headquarters is expected to grow to at least 200 users, at least ten times what is supportable by a single Wang virtual disk. New users beyond the initial prototype would have to be supported by use of additional Wang minicomputers or via direct connection to the EXIS mainframe over the ADTN. Two separate solutions at FAA headquarters would probably be necessitated. In the still longer term, porting the database from the Wang to CORN and OATS environments would probably require some recoding, given the extremely proprietary nature of Wang's telecommunications protocols.

Other problems with use of the Wang virtual disk include limitations to the Wang operating system. Use of the Wang virtual disk requires that data updates to the system be performed sequentially rather than simultaneously, increasing the downloading time and locking out other users for longer periods of time, since the Wang supports only a single exclusive user with write capability to the disk. A significant amount of performance degradation is also expected with usage of the Wang virtual disk when five or more users are accessing data from the disk.

Finally, use of the Wang virtual disk will not permit interactive queries to the EXIS mainframe for all the EIS vendor systems. Most of the systems are supported to some extent, but will only allow batch downloads to the Wang virtual disk. Use of this method would therefore mean some reduction in functionality to the EIS.

For these reasons, connectivity through the Wang VS 300 virtual disk is not recommended.

CONNECTIVITY OPTION #2

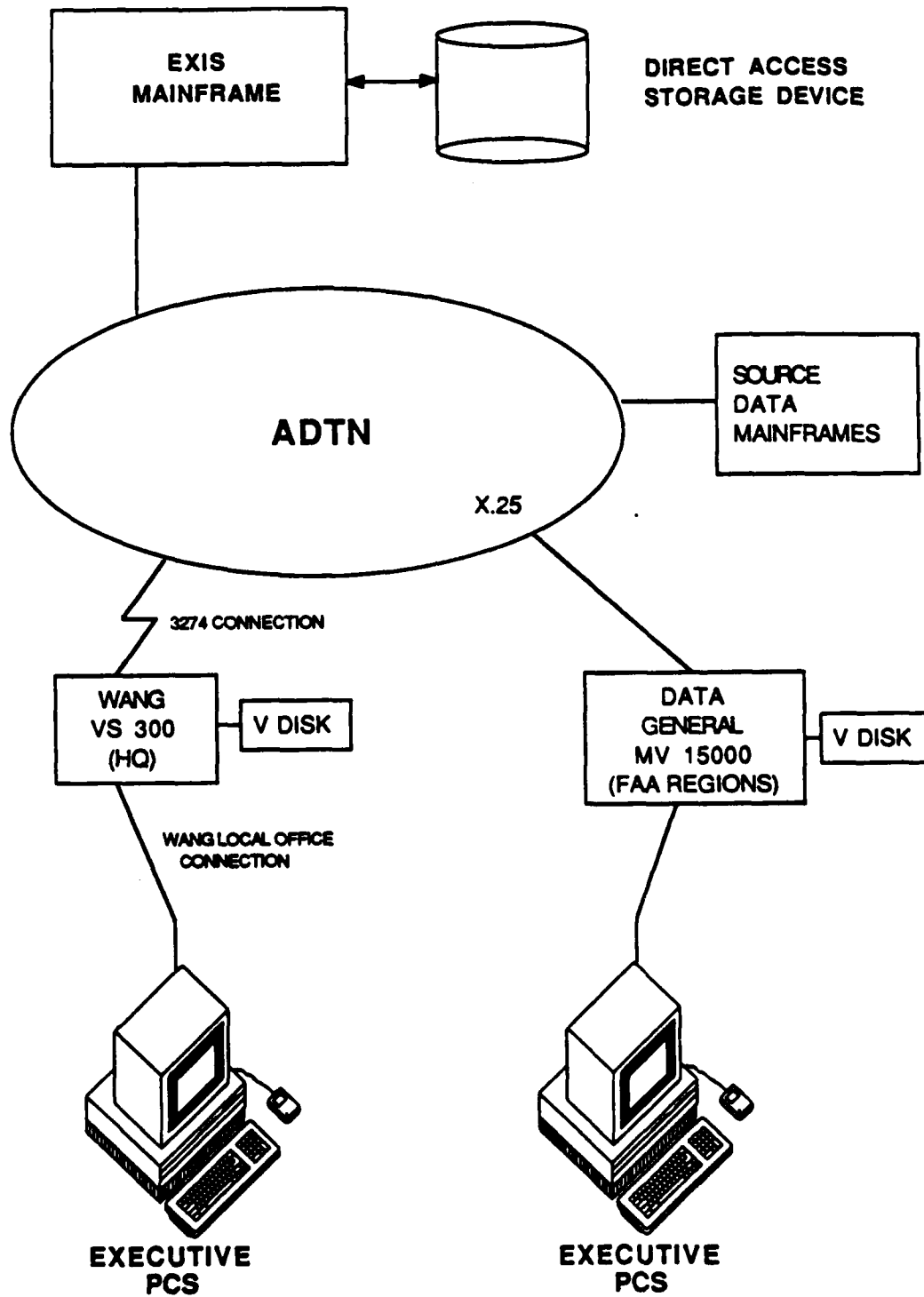


Diagram 4 - 2

4.2 Mainframe Hardware Options

4.2.1 Timesharing until CORN

The following timesharing computer services were considered for use by the FAA in the development and implementation of the EIS.

4.2.1.1 Boeing Computer Services (BCS)

BCS currently provides timesharing services under a general contract with the Department of Transportation (DOT). They provide the whole range of services and products for the interactive and batch processes. They are already connected to the FAA ADTN but do not currently support any of the EIS or DSS software products evaluated. Since BCS is an established source for providing timesharing service to the FAA, they are an option for EXIS development and implementation. However, as described in Section 5, costs for such services are prohibitive.

4.2.1.2 Timesharing access to EIS Products

Two of the companies whose software products were evaluated also provide internal timesharing services as an integral part of their overall corporate business line. These two companies, Comshare and Information Resources (EXPRESS), both offer a wide range of timesharing services and product applications. While they are not currently connected to the FAA ADTN, arrangements could be made for this connection. Each company's timeshare also supports the whole range of their EIS/DSS product lines, deferring the need to purchase a license for the mainframe until CORN (or until an internal mainframe is made available). Each of these companies is a viable option for EXIS development and implementation. However, as with BCS, costs for long-term use of these services are prohibitive (see Section 5).

4.2.1.3 Government Provided Timesharing Services

Two government organizations who provide timesharing services to other government agencies were also considered for possible EXIS development and implementation. The Navy Regional Data Automation Center (NARDAC) in Washington, D.C. and the Department of Commerce Computer Service Bureau in Springfield, Va., are both IBM-oriented timesharing services available through reimbursable agreements to other federal government organizations. While currently not connected to the FAA ADTN, arrangements for this connection are possible. NARDAC does not currently support any of the products evaluated. Commerce, however, supports Comshare's complete line of EIS and DSS products as a result of purchasing licenses for NOAA's EIS. As a result, they could provide access to Comshare's mainframe products in a timesharing environment at no additional cost to the government for use of the Comshare license.

4.2.2 Lease Options

4.2.2.1 Digital Equipment Corporation VAX

The VAX 8250 is the smallest dedicated VAX mainframe that can be expected to provide adequate support for all of the systems evaluated except Pilot. The 8250 can expand to 96MB of memory and can be upgraded to a VAX 8350 simply by adding a board to the CPU.

The VAX 8250 includes:

- o VAX 8250 CPU with 12-slot VAXBI
- o 16 Mbytes of ECC MOS memory
- o Integral floating point
- o CIBCA VAXcluster port and 1 set of CI cables
- o 1-year onsite hardware warranty

The VAX 8350 has same configurations as the 8250 except the 8350 has 32 Mbytes of ECC MOS memory instead of 16. Also the processing speed (MIPS) is superior to the 8250.

The VAX 8810 would be the largest mainframe required for an EIS; of the evaluated products, only Pilot would require this size machine from the initial startup of the system. The 8810 can also be upgraded to an 8820, 8830 and an 8840.

The 8800 series base-system includes:

- o VAX 8810 CPU
- o 48 Mbytes of 256K ECC MOS memory
- o Battery back-up
- o Integral floating point
- o One VAXBI channel
- o VAXcluster port and 1 set of CI cables
- o Console subsystem
- o 1-year onsite hardware warranty

Regardless of size, each of the VAX mainframes would have the following configuration:

- o **2 Storage Arrays :** Each storage array can hold up to 2.48 GB
- o **Hierarchical Storage Controller (HSS70-AA) :** Has space for 8 HSC5X-CA or HSC5X-BA (channels). Some of the features include the following:
 - o Data buffering - provides the buffering of up to 512 Kbytes of data
 - o Multiple processors may read and write shared files

- o Self-contained diagnostics - provides host-independent diagnostic
- o One-year onsite hardware and software warranty
- o Disk Interface (HSC5X-BA) : Data channel interface for interfacing up to 4 SDI disk drives
- o Tape Drive (TA79-BF) : High-density magnetic tape subsystem
- o Tape Interface (HSC5X-CA) : Data channel for interfacing up to 4 DSA tape formatters.
- o DELNI-BA : Local Network Interconnect is a concentrator that allows up to 8 Ethernet-compatible devices to be grouped together. The DELNI can be configured 3 ways : stand-alone, hierarchical stand-alone, and connected. A connected DELNI LAN reduces the cost of multiple connections to the Ethernet coaxial cable.
- o (4) DECserver200's (DSRVB-CA) : A network terminal switch for Ethernet local area networks (LANS), supporting the simultaneous operation of up to 8 terminals. The DECserver200 provides modem support for asynchronous modems and transparent logical terminal connections to hosts that do not implement the LAT protocol.
- o (5) Transceiver Cables (BNE3L) : The transceiver cable is a 4 twisted-pair IEEE 802.3-compliant low-loss cable assemblies and are used with the H4000 Ethernet transceiver and DELNI.
- o (3) Terminals VT-340 : Color Graphics Terminal w/Standard Keyboard, 120V
- o (3) Terminal Cables (BC22D-25)

If there are problems with the system, VAX offers an 8-hour/5 days a week help plan with a 4-hour response time. This plan can be upgraded to the customer's needs.

4.2.2.2 IBM

The IBM 4381-P22 is the smallest mainframe that can be used for EIS software. The 4381 can be upgraded to a model 24.

The IBM 4381 has the following hardware configuration:

- o CPU (4381-P22)
- o Console (3278-A02): A display station for local and remote line applications
- o Storage Control (3880-003): contains 2 storage directors for independent control of attached DASDs.
- o (2) DASD (Direct Access Storage Devices) (3380-AJ4 - 5.04 GB): large capacity, nonremovable medium, high performance DASD device.
- o (2) Magnetic Tape Drives (3480-A22): 3Mb/sec bytes per second instantaneous data rate.
- o Communication Controller (3174-01L)
- o Terminal multiplexor (3299-002) (24 ports each - 48 users)

All of the hardware and software include sets of documentation (already included in the cost). A completely new version of the software requires an additional fee, but with each new release there is no charge.

4.2.3

Use of Government-owned Mainframe

The following FAA and DOT-owned machines were considered for use as the host mainframe for the FAA EXIS. Their status is listed below.

- a. Transportation Computer Center (TCC) Amdahl 5868, located in Washington, DC.

Contact name: Dennis Chastain.

Current use: Moderate; willing to support installation of EXIS.

Machine (CPU) size: Large. Equal to IBM 3081.

Connected to ADTN.

- b. Transportation Computer Center (TCC) COMTEN 3690, located in Washington, DC.

Contact name: Dennis Chastain.

Current use: Used for communication front-end. Cannot be used for EIS.

- c. FAA Southern Region, DEC VAX 11/751, located in Atlanta, Georgia.

Contact name: Jeff Granier.

Current use: Heavy; cannot be utilized since system is at maximum capacity.

- d. DOT/Transportation System Center (TSC) DEC VAX 11/785, located in Cambridge, Mass.

Contact name: Dick Gaudett

Current use: Heavy; system at maximum capacity.

4.2.3

Use of Government-owned Mainframe (Continued)

- e. DOT/Transportation System Center (TSC) DEC VAX 8250, located in Cambridge, Mass.

Contact name: Dick Gaudett

Current use: Moderate to heavy; system anticipated to be at maximum capacity in 6-9 months. Procurement currently in process for upgrade to 8350 for 3/89.

Machine (CPU) size: Medium

Connected to ADTN.

- f. DOT/Transportation System Center (TSC) Amdahl, located in Cambridge, Mass.

Contact name: Dick Gaudett

Current use: Moderate to heavy; can accommodate additional use.

Machine (CPU) size: Large

Connected to ADTN.

- g. FAA Eastern Region DEC VAX 11/730, located in Jamaica, New York.

Contact name: Tom Behring

Current use: Heavy - system at maximum use

- h. FAA New England Region DEC VAX 11/751, located in Burlington, Mass.

Contact name: Jerome Doyle and Mark Fradette.

Current use: Heavy - system at maximum use. Planned installation of new system at end of March 1989. Unable to support EIS during this transition. Contact again at end of April 1989.

Machine (CPU) size: small

Not connected to ADTN.

4.2.3

Use of Government-owned Mainframe (Continued)

- i. Mike Monroney Aeronautical Center IBM 3084, located in Oklahoma City, Oklahoma.

Contact name: Sherman Cravins, Mark Lewis

Current use: Heavy; can support additional processing after 5pm and before 7am. Data Systems Division is currently trying to obtain funding for upgrade to 3090. With upgrade, system could handle EIS applications without any time limitation.

5.0 COSTS

5.1 Software Costs

Life-cycle costs of the EIS software over a four-year period (to the CORN acquisition) are estimated, assuming 400 users by the end of the four years. Total software costs for each of the five vendors whose performance against the previously-approved EIS criteria was at least 70% is calculated, based on copies of current GSA schedules provided by the vendors. See Tables 5-1a through 5-1e for a specific software cost breakdown for each of the vendors by fiscal year.

Table 5-1a
Five Year Costs - PILOT

PILOT	FY 89	FY 90	FY 91	FY 92	CORN	5-year Total
Number of users	50	150	250	350	400	400
PC Software						
No cost	0	0	0	0	0	0
Mainframe Software - DEC VAX 8810						
Command Center	76,500	0	0	0	0	76,500
Development Software						
Tools:						
Advantage	17,000	0	0	0	0	17,000
Dimension	13,600	0	0	0	0	13,600
Target	12,750	0	0	0	0	12,750
Newstrack	4,250	0	0	0	0	4,250
Less 25% discount	(11,900)	0	0	0	0	(11,900)
Maintenance	0	13,464	13,464	13,464	13,464	53,856
(12% per year						
after first year)						
Total for Software						
DEC VAX 8810	112,200	13,464	13,464	13,464	13,464	166,056

Table 5-1b
Five Year Costs - COMSHARE

COMSHARE	FY 89	FY 90	FY 91	FY 92	CORN	5-year Total
Number of users	50	150	250	350	400	400
PC Software						
Commander Executive (First 10 copies free; next 40 @ \$975 ea. rest @ \$825 ea.)	39,000	82,500	82,500	82,500	41,250	327,750
Builder's Easel (1 copy)	15,900	0	0	0	0	15,900
Maintenance 20% after 15 months	0	0	10,980	27,480	43,980	82,440
Mainframe Software - DEC VAX 8250						
Commander EIS w/Execuview	82,550	0	0	0	0	82,550
Forecasting	1,300	0	0	0	0	1,300
Maintenance 15% after 15 months	0	0	12,578	12,578	12,578	37,733
Total for Software DEC VAX 8250	138,750	82,500	106,058	122,558	97,808	547,673

Table 5-1c
Five Year Costs - EXECUTIVE EDGE

EXECUCOM (Full system)	FY 89	FY 90	FY 91	FY 92	CORN	5-year Total
Number of users	50	150	250	350	400	400
PC Software						
Executive Edge Extension (inc. 3 copies Vantage Point)	28,000					28,000
Maintenance (\$3204/year)	0	3,204	3,204	3,204	3,204	12,816
CL Vantage Point (\$200 each)	9,400	20,000	20,000	20,000	20,000	89,400
Maintenance (\$32/year each copy)	0	1,600	4,800	8,000	11,200	25,600
Dow Jones V. Line (\$200 each)	10,000	20,000	20,000	20,000	10,000	80,000
Mainframe Software - DEC VAX 6250						
IFPS/Plus	32,000					32,000
Data Transfer Extension	12,000					12,000
Maintenance		10,800	10,800	10,800	10,800	43,200
Total for Execucom Software						
DEC VAX 6240	91,400	55,604	58,804	62,004	55,204	323,016

Table 5-1d
Five Year Costs - EXPRESS

EXPRESS	FY 89	FY 90	FY 91	FY 92	CORN	5-year Total
Number of users	50	150	250	350	400	400
PC Software						
PC Express	70,000	130,000				200,000
PC Maintenance	0	12,000	18,000	24,000	24,000	78,000
EIS Toolkit	25,000	20,000				45,000
Mainframe Software - DEC VAX 8250						
Express MDB		100,000				100,000
Maintenance		15,000	15,000	15,000	15,000	60,000
Total for Software DEC VAX 8250	95,000	277,000	33,000	39,000	39,000	483,000

Table 5-1e
Five Year Costs - Stratagem/EASEL

STRATAGEM/EASEL	FY 89	FY 90	FY 91	FY 92	CORN	5-year Total
Number of users	50	150	250	350	400	400
PC Software						
EASEL Development System (inc.5% disc.)	17,005					17,005
Maintenance	995	995	995	995	995	4,975
Manager's Portfolio (All Modules)	29,400					29,400
Maintenance	5,250	5,250	5,250	5,250	5,250	26,250
Run-time Systems (\$713 ea. for first 50; \$618 ea. for rest)	35,625	61,750	61,750	61,750	30,875	251,750
Maintenance (\$90 each for first 50; \$76 for next 100; \$67 for rest)	4,513	11,400	16,625	23,275	26,600	82,413
Mainframe Software - DEC VAX 8250						
Stratagem (inc. 35% discount)	40,560					40,560
Maintenance	7,488	7,488	7,488	7,488	7,488	37,440
Tellagraf (inc. 35% discount)	18,720					18,720
Maintenance	3,456	3,456	3,456	3,456	3,456	17,280
Total for Software DEC VAX 8250	163,012	90,339	95,564	102,214	74,664	525,793

5.2 Development, Training and Consulting Costs

Use of each of the products requires training and consulting at various levels. Further development costs over the baseline will be incurred by the EXIS development team, as specified in the scope of additional work identified in section 3.0, "Scope of Development and Schedule." Costs for each of the options are identified below.

5.2.2.1 Pilot

Training: \$5000 for first year only
Consulting Costs: 20 days x \$1000/day = \$20,000
Additional development work: None.
TOTAL: \$25,000

5.2.2.2 Comshare

Training: \$5000 for first year only
Consulting Costs: 20 days x \$1000/day = \$20,000
Additional development work: None.
TOTAL: \$25,000

5.2.2.3 Execucom (full-system)

Training: \$5000 for first year only
Consulting Costs: 20 days x \$1000/day = \$20,000
Additional development work: None.
TOTAL: \$25,000

5.2.2.4 Execucom with ORACLE

Training Costs: \$5000 from Execucom; \$5000 from ORACLE (first year only)
Consulting Costs: 60 days x \$1000/day = \$60,000 (Execucom); 30 days x \$1000/day = \$30,000 (Oracle)
Additional development work: 18-24 man-months x \$8,000/man-month = up to \$192,000
TOTAL: \$292,000

5.2.2.5 EXPRESS

Training: \$5000 for first year only
Consulting Costs: 20 days x \$1000/day = \$20,000
Additional development work: None.
TOTAL: \$25,000

5.2.2.6

Stratagem/Tellagraf/CADET

Training Costs: \$10,000 for first year only
Consulting Costs: 20 days x \$1000/day = \$20,000
(Computer Associates); 10 days x \$1000/day =
\$10,000
Additional development work: 16-21 man-months x
\$8,000/man-month = up to \$168,000
TOTAL: \$208,000

5.2.2.7

Stratagem/EASEL

Training Costs: \$5000 from Computer Associates;
\$5000 from EASEL
Consulting Costs: 20 days x \$1000/day = \$20,000
(Computer Associates); 20 days x \$1000/day =
\$20,000 (EASEL)
Additional development work: 16-21 man-months x
\$8,000/man-month = up to \$168,000
TOTAL: \$218,000

5.3 Mainframe Hardware Costs

5.3.1 Timesharing

To estimate the mainframe utilization costs of developing, implementing and maintaining the EXIS in a timesharing environment, the following method was used:

1. The average monthly cost for four active users of Boeing timesharing services was calculated, based on actual Boeing Computer Services (BCS) timesharing costs accrued by AMS-420 during FY88. This average cost per month, \$3,586.55, was divided by 4, the number of active users, which resulted in an average per user cost per month of \$900.

2. If ADTN communication services are used, the connect time charges are eliminated. This results in a reduction of approximately 15% of the average cost. The adjusted cost per user per month is \$900 x .85 or \$765.

3. Assuming the following rate of growth for the EXIS, the approximate cost for developing, implementing and maintaining the system in a BCS timesharing environment would be as follows:

FY	Cost/user/month		Active users		Months		Annual cost
89	\$765	x	50	x	4	=	\$ 153,000
90	765	x	150	x	12	=	1,377,000
91	765	x	250	x	12	=	2,295,000
92	765	x	350	x	12	=	3,213,000
93	765	x	400	x	12	=	3,672,000

Total through FY93 (CORN) = \$10,710,000

4. Based on discount rates provided by Information Resources (EXPRESS) for their timesharing services (up to \$10,000 per month, no discount; \$10,000 to 20,000 per month, 50% discount; greater than \$20,000, 60% discount) the costs in 4 above would be reduced as follows:

FY	50% discount (1st \$20K)		60% discount (over \$20K)		Total discounted cost
89	\$10,000	+	\$ 133,000 x .4	=	\$ 63,200
90	10,000	+	1,357,000 x .4	=	552,800
91	10,000	+	2,275,000 x .4	=	920,000
92	10,000	+	3,193,000 x .4	=	1,287,200
93	10,000	+	3,672,000 x .4	=	1,468,800

Total through FY93 (CORN) = \$ 4,292,000

5.3.1 Timesharing (Continued)

5. Costs for using other government agency services such as NARDAC or Commerce would be approximately 25% less than the discounted costs for Information Resources (EXPRESS) (number 4 above). Thus, timesharing costs for NARDAC or Commerce could be estimated as follows:

FY	IRI Discounted Cost	Less 25%	Total NARDAC/Commerce
89	\$ 63,200 -	15,800 =	\$ 47,400
90	552,800 -	138,200 =	414,600
91	920,000 -	248,000 =	690,000
92	1,287,200 -	321,800 =	965,400
93	1,468,800 -	367,200 =	1,101,600
Total through FY93 (CORN) =			\$ 3,219,000

5.3.2 Lease Options

5.3.2.1 Digital Equipment Corporation

The mainframes listed below are in descending order of performance and power. The VAX 8250 is the minimum acceptable size dedicated mainframe for all the EIS systems considered except Pilot. Pilot will require a dedicated VAX 8810 to meet acceptable performance levels.

1. VAX 8810

- o The VAX 8810 can be upgraded to an 8820, 8830 and an 8840. The 8810 is upgraded by adding a board to the CPU.
- o 6 MIPS (Millions of Instructions Per Second)
- o Expands to 512 MB of memory

- o Total Purchase cost : \$791,429.10
- o Cost per month : \$28,016.59
 (36 month lease-to-purchase)

2. VAX 8350

- o Upgrade for the VAX 8250
- o 2.3 MIPS
- o Expands to 96 MB of memory

- o Total Purchase Cost : \$380,191.44
- o Cost per month : \$13,458.78
 (36 month lease-to-purchase)

3. VAX 8250

- o 1.2 MIPS
- o Expands to 96 MB of memory
- o Can be upgraded to a VAX 8350

- o Total Purchase Cost : \$352,164.61
- o Cost per Month : \$12,466.63
 (36 month lease-to-purchase)

The cost of updates to the VAX software is:

- o VMS: \$2880/yr
- o DECNET: \$300/yr
- o VAX Cluster \$300/yr
- o DECserver200 \$240/yr

5.3.2.1 Digital Equipment Corporation (Continued)

In addition, each of these systems will require the following one-time software and software installation costs.

- o Cost for the software & documentation: \$3599.83
This is broken down as follows:
 - o VMS: \$2977.51
 - o DECNET: \$300.00
 - o DECserver200: \$322.32
- o Cost of software installation: \$2710.00
This is broken down as follows:
 - o VMS: \$1200
 - o DECNET: \$750
 - o VAX Cluster: \$380
 - o DECserver200: \$380

The VMS Operating System is on magnetic tape, with the actual code and complete set of documentation.

Optional training and consulting costs are as follows:

- o Training: Approx. \$12,000 for 2-3 people for 10 weeks of training (if that much training is needed)
- o Consulting: 3 weeks of training (120 hrs.) :
\$15,000 - \$1,000/day

5.3.2.2 IBM

The IBM 4381-P22 is the minimum size dedicated IBM mainframe required to support an Executive Information System application for the majority of the EIS vendors.

- o Can be upgraded to the 4381 Model 24
- o Expands to 64 MB of memory
- o Estimated cost : \$615,000
- o Approximate cost per month : \$35,000 (straight lease without purchase)

Approximate Software Costs : \$52,828 (Initial Cost)

(MVS Products) \$4,550/month

5.3.2.2

IBM (Continued)

These software costs are broken down by the following:

o	Time-Sharing Option (TSO):	\$15,219
o	Data Facility (5665-295):	\$1,665
		\$670/mon
o	Communications Software (ACF-VTAM):	\$5,385
	(5665-313)	\$1,710/mon
o	ISPF/PDF(5665-317):	\$13,582
o	ISPF pre-requisite program (5665-319):	\$5,007
o	Maintenance Files (5668-949):	\$12,020
o	MVS/SP (5740-XYs):	\$2,170/mon

5.3.3

Government-owned Machines

The possibility of using government-owned mainframes as an integral part of the development and implementation of the EXIS was also considered. Using either the FAA's IBM 3084 mainframe at the Aeronautical Center or the Amdahl 5880 (equivalent to the IBM 3084) at the Transportation Computer Center (TCC) would result in costs comparable to the timesharing costs described above. Both the FAA and TCC computer facilities have developed their own "user charge" algorithms comparable to those used by commercial timesharing services which would be applied to EXIS applications and use. While these charges would only result in the internal transfer of funds amongst the DOT parties involved, the costs incurred would still be chargeable to the EXIS. In fact, using any government-owned service would result in costs comparable to the discounted commercial timesharing services.

5.4 PC Hardware Costs

5.4.1 Mouse and adapter

A Mouse for the Wang PC configuration costs \$150 plus \$25 for an adapter (total cost per PC = \$175 less 10% discount = \$157.50 per PC). If each PC were equipped with a Mouse, the cost would be as follows:

FY89	50 users x \$157.50	=	\$ 7,875
FY90	100 users x 157.50	=	15,750
FY91	100 users x 157.50	=	15,750
FY92	100 users x 157.50	=	15,750
FY93	50 users x 157.50	=	7,875

Total for five years = \$63,000

5.4.2 Infrared Pad

Several of the systems used an infra-red pad as the medium for access to the PC. The GSA schedule cost for each pad is \$240. If each of the AMT members were equipped with a pad the cost would be:

$\$240 \times 25 = \$6,000.$

5.5 Total Cost for Each Option

The total software, additional development above the baseline, and hardware costs for each of the vendors which met the minimum FAA functional requirements are identified below. Costs for each of the systems over five years is given below. All additional development costs are assumed to be incurred during the first year. The least costly mainframe alternative, leasing a VAX, is used for hardware costs. See section 1.6 for a diagrammatic representation of this information.

Five Year Costs (in \$K)					
	Pilot	Comshare	Execucom	EXPRESS	Stratagem/ EASEL
Software	166	548	323	483	526
Additional Development	25	25	25	25	218
Hardware (Lease)	1,086	474	474	474	474
TOTAL	1,277	1,046	822	982	1,217

First Year Costs (FY 89) (in \$K)					
	Pilot	Comshare	Execucom	EXPRESS	Stratagem/ EASEL
Software	112	139	91	95	163
Additional Development	25	25	25	25	218
Hardware (Lease)	366	126	126	0	126
TOTAL	503	290	242	120	507

Second Year Costs (FY 90) (in \$K)					
	Pilot	Comshare	Execucom	EXPRESS	Stratagem/ EASEL
Software	13	83	56	277	90
Hardware (Lease)	360	156	156	162	156
TOTAL	373	239	212	439	246

APPENDIX A - List of EIS Vendors Evaluated

Ms. Kathy May
Express/pcExpress
Information Resources, Inc.
200 Fifth Ave.
Waltham, MA 02254

Mr. Robert Bittlestone
Resolve
Metapraxis, Inc.
900 Third Avenue, 36th Floor
New York, NY 10022

Mr. Mark Jones
CADET
CADET Executive Information Systems
P.O. Box 4545
Atlanta, GA 30302

Mr. Steve Schlesinger
EASEL
Interactive Images
600 W. Cummings Park
Woburn, MA 01801

Mr. Peter Muller
Executive Edge
Execucom
2000 Corporate Ridge
Suite 415
McLean, VA 22102

Mr. Harry Senopoulos
Metaphor
Metaphor Computer Systems
2000 Corporate Ridge
Suite 570
McLean, VA 22102

Mr. Rusty Luhring
Encore! Plus
Ferox Microsystems
1701 North Fort Myer Drive
Suite 1205
Arlington, VA 22209

Mr. Jay Selman
CA-Stratagem and CA-Tellagraf
Computer Associates International
8227 Old Courthouse Road
Vienna, VA 22180

APPENDIX A - List of EIS Vendors Evaluated (Continued)

Ms. Susan Kearney
COMMANDER EIS
Comshare, Inc.
1225 Jefferson Davis Hwy.
Suite 600
Arlington, VA 22202-3227

Mr. John V. W. Buie
Pilot Executive Software
2111 Wilson Blvd., Suite 700
Arlington, VA 22210

APPENDIX B
Detailed breakdown of vendor scores vs. FAA criteria

Table B-1 contains a detailed compilation of scores given to each of the evaluated systems, based on their performance against the set of criteria developed and approved by FAA. The major areas evaluated include functionality and ease of use, design and development considerations, hardware and software issues, level of maintenance, and company and product history. Each of these areas is given a weight relative to the others. These weights are broken down as follows:

Functionality and Ease of Use	30%
Design/Development	20%
Hardware/Software Issues	30%
Maintenance	15%
Company/Product History	5%
Total	100%

Within each of these areas and sub-areas, each system's rating is given, followed by the total amount of points possible in each area or sub-area. Thus, a notation of "84/100" indicates that the system received 84 out of a possible 100 points in that area.

TABLE B-1
PRODUCT SCORES VS. FAA CRITERIA

	Pilot	Comshare	Complete Exec Edge	Partial Exec Edge	EXPRESS	Stratagem/ Tellograf/ CADET	Stratagem/ Stratagem/ EASEL
FUNCTIONALITY AND EASE OF USE							
User-Friendliness	14 /15	13 /15	12 /15	12 /15	8 /15	8 /15	13 /15
Data Manipulation	10 /15	14 /15	13 /15	7 /15	13 /15	12 /15	13 /15
Security	9 /10	9 /10	9 /10	6 /10	9 /10	7 /10	7 /10
Operations	6 /10	8 /10	8 /10	8 /10	8 /10	4 /10	8 /10
Data Sources/Input	6 /10	8 /10	9 /10	7 /10	7 /10	3 /10	3 /10
Data Integrity	9 /10	3 /10	6 /10	4 /10	8 /10	9 /10	8 /10
Presentation	8 /10	8 /10	8 /10	8 /10	8 /10	8 /10	8 /10
Monitoring Functions	8 /10	10 /10	7 /10	6 /10	8 /10	9 /10	8 /10
Additional Functions	7 /10	5 /10	8 /10	8 /10	6 /10	7 /10	7 /10
TOTAL: FUNCTIONALITY	77 /100	78 /100	80 /100	66 /100	75 /100	67 /100	75 /100
x Weight (30%)	23.1	23.4	24	19.8	22.5	20.1	22.5
DESIGN/DEVELOPMENT							
System design/build	12 /15	12 /15	12 /15	7 /15	13 /15	9 /15	10 /15
Tools or 4GL language	13 /15	12 /15	12 /15	5 /15	14 /15	12 /15	12 /15
Database bldg & manip.	15 /20	15 /20	15 /20	8 /20	15 /20	10 /20	12 /20
Time to 1st application	18 /20	10 /20	15 /20	8 /20	19 /20	10 /20	10 /20
Installation of enhancements	10 /10	8 /10	10 /10	7 /10	9 /10	8 /10	8 /10
Adaptability to change	8 /10	8 /10	8 /10	8 /10	8 /10	10 /10	9 /10
Transparency to user	8 /10	8 /10	9 /10	6 /10	8 /10	7 /10	7 /10
Ease of portability	8 /10	8 /10	8 /10	8 /10	8 /10	66 /100	68 /100
Quality of vendor support	84 /100	73 /100	81 /100	49 /100	86 /100	13.2	13.6
TOTAL: DESIGN/DEVELOPMENT	16.8	14.6	16.2	9.8	17.2	13.2	13.6
x Weight Factor (20%)							
HARDWARE/SOFTWARE							
Efficiency of Operation	8 /15	10 /15	10 /15	5 /15	14 /15	8 /15	9 /15
Application size limits	9 /10	9 /10	8 /10	8 /10	10 /10	10 /10	10 /10
Use of hardware resources	6 /15	12 /15	12 /15	4 /15	10 /15	11 /15	11 /15
Mainframe	6 /10	8 /10	8 /10	8 /10	8 /10	8 /10	6 /10
PC's	0 /10	8 /10	6 /10	6 /10	7 /10	9 /10	9 /10
Wang VS 300	3 /10	10 /10	4 /10	4 /10	10 /10	2 /10	1 /10
Timesharing provided	6 /10	5 /10	5 /10	5 /10	8 /10	8 /10	8 /10
Networking Capability	8 /20	12 /20	15 /20	20 /20	13 /20	13 /20	13 /20
Portability to CORN	46 /100	74 /100	68 /100	60 /100	80 /100	69 /100	67 /100
TOTAL: HARDWARE/SOFTWARE	13.8	22.2	20.4	18	24	20.7	20.1
x Weight (30%)							
MAINTENANCE							
Ease of maintenance	24 /25	13 /25	20 /25	16 /25	24 /25	19 /25	20 /25
Modifications to system	19 /20	19 /20	18 /20	10 /20	18 /20	18 /20	18 /20
Data updates/refreshes	25 /25	14 /25	18 /25	18 /25	21 /25	13 /25	18 /25
Distribution of Data	8 /10	7 /10	9 /10	7 /10	8 /10	5 /10	5 /10
Backup and Recovery	16 /20	18 /20	15 /20	12 /20	19 /20	18 /20	18 /20
Configuration Mgmt Tools	92 /100	71 /100	80 /100	63 /100	90 /100	73 /100	79 /100
TOTAL: MAINTENANCE	13.8	10.65	12	9.45	13.5	10.95	11.85
x Weight Factor (15%)							
COMPANY/PRODUCT HISTORY							
Company maturity	20 /30	25 /30	25 /30	25 /30	20 /30	25 /30	25 /30
Product maturity	35 /40	35 /40	10 /40	35 /40	25 /40	10 /40	15 /40
Related products avail.	5 /30	25 /30	28 /30	25 /30	25 /30	15 /30	15 /30
TOTAL: PRODUCT HISTORY	60 /100	85 /100	63 /100	85 /100	70 /100	50 /100	55 /100
x Weight Factor (5%)	3	4.25	3.15	4.25	3.5	2.5	2.75
GRAND TOTAL	70.5 %	75.1 %	75.75 %	61.3 %	80.7 %	67.45 %	70.8 %

The following is a detailed breakdown of the criteria used to evaluate each of the systems in each of the major areas of evaluation. Detailed discussion of each the vendor's systems is included in Section 2 of this report.

2.n.1 Functionality and Ease of Use

2.n.1.1 User-Friendly Access

- Intuitive; little or no training required
- Menu-driven option available
- Amount of individual user menu customization possible
- Easy access to data
- Easy generation of reports
- Customized standard report generation possible
- Customized on-line "Help" available

2.n.1.2 Data Manipulation

- Store and present text, numeric, historical and timeseries information
- Flexibility in allowing ad hoc queries from user
- Ability to recall multiple ad hoc query reports
- Ability to compare/correlate data from multiple tables
- Ability to drill down from summary level to more detailed levels of information
- Ability to present same data in multiple views
- Ability to store data at user workstation
- Ability to perform mathematical calculations (such as ratios, percents, averages) and aggregations of data and to sort and store the results
- Ability to perform statistical calculations, trend analysis
- Ability to view (any) data in a historical context
- Ability to perform "what-if" modeling
- Ability to compare performance data to goals/objectives
- Ability to produce exception report containing list of all results not meeting goals/objective criteria
- Ability for user to change goals/objectives criteria (high or low trigger points)
- Ability to display exceptions only

2.n.1.3

Security

- ID and password protection
- Access level of users restricted by data owner
- Change/release/update data privileges given only to data owners

2.n.1.4

Operations

- Support up to 400 users at many physically-remote locations
- Response time of 10 seconds or less for 95% of queries
- System still available to users during data updates
- Efficient use of mainframe resources, where applicable:
 - Designed to allow processing only of user-requested data
 - No mainframe graphics processing

2.n.1.5

Data Sources/Input

- Amount of manual rekeying of data required
- Ability of system to import data from other applications (both mainframe and PC-based): database transaction systems, file dumps, reports (how many sources/interfaces and how seamless is the integration?)

2.n.1.6

Data Integrity

- Insurance that user is accessing most current data
- Insurance that data is consistent among all users
- Constraints on frequency of data updates
- Degree of automation of updates
- Change/release/update data privileges given to data owners and/or to system administrators

2.n.1.7

Presentation

- Utilize keyboard, mouse, touchscreen
- Graphics: color or black and white; 2-dimensional or three
- Provide pie, bar, stacked bar, 3D bar, line charts
- Color palette includes solid, dither, horizontal, vertical, crosshatch, upslant, downslant, weaving
- Automatic scaling
- Ability to present simultaneous display of graph with table/text
- Ability to customize colors, graph type
- Ability to customize graphs

2.n.1.7

Presentation

- Color flags highlighting problems
- Ability to print graphs on screen to file or directly to printer
- Ability to automatically generate printed reports
- Quality and production speed of hard copies

2.n.1.8

Monitoring Functions

- Tracking usage by application area and by user

2.n.1.9

Additional Functions

- User access to or system providing of other applications, such as word processing, Dow Jones news, E-mail
- Ability of user to export EIS data to other applications for personal use, such as Lotus 1-2-3 or other spreadsheet applications, word processing, etc.
- Ability of system to provide communication between other users, e.g. E-mail

2.n.2 Design/Development Issues

2.n.2.1 System design/build

Tools or 4GL language for EIS user interface development

- online help
- menu driven
- windowing
- easy to master
- easy integration of tools
- Pre-written application modules supplied
- Access to 4GL for customization
- Report generation
- Graphic design

Database building and manipulation

- Data extraction
- Data loading
- System performance of DBMS functions (aggregations, calculations including ratios, percentages, averages, and statistical correlations)
- Handling of time-based data

Easy installation of first application

2.n.2.2 Easy installation of enhancements and modifications

Adaptability to change

- Changes in business unit structure
- Changes in content of data: changes, additions, deletions of field, record, file definitions
- Change in information requirements: internal, legal, accounting, environmental
- Ease of changing menus

Transparency to User

- Not seen by user community till fully tested, validated, verified and implemented
- Not requiring user to change intuitive feel for system

2.n.2.3 Portability

- amount of repeated effort
- media required (e.g., floppy disks, mag tapes)

2.n.2.4

Quality of Vendor Support

- Technical references
- User documentation
- Training
- Professional services
- Technical support hotline

2.n.3 Hardware/Software Issues

2.n.3.1 Efficiency of product operation

- Benchmark performance for given scenario

2.n.3.2 Application Size limitations

- Constraints to total system size (e.g., memory limitations, limitations on number of records, number of databases, number of host or PC linked computers), whether due to hardware or software limitations
- Optimization considerations (architectural flexibility)

2.n.3.3 Use of currently-available FAA mainframe and PC equipment

Wang 240 or 280 PC connected to Wang VS 300

- Disk Space
- RAM
- Ports
- Monitors
- touchscreen/mouse
- printers/plotters
- communications software
- modem
- other P.C. based software

Mainframe

- available makes/models
- memory
- workspace per user
- peripherals
- operating system required

Timesharing options available

2.n.3.4 Networking Capability

Ability to utilize a cluster of several PC's or mainframes acting as a single place where data resides

Ability to interface with FAA's X.25 packet switching network, the ADTN

- For user access
- For data downloading

2.n.3.5 Portability to CORN

Number and types of mainframe platforms available

2.n.4 Maintenance Issues

2.n.4.1 Ease of Maintenance

Modifications to System

- Effort required
- Amount of hardcoding required to make changes to system
- Expandability of the system

Updates

- Time required to perform updates
- Mainframe database vs. PC downloading
- Automated procedures for updates
- Amount of human intervention required for updates

2.n.4.2 Distribution of Data

Ability to support users with timely data at many physical locations via electronic interface

2.n.4.3 Nightly backup and recovery facility

- Automated procedure
- User access data
- Ability to recover data/how long?

2.n.4.4 Areas of Concern

- Use of trouble reports?
- Development efforts (problems involved)

2.n.4.5 Automated Configuration Management Tools

Utility of tools

- data dictionaries
- audit trails
- documentation

APPENDIX C
Contacts with Vendor Customers

Pilot

Two government users of Pilot's products and services were contacted and/or visited: the GSA which has implemented an EIS called Executrac, and the Animal and Plant Health Inspection Service (APHIS) of the Dept. of Agriculture which used Pilot's products to implement an EIS they call their Management Support System (MSS). In both cases, Pilot's products and services were favorably commented upon.

The GSA has had some difficulty with their system which may be partially attributable to the nature of Pilot's software system. Implemented in a timesharing environment, response time was sometimes longer than acceptable: more than 10 seconds in many cases. While the response time problem is affected by a combination of factors, one of these is the nature of the Pilot software, which is strictly mainframe-based, and the amount of memory the system consumes.

This concern was shared by APHIS even though their MSS prototype was installed on a dedicated DEC Microvax microprocessor. In its prototype form, they are only capable of having seven of their twenty-six executives on the system simultaneously. Using all of their own in-house staffing, up to 12 persons at most times, it took almost six months to implement their prototype system. When they move to their first "production" system, they are installing it on a dedicated DEC VAX 6220, a larger mainframe capable of handling up to 75 users.

In both cases, Pilot was given high marks for all aspects of their products and services. The functionality of the Pilot software was especially complimented along with its versatile development capabilities.

Comshare

A representative of the National Oceanographic and Atmospheric Administration (NOAA), a federal government organization using Comshare's Commander EIS software products for the development and implementation of an EIS, was interviewed to determine their satisfaction with Comshare's products and services. In general, NOAA is very pleased with Comshare's products and services.

NOAA selected Commander to implement their EIS after conducting a market survey of the "top EIS product lines". The basis for their selection was primarily because they felt that Comshare's software systems were most in tune with the life cycle flow of data from its transaction process origin to its summarized form for EIS use. In addition, NOAA had an overriding requirement that all data feeding their EIS be automatically and systematically captured and converted. NOAA felt that Comshare's software systems best satisfied this basic requirement.

NOAA installed all modules of Comshare's PC and mainframe products for their prototype EIS. Using a Comshare consultant full time for 3 months and a staff of developers (up to 7 full time for most of the time), NOAA implemented a prototype that consisted of 18 applications in 4 months. They currently have 15 users of their EIS, 7 of which are top level executives. At present, they are somewhat disappointed with executive usage of the system, commenting that the EIS is not yet a part of the executives way of doing business.

They are planning on expanding system in phases to 40 users and finally to 100 users, with many more applications being added to the system. With a current budget of two developers, NOAA is planning to expedite the implementation of their expanded EIS by getting "information providers" involved. These "information providers" are staff analysts who are most knowledgeable of the information requirements of the executive they serve. They are hopeful this approach will help promote usage by executives and eventually lead to the EIS becoming an integral part of the NOAA management culture.

When asked to comment on the flexibility of Comshare's products in responding to the changing needs of their executives, the response was somewhat mixed. In some cases, changes could be accommodated in a matter of hours. However, many request would and are taking much longer to satisfy. This was somewhat attributable to the relatively inflexible nature of Comshare's Briefing Book sub-system.

NOAA verified the fact that all of Comshare's mainframe software products are available through the Dept of Commerce's Springfield Data Center at no additional cost to government users. They also commented that they have stopped allowing access to the Dow Jones News Retrieval System because it was too costly (\$80,000 per year for the 7 top executives).

Comshare (continued)

NOAA continues to be satisfied with Comshare's products and services. They use the Comshare 'hot line' extensively and receive consistently good response. In addition, they receive continuing good support from their Comshare customer representative.

Execucom

Telephone contact was made with two of the organizations using Execucom software products and services, the Internal Revenue Service Regional Office in Atlanta, Ga. who use the DSS capability provided by IFPS Plus and the Consolidated Natural Gas Corporation headquartered in Pittsburgh, Pa. using the CL Vantage Point EIS capability. While each of the two applications were undertaken from almost opposite perspectives, i.e. Consolidated implemented an EIS for a high level corporate executive while IRS is implementing a Financial Analysis System which combines data from several of their transaction systems into an integrated DSS environment, each of their comments were equally complimentary of the Execucom products and services.

Consolidated was under a mandate from their "sponsor" corporate executive to implement an EIS as soon as possible, i.e. a few months. Once they decided on the Vantage Point product, they were able implement two key modules of their system (125 screens) within a months after two developers attended a 3 day training session. From the beginning to the present time, Consolidated has received good support from Execucom consultants and 'hot line' personnel. They were especially impressed with the competence of all of the services received from Execucom.

The IRS echoed Consolidated's complimentary remarks about Execucom. In addition to being completely satisfied with all the products and services received from Execucom, they were additionally impressed with the personal concern, interest and diligence of all Execucom personnel. Being a federal government organization, they were pleased with the competent manner Execucom was able to guide the purchase of their product through the IRS/GSA procurement process. This support enabled the IRS to 'buy' products and services in about 60 days.

EXPRESS

An on-site visit to observe an actual application of Express/PC Express software products was made to a U.S. Air Force system development organization at Bolling AFB. The particular application involved the development and implementation of an Enlisted Force Management System (EFMS). This application relied heavily on the PC Express/Classic Express mainframe software and was described as a series of models, not either a DSS nor an EIS. The IRI product line was selected as a result of a Rand Study of DSS software products appropriate for the specific implementation of the EFMS.

The Air Force personnel involved with using the products to develop and implement the EFMS were highly complimentary of them. It was noted, however, that it took almost two years to develop the system to its present state and that there were as many developers as users of their system (four each). IRI's services were generally praised and their documentation was rated as outstanding. It was also noted that, because of the broad use of the IRI products, there are numerous consultants available who are as competent as and maybe even a little cheaper than IRI consultant's. IRI also sponsors a very active User's Group, the source for excellent product improvement suggestions and the exchange of applications.

In addition, phone conversations were made to four other IRI customers who were using Express/PC Express in EIS/DSS applications. In two cases, the EIS system was developed after they had been using the DSS capabilities of mainframe Express for several years.

The first company, Baxter Travenol Pharmaceutical, located in Chicago, IL, developed an executive level Financial Analysis System as their first and only application so far. Their goal was to provide their 20 top executives with financial information in an EIS environment they were previously receiving in numerous and voluminous paper reports, mostly coming directly from their transaction level accounting systems. They are currently downloading summary level data from their transaction systems into a PC network. Using PC Express, the Financial Analysis application was developed in less than a month. They had expert PC Express developers available to accomplish this in such a short time and their application was relatively simple and straight forward, i.e. 200 units with 50 line items per unit for 24 months.

The comments relative to the IRI products and services were extremely complimentary. PC Express/Express were described as extremely powerful software products. They have expanded access to the system to between 50 and 75 users. It was possible to train their users in about 10 minutes, after which they were able to use the system with no difficulty. Maintenance of the system

EXPRESS (continued)

was described as easy, accomplished with PC Express in a table driven manner. Training provided by IRI was good and hot line service excellent, answering most questions within 24 hours. As with the Air Force, Baxter Travenol was impressed with the quality User's Group and the availability of good consultants and trainers outside of the IRI workforce. As a result of their first application, the 20 executives no longer use any paper reports. In fact, the system is used in "board room" presentations when financial status/problems are discussed. Baxter plans to extend the system downward throughout their organization using PC Express as their medium.

The Chemical Group of FMC Inc. located in Philadelphia, Pa used PC Express as an outgrowth of their extensive and continuing use of the DSS capabilities of mainframe Express. As with Baxter, FMC concentrated on financial and sales information in developing their prototype. FMC used IRI as their developers and described the results as "even more than we asked for". Starting in mid-November 1988, IRI was able to deliver a prototype system by early January 1989. The system was developed in conjunction with financial analysts and 4 top level executives. FMC was impressed and very pleased with all aspects of the service provided by IRI to develop the system, as well as the power and user friendly nature of the software. At present, there is no connection between their mainframe and PC applications. Like Baxter, files are downloaded to the PC environment for their EIS application. FMC is, however, planning to integrate their mainframe and PC applications to automatically feed their EIS from summary level transaction data resident in their Express mainframe DSS.

The other two companies, Duracell located in Connecticut and Ore Ida located in Washington State, were not EIS users of IRI. Both were long time users of Express mainframe, especially its DSS capabilities.

In discussions with Duracell it was interesting to note that they have an EIS functioning in their corporate structure using Pilot as the software medium. While they were initially impressed with the EIS in it's early stages of implementation, they are becoming more and more disenchanted with it because of the limitations of the Pilot software, i.e. no DSS capability and the inability to make changes to the system in a timely manner. They noted that the system was labor intensive both during development and maintenance, and that as executives became used to the EIS environment, they became frustrated with the inflexibility of the system and the lack of "what if" analytical capabilities. In fact, they are now considering making a connection between their Pilot EIS and their Express DSS to help alleviate this problem. If the politics of the situation were such that they could start over, they would migrate their EIS to a PC Express/Express environment.

EXPRESS (continued)

They are extremely pleased with the IRI products, especially the combination of Express/PC Express. Their general observation was that they have all the tools anyone would need for analysis and forecasting. Their application is focusing on the marketing portion of their overall business and was implemented and accepted by their users with no problem. Their users vary from Vice President level executives to marketing staff analysts. Each user was brought up to speed with little problem after receiving excellent training from IRI. Their particular application took about 6 months to implement and, although they were extremely pleased with the power of the products and the direction that IRI is going with them, they were somewhat less pleased with the service they received at various times during the implementation process. Although this has recently improved, there were peaks and valleys over the past year, although they commented that in discussions with companies using other products, service was consistently "up and down." In conversation with Ore Ida, their use of IRI products has been longstanding, dating back 9-10 years. They have used the DSS capabilities of Classic Express throughout their company for financial, sales and other applications. The recent application, in the marketing area took advantage of the extended DBMS capabilities of PC Express. They have installed a system that utilizes the "invisible interface" between the PC and the mainframe in this application. They are especially impressed with the user friendliness of the products. It was very easy for their sales staff to become proficient practitioners of the system. After a few 1/2 day training sessions the users were turned on to the system and have literally taken off with it. The service received from IRI was described as very professional. They were always anxious to please and did an outstanding job in designing a workable and very useful system for them in a relatively short period of time.

APPENDIX D

Glossary of Terms

Administrative Data Transmission Network (ADTN) - FAA's X.25 packet switching network, contracted to Telenet. To be used for all FAA long-distance administrative data transmission.

Decision Support System (DSS) - Software products which provide a wide range of analytical tools for forecasting, modeling, trending and "what-if" analysis.

Executive Information System (EIS) - Decision support tools combined with attractive and simple user interface providing summary-level information to top management.

FAA Executive Information System (EXIS) - The FAA's EIS system.

Multidimensional Relational Database (MDB) - A representation of data which allows multiple views or slices of information. Usually stored in sparse arrays.

Standard Query Language (SQL) - Common command language used for several relational database management systems, such as ORACLE and DB2.

Addendum to

EXECUTIVE INFORMATION SYSTEMS
FOR PROVIDING NEXT GENERATION STRATEGIC INFORMATION:
An Evaluation of EIS Software and Recommended
Applicability within the FAA Computing Environment

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Management Information System (FAAMIS)
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Executive Summary

This addendum to MiTech's report on the capabilities of Executive Information System (EIS) software is in response to issues raised at the report's formal presentation to the FAA on January 31, 1989. These issues concerned two EIS software products which may be capable of supporting a stand-alone PC-based EIS implementation in the short term, Comshare's COMMANDER and Information Resources' EXPRESS. Comshare issues concerned the capabilities of a new Comshare PC product, "One Up." Questions about EXPRESS concerned its memory requirements on the PC. The most important issue was whether the capabilities of the new Comshare product would change MiTech's recommendation to use pcEXPRESS/EXPRESS for the FAA Executive Information System.

After evaluating "One Up's" functional capabilities and its ability to work in a stand-alone PC configuration, MiTech concluded that "One Up" does not provide sufficient power to meet FAA's EIS needs, particularly in the longer term (12-16 months and beyond). Comshare's PC offerings cannot on their own satisfy the information needs of the FAA. pcEXPRESS's potential far outstrips Comshare's capacity to provide a long-term EIS solution to the FAA. A comparison of the differences between the products (shown in Table A) makes the weaknesses of Comshare's PC product offerings apparent.

Table A
PC-based EIS Feature Comparison

	Comshare Commander and <u>"One Up"</u>	<u>pcEXPRESS</u>
<u>Data Storage and Manipulation</u>		
Has PC data base management system	No	Yes
Large PC data base supported	No	Yes
Active data dictionary	No	Yes
Able to import preformatted reports	Yes	Yes
Can produce standard reports	Yes	Yes
Multidimensional data storage	No	Yes
Multidimensional data modeling	Yes	Yes
All data types supported (text, boolean, numerical)	No	Yes
Automatic joins of tables	No	Yes
Transaction data summarized	No	Yes
<u>Maintenance</u>		
"Data Driven" reports possible	No	Yes
Application Dictionary on PC	No	Yes
Data/File Manager on PC	No	Yes

Table A (Continued)
PC-based EIS Feature Comparison

	Comshare Commander and <u>"One Up"</u>	<u>pcEXPRESS</u>
<u>Data Integrity</u>		
Integrated data storage and manipulation	No	Yes
Lack of data redundancy	No	Yes
<u>Graphics</u>		
Menu-driven development tools	Yes	Yes
Dow Jones interface provided	Yes	No
Powerful, simple 4GL	No	Yes
Icon-based user interface possible	Yes	Yes
Icon library included	Yes	No
<u>PC/Mainframe Integration</u>		
Simple transition to mainframe system	No	Yes
"Invisible" link between PC and mainframe databases	No	Yes

For these reasons, it is recommended that the Federal Aviation Administration select pcEXPRESS with a follow-on to EXPRESS as the backbone for its Executive Information System. As stated in the initial report, Information Resources' mainframe and microcomputer software products EXPRESS/pcEXPRESS are recommended primarily due to their multidimensional data base management capability on the PC and the ability to implement a phased PC stand-alone-to-mainframe approach. In addition, pcEXPRESS will be able to provide a strong PC stand-alone solution even if a mainframe is never provided to the EIS effort. The recommended implementation strategy will enable the FAA to begin early development of a prototype system in a PC environment, an approach providing the FAA with maximum capability at minimum initial cost. The heavy long-term maintenance required and the lack of a central data storage and manipulation capability mean that Comshare's PC products will not be able to support the FAA's broadly-based information needs.

1.0 Comshare "One Up" vs pcEXPRESS

Comshare representatives gave a demonstration of their new PC-based product, "One Up", a five-dimensional modeling tool. The product was first released in November, 1988; a further enhancement will be available in April, 1989. Five hundred copies have been sold to 75 current Comshare clients. Site licenses are not currently available.

1.1 Functional Capabilities

"One Up" performs modeling functions on data, and can work in a stand-alone PC environment. It will support ad hoc queries in its April 1989 upgrade, but it is not a data base management system (DBMS). Rather, it allows models to be built which are comparable to Comshare's mainframe modeling product, "W". The models are then stored in flat ASCII text specification files. A separate PC-based DBMS product such as DBase III is required and recommended by Comshare, Inc., in order to build data bases of historical and summary-level information. Data from those separate data bases could then feed the various different models required for ad hoc queries.

In comparison with pcEXPRESS (the PC-based counterpart to EXPRESS), "One Up" provides inferior functionality in two important ways. First, because "One Up" is not a data base manager, a separate DBMS product would be required to supply the EIS with data, especially for its ad hoc queries. In pcEXPRESS, the multidimensional data modeling capabilities and the data base management functionality are contained in a single tool. In addition to the increased efficiency of this architecture, pcEXPRESS's single product also eliminates the data redundancy and integrity problems which would be produced by Comshare's separate data storage and data manipulation functions. "One Up" is also limited to the manipulation of numerical data only; in pcEXPRESS, textual, graphical and numerical data and their relationships are supported.

Second, like its mainframe counterpart, W, Comshare's "One Up" can only support one multidimensional view of data at a time, since separate files must be created for each model. pcEXPRESS, on the other hand, can access multidimensional views of its entire set of data bases, since the data is not separate from the model. Joins with separate tables are created automatically, as the user selects data areas he or she wishes to view. If "One Up" is used, however, relations must be selected and created in advance by system developers.

1.1 Functional Capabilities (Continued)

Both EXPRESS and pcEXPRESS have a third capability which is supported by Comshare only in its mainframe product Datman. This is the ability to summarize transaction-level data into executive-level data as the data is read into the system. Data loaded into "One Up" must already be in a summary-level format. There is no capability with Comshare's PC products to transform transaction-level data into summary data. That entire function must take place outside the Comshare PC products -- either by loading the transaction-level data into a relational DBMS such as Oracle or by writing code in some 3GL such as COBOL to perform these summarizations. More importantly, without a true data base storage capability, different summary-level reports must be created for each "One Up" and Briefing Book application.

Even with "One Up", Comshare's PC products do not provide equivalent functionality to its mainframe products, in contrast to pcEXPRESS. In addition to the data summarization functions performed only on the mainframe (by Datman), Comshare's PC products lack the file management functions performed by the mainframe "Workstation Manager." The lack of a Workstation Manager (which directs EIS files to individual users) restricts the system's growth. Comshare's "application dictionary" is also available only on the mainframe, a tool important in helping with maintenance and tracking of data files.

On the mainframe, EXPRESS and Comshare are more nearly similar, as stated in MiTech's original report. However, Comshare lacks EXPRESS's combined data storage/data modeling capability, as well as an "invisible" user link between PC and mainframe data. The functionality of the two products differs radically at the PC. Comshare's product "One Up" does not measure up to the capabilities of pcEXPRESS. Comshare's hesitancy in supporting a PC-only approach with their products is evidenced by the fact that they have no PC-only users and would be making a special exception for the FAA in marketing "One Up" as a stand-alone PC system.

1.2 Comshare User Interface

After testing and evaluating the demonstration system provided by Comshare, the following details of the system were noted.

(1) Simple charts were easy and fun to build; more complex charts were nearly impossible.

(2) Data files used by "One Up" were not encrypted and were easily modified from a simple text editor, suggesting possible data security problems.

1.2 Comshare User Interface (Continued)

(3) In the current configuration (Wang 240 with 640K RAM) all the Comshare products in development mode were very slow:

- at least 20-30 second response times
- after a wrong choice the developer must wait for error message to appear and then hit cancel (total process takes 30-40 seconds)

(4) Documentation is not very clear (poor index)

(5) In using "quick chart," when attempting to graph an Execuview application only 4 groups of data can be graphed on a single chart.

(6) In the text annotation feature of the quick chart there is no place to include the date. (The date may be put on a chart as text, but no documentation was found on how to include the system date.)

(7) Moving around the separate products of the system ("One Up", Executive Builder, etc.) is cumbersome.

(8) The developer must go through several steps to create a screen from the data:

```
create model in One-up
exit out
bring up EIS Development Tool
bring up Execuview Builder product
create Infocat
create modelmap
exit Execuview Builder product
bring up Commander Builder Product
create screen
call screen
access model
test model
```

Modifications and updates to data must start at the beginning (with the One-up model); all the steps must be repeated to include new data requirements.

2.0 pcEXPRESS

2.1 Memory requirements

Information Resources recommends 640K RAM and at least two megabytes extended memory for its large PC EIS applications. The extended memory version of pcEXPRESS (pcEXPRESS EM) improves performance by placing all pcEXPRESS code in extended memory which eliminates the need for an overlay structure and by dramatically expanding the memory available for paging of application code and data. pcEXPRESS EM is required for (1) those EIS applications that will be using synchronous communication and (2) for those that will be primarily in graphics mode. Graphics mode applications are those that require extensive use of graphics, i.e., frequent icons, etc. We would, therefore, recommend getting extended memory boards for those users that would require an extremely graphical interface versus those who could do well with a primarily text mode interface. "Text mode" still allows for graphs, forms, menus, pick lists, drill downs, reports, etc. Graphs in this version are in graphics mode but split screens (with graphs and reports on the same screen) are not supported. The 640K version requires 640K RAM plus 2MB expanded memory. IRI states that "many of our clients (Baxter Travenol, etc.) have Executive Information Systems in text mode on our 640K version of pcEXPRESS. Their executives are very happy with the interface, ease of use and reliability of the product." (From Information Resources letter to MiTech, 2/2/89.) Extended memory is recommended for those users that require an extremely graphical interface.

2.2 Size restrictions on the PC

IRI states that with the Extended Memory version of pcEXPRESS, "a large (3 or more dimensions) EIS application of 10-30 MBytes should provide reasonable performance. The 640K version of pcEXPRESS should support up to 10MB with acceptable performance levels." (From Information Resources letter to MiTech, 2/2/89.)

3.0 Discussions with EXPRESS and Comshare Users

3.1 DuPont - EXPRESS and Comshare

Discussion: 2/22/89, DuPont Corp., Medical Products Division, Delaware, Bill Dickenson, 302-992-5078.

Dupont owns and uses both Comshare and EXPRESS products. Comshare's line of products was initially purchased to implement an EIS for use by Dupont's Corporate Executive Committee, a group of twenty top level executives who are not very computer literate and not interested in analyzing data. The resulting system is almost totally used as a slide show platform for electronically presenting, in the Briefing Book portion of Commander EIS, a copy of a monthly report previously prepared in a paper form. This same report is the traditional report made available to stockholders on a monthly basis. Lower level managers want access to the system so that they can concurrently have access to the same information as their bosses. Once more, the information is not the key. Commander EIS's Execuvue is available but seldom used by the twenty top level executives. They plan to increase access to the system to lower level executives and managers, from 20 to 200 users.

Maintenance of the system is extremely awkward with 20 users, and they expect it will become even worse with more users. In fact, the system is updated by a "manual" entering of the data. Overall, the application development was described as "awful." Application development, although pretty, was not at all simple. They are finding that as you go to lower level managers, their requirements are more dynamic. They want more DSS capability. These requirements are difficult to satisfy using existing system design and Comshare products. In summary, they have not been thrilled with results of their EIS using the Comshare line of products. In fact, they would prefer to scrub the current EIS if it were not for the fact that a "very high level executive" sponsored the system and Comshare.

Instead, they now are using EXPRESS/pcEXPRESS software to implement a dynamic EIS/DSS in parallel with the other EIS. They are impressed with the power and functionality of the EXPRESS/pcEXPRESS software, and are building a data-driven capability at the PC. They are also using Express MDB to provide the counterpart capability on their mainframe. The invisible interface between the pc and the mainframe "works great," especially in the MDB version which allows for synchronous communication interface capability. The active data dictionary is extremely functional. It allows data administrators to truly manage the data. It also enhances the ability to make changes to the data base structure to satisfy emerging and changing requirements of users.

3.1 DuPont - EXPRESS and Comshare (Continued)

Application development is much easier using EXPRESS products, although, admittedly not as pretty. However, making the system pretty is much easier to overcome than all of the other inherent application development and maintenance deficiencies of Comshare products. The ability to develop applications requiring data from different data bases is a trivial matter using EXPRESS/pcEXPRESS. They are able to easily extract data from several different mainframe sources and create accessible data bases in the EXPRESS/pcEXPRESS environment. These data bases can then be accessed in any combination required during application development.

Technical support from Information Resources is good. Consultants are prompt in addressing user problems with system. Documentation and training are both good. Dupont recommends using IRI for general support and training but using other, private EXPRESS consultants for help with application development. They feel that experienced consultants can offer a wider range of development experience than EXPRESS employees.

3.2 Sun Oil - EXPRESS and Comshare

Discussion: 2/6/89, Sun Oil Company, Philadelphia, Pa,
Ken Fulmer, 215-977-6521

Sun was drawn to Comshare because of the ease of use of its interface capability. Executive use increased markedly when Commander EIS was introduced as the interface media. The EIS is entirely in the Briefing book subsystem, with over 500 reports/graphs available in two major areas, financial and operational. Sun continues to use Express for DSS capability. They also draw on many other DBMS/DSS software products for data to feed the EIS, i.e. Ramis, Focus, Empire, 123, and SAS, for various departmental applications. Required information from these applications is integrated into the EIS using Comshare's Workstation Manager/Information Gateway mainframe software products. They initially attempted to build their EIS with other software products like Symphony, with little success. At one point they attempted to use pcEXPRESS/EXPRESS to build an application to add to their EIS and after two months of development effort abandoned it because it was too difficult to match the "ease of use" interface already built into their system using Commander EIS. They even thought about using Interactive Image's product EASEL as a front end to EXPRESS, but finally settled on Comshare's Commander EIS mainly because of its advanced user interface capability as well as its overall versatility. They built their first robust application using Commander EIS in about two months over two years ago. The EIS currently has 20 executive users.

3.2 Sun Oil - EXPRESS and Comshare (Continued)

Although they are not yet using "One Up", Fulmer believes that "One Up" has "human engineering" built into it like other Comshare products, although there are no application development tools in "One Up" that he knows of. They bought "One Up" on the first day it was available and are waiting for the connection to Execuvue at the PC to be released to build their first application. They plan to use "One Up" to build the Execuvue segment of the EIS entirely on the PC, which will allow for an ad hoc analysis capability enabling executives to view information in various dimensions that is currently only available in a cumbersome manner in the Briefing Book. "One Up" appears to be a pretty "clean" product at this point, and they expect service from Comshare to be good.

Unattended updates of the PC's using EXPRESS was not possible; Comshare software allows them to refresh their EIS automatically two times a day. They did have some difficulty with Comshare service during the early days of Commander EIS, mainly because local representatives were not current with the software. Also, numerous bugs were found in the system which were corrected fairly efficiently by Comshare. Support from Ann Arbor has always been good, as has been "hot line" service.

3.3 GE Aerospace - Comshare

Discussion: 2/6/89, GE Aerospace Group, Utica, NY,
Chuck Weller, 315-793-7206

GE Aerospace acted as a beta test site for "One Up" several months before the product was released commercially in mid-November 1988. His comments were generally complimentary of the product, calling its report generation "superb." Their development work is done on one pc, then distributed to users via mainframe and other Comshare software products. There is no link between "One Up" and Execuvue at the pc as of yet.

The EIS has many applications serving 16 executive users, from the Group VP to Division General Managers to Department Managers. They will add 12 users this year, down to section level in their Finance Office. The "One Up" application implemented into their EIS requires that 150 analysts update the application, an integral part of the financial segment of their total EIS, which in turn processes the data through a mainframe to the work station of the executive user. GE is heavily mainframe oriented.

3.3 GE Aerospace - Comshare (Continued)

GE did a product review last year and decided to stay with Comshare. They considered EXPRESS/pcEXPRESS but decided it was "not user friendly, hard to use and hard to use for development." They have been using Comshare products for their EIS for two and a half years and are completely satisfied with their performance. Also, they believe that "One Up" is a powerful addition to their pc software products, especially when the link to Execuvue is made available in April 1989.

3.4 National Oceanic and Atmospheric Administration (NOAA) - Comshare

Site visit: 1/25/89: National Oceanic and Atmospheric Administration (NOAA), Rob Swisher, Project Coordinator, 301-443-3581

Subsequent to the telephone conversation with NOAA about their EIS and use of Comshare's line of software products, a visit was made to their office to actually see a live demonstration of their prototype system. Rob Swisher conducted the demonstration and provided insight into their implementation plan, its shortcomings, successes and how they are proceeding with their expansion of the system. Their way of meeting data requirements was to provide a little bit about a lot of things in their Briefing Book section of the EIS. This approach was evidently unsuccessful. While the initial executive user reaction to each of the modules was always good, usage rapidly dropped off. Most of the information in the Briefing Book was static textual reports. While they covered a variety of areas, including legislation, regulatory actions, program status, procurement tracking, and financial management, the presentations were electronic versions of information probably available in other paper forms already. No comparisons or correlations were included in the Briefing Book, and only a minimal amount of graphical presentations. They have not included any historical information or trends in their system at all.

NOAA broke down their implementation process into five steps: applications/requirements analysis, data capturing and conversion, data administration, host programming and work station programming. Swisher commented that the most difficult of these turned out to be implementing within the static Briefing Book the dynamic data requirements identified at the outset by the information providers. On the other hand, when he switched to the Execuvue mode of the system, which actually took about 5 minutes to accomplish, much greater ad hoc capability was provided. The system permitted a flexible set of alternatives in easy to understand menu selections. Accessing the mainframe database permitted the manipulation of that data in almost any

3.4 National Oceanic and Atmospheric Administration (NOAA)
- Comshare

way the user could imagine. Again, since they only have current information in their system, comparisons and trends were not possible. Graphical presentations of the data were easily and colorfully provided.

As an overall comment to the entire demonstration, the user interface was generally not impressive, especially in the Briefing Book mode. While this may be a function of the application and not the Comshare software per se, the lack of a user seductive interface did detract from the system. In addition, the approach used by NOAA of providing a little information about a lot of things seems to be a major reason for the limited success of their system. So many questions are left unanswered by the Briefing Book reports that an executive could easily become frustrated and disenchanted with the system in its present form. In retrospect, it would have been a better strategy to provide an in depth representation of a specific area than to attempt to cover many areas superficially.

Comshare's software products are being used to their advertised capability and performing quite satisfactorily. The static nature of the Briefing Book is a constraint that is difficult to overcome when demands for new and different information start coming from executive users. While the Execuvue module is impressive, a 5 minute process to change modes could also frustrate executive users.

3.5 Office of the Future Consulting - EXPRESS and Comshare

Discussion: Emerick Woods, DSS/EIS Consultant, Office of the Future, NJ, 201-420-9100.

Office of the Future is an independent company that specializes in the development of DSS/MIS/EIS systems almost totally in support of various private sector enterprises. They have extensive experience and/or knowledge of all of the products that Mitech included in its product evaluation.

Woods described pcEXPRESS/EXPRESS as a "Ferrari engine in a Volkswagen body." As a company, they have used pcEXPRESS to build quite complex and complete EIS's in the PC mode. He stated that caution should be used in being overwhelmed by the sizzle of some products such as Commander EIS and Pilot. He did admit that Commander/"One Up" is a slick product line from the perspective of the user interface. However, in large applications, he felt that the maintenance of numerous flat files could easily become a nightmare. He felt the interface shortcomings of pcEXPRESS/EXPRESS are far outweighed by the power of the software and the application tools provided especially related to their DSS and MDB capabilities.

3.5 Office of the Future Consulting - EXPRESS and Comshare
(Continued)

Woods admitted that EXPRESS's interface capability "sucks." However, his firm finds it much easier to overcome this deficiency than to face the long-term shortcomings of the other products. He also stated that EXPRESS offered a much easier-to-apply DSS environment and that applications could be installed by users with relative ease. On the other hand, Comshare's W requires rather complicated programming, not nearly as easy from the developer/user perspective. He offered to continue a dialogue with us as we move ahead in our development effort. They have excellent EXPRESS expertise available which may be helpful during our early development stages if EXPRESS is selected as the development software.

4.0 Importance of DBMS Capabilities in the FAA EIS

The need for a distinct FAA Executive Information System (EXIS) data base cannot be too strongly emphasized. Because many of the data sources for the EXIS are transaction-level systems such as CPMIS (for personnel data), CUPS (for payroll), and DAFIS (for accounting data), an EIS data base storage capability is vital for the success of the EXIS at the FAA. These transaction-level systems maintain current status only; no historical information is kept. In addition, the level of detail in these systems is too great to be of use to executive-level or even operational-level managerial functions, which require data in a more aggregated form to be of use. Thus, these systems will never be capable of directly supporting a management information system. The EXIS must be supported by a summary-level data base containing historical data; since one is not yet in existence, it must be built. The integrity of the EXIS data base is vital to its success -- a beautiful system with inaccurate data will certainly fail. Thus, one of the many important factors in choosing an EIS software product must be its data base management capabilities.

The best architecture for an EIS data base is a multidimensional data base. A multidimensional data base is superior to a flat relational data base (e.g., Oracle, Focus, DBase III, etc.) for this application because it can survive changes in the data without needing to reorganize, redesign, rebuild, and reload the data base. The FAA is now witnessing this very occurrence, due to the FAA's change to a straightline organization. Data formerly keyed to a particular region is now being reorganized to be keyed to FAA functions. In a multidimensional data base environment, this data base reorganization would not occur, since the various dimensions of the data base allow the data to be stored in multiple structures, taking advantage of array technology.

Of the products evaluated, only EXPRESS and Computer Associates' mainframe product "Stratagem" provide multidimensional data base capability. The other systems evaluated (Executive Edge, Comshare) summarize and store data in a relational data base only (as in Comshare's Datman) and then various reports created from the data base are moved into separate, multidimensional models (in Comshare, W and "One Up"). In contrast, EXPRESS and Stratagem model the data within the multidimensional data base itself, eliminating data redundancy (and its inherent dangers of conflicting data). There is no need to copy data from the data base into the various data models. (EXPRESS, of course, has the further advantage over Stratagem of working on a PC as well as a mainframe. When the data base size expands beyond the limits of the PC, the data base can be ported to the mainframe version of EXPRESS without loss of data.)

4.0 Importance of DBMS Capabilities in the FAA EIS (Continued)

Both pcEXPRESS and Comshare have the capability of reading in finished PC-based reports and presenting them within their menu structure, an important capability since some offices will prefer to provide finished reports to the EXIS rather than to provide access to data. However, only pcEXPRESS provides a data storage and manipulation capability for data not yet in its finished state. Both types of data inputs should be accommodated by the FAA EXIS.

5.0 Conclusion

After evaluating Comshare's product "One Up" for its viability in a PC-based EIS, MiTech concluded that Information Resources' products EXPRESS and pcEXPRESS are superior to Comshare's range of products for the reasons listed below. A tabular comparison of the products' important features is included in Table A in the Executive Summary.

Data Management and Manipulation. pcEXPRESS can handle any/all types of differently structured data in its integrated data base manager and modeling tool. It performs automatic joins and handles dimension relationships such as multiple roll-ups and reorganizations. It can handle textual, numeric, graphic, boolean and other data objects. It can handle large data bases both on the PC and on the mainframe and can address sparse, record-oriented data. It has a powerful, completely active data dictionary. Comshare's "One Up"/Commander EIS software cannot provide any of these capabilities.

Maintenance. As shown by discussions with current users of both systems, such as DuPont and Sun Oil, as well as with other customers of each system, Comshare's file-oriented rather than data base-oriented architecture demands steadily increasing maintenance and configuration management efforts in keeping track of the growing number of disjointed reports produced. pcEXPRESS's core data base and active data dictionary in comparison will reduce the ongoing maintenance required to update reports, since all reports can be data driven.

Product Integration. EXPRESS and pcEXPRESS are syntax and data base compatible, an advantage when moving from a PC to a combination PC/mainframe-based system. If Comshare's products were chosen for a PC implementation, additional software for data base management would be required, and would need to be redesigned and organized in a move to the mainframe.

PC Product. Because of the power and functionality of pcEXPRESS, the FAA EXIS will be able to survive for a longer time in a PC-only environment.

5.0 Conclusion (Continued)

4GL/Development Language to Develop Customized Tools. As shown by tests of Comshare's graphics-only development tools, there are severe limitations in producing reports: for example, only four groups of data can be graphed at once. This limitation cannot be overcome without access to the Comshare code. pcEXPRESS writes all applications in its own fourth generation language and provides developers the code, so that limitations in the initial set of tools can be overridden. Icons can be and have been built using these tools. Thus, although pcEXPRESS's graphical and user interface capabilities do not come in the same predesigned format as Comshare's, the lack of predesigned capability can be overcome with much greater ease than can Comshare's lack of a data base engine on the PC. The U.S. regional map produced for the final FAA briefing demonstrates the lack of limitation in pcEXPRESS.

Price. pcEXPRESS's site license allows additional users to be added to the EXIS without additional cost for each user, resulting in lower overall costs to the FAA. The PC-only prototype application ensures a low initial outlay.

For these reasons, it is recommended that the Federal Aviation Administration select pcEXPRESS with a follow-on to EXPRESS as the backbone for its Executive Information System.