

Construction Materials Testing and Quality Assurance Study

0103C

Arizona Department of Transportation
Construction Materials
Testing And Quality Assurance Study
December 16, 1987

ACKNOWLEDGEMENTS

The committee would like to offer special thanks to Mr. Jim McGee who participated as the team leader for this study. Mr. McGee's personal character and leadership was inspirational to this committee; without it this project would not have been possible.

On behalf of ADOT we would also like to thank IBM for providing the Application Transfer Study service. This process was extremely beneficial to ADOT and hopefully will have a significant impact on ADOT's ability to improve our construction testing and reporting procedures.

The study team consisted of the following personnel:

ADOT

Paul Bolster, Tr. Engineering Specialist
Don Dorman, Tr. Engineering Specialist
John Daru, EDP Manager, Information Systems Group
Don Green, Tr. Engineer Supervisor
Jim McGee, Deputy State Engineer, Highway Operations
Larry Scofield, Tr. Engineer Supervisor

IBM

Kris Barr, System Engineer
Jim Bertsch, Application Specialist
Larry Hanson, Application Specialist
Katie Underwood, Marketing Representative

TABLE OF CONTENTS

Executive Summary	i
Introduction	1
Study Methodology	4
Current Environment	7
Highway Operations	8
Project and District Materials Testing	9
Materials Section and Central Laboratory	11
Summary of Problem Statements	12
Future Environment	20
Highway Operations	21
Project and District Materials Testing	21
Materials Section and Central Laboratory	22
Recommended Conceptual Solution	24
Conceptual System Design	25
Implementation Tasks	26
Implementation	32
Implementation Schedule	33
Detailed Implementation Plan	34
Justification	35
Tangible Justification	37
Computation of Anticipated Samples	37
Existing System Impact	39
Estimated System Impact due to Reduction in logging time	40
Estimated System Impact from Reduction in Specification Research	41
Summary	42
Intangible Justification	43
Claims	43
Independent Assurance	44
Other Impacts	45

TABLE OF CONTENTS

General Laboratory Configuration	46
System Requirements	47
Costs	48
Hardware Costs	49
Software Costs	50
Investment	51
Appendices	52
A. Problem Statements	53
B. List of Interviewees	58
C. Study Work Charts	61
D. Letter to Interviewees	72
E. Midpoint Review	76
F. Hardware	84
IBM Personal System/2	85
IBM 7494 ELF Data Collection Terminal	87
IBM 9370 Information System Overview	90
IBM 9335 Direct Access Storage Subsystem	94
IBM 1589 Magnetic Tape Subsystem	95
IBM Personal System/2 Model 50	97
IBM Personal System/2 Model 60	98
IBM 4201 Proprinter	99
IBM 3299 Terminal Multiplexer	100
IBM 3864 Modem	101
G. Software	103
IBM Solution Pac: Office Series VM Edition	104
Virtual Machine/Integrated System (VM/IS)	108
Application System	110
Displaywrite/370	114
Professional Office System (PROFS)	115
Structured Query Language/Data System (SQL/DS)	117
Query Management Facility (QMF)	119
File Transfer Program (FTP)	120
H. IBM Support Services	121
I. Maintenance Support	132
J. Hardware Maintenance	143
K. Test Allowance	145

LIST OF FIGURES

ADOT Materials Test System	25
Implementation Schedule	33
Detailed Implementation Plan	34
System Requirements	47
Material Test Sample Flow Chart	62
ADOT Organizational Structure	146

EXECUTIVE SUMMARY

The ADOT recognized a need to improve the consistency and timeliness of our construction materials reporting and quality assurance on state transportation projects.

The ADOT established a joint ADOT/IBM study team to determine current and long-range highway operations requirements, to prepare a plan that will meet those requirements, and to evaluate the cost/benefits of that plan. In pursuit of their mission, the study team interviewed 55 individuals who represented a broad spectrum of Highway Operations field engineers, management, lab technicians, and staff personnel from rural, suburban, and headquarters locations. These interviews resulted in approximately 189 statements addressing apparent needs, from the perspective of the interviewee. These statements were then consolidated into 10 major summary statements which represented Highway Operations materials testing information requirements.

The study team then strove for an information system solution that would satisfy these requirements. Through study team consensus it was determined that Highway Operations required an automated information system that was based on a single integrated data repository for all materials test data. The system must provide access to that data, as well as manipulative and analytical functions to work with the data, for all Highway Operations personnel as required for operational usage, analysis, and product preparation.

The solution calls for an investment of approximately \$1.5 million to \$2 million of automation hardware and software, Highway Operations personnel, and data processing personnel (either ISG or contract) over an 18 month period. Although this is a significant enterprise for Highway Operations, the potential benefits to be derived are equally significant and could ultimately approach upwards to \$2.4 million per year in improved productivity, more effective use of personnel, and consequently, better response to construction program needs. Based upon the above costs and that obtainable benefit ADOT would receive payback on their investment during the third year after initiation.

It is the study team's unanimous and strong recommendation that the ADOT commit the necessary funding and authorize the project initiation in a most expeditious manner.

INTRODUCTION

INTRODUCTION

The first attempt at automating ADOT's construction materials testing and reporting occurred in 1981 in the Flagstaff District. A lab technician independently developed a program for use in a field construction laboratory to calculate and report test results.

Although this program fulfilled the needs of the developer, little additional effort occurred in this area and very little use of the program outside of the developer's office occurred.

In 1984 research funds were used to purchase one microcomputer for each of the four Districts. A basic program was developed for calculating, reporting, and transmitting materials test results. After several years of limited support, it was evident that the program lacked the features necessary to be widely accepted and utilized at the project field office level.

At this same time (1984) another research project was initiated to automate the Central Materials Laboratory using bar code technology. After considerable effort, it was realized that the proposed technology was not adequate and the effort terminated.

In 1986 research funds were again sought to improve the construction materials testing and reporting procedures. Previous efforts indicated a lack of management support and the need for a system wide design. Therefore, a concerted effort was made to canvass other agencies for available experience and systems.

During this discovery phase, it was learned that the IBM Application Transfer Study (ATS) technique had been successfully utilized by other agencies to resolve similar problems.

The ATS approach consists of forming a team of selected agency and IBM representatives to address specific issues in a systematic manner. The thrust of the effort involves interviewing agency personnel knowledgeable in the problem at hand, analyzing the problems, and formulating specific solutions.

In October 1987 ADOT and IBM participated in an ATS study to determine what ADOT needs to do to improve the consistency and timeliness of our construction materials reporting and quality assurance on construction projects. The executive sponsor for ADOT was Mr. Owen Ford-Assistant State Engineer. The ADOT team members included Mr. Jim McGee-Deputy State Engineer, Mr. Don Green-Quality Assurance Eng., Mr. Larry Scofield-Tran. Eng. Sup., Mr. Parker Gregg-Information

Systems Group, Mr. Don Dorman-Tran. Eng. Spec., and Mr. Paul Bolster-Tran. Eng. Spec.. IBM representatives included Dr. Jim Bertsch-Application Specialist, Mr. Larry Hansen-Application Specialist, Ms. Kris Barr-Systems Eng., and Ms. Katie Underwood-Marketing Representative. During the course of the study Mr. Gregg was replaced by Mr. John Daru.

STUDY METHODOLOGY

ATS APPROACH

The ATS process begins by identifying the executive sponsor and team members to participate in the study. Once selected, a "kick off" meeting is conducted by the executive sponsor to charge the committee with the responsibility of accomplishing the designated mission. The executive sponsor, and a significant portion of the study team, are agency personnel.

The study team concentrates approximately half its efforts in conducting interviews with agency personnel to identify all the elements of the problem. The results of these interviews are then evaluated and presented in capsule form to the executive sponsor at a mid-point briefing.

The intent of this meeting is to obtain confirmation on the direction of the study and to obtain approval to proceed with the system design and economic justification.

The remainder of the study effort is directed at developing the recommended solutions, cost benefit analysis, and final report. The study findings and final report are presented to the executive sponsor in a final presentation.

ADOT ATS APPROACH

The study conducted at ADOT lasted for seven weeks ,3 days/week, and consisted of seven elements; Study Strategy, Interview Process, Problem Analysis, Solution Identification, Cost/Benefit Analysis, Implementation Plan, and Presentation of Results. These elements are discussed below.

STUDY STRATEGY

Due to the nature of this problem, the team elected to conduct interviews on personnel representing every level of involvement with construction materials testing and reporting. During the course of the study interviews were extended to include representatives from contracts and specifications and pavement design services.

Five questions were developed for the interviews. The questions were sent to each of the interviewees prior to their arrival at the meeting. Additionally, a brief description of the process and mission was included.

INTERVIEW PROCESS

Fifty-five employees were interviewed in 34 separate interviews. Interviewees ranged from field inspectors to the Deputy State Engineer. Interviews were generally conducted with one individual at a time but some interviews had as many as four people. The responses to the questions and additional comments were not discussed outside the meeting room.

PROBLEM ANALYSIS

189 problem statements were identified by the interviewees. These were evaluated for similarity and condensed into 10 statements by the study team. The significant reduction in statements was necessary to meaningfully address the problems in the short period of time with the limited resources. The identified problem statements are included in the appendix.

SOLUTION IDENTIFICATION

Potential solutions were identified and analyzed for applicability and cost effectiveness. A communications expert was brought in by IBM to provide additional expertise. Due to the remote nature of many ADOT construction field offices, special consideration was warranted.

Once a satisfactory solution was developed, system requirements were determined and a cost analysis performed. The resulting system addressed both the immediate needs for an economical solution while still addressing future expansion.

The recommended solution included both commercial software and the need for custom programming. The desired hardware architecture was established with recommended devices designated.

COST/BENEFIT ANALYSIS

To develop realistic costs for the present methods of operation, limited time studies were performed at an area lab. Additionally, considerable phone canvassing was performed to supplement this information with as broad an experience background as possible.

Costs for the equipment and software were provided by IBM.

IMPLEMENTATION PLAN

A recommended implementation plan was developed which provided not only critical path scheduling but also the resource requirements to accomplish the tasks. These items included preparation of bid documents, equipment procurement, installation and field testing.

PRESENTATION OF FINAL RESULTS

The findings of the study team were presented to the executive sponsor on December 16, 1987 and are detailed in this final report.

CURRENT ENVIRONMENT

CURRENT OPERATING ENVIRONMENT

A. - HIGHWAY OPERATIONS

The portion of the Highway Operations Group that is directly influenced by this proposal consists of the Construction Districts, the Construction Section and the Materials Section. The data and information transfer between these organizational elements is effected by voice transmission, through the mail and on occasion by communications software through the mainframe or micro-computer to micro-computer. The current electronic transfer is far from satisfactory.

The Construction Section is charged with a quality control function that requires Staff Engineers to review the records of Construction Projects during that process. These individuals must rely upon past-tense reporting to schedule their activity. In addition, valuable field time is spent pouring over laboratory test reports and the logs of the same during field inspection.

The Construction Section is often required to review Change Orders, Claims and proposed specification changes. All research for these activities must be accomplished manually. This is generally time consuming and yields less than complete information.

The Executive Management of this Group must depend upon information transfer by telephone or mail to formulate opinions with respect to construction problem areas. Their timely access to project specific information is nonexistent. Therefore, they must depend upon other opinion with respect to Change Orders or Claim research. This research may be of incomplete files that are maintained in the headquarters area. Consequently, the decisions regarding these issues are not generally timely and may be based upon incomplete information.

B. - PROJECT AND DISTRICT MATERIALS TESTING

At the present time, the construction materials personnel are spending a reported 50 percent of their time processing paperwork. Some have reported as high as 72 percent; but, few have reported less than 50 percent. These tasks vary widely, depending on the type of construction. None the less, they are highly redundant.

All materials incorporated into any construction is either tested or accepted on the basis of manufacturer's certification. Each material that is tested requires an identification card. When the sample and its identification arrive at the laboratory, the identification information is manually transferred onto a laboratory log that is used for the purpose of tracking samples through that facility. This same information is also placed upon each laboratory card and subsequent report that is generated from the testing of each sample. The general information consists: the project, the project supervisor, the type of material, source of material, type of sample, and some additional information as necessary.

A laboratory work card is prepared for each sample which contains the sample identification information, the specifications and a listing of the required tests. After each laboratory and field test are completed, a specified individual is assigned the task of checking all calculations. In addition to the testing and checking, a series of reports known as logs are prepared by either Laboratory or Project personnel. They are identified as; 1.) Weekly Lab Logs, 2.) Embankment Logs and Charts, 3.) Concrete Cylinder Logs, and 4.) Other Locally Determined Records. In addition to the testing associated activity, each manufacturer's certification must be manually reviewed, verified and logged.

The tasks described above are routine and provide only normal documentation. Any exception reporting or trend analysis is in addition to normal documentation. However, there is a common need for these analyses of material that is of questionable consistency or quality.

The normal documentation procedures, described above, are not used to administer projects. It is only used as documentation and reporting for numerous other ADOT and FHWA authorities.

Practically all of the communication necessary to administer the day to day construction is performed by telephone, radio, or personal contact. The key information or important information, regarding any difficulty is determined by project personnel. When this information is passed on, by telephone or radio, to some "Expert" it may be incomplete and sometimes based upon personal bias. Consequently, conclusions based upon the transferred information may not be the most expeditious or cost effective.

Communication between the Area Labs and project offices is usually accomplished by telephone when failing tests are involved. This appears effective, providing the phone message is accepted by a responsible individual at the project office. Otherwise, communication is effected through the inter-departmental mail, which generally takes two days at best. Consequently, trends cannot be analyzed as they occur.

The present control over the quality of materials is executed in a variety of ways throughout the State. The Resident Engineers in District I and a portion of District II delegate a major portion of the materials administration to the Area Laboratories. This is due primarily to production occurring in a limited number of rather uniform Commercial Sources. An occurrence of noncompliance is administered by the materials support function of the Area, District and sometimes, the Central Labs, without the intervention of the project administrators.

The materials produced in the outlying areas are generally more inconsistent and variable than those produced in the major metropolitan areas. Generally, materials are produced from sources that have no history or record of poor performance. The production tools consist of portable aggregate and product plants that require more intensive inspection than established Commercial Plants. These situations require specific project management level administration of noncompliance with only concurrence from District and Central Offices.

Materials produced to a statistical acceptance plan may not perform satisfactorily, even when accepted at full payment. In these situations, timely availability of all test characteristics may establish a parameter that, through experience, will indicate potential poor performance. This may allow contract revisions to occur prior to unknowingly constructing a poorly performing facility.

Better product control results when trend analyses or statistical evaluations are available. However, the current system only allows these attributes through a manual effort or from some applications software that is cumbersome to use. Therefore, these techniques are rarely utilized for any decision making with respect to materials production.

C. - MATERIALS SECTION AND CENTRAL LABORATORY

The Materials Section is a support function to the Highway Development Group as well as to the Construction Districts. The Geotechnical and Pavement Services support project development by developing the pavement structure designs and provide recommendations for contract specifications. Materials Services supports this activity by developing specification language for some materials related items.

The Central Laboratory and Materials Services supports contract administration through the performance of acceptance tests on bituminous products, portland cement, reinforcements and specialty items. In addition, Materials Services provides assistance in determining acceptable asphaltic concrete and portland cement concrete. This expert advise is sometimes not effective due to the unavailability of complete project files in the Laboratory office.

Each Construction ORG transmits copies of their "Weekly Reports" to the Central Laboratory to form records for review. These records are maintained manually and seldom represent anywhere near complete information. However, they are continually maintained by manually sorting and filing in the same fashion as the project records and those kept at each District Office.

The results of acceptance tests performed in the Central Laboratory on samples secured at the project are forwarded to the project offices through the inter-departmental mail or by telephone, in the case of noncompliance. In any event, the test results do not reach the project office in a timely manner. The Central Laboratory's total efforts, including those for geotechnical support, are hampered due to the lack of laboratory automation.

The Quality Assurance Branch of Materials Services requires project information for analyses to further develop this program for the Department's goals and the requirements of the Federal Highway Administration. Currently, all information must be retrieved manually from the files maintained in the Central Laboratory that are generally incomplete. Therefore, the lack of accurate and complete information from the construction process is a serious impediment to the development of a valid quality assurance program.

SUMMARY OF PROBLEM STATEMENTS

INFORMATION = RESOURCE

Our data and information is an important resource. Yet, we have not provided for the overall planning direction, organization and control of this resource.

- * Decisions based upon incomplete information
- * Inconsistencies
- * Incompatible systems
- * Duplication of efforts
- * Misdirected Efforts
- * Lack of technical information support
- * Audit Trails

The interviewees identified these elements of this Summary Statement. The overall planning and direction of this resource is hampered by the manual nature of the system. The conceptual solution will provide a vehicle to greatly minimize the effects of the elements of this statement.

ANALYSIS

We lack the ability to perform analytical and statistical techniques on our test data to provide information in a useful format and in a timely manner.

- * Exception reporting
- * Trend analysis
- * Forecasting
- * Quality Assurance

The manual system does lend itself to these types of analyses as most all information must be collected manually and entered into an application software to perform the required task. The conceptual solution does address these needs to the extent the data will not have to be re-entered for analysis.

ACCESSIBILITY

We do not have the ability to access test results and specifications easily and in a timely manner.

- * Current test results
- * Historical test results
- * Quality Assurance

The current system only allows access to information through manual file searching. However, there is a need by a number of personnel throughout the Department to require complete information on a project specific basis. The conceptual solution solves the access problem.

COMMUNICATIONS

There is a need for better communications between field, district and central office.

- * ADOT expertise
- * Telephone / radio "tag"
- * Failing test results
- * Scheduling
- * Mis-communications

The interviewees indicated there were difficulties in communication within the Department. In some cases, there is a need to contact central office expertise to solve a potential construction problem or simply communicate from laboratory to project office. This situation is minimized in the conceptual solution.

CREDIBILITY

There is a perceived lack of credibility in some test information provided to management, contractors, and central lab.

- * Materials certification
- * Check and balance
- * Accuracy
- * Completeness

The complexity of the current system does not support a credible function. The solution of the previous Summary Statements will serve to greatly increase the credibility of the proposed system.

TRAINING

There is a need for:

Cross training and cross orientation of
Construction Technicians

Additional training in testing
procedures, evaluation and
interpretation of test results for Lab
Technicians

Additional training for Project Supervisors
and Resident Engineers in specification
interpretation and evaluation of test
results

The Department is currently involved in many training programs. However, the interviewees expressed a need for more specific training in actual job related activity.

PROCEDURES

There is a need to change our Quality Assurance procedures
in:

Sampling

Testing

Reporting

Certification

Inspection

Facilities

Consideration should be given to streamlining the items identified in this Summary Statement. There are many cumbersome and redundant procedures that will be modified by automation. However, changes in philosophy may have to occur before some procedures will become more efficient.

At the time of the mid-point review, 5 Summary Statements were identified as being outside the capabilities of the study group to provide recommendations for solution. However, as the Summary Statements represent the opinions of the Department's staff, the Study Group is obligated to present these problem statements to Management. The following represents those Summary Statements along with a few brief comments.

WORK LOAD

We lack the ability to perform all required functions due to:

Limited personnel resources

Geographical distance

Seasonal Scheduling

Lack of District input into project scheduling

Funding inconsistencies

Lack of control over the Contractor's Scheduling

Inexperienced personnel

Personnel relocation problems

The interviewees expressed the opinion that they are hampered from effectively performing quality service due to the items listed in this Summary Statement. Many of these items are even beyond Executive Management control. However, consideration should be given to these situations in order to have maximum efficiency and quality with the current limited personnel resources.

As an example, the Federal Highway Administration currently desires the Department to perform one independent assurance test for each 10 acceptance tests. The Department reached an agreement with F.H.W.A. to perform one independent assurance test for each 40 acceptance tests. This was based upon the provision that several other programs remain in place, including the Correlation Sampling Program. This program is no longer mandated by F.H.W.A.; therefore, it could be eliminated.

In view of the agreement, the Department currently performs some type of quality assurance activity at a frequency of one test for each 4.5 acceptance tests, in lieu of the mandated 1 in 10. The mandated 10 percent, 2.5 percent in our case, does require independent sampling; whereas, the 1 in 5 splits are sampled by project personnel. This issue should be given careful consideration with respect to the efficiency of the entire system. At a greater frequency, the independent assurance sampling could be performed from statistically based hypothesis rather than on a specified uniform frequency. This procedure would provide a more meaningful scientific evaluation of quality assurance.

CONSULTANT RELATIONSHIPS

There is a need to re-evaluate our relationships with our consultants in:

Project Development

Materials Testing

Surveying

Contract Administration

The interviewees expressed the consultants that are providing service to the Department, through consultant contracts or contractor surveying, do not understand our procedures. Consequently, Department personnel spend large amounts of time attempting to train the consultant in proper procedure. Furthermore, the consultant contracts are not being made available to the Project Administrators. Therefore, they are not aware of what sanctions can be taken against a consultant for nonfeasance or malfeasance of duty. In general, the contracts should be more specific in these areas.

MISCELLANEOUS

There is a need to:

Predict pavement design performance and
reliability

Know the status of aggregate pits

Enhance our career development program

Know the status of projects under
development

These items were identified by some interviewees.
Consideration should be made as appropriate.

FUTURE ENVIRONMENT

FUTURE OPERATING ENVIRONMENT

A. HIGHWAY OPERATIONS

The proposed system will provide a database that may be accessed from a number of locations. The database will include all validated materials testing information.

The Construction Section's Quality Control Branch can use the database information to schedule field inspection in a more timely fashion, thereby reducing nonproductive efforts. In addition, the records and sample frequency may be reviewed in the Headquarters Office in advance of the actual field inspections. This capability will allow the staff engineers to focus their attention and expertise upon assuring that Federal and Department guidelines are met in lieu of spending untold amounts of time reviewing the paper trail for the sake of procedure.

The Construction Section's access to all information will enable them to more intelligently comment upon the administration of Change Orders, Claims and proposed specification changes. The proposed statistical techniques will be especially important in assessing specification changes, as well as the ability to perform modeling, forecasting and trend analysis.

B. - PROJECT & DISTRICT MATERIALS TESTING

The project laboratory, either project specific or Area Laboratory, will receive a sample and input the general information into an automated system. This will serve as the only input of this information that will follow the processing of each sample from receipt at the laboratory to archives. As the sample is tested, the system will perform all necessary calculations, apply appropriate specifications, flag all characteristics of noncompliance and generate any required reporting upon request.

The system attributes will allow the input of Standard Specifications into a database that is accessible to all users. Therefore, the only project input will be the Special Provisions at the beginning of the Project, as the database will marry those specifications to the project specific files.

Once the test and sample information is stored, the sorting and manipulation techniques will allow any type of report format to be generated and any type of analysis to be performed at the stroke of a few keys. The database may be queried by the Testing Laboratory, Resident Engineer, Area Engineer, District Management or the Central Office any time after the data is validated. This type of data management eliminates the need for the redundant reports and redundant copying that is susceptible to transcription errors. Any user of this information may have immediate access in a format of his pleasing.

These technically feasible functions would virtually set the qualified materials technician free to supervise testing procedure, sampling technique, sampling frequency and many other tasks more worthy of his specialized abilities. Furthermore, statistical evaluation, charting, trend analysis, and exception reporting would be immediately available, which would provide a complete informational foundation for administrative decision making.

The enhanced communication capabilities will provide statewide access through the use of an electronic mail system. Noncompliance test results may be posted in the system for a Resident Engineer to access from any point in the system. This will eliminate the problem of poor or incomplete communication.

C. - MATERIALS SECTION AND CENTRAL LABORATORY

Pavement Services will utilize the database to enhance their pavement evaluation process and pavement performance modeling. This is of special importance in being able to forecast the service life of the Departments Highway System with respect to the quality of materials incorporated into the Construction. The data base will provide important information that can be utilized in designing pavement rehabilitation techniques and developing specification recommendations. The easy access of this information will definitely encourage its use that will result in a superior product for the traveling public.

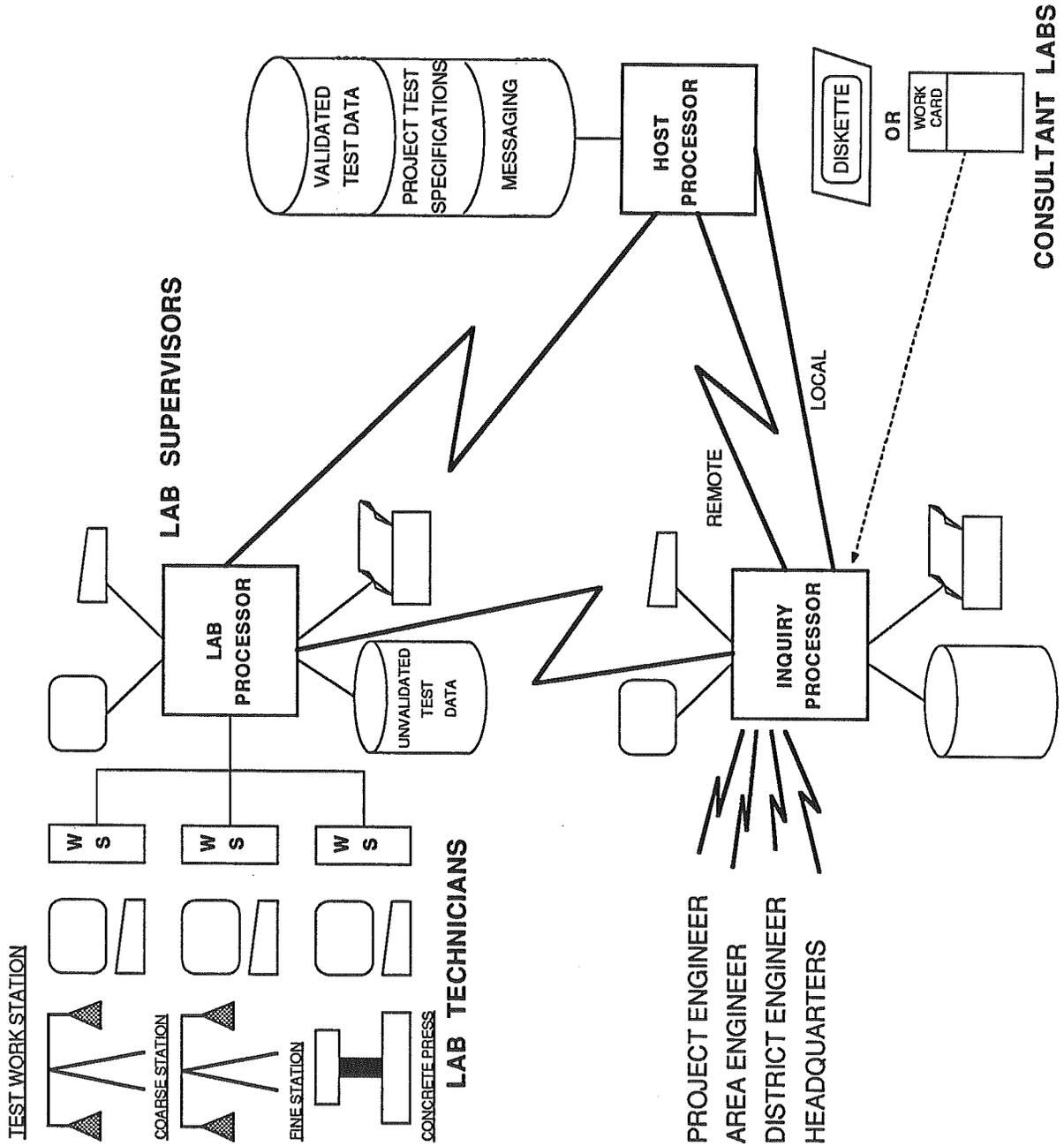
The automation of the Central Laboratory will allow the results of tests performed upon acceptance samples to be entered directly into the database. Consequently, that information will be immediately accessible to project personnel. This is of special importance with bituminous materials where penalties may be involved and with reinforcement in noncompliance that may be incorporated into the structures. In addition, this automation will aid the Central Laboratory in the support of the geotechnical efforts of the Section. Another feature of this effort is that it does create an audit trail that can be easily tracked and verified.

The Materials Engineer and the Materials Testing Engineer are consistently involved in materials related problems that arise throughout the State. These difficulties require immediate attention and solution as they generally, if not always, involve an expensive construction process. The availability of all test information in the database that is immediately accessible will allow better decisions to be made in a more timely manner. This will reduce potential Change Orders and Claims.

The Quality Assurance Branch will have access to all construction test information and frequency from the proposed database. This will allow that Branch to monitor the defined program for performance, as well as providing information to improve the total program. The proposed statistical procedures will certainly enhance the investigation of variance contributions from product, sampling and testing. In addition, hypothesis testing will validate the elements of the quality assurance program.

RECOMMENDED CONCEPTUAL SOLUTION

ADOT MATERIALS TEST SYSTEM



IMPLEMENTATION TASKS

The ADOT Materials Testing Study team identified five major project areas which need to be addressed during the implementation of the proposed solution.

The five project areas are:

- A. Provide timely access to department test data and test results.
- B. Provide the ability to analyze test data and test results.
- C. Provide better communications between department personnel.
- D. Establish a function responsible for the management of the department's information resource.
- E. Perform other necessary tasks which do not fit into one of the above categories.

The following pages define the tasks within each project area.

ARIZONA DEPARTMENT OF TRANSPORTATION

INDIVIDUAL IMPLEMENTATION TASKS

A. ACCESS OF DATA

1. Develop system data specifications. (Elements, timing, recording)
2. Size the volume of data to be supported and determine the quantity of historical data and specifications to be maintained.
3. Determine the number of users, their locations and their frequency of use.
4. Perform overall system design. (Laboratories, construction and highway operations.)
5. Design Laboratory system. (test equipment, interfaces, test algorithms)
6. Investigate affected policy procedures.
7. Evaluate and determine appropriate "release of data". from the Laboratory Processors to the Host Processor.
8. Select hardware. (Laboratory Workstations, Laboratory Processors, Inquiry Processors and Host Processor)
Select software. (Operating Systems, Communications System, Database Systems, Programming Languages)
9. Procure system
10. Program the Laboratory Processor system. (test equipment, interfaces, test algorithms.)
11. Program the Inquiry Processor system.
12. Survey and design physical facilities for Host Processor, Laboratory Processors and Inquiry Processors.
13. Install and test the Host Processor.
14. Collect data and specifications of current projects and enter into the Host Processor.
15. Write Host System, Laboratory Processor and Inquiry Operating Procedures.
16. Install Laboratory Processors.
17. Laboratory Technician Operator Orientation
18. Provide management and user support.

ARIZONA DEPARTMENT OF TRANSPORTATION
INDIVIDUAL IMPLEMENTATION TASKS

B. ANALYSIS OF DATA

1. Identify necessary statistical and analytical techniques. (modeling, forecasting, sorting, extracting) and select the necessary software.
2. Select the necessary Statistical and Analytical software for the Host Processor
3. Define desired standard output formats for the Laboratory and Inquiry Processors.
4. Install and test the software on the Host Processor.
5. Write the Operating Procedures for accessing the Analytical and Statistical programs on the Host Processor from the Laboratory and Inquiry Processors.
6. Train Department Management, Engineers and Technicians in the use of the Analytical and Statistical programs.
7. Provide management and user support.

ARIZONA DEPARTMENT OF TRANSPORTATION
INDIVIDUAL IMPLEMENTATION TASKS

C. BETTER COMMUNICATIONS

1. Evaluate current data communications system and identify locations lacking access.
2. Design a communications system to support the collection and dissemination of messages for Highway Operations and to run on the hardware and Operating System selected to support the ADOT Materials Test System.
3. Select software compatible with C.2.
4. Install and test the system.
5. Train Highway Operations personnel in the use of the system.
6. Provide management and user support.
7. Additional tasks after implementation.
 - a. Validate Testing Network to Highway Network.
 - b. Evaluate existing Highway communications equipment to support the Materials Testing System.
 - c. Determine Highway Department communications volume vs Materials Testing Network volume.

ARIZONA DEPARTMENT OF TRANSPORTATION
INDIVIDUAL IMPLEMENTATION TASKS

D. INFORMATION AS A RESOURCE

1. Establish a full time responsibility and authority within Highway Operations to manage information and automation. This function should report directly to the Deputy State Engineer.
2. Establish the necessary procedures to provide information systems support to all levels of Highway Operations.
3. Establish a management education program.

ARIZONA DEPARTMENT OF TRANSPORTATION
INDIVIDUAL IMPLEMENTATION TASKS

E. OTHER SYSTEM TASKS

1. Develop a program to reference required:
 - a. Materials Test criteria (eg. 80-100% passing 3/4" sieve.)
 - b. Submittals
 - c. Certificates
 - d. Test Results
 - e. etc. for construction projects.

2. Investigate field data collection technologies and make recommendations for improving the identification of test samples.

3. Develop a program to validate that the proper number of tests have been taken for the materials produced.

(The system will have a record of the actual number of tests taken. If a methodology is developed for determining the number of tests required, the system will be able to make the comparison.)

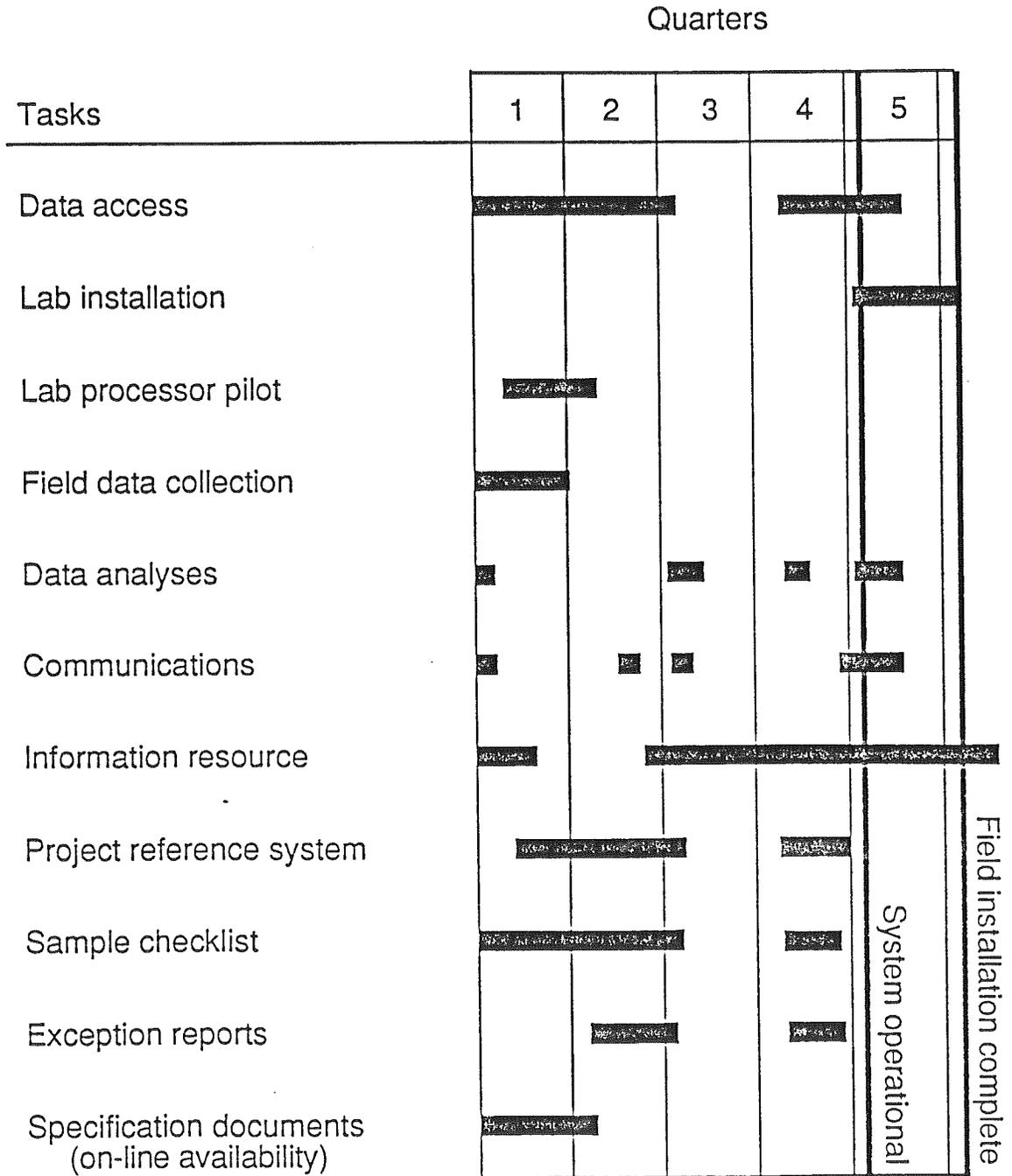
4. Develop a program to advise management of critical failures and important issues.

5. Establish a team to investigate the requirements to :
 - a. Automate ADOT specification development and revision process (beyond just document word-processing.)
 - b. Provide automatic passing of ADOT materials test criteria to the Materials Test System.
 - c. Provide on-line inquiry and revision for all project specification documents.
 - d. Provide on-line historical tracking and archiving for all project specification documents

IMPLEMENTATION

The following pages define the estimated personnel requirements, the relative timing and the estimated duration of the tasks necessary to implement the proposed solution.

IMPLEMENTATION SCHEDULE



JUSTIFICATION

CONSTRUCTION MATERIALS TESTING

AND

QUALITY ASSURANCE

STUDY

JUSTIFICATION

The justification is separated into two categories, tangible and intangible. The items identified by the tangible justification are some of the more obvious areas of impact. This area may be expanded upon if additional time is available for study. The intangible items such as increases in credibility are not expressed in time or dollars.

The tangible justification is based upon estimates of the number of samples tested on an annual basis. In addition, estimates have been made of the time required for specification research by laboratory and project personnel. These estimates along with some time studies have been translated into man hours and dollars with a Department defined rate.

TANGIBLE JUSTIFICATION

I. - COMPUTATION OF ANTICIPATED SAMPLES

The number of anticipated samples is derived from the Correlation Samples that are run in each of the District Laboratories. There is one sample sent to the District Laboratory for each five acceptance samples taken in the Field for Soil, Soils and Aggregate and Asphaltic Concrete. In addition, there are other acceptance tests performed by the District and Central Laboratories. The following is an estimate of the total number of samples that is expected to develop from the current five year construction program for each year.

A. Correlation Samples

District I	3,719
District II	1,034
District III	1,986
District IV	2,700
Total	9,439

B. Concrete Cylinders

Individual Tests	23,436
------------------	--------

C. District Laboratory Miscellaneous Samples

Miscellaneous	2,360
---------------	-------

D. Central Laboratory

Reinforcement Items	6,000
Bitumen	600
Chemistry (Specialty Items)	1,247

E. Total Tests

Acceptance Samples	47,195
Correlation Samples	9,439
Independent Assurance Samples	1,180
Reference Samples	370
Sub-Total (Except P.C. Conc, Bitumen & Specialty)	58,184
Concrete Cylinders(sets)	5,859
Reinforcement	6,000
Bitumen	600
Chemistry	1,247
District Lab. Specialty	2,360
TOTAL	74,250

F. Tests Distribution

Sieve Analysis	45,383
Bin Composites (4 Bin)	2,327
Moisture - Density Relations	1,745
Extraction - Gradation (with Voids Analysis)	8,729

II. - EXISTING SYSTEM IMPACT

The estimated impact to the existing system for the installation of an automated materials data management system is based upon the estimated number of samples in Item I. and a time study in an actual laboratory environment. Additional information was developed from interviews with project personnel that are responsible for preparing the necessary project test data logs, such as the weekly logs, running logs of portland cement concrete cylinder tests and running logs of asphaltic concrete acceptance tests.

A. Actual Calculation Times

	Calculation (Mins)	Checking (Mins)
Sieve Analysis	3.33	1.10
Bin Composite (4 Bins)	16.61	5.02
Extraction - Gradation (With Voids Analysis)	17.51	6.50
Moisture - Density Relations w/ Sieve	19.78	2.88

B. Estimated System Impact Due to Reduction in Calculations

Sieve Analysis	$45,383 \times 4.43$ ----- 60	= 3,351 man-hrs
Bin Composite	$2,327 \times 21.63$ ----- 60	= 839 man-hrs
Moisture - Density Relations	$1,745 \times 22.66$ ----- 60	= 659 man-hrs
Extraction - Grad.	$8,729 \times 24.01$ ----- 60	= 3,493 man-hrs

Concrete Cylinders	5,859 x 1.0	=	98 man-hrs

	60		
Reinforcement	6,000 x 0.45	=	45 man/hrs

	60		
TOTAL MAN HOURS			8,485 MAN - HRS

C. Estimated System Impact Due to Reduction in Logging Time

There are several transcriptions of test results from one document to another throughout the Department. An automated system that would generate the necessary reporting from the original data capture will have significant impact upon the system in terms of man hours. The estimate is based upon a reduction of 3.5 man hours per day for each of the 29 Construction ORGs in Highway Operations.

1. Field Office or Project Lab		
3.5 hrs x 29 Orgs x 260 days =		26,390 Man-hrs
2. Duplicate A. C. Logs		
10 Mins x 8729 Samples =		1,455 Man-hrs
3. Area Labs		
Three of the Area Labs Spend 2 Hours per Day Copying Test Reports for Transmittal		
2 hrs x 3 labs x 260 days		1,560 Man-hrs
TOTAL POTENTIAL IMPACT DUE TO LOGGING REDUCTION		29,405 Man-hrs

D. Estimated System Impact from Reduction in Specification Research

The Highway Operations Group has 530 personnel involved in Construction Administration. It is estimated that 375 people spend approximately 1/2 hour daily involved in specification research. The proposed ultimate automated system will provide a Specification Library that may be accessed from all locations thereby reducing this effort to only the time required to assimilate and interpret the specification.

The 530 total construction personnel have been reduced by an appropriate amount to 375 for those such as office men, surveyors and scale men that would not be involved in specification research.

In addition to the project efforts with respect to specification research, it is further estimated the laboratory personnel will spend an average of 5 minutes per sample to retrieve the applicable specifications for the required test characteristics.

The estimated impact is as follows:

375 Men x 0.5 Hrs =	187.5 Man-hrs Per Day
187.5 Man-Hrs x 260 =	48,750 Man-hrs Per Year
58,184 Samples x 5 Mins. ----- =	4,849 Man-hrs Per Year
60	

TOTAL SYSTEM IMPACT FROM
REDUCTION IN SPECIFICATION RESEARCH 53,599 Man-hrs
Per Year

E. Summary

Impact from Reduction of

Calculations	8,485 Man-hrs
Logging	29,405 Man-hrs
SUB-TOTAL	37,890 Man-hrs Per Year

These Man-hrs represent 21.3
Man - years per year based upon
1776 available man hours per year.

At an average employee cost of
\$26.00 per hour this has an estimated
dollar value of
\$983,550.00

Impact from Reduction of

Field Specification Research	48,750 Man-hrs
Lab Specification Research	4,849 Man-hrs
SUB-TOTAL	53,599 Man-hrs Per Year

These Man-hrs represent 30.2
Man - years per year based upon
1776 available man hours per year
per employee

At an average employee cost of
\$26.00 per hour this has an estimated
dollar value of
\$1,394,515.00

TOTAL	\$2,378,065.00
-------	----------------

INTANGIBLE JUSTIFICATION

This study has not been conducted in sufficient detail to identify all areas of "tangible" benefit from the automation of the materials data and information management. However, it does definitely indicate the potential economic impact to justify the apparent expenditure for the automation system. The foregoing discussion will attempt to identify other areas of justification, some definitely intangible, but others that may be associated with economic impact if additional study were conducted.

A. Claims

On an annual basis there are Contractor claims filed that amount to from 30 to 40 million dollars. It is estimated that approximately 40 percent are related to materials or materials testing difficulties. Of this 40 percent there is an estimated 10 percent settled by payment. This does not include change orders that may be negotiated due to some materials related problem. The substance of these claims may include some testing that may well be a result of poor communication between the laboratory support function and project administration. However, it is not justifiable to state an automated system would mitigate all of those claim settlement costs but it would certainly minimize those losses through the development of more precise and timely information.

An automation system will impact the record research that is associated with administering all claims that develop from materials related items. Currently, there is a duplication of record research throughout the Department at all levels of management to identify a resolution to a claim situation. The immediate access to all information would allow any manager to identify the information he needs to provide input into the administration of any claim. The same scenario would apply to management approval of change orders and force accounts. The quicker response time with more credible information and decisions could eventually influence the bidding process and result in additional savings.

B. Independent Assurance Program

The requirements for the Independent Assurance Program are established in the Federal Register, 23 CFR Part 637, entitled "Sampling and Testing of Materials and Construction". This requirement was adopted by final rule making on November 7, 1986. The Federal Highway Administration, based upon the Federal Register, developed the policies, procedures, and guidelines relating to sampling and testing of materials and construction in Federal-aid highway projects. This is identified in Volume 6, Chapter 4, Section 2, Subsection 7 of the Federal-Aid Highway Program Manual.

The Federal Register imposes the following regulation on each State Highway Agency.

Independent assurance sampling and testing shall be performed by State personnel who have no direct responsibility for acceptance sampling and testing using test equipment other than that assigned to the project. The program may permit a reasonable portion of the independent samples and tests to be accomplished by independent observation of the acceptance sampling and testing.

A prompt comparison of acceptance test results with independent assurance test results and documentation of that comparison

This program is currently being initiated in the Department. The requirement of independent sampling and prompt comparison with specific documentation exceeds the personnel resource that currently exists for that activity. The prompt comparison requires the District Materials Engineer to have access to all project acceptance test results. Additionally, the comparison must currently be accomplished by manual efforts. This generally requires considerable research and manual effort to develop a comparison based upon an opinion, rather than scientific fact through some statistical evaluation.

The total automation of the materials data and information management will allow the required comparisons and documentation to be performed electronically; otherwise, it appears beyond the current personnel resource plan to meet the requirements of F.H.P.M. 6-4-2-7.

C. Other Impacts

The automation of the materials data and information will create a historical database that can provide information for improved modeling of pavement performance as a function of the quality of materials incorporated into the construction. This may allow the Department to better predict the maintenance needs and consequently the service life of the highway system.

This database will provide a library of information that may be accessed for the purpose of specification development and revision. At best, the current procedures require manual research or rely upon an individual's recall.

There is a considerable amount of redundant copying and filing that is performed throughout the Department. The creation of the proposed database will tend to eliminate these efforts as all interested parties will have access to the materials test data and information.

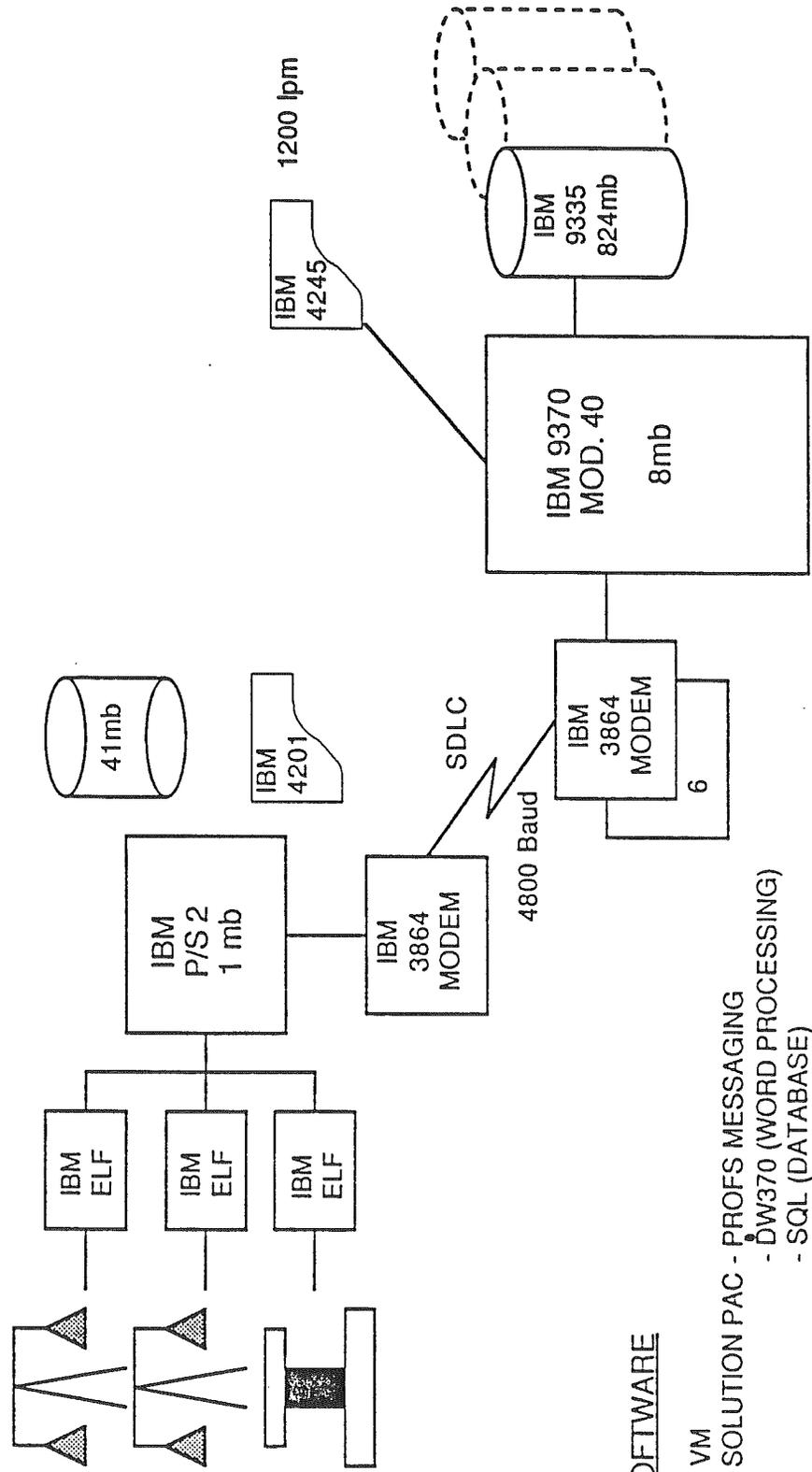
There are a number of audits performed at the project level for various investigations, including those for materials testing. The proposed system will allow the current audit procedures to be performed with a minimum of disruption and a minimum of the auditor's time. The efforts of quality assurance and quality control can be viewed as a form of audit.

General Laboratory Configuration

The proposed Laboratory Processor is an IBM PS/2 Model 60 with keyboard, color monitor, printer, hard disk and a modem for communicating with the Host Processor at ADOT Highway Division Headquarters. Each Laboratory Processor will control two or more Electronic scales through IBM 7494-ELF intelligent industrial terminals. Each terminal will interface with one scale. There will be one Laboratory Processor in each of the 23 existing Laboratories.

Test data will be read directly from the scales and stored on the hard disk of the Laboratory Processor. The Laboratory Processor will compare the test data with project specifications and store the test results with the test data. With the approval of the project engineer, the test data and test results will be transmitted to the IBM 9370 Host Processor at ADOT Highway Division Headquarters where it will be available for inquiry by all interested and authorized users.

SYSTEM REQUIREMENTS



SOFTWARE

- VM
 SOLUTION PAC - PROFS MESSAGING
 - DW370 (WORD PROCESSING)
 - SQL (DATABASE)
 - QMF (INQUIRY)

COSTS

HARDWARE COSTS

	<u>Quantity</u>	<u>State Purchase Price</u>	<u>Annual Maintenance</u>
9375-040 Processor	1	\$ 83,200	\$ 280
9335-A01 DASD Controller	1	6,800	18
9335-B01 DASD	2	34,000	100
9309-002 Rack Enclosure	2	4,800	8
1589 Tape & Controller	1	44,000	395
4245-D12 Printer	1	26,660	250
3864-002 Modem, 2-Wire	92	220,486	15,670
3299-002 Terminal Multiplexer	2	954	NA
PS/2 Model 50	63	215,336	180
PS/2 Model 60	23	104,421	190
7494-012 Elf	46	<u>69,368</u>	
HARDWARE TOTAL:		\$810,025	

SOFTWARE COSTS

	<u>Quantity</u>	<u>State Purchase Price</u>
9375-040 Software		
SolutionPac	1	\$101,580
VM/IS		
PROFS		
AS		
DW/370		
SQL		
QMF		
PC File Transfer		
VM/RSP Support		
PS/2 Software (Model 60)	23	14,812
3270 Emulation Program (Model 50)	63	40,572
IBM DOS 3.3		
OS/2 V1.1		
PC Software*	1	417
PC 3270 Emulation Program		
IBM DOS 3.3		
SOFTWARE TOTAL:		\$156,964

*Excluded from Software Total.

INVESTMENT

Hardware	\$ 810,000
Software	157,000
Personnel	
Highway Operations	161,000
Data Processing (ISG)	360,000
	or
(contract)	<u>780,000</u>
	\$1,488,000
	or
	\$1,908,000

APPENDICES

A. PROBLEM STATEMENTS

ADOT MATERIALS TESTING STUDY - PROBLEM LISTING BY NUMBER

December 15, 1987 at 1:26 p.m.

Page 1

PRB PKEY	PSA PTXT1
1 access	There is an inability to access test results easily
2 access	We are unable to validate test results randomly on
3 workload	We are not adequately staffed to meet the federal
4 workload	We do not take adequate independent assurance samples
5 credibility	There is a perceived lack of credibiity in some data
6 access	There is a lack of timely accessiability to data or
7 credibility	There is a significant concern that all the materials
8 analysis	There is an inability to get information in a useful
9 credibility	We are unable to collect cost and productivity data
10 access	We do not have good access to testing history.
11 credibility	We do not have an adequate "check and balance" system
12 access	We need more timely access to test results.
13 credibility	5 By contractor
14 analysis	The project labs require more analytical and
15 technology	The project labs do not have sufficient information
16 analysis	The CMT program does not allow project specific results
17 workload	There is an inefficient use of lab personnel to
18 access	1 For Project Engineers
19 technology	There are no standard operating procedures for
20 training	There is a lack of trained inspectors to interpret lab
21 analysis	There is a lack of forms and reports standardization.
22 testing	There is a lack of ability to keep track of materials
23 analysis	There is a need for reporting procedures which
24 communications	There is difficulty in sharing information
25 access	There is a need to identify specifications for
26 training	There are math and transcription errors.
27 technology	There is a lack of computer availability at the
28 communications	There is a need for better communication between
29 analysis	There is a need for exception reporting for
30 access	There is a need to access specific information on
31 analysis	There is a need for trend information for executive
32 analysis	There is a need to track costs associated with
33 technology	There is a need to identify and minimize duplication
34 access	12 For Geotechnical Services.
35 analysis	The CMT program is not being used by all Project
36 access	We do not have the ability to review centrally the
37 training	The weekly logs are not always complete, correct
38 access	It is difficult to match specifications to the project
39 technology	There is a perception that computerized tools are
40 access	12 For Independent Assurance Testing.
41 analysis	31 For District Independent Assurance testing.
42 training	There is a shortage of trained technicians.
43 access	There is an inability to determine the current
44 misc.	The current concrete mix design approval process
45 testing	Necessary "location" data is not always being
46 technology	It is time consuming to file weekly logs.
47 access	1 For Central Lab
48 credibility	5 For Central Lab
49 access	12 For Central Lab
50 analysis	We are unable to perform adequate analysis,
51 credibility	Project test data is so voluminous that it is
52 access	Need local access to all detailed test data.
53 access	10 For Central Lab
54 technology	Some past automated system efforts have resulted
55 communications	There is a need for more efficient communication

PRB PKEY	PSA PTXT1
56 consultants	We need to re-evaluate our contractual relationship
57 testing	We need to re-evaluate current test methodology and
58 analysis	50 For Consultant Administration
59 access	25 For Consultant Administration
60 communications	28 For Consultant Administration
61 access	1 For Project Engineers.
62 access	12 For Project Engineers.
63 communications	It is difficult to have prompt communication between
64 consultants	There is an apparent need for more project
65 analysis	There is a need for trend analysis of lab data by
66 access	30 For Pavement Services. (test result access)
67 access	10 For Pavement Services. (history)
68 analysis	We need an easier to use correlation of milepost
69 analysis	We need the ability to analyze the history of existing
70 analysis	We need more powerful analysis and forecasting
71 analysis	We need the ability to reorder test data into a
72 access	We need more timely access to Geotechnical data.
73 analysis	We need a better way to predict design reliability.
74 technology	We need to establish procedures for archiving and
75 access	1 For Quality Control
76 access	1 For District Labs
77 workload	3 For District Labs
78 communications	28 For District Labs
79 training	42 For District Labs
80 analysis	65 For District Labs
81 testing	We do not have accurate project schedules to schedule
82 consultants	We are incurring difficulties with our consultant
83 analysis	We do not have the ability to "organize" our test data.
84 misc.	We don't know the status of our aggregate pits.
85 communications	Change Order distribution is not timely.
86 workload	There is extensive transport time involved in
87 technology	33 For Project Labs
88 testing	22 For Project Labs
89 access	1 For Materials Section
90 credibility	5 For Materials Section
91 analysis	50 For Materials Section
92 technology	54 For Materials Section
93 testing	81 For Materials Section
94 access	We waste valuable personnel resources in having to
95 access	Erroneous test results are due to the many manual
96 credibility	Because of the lack of proveable test results, we
97 workload	Independent Quality Assurance samples must be obtained
98 technology	Many of our field materials automated systems do
99 technology	27 For Project Engineers.
100 access	94 For Project Engineers.
101 training	Not always do contractors and project engineers
102 workload	3 For District Engineering
103 analysis	21 For District Engineering
104 training	42 For District Engineering
105 communications	Our method of "Red Lighting" critical test failures
106 testing	A more "intelligent" sampling program might reduce
107 analysis	There is no "selective exception" system regarding
108 communications	There is no built-in "stop" on contractor payment
109 training	We need to assure that all of our inspectors are cross
110 misc.	The lack of a Materials Inspector "growth plan"

PRB PKEY	PSA PTXT1
111 technology	We apparently do not have an ADOT function to
112 communications	We have no effective way of sharing information
113 none	Skipped number.
114 workload	3 For Deputy District Engineers.
115 technology	15 For the District Labs
116 training	42 For the District Labs
117 technology	27 For the District Labs
118 technology	39 For the District Labs
119 workload	"Feast or famine"(ie poor project scheduling) causes
120 workload	There is a need for two Deputy District Engineers
121 training	There is a need for increased skills in the Project Lab.
122 testing	Our portable labs are inadequate in number and not
123 training	There is little recognition that the installation
124 testing	57 For the District Labs
125 access	1 For the District Materials Engineer.
126 workload	3 For the District Materials Engineer.
127 access	6 For the District Materials Engineer.
128 testing	81 For the District Materials Engineer.
129 analysis	83 For the District Materials Engineer.
130 technology	111 For the District Materials Engineer.
131 workload	There is not a good statewide system in place for
132 misc.	We lose District 1 Lab Technicians because of the
133 workload	Our ability to temporarily shift personnel for
134 training	Our technical training for lab personnel is not
135 technology	We are not currently taking full advantage of current
136 analysis	14 For Materials Engineering.
137 communications	It is difficult to make communications contact
138 training	There is a lack of adequate training programs for
139 misc.	There is some confusion existing in the performance of
140 consultants	There is confusion in the relationship between
141 testing	Our sampling procedures do not adequately address
142 testing	There is an inability to sample, inspect and test
143 credibility	Management cannot verify that test equipment is being
144 credibility	Management cannot verify that correlation testing
145 misc.	We do not have access, at all levels, to the status of
146 communications	Unique District data is not being fed back into the
147 none	No new problems identified.
148 analysis	We need to predict and validate how materials affect
149 analysis	There is an inability to predict the impact of our
150 analysis	There is an inability to develop meaningful models.
151 technology	There is a lack of updated test equipment
152 misc.	There is a lack of updated facilities.
153 training	There is a need for more cross-orientation.
154 testing	Our scheduling of sampling arrivals is sometimes
155 testing	There is not enough time (sometimes) to perform
156 communications	137 For "Radio Tag".
157 communications	28 For the Area Engineers.
158 access	38 For the Area Engineers.
159 analysis	70 For the Area Engineers.
160 technology	We are so inundated with paperwork that we are
161 communications	We are spending a lot of management time resolving
162 credibility	We are not generating useful information from our
163 testing	We have no easy way to recognize the required
164 analysis	We are burdened by our current manual information
165 testing	We need to supplement our field technicians with

166 training		There is a lack of management understanding regarding
167 misc.		Our field facilities need repair.
168 access	1	For Project Engineers.
169 communications	28	
170 communications	85	
171 workload	119	(seasonal)
172 training		For Project Engineers.
173 consultants		There is a loss of knowledge to ADOT through the use
174 consultants		There appear to be a greater number of errors in new
175 none		FHWA
176 communications	28	For Inspectors.
177 consultants	174	
178 communications	137	
179 training	138	
180 workload	119	
181 training	42	
182 training		In some ares there is no program to develop and
183 communications		We are not making effective use of the suggestions
184 analysis		We require an audit trail for any new systems.
185 analysis		We require "personal signature" identification in
186 analysis		Any new system must be able to provide to the
187 none		no new problems
188 none		No new problems.

B. LIST OF INTERVIEWEES

ADOT MATERIALS STUDY INTERVIEWEES

December 14, 1987 at 1:29 p.m.

Page 1

NAME	TITLE	FUNCTION
Don Green	Materials	
James A. Judd	Chief Deputy State Engr.	
Ken Speer	Project Lab	District 1
Calvin Werth	Project Lab	District 1
Perry Powell	Project Engineer	District 1
Diane Schotka	Project Engineer	District 1
James A. McGee	Deputy State Engineer	Highway Operations
John Lawson		Hq Geotechnical Services
Robert Morden		Quality Control Branch
Robert Laux	Ind Assur Tech	District 1
Douglas Forstie		Hq Testing Services
Ron Romley	Consultant Administration	District 1
Cliff Passmore	Project Engineer	District 3
Robert Schneider	Project Engineer	District 3
George Way		Hq Pavement Services
Herb Hazelwood		Hq Field Review Services
Deidre Beekman	Materials Engineer	District 4
Jim Glasgow	Materials Engineer	District 3
Steve Black	Project Lab	District 2
Solomon Murphree	Project Lab	District 2
Gary Cooper	Asst. State Engineer	
Noland Durnell	Project Engineer	District 2
Tom Kilargis	Project Engineer	District 2
Thomas A. Bryant II	District Engineer	District 1
Eugene F. Ireland	District Engineer	District 2
Dan Lance	Deputy District Engineer	District 1
Gerry B. Ohnesorgen	Deputy District Engineer	District 2
Willard Beck	Materials Engineer	District 2
William Hoffman	Materials Engineer	District 1
Jesse Benitez	Lab Technician	District 1
Jerry Garlinghouse	Lab Technician	District 4
Ronnie O'Daniel	Lab Technician	District 2
Richard A. Genteman	District Engineer	District 4
Donald A. Smith	District Engineer	District 3
Frank Adair	Project Lab	District 4
Wayne Smith	Project Lab	District 4
Joseph Stewart	Lab Technician	District 3
Ken Damgaard	Area Engineer	District 2
Tom Warne	Area Engineer	District 1
Mark Anthony	Project Lab	District 3
Don Walden	Project Lab	District 3
Keith DeWitt	Project Engineer	District 4
Phil Bleyl		FHWA
Jimmy Cruz	Inspector	District 3
Bob Parsons	Inspector	District 4
Bob Posey	Inspector	District 4
John Stiver	Inspector	District 3
Brian McInnis	Auditor	ADOT Internal Audit
Ervin Boren	Area Engineer	District 3
George Christianson	Area Engineer	District 3
August Hardt	Area Engineer	District 3
Thomas Schmitt	Area Engineer	District 4
Marvin Parsons	Project Engineer	District 4
Gary Post	Area Lab Supervisor	District 1

December 14, 1987 at 1:29 p.m.

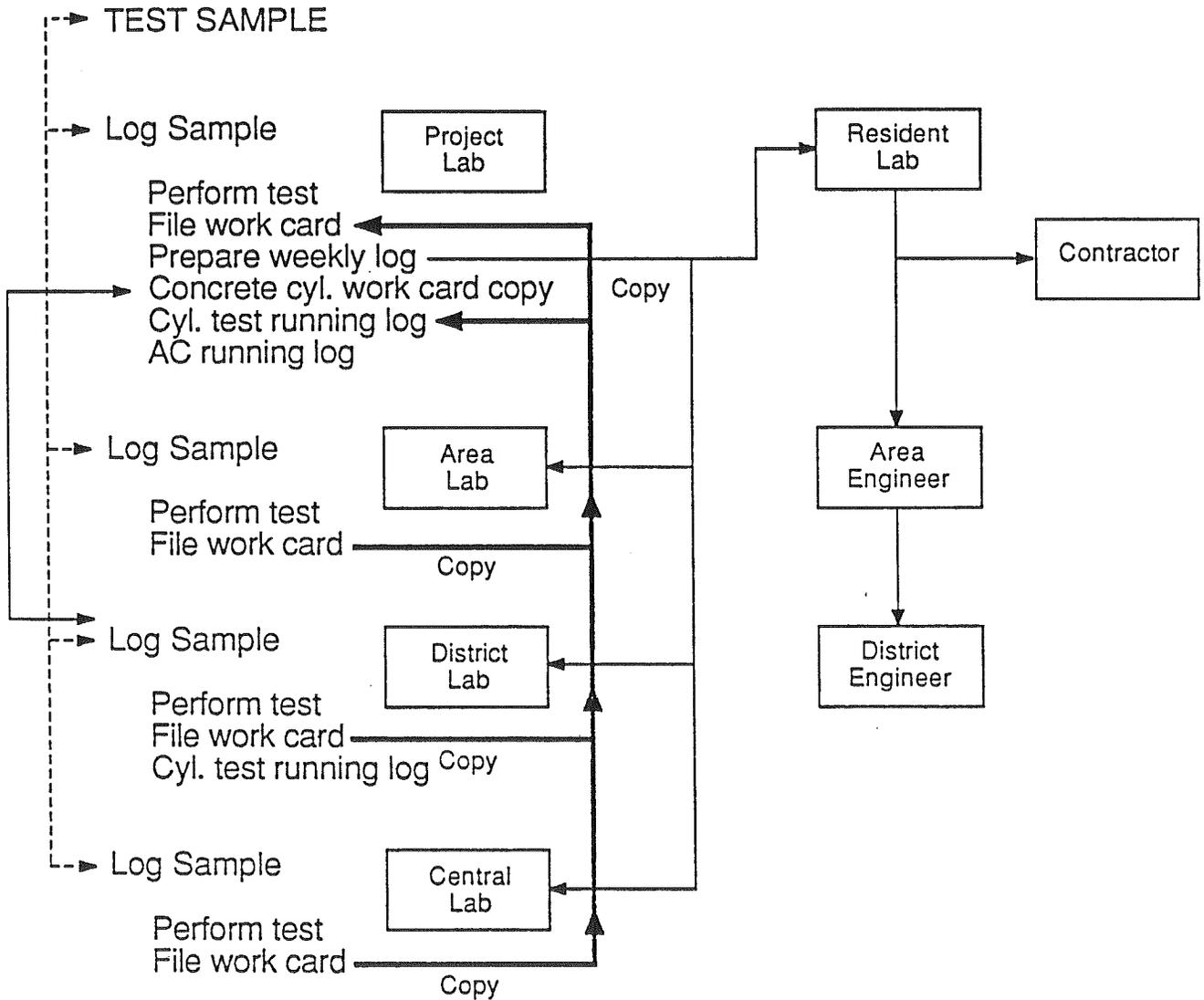
Page 2

NAME	TITLE	FUNCTION
Randy Swick	Area Lab Supervisor	District 1
Lloyd Thomas	Area Lab Supervisor	District 2

C. STUDY WORK CHARTS

MATERIAL TEST SAMPLE FLOW CHART

(acceptance, correlation, independent assurance)



DISTRIBUTION OF PROCESSORS BY LOCATION

	Lab	Inquiry
DISTRICT 1		
District Lab	(Phoenix) 1	7 (1-DE, 2-DDE, 4-AE)
Area Lab(2)	(Phoenix) 2	22 (12-PE, 10-MC)
DISTRICT 2		
District Lab	(TUCSON) 1	3 (DE, 2-DDE)
Area Lab(2)	(TUCSON) 2	4 (2-AE, 2-PE)
Project Lab	(Safford) 1	2 (AE, PE)
	(Globe) 1	3 (AE, 2-PE)
	(Casa Gr) 1	1 (PE)
	(Benson) 1	1 (PE)
DISTRICT 3		
District Lab	(Prescott) 1	4 (DE, 2-DDE, AE)
Project Lab	(Yuma) 1	2 (AE, PE)
	(Quartzit) 1	
	(Kingman) 1	2 (AE, PE)
	(Cor. Jct) 1	1 (PE)
	(Rye) 1	
	(Colcord) 1	
DISTRICT 4		
District Lab	(Flagstaf) 1	5 (DE, 2-DDE, AE, PE)
Project Lab	(Holbrook) 1	3 (AE, 2-PE)
	(Gray Mtn) 1	
	(Williams) 1	1 (PE)
	(Grn Riv) 1	1 (PE)
Project Eng.	(Camp Ver)	1 (PE)
	(Show Lw)	1 (PE)
Area Eng.	(Page)	1 (PE)

DISTRIBUTION OF PROCESSORS BY LOCATION (CONT)

HEADQUARTERS

Materials	7 (ME, 3-SH, 2-PD, GT)
Construction	3 (CE, 2-QC)
Operations	1 (DSE)
Audit	1 (Auditor)
FHWA	1
R&D	2
Mgmt	3 (Dir, SE, CDSE)

CENTRAL LAB

Test Stations-6 A/C	
-3 Steel&Concrete	
-2 Coarse	
-1 Fine	
Asphalt Lab	1
Chem/Cement Lab	1
Receiving	1
Q/A	1
Bituminous Eng.	1
Concrete Eng.	1
	<hr/>
	23Lab
	<hr/>
	85INQUIRY

SPARES

Dist HQ (1ea.)	4 Work Stations
Central HQ	1 Work Station

DISTRIBUTION OF TESTS BY TYPE

Volume:125 Projects/Yr.

FIELD TESTS		100 People
Compaction(Density)	60-70%	
Proctor		
Concrete	30-40%	
Cyl, Slump, Air		

DISTRIBUTION OF TESTS BY LAB

			% OF TOTAL
25 PROJECT LABS/3AREA LABS*		90 People	65%
Sieve Analsis	60%		
AC Tests(Exc.Sieve)	30%		
Other	10%		
4 DISTRICT LABS		32 People	25%
Sieve Analysis	60%		
Concrete Test(Brk)	15%		
AC Tests	15%		
Others	10%		
CENTRAL		35 People	10%
Sieve	60%		
Mix Design	20%		
Asphalt Cement	10%		
Others	10%		

* + 4 Consultant Labs

TYPE OF TEST BY LAB

DISTRICT LAB

Spelter Test
Abrasion Tests
Resistivity
Asphaltic Concrete Cores
Concrete Compression Tests
*Liquid Tests on Asphalt

*Some

CENTRAL LAB

Reinforcement Testing
Portland Cement
Fly Ash
All Asphalt Cement Testing
Chemical Tests on Specialty Items
Mix Design Verification
Recycle Mix Design
Perms
Direct Shear
Consolidation

TESTS

Field

- **Compaction (Sand Cone, Volumeter, Nuclear)
- **One-Point Proctor
- **Fabricate Concrete Cylinders
- **Slump Test
- **Air Content

Project or Area Lab

- *&*&*&Sieve Analysis
- *&*&*&Proctor(Moisture-Density Relations)
- *&*&*&Moisture Content
- *&*&*&Extraction-Gradation
- *&*&*&Sand Equivalent
- *&*&*&Fractured Faces
- *&*&*&Flakyness Index
- *&*&*&Plasticity Index
- *&*&*&Marshall Density
- *&*&*&Marshall Stability
- *&*&*&Marshall Flow
- *&*&*&Rice Tests
- *&*&*&Coarse Specific Gravity
 - #Asphaltic Concrete Cores
 - #Concrete Compression Tests

- #Only Some Labs Where Equipment Exists
- *1/5 Quality Assurance Test Required
- **1/40 Independent Assurance Test Required

POTENTIAL JUSTIFICATION AREAS

Sample Lab Log Record	Time
Individual Test	
Recording&Capture	Time, Paper
Calculation	Time, Calculator, Error
Specification Comparison	Time, Paper
Recheck	Time, Calculator
AC Running Ave. Comparison	
Concrete Cyl. Log	
Weekly Log	
Preparation	Time, Copier, paper
Filing	Time, filing cabinets, space
Recheck	Time
Transmittal	Time, Postage, Paper
Review	Time
Embankment Density Charting&Logging	
Specification Research	Time, Distribution
Claims-Research To Prepare For	
Personnel Turnover	
Pavement Mgmt Research	
Project Scheduling	

ADOT MATERIALS TESTING STUDY TEAM

Jim Bertsch	IBM - ATS Specialist
Katie Underwood	IBM - Marketing Representative
Larry Schofield	ADOT Research
Larry Hanson	IBM - ATS Specialist
Parker Gregg	ISG *
John Daru	ISG *
Don Dorman	Construction - District 4
Paul Bolster	Construction - District 1
Don Green	Materials
Jim McGee	Deputy State Engineer, Highway Operations
Kris Barr	IBM - Systems Engineer

* Split Assignment

JUSTIFICATION

Time Considerations

Area Engineers - Paper filing

Weekly Logs - Filling out, filing, copying, paper, printing, distribution, sending, storage, initialing

Test Cards - Filling out, calculate, checking, filing, copying, sending, initialing, travel, storage

Testing - Accuracy, filling out

Exception Reports - Research, preparing, finding, travel, validating, summary

Audit - searching

Project records - Claims, Specifications, Force Accounts, etc.

Specification Research

Claims - man-hours to research and prepare

Personnel turnover

Pavement management research

Project scheduling

JUSTIFICATION

Project and Area, District, Central Laboratories

1. Testing

- Accuracy
- Calculating
- Preparing
- Filing
- Checking
- Copying
- Transmitting
- Storage
- Verifying

2. Audit - Searching

3. Weekly Logs

- Accuracy
- Preparing
- Filing
- Checking
- Copying
- Transmitting
- Storage
- Supplies (Project and District)

4. Project Records

5. Exception Reporting

- Research
- Preparation

D. LETTER TO INTERVIEWEES

OFFICE MEMO

TO:

FROM: JAMES A. MCGEE
Deputy State Engineer
Highway Operations Group, 174A

RE: Application Transfer Study

Mr. Charles L. Miller, Director, and Mr. W. O. Ford, State Engineer, have authorized a Joint A.D.O.T./I.B.M. study effort to achieve the following mission:

Determine what ADOT needs to do to improve the consistency and timeliness of our construction materials reporting and quality assurance on state transportation construction projects.

Mr. Ford has formally designated an Application Transfer Study Team which is composed of ten members; six from ADOT and four from IBM. The ADOT members represent a cross section of those involved in our construction project administration and our construction materials quality assurance program. The members of the team are:

James A. McGee Team Leader
Don Green, Engr. Quality Assurance Branch, Materials Section
Don Dorman, Tr. Engr. Spec., District 4
Paul Bolster, Tr. Engr. Spec., District 1
Larry Scofield, Arizona Transportation Research Section
Parker Gregg, Information Systems Group
James Bertsch, IBM ATS Specialist
Larry Hanson, IBM ATS Specialist
Katie Underwood, IBM Marketing Representative
Kris Barr, IBM Systems Engr.

The key to the success of this project is a precise identification of the collective information requirements of the Division in support of our mission goal. To that end, you are being contacted by the Study Team to indicate the support which is or will be necessary for you or your organization. This opportunity is being provided to a cross section of the Division through a series of personal interviews conducted by the ATS Team.

The questions which you will be asked during the interview are being sent to you now so that you may have the time to properly consider them. Remember that the focus of this Study covers our future planning horizon, so it is important to focus on anticipated future needs as well as today's requirements.

The Study will be conducted from October 27, 1987 through December 17, 1987 with one hour interviews to be scheduled. This Study is of vital importance to the planning and evaluation of the construction materials reporting requirements of the Division. Please give your full cooperation and support to the ATS Team so that this Study may be expeditiously completed.

Interview Procedures

A list of questions that will be asked during the interview is attached. The purpose of these questions is to help, through your answers, establish the requirements necessary for you to effectively and efficiently perform your job function. Your requirements will be merged with the requirements of other members of the Division into a composite plan. The purpose of the document is to assist in the development of a long-range plan that is not only compatible with, but will contribute to the attainment of ADOT's goals.

The interviewers would like to take notes during the interview and will, as soon as possible after the interview, document the interview and return a copy to you for review and concurrence that the interviewers have correctly related and interpreted your thinking. You are encouraged to make notes on your answers to the questions while you prepare for the interview.

It is important to recognize that this solicitation of your requirements is no guarantee that the Division will meet those requirements. Those requirements will, however, be reflected in the planning group's overall requirements document. It is intended that through this vehicle, which will permit common requirements to be merged and compromises where necessary, the Division will be able to properly plan the expenditure of its resources to expeditiously provide you the tools necessary to meet your responsibilities.

JAMES A. MCGEE, Deputy State Engineer

JAM/aa
Attachment

QUESTIONS

1. Briefly describe your job function and responsibilities.
2. What do you need to do your job more effectively or efficiently now and in the future?
3. What data or information do you now receive necessary to your job?
4. What additional data or information do you need to do your job more effectively or efficiently now and in the future?
5. Do you have any other comments which might be of value to the Study Team?

E. MID-POINT REVIEW

ADOT

Construction Materials
Testing and Quality Assurance Study

Mid-Point Review

November 19, 1987

MISSION

Determine what the ADOT needs to do to improve the consistency and timeliness of our construction materials reporting and quality assurance on state transportation construction projects.

FACT FINDING

- * Who to interview
- * Questions
- * 55 Interviewees
- * 34 Interviews
- * 189 Statements

INTERVIEW IMPRESSIONS

- * Identification with ADOT
- * High level of dedication
- * No misrepresentation
- * ADOT is the "BEST"
- * Pride in ADOT
- * Frankness of Expression

10 SUMMARY STATEMENTS

- * 5 Within the scope of the study
- * 5 Outside of the scope of the study

WITHIN THE STUDY SCOPE

1. INFORMATION = RESOURCE
2. ANALYSIS
3. ACCESSIBILITY
4. COMMUNICATIONS
5. CREDIBILITY

1. INFORMATION = RESOURCE

Our data and information is an important resource. Yet, we have not provided for the overall planning direction, organization and control of this resource.

- * Decisions based upon incomplete information
- * Inconsistencies
- * Incompatible systems
- * Duplication of efforts
- * Misdirected efforts
- * Lack of technical information support
- * Audit trails

2. ANALYSIS

We lack the ability to perform analytical and statistical techniques on our test data to provide information in a useful format and in a timely manner.

- * Exception reporting
- * Trend analysis
- * Forecasting
- * Quality Assurance

3. ACCESSIBILITY

We do not have the ability to access test results and specifications easily and in a timely manner.

- * Current test results
- * Historical test results
- * Quality Assurance

4. COMMUNICATIONS

There is a need for better communications between field, district, and central office.

- * ADOT expertise
- * Telephone / radio "tag"
- * Failing test results
- * Scheduling
- * Mis-communications

5. CREDIBILITY

There is a perceived lack of credibility in some test information provided to management, contractors, and central lab.

- * Materials certification
- * Check and balance
- * Accuracy
- * Completeness

OUTSIDE OF THE STUDY SCOPE

6. WORKLOAD
7. TRAINING
8. PROCEDURES
9. CONSULTANT RELATIONSHIPS
10. MISCELLANEOUS

6. WORKLOAD

We lack the ability to perform all required functions due to:

- * Limited personnel resources
- * Geographical distance
- * Seasonal scheduling
- * Lack of District input in project scheduling
- * Funding inconsistencies
- * Lack of control over contractor scheduling
- * Inexperienced personnel
- * Personnel relocation problems

7. TRAINING

There is a need for:

- * Cross training and cross orientation of construction technicians
- * Additional training in testing procedures, evaluation and interpretation of test results for lab technicians
- * Additional training for project supervisors and resident engineers in specification interpretation and evaluation of test results

8. PROCEDURES

There is a need to change our Quality Assurance procedures

- * Sampling
- * Testing
- * Reporting
- * Certification
- * Inspection
- * Facilities

9. CONSULTANT RELATIONSHIPS

There is a need to re-evaluate our relationships with our consultants

- * Project development
- * Materials testing
- * Surveying
- * Contract Administration

10. MISCELLANEOUS

There is a need to:

- * Predict pavement design performance and reliability
- * Know the status of aggregate pits
- * Enhance our career development program
- * Know the status of projects under development

SUMMARY

* WITHIN THE STUDY SCOPE

1. INFORMATION = RESOURCE
2. ANALYSIS
3. ACCESSIBILITY
4. COMMUNICATIONS
5. CREDIBILITY

* OUTSIDE OF THE STUDY SCOPE

6. WORKLOAD
7. TRAINING
8. PROCEDURES
9. CONSULTANT RELATIONSHIPS
10. MISCELLANEOUS

HARDWARE

IBM Personal System/2

The IBM Personal System/2 is an entire family of products based on advanced technology that gives new meaning to personal computing. IBM Personal System/2 is new system units, displays, and printers....new standards for graphics....an enhanced IBM PC DOS....a powerful new operating....impressive connectivity capabilities and more.

With just one powerful Personal System/2 model - used as a server - you can increase the cost effectiveness of an entire network. Use it as a gateway, and you can enhance mainframe communications for a whole group. Additional value comes with the new IBM operating System/2, which allows a single Personal System/2 model the capability to: support multiple applications, support multiple applications and host sessions, and even support multiple applications, host sessions and a network session.

Together, Personal System/2 and Operating System/2 can provide a firm foundation for future growth. Because this family is compatible, most applications and peripherals used with one model can be easily shared or used with others.

The new IBM micro channel architecture is key to that growth. It prepares this family for expansion - to levels of capability and capacity that most microcomputers couldn't approach before now. More peripherals can be attached and supported simultaneously. On some high-end models, memory can be doubled on the system board, then increased all the way to 15 MB or 16 MB with memory expansion options.

System Units

Within the five models of the Personal System/2 family - models 25, 30, 50, 60 and 80 - you've got a range of choices to suit your needs. Two floor standing models and three desktop models provide 80386, 80286 or 8086 microprocessing power, memory and storage to match your needs.

Displays

Created especially for Personal System/2 - yet compatible with the IBM PC line - five new color and monochrome displays provide new levels of performance. Complex graphics are brighter, on-screen text is clean and easily readable.

Printers

IBM's expanded line of printers can be used to produce everything from quick drafts to quality presentations. The print technologies you can choose include: dot matrix, resistive ribbon, thermal transfer, ink jet, daisywheel, and more.

Operating Systems

A new version of the widely accepted Disk Operating System (DOS), IBM PC DOS Version 3.30, supports the enhanced performance and many of the new functions provided by Personal System/2.

Version 3.30 offers several enhancements over Version 3.20, including:

- *Faster access to files that are opened and closed very frequently.
- *Faster and more secure methods of writing data.
- *Better support for data base applications requiring access to large numbers of files at once.
- *Enhanced utility commands.

The new IBM Operating System/2 will put the large memory addressability of the 80286 and 80386 Personal System/2 system units at your disposal. Standard Edition provides a way to break through the 640 KB memory barrier and support flexible operations with multiple applications using up to 16 MB of memory. And those applications can include text and graphics in a windowing environment.

Extended Edition will supply all the enhanced functions that the Standard Edition does and much more. This edition makes data base management easy, provides all the tools to create a data base and even reduces the need for data base programming. Extended Edition also includes a powerful communication subsystem that permits multiple connections to hosts and peer stations on a network.

With either edition of Operating System/2, frequently used applications can be held in memory for quick access. In addition, several tasks can be handled at a time, whether they are being held at the ready or are running, you can switch quickly from one to another.

The wealth of features common to both edition of this powerful operating system include:

- *16 MB memory addressability
- *Multiapplication support
- *Enhanced ease-of-use facilities
- *Graphics
- *Windowing
- *Optional DOS environment
- *Consistent user interface

THE IBM 7494 - ELF

The 7494 Entry Level Facility (ELF) Data Collection Terminal is a compact microprocessor based unit which attaches to a host computer using a polled, serial ASCII protocol. The terminal function is personalized by a user created download from the host. The three models of the 7494 ELF Terminal are:

- Model 012 - RPQ 8X0012 DCT/with no Badge Reader
- Model 013 - RPQ 8X0013 DCT/with Bar Code Badge Reader
- Model 014 - RPQ 8X0014 DCT/with Mag Badge Reader

Description:

The Model 012 has the following standard features:

Display

A one line, thirty two (32) character, alphanumeric, liquid crystal display with 0.19 inch high characters is provided. The display will normally show prompt messages, the time-of-day (12 hour or 24 hour format), and key entry or bar code data. It is under control of the personalized user download.

Communications

An RS-422 electrical interface allows local attachment to a host computer with communication speeds of 1200, 2400, 4800, or 9600 BPS. Up to 16 terminals may be multidropped from one RS-422 port on a computer. Distance may be up to 4000 feet of total accumulated wire length.

The electrical interface has a 9-pin D shell connector.

User RAM Storage

User RAM storage of 13K bytes may be used to hold transaction records and downloaded data files.

Membrane Keyboard

This is a combination keyboard with 12 numeric (0-9, clear, enter) and 28 function keys. Function key operations are defined in a personalized user download. Keys are on 3/4 inch centers. An audible feedback signal is provided when a key is depressed. Customized keyboard to provide custom key legends. A slot in the side of the enclosure allows the customer to change the overlay as required. The overlay is held in place by a fastener which can be accessed only from the back of the enclosure.

Time-of-Day Clock

The TOD Clock chip maintains the time and date within the unit. This clock is initially set by a command from the host computer; the host can also read it and update it as required. The terminal firmware uses the TOD Clock to "Timestamp" transactions.

Bar Code Wand Capability

Bar code 3 of 9, I 2 of 5, and UPC-A can be read when the terminal is used with one of the optional, digital, high or low resolution hand held Bar Code Scanners (Wands).

Host Commands

7494 - ELf firmware provides a powerful command set used to program terminal functions specified in command files. Command files are customized at the host and downloaded to each terminal. Program download capabilities include:

- Read and Write Time-of-Day (TOD) Clock;
- Read Terminal Status;
- Read Transaction Buffer;
- Write to Buffer;
- Turn-on Audible Tone;
- Reset Terminal and Run Self-Test Diagnostic;
- Load and Manage ASCII Data Files;

Self-Test Diagnostic Mode

A Self-Test Diagnostic Mode may be initiated either by command from a host computer, or automatically during a terminal power-on sequence.

Power Requirements

The terminal power input is 18 volts DC or 18 volts AC (60 HZ). A 110 Vac to 18 Vac transformer is included in the wall mounting option. The desk mounting option includes an external power module.

Watchdog Timer

Watchdog Timer circuitry automatically forces a terminal reset and restart sequence in the event of a "hang" condition.

Low-Power Detect

Power sensing circuitry monitors main power and forces an orderly shut down in the event of a low power condition (Brown-Out). For short duration power losses, the TOD Clock chip and user RAM will remain operational. However, this feature does not provide for operation of the terminal when primary power has been interrupted.

Audible Tone

A transducer provides an audible tone under control of terminal firmware, or directly by command from the host computer.

Mounting

Two types of mounting are available as options. One is a wall mount with a key lock and the other is a desk mount. Both mountings include the power transformer, cabling to the terminal, and power/signal terminations.

Environmental Protection

The 7494 - ELF Terminal has been ruggedized for use in industrial environments. Except for the customer access area, the rest of the terminal, including the main processor board, is completely sealed. The customer access area contains connectors for signal and power lines and a port for the optional Bar Code Wand.

IBM 9370 INFORMATION SYSTEM OVERVIEW

The IBM 9370 Information System, a family of data processing systems with System/370 architecture, is designed to meet the information processing needs of today's end users--wherever they work, throughout your organization. We are proposing the 9375 Model 60, from this family of processors, as one option to meet the processing needs of the Maricopa County Assessor's Office.

The 9370 Information System is modular, designed to provide mainframe power in a remarkable compact package. And, the 9370 System is versatile. It offers three processor models, a choice of input/output and storage devices, plus exciting innovations in packaging that help make it the perfect fit for almost any department or remote location.

The 9370 System is built on IBM's proven System/370 architecture. That means it can give the people who use it access to an enormous range of System/370 software--including IBM operating systems and a variety of office, commercial, engineering/scientific and industrial applications.

At the same time, the 9370 System gives data processing management an effective way to distribute System/370 capacity and performance to users who need it most--without compromising data integrity, and without requiring users to learn a completely new architecture. The results: improved ease of use for everyone and a continued return on the investment already made in System/370 software and training.

The most obvious feature of the 9370 System--and one of its major advantages--is its size. Never before has IBM offered this much power in a system that requires no special cooling and is small enough and quiet enough to sit in the corner of your office.

The 9370 System's compact design along with its System/370 architecture and broad connectivity potential means it can go to work in many ways for many kinds of organizations. Its affordable price, combined with the ability to perform well in both commercial environments and those with intensive computing requirements, makes the IBM 9370 System a solid business solution.

In addition, IBM has designed the 9370 System so that it can coexist with equipment and systems from other manufacturers. The IBM 9370 System can include an Ethernet* (IEEE 802.3) network connection, for example, as well as a Serial OEM Interface (SOEMI) for direct attachment of devices based on Multibus**.

It all adds up to the kind of high-performance, easy-to-use, versatile IBM system that both management and end users have been waiting for.

* Ethernet is a trademark of the Xerox Corporation.

** Multibus is a trademark of the Intel Corporation.

The IBM 9370 Systems's rack-mounted design makes it easy to expand the system. As your needs for processing power or storage change, you can have your system upgraded right in the rack simply by adding cards or an additional rack for enhancements.

The basic components of the IBM 9370 information processing system include:

- Rack enclosure. Two sizes are available. Both feature a small "footprint" and are designed to hold the processor and data storage devices. Input/output controller cards slide into the processor module as part of this integrated design. Cables are housed within the rack, which also provides a common power source for system components.
- 9370 processors. Three models are available, 9375 Model 40, 9375 Model 60, and 9377 Model 90. They differ in their performance, storage sizes and the number of devices you can attach to each.
- Input/Output subsystem controllers. I/O controllers consist of one or more compact logic cards that can be plugged into the processor or into I/O card units. They act as control units, allowing direct attachment of I/O devices. IBM 9370 controllers include a DASD/Tape Subsystem Controller, a Workstation Subsystem Controller, a group of Communications Subsystems including support for an IBM Token Ring Local Area Network, and a System/370 Block Multiplexer Channel Controller.
- Rack-mounted input/output devices. The 9370 System offers two types of direct access storage devices (DASD) and a magnetic tape unit. They can be combined to fit your specific requirements.
- Processor console. The specially configured Personal Computer (PC) console provides overall system control and is used to install, operate and maintain the system. The console is also used to perform certain problem determination, diagnostic and service functions. When not being used to control an IBM 9370 System, the console can be a user terminal as well.

Like other computers, the IBM 9370 System runs under the control of an operating system. The kind of operating system you should use depends on what you want to do with your system and the workload it will be supporting.

In keeping with this system's emphasis on versatility, IBM gives you a choice of four operating systems to help you meet your unique system requirements. They are Virtual Machine/System Product (VM/SP) with a pregenerated VM/Integrated System (VM/IS) option, Virtual Storage Extended/Systems Product (VSE/SP), IBM Interactive Executive for System/370 (IX/370), and Multiple Virtual Storage/System Product (MVS/SP).

These are the same operating systems available on other System/370 processors and offer great flexibility to new System/370 users. Each is a proven operating system, and each is best suited for particular types of applications and environments. If your needs change, upward migration between operating systems is facilitated by migration tools and extensive compatibility.

Several software offerings for the IBM 9370 Information System are available as pregenerated "packages" that group common applications together. These packages are generally easier to install and use than other software components installed individually.

Software packages for the IBM 9370 System can support such key areas as document generation and distribution, executive decision support, mail and calendar functions, applications development, data base management and query, networking support, and much more. These packages can be an efficient way to increase the functional capabilities of the system for users with minimal data processing skills.

IBM now offers graduated one-time charges for selected software. Under this plan, the price you pay for software is based on your particular system's performance capacity. This can make an IBM 9370 System solution even more cost-effective whether your organization is large or small.

The IBM 9370 Information System can provide both end users and data processing management with balanced performance and versatility. Here's what makes the IBM 9370 Information System unique:

- ° A family of modular IBM systems; providing a more affordable entry point to IBM's System/370 architecture, plus new opportunities for manageable growth.
- ° Space-saving rack design, acoustic and power characteristics, and remote and automatic operations capabilities enable an IBM 9370 System to fit wherever the work is--including office, manufacturing and laboratory environments.
- ° Support of several proven IBM operating systems, enabling it to work in interactive or batch modes, support commercial or scientific applications, and serve as a central host in stand-alone departmental environments.
- ° Its System/370 architecture helps protect your investment in operating training, software and applications. And it gives you access to the library of existing System/370-based applications.
- ° Broad communications capabilities let it coexist easily with a variety of IBM and non-IBM systems and equipment.
- ° It provides all this in a system that is easy to use, easy to configure, and affordable.

IBM 9370 System Processor Console

- Provides overall system control; it attaches directly to the IBM 9370 processors through a cable.
- Each IBM 9370 processor is shipped with a processor console; the processor console is not rack-mountable but requires a flat surface (table) for use.
- It is the principal device for the operator to communicate with the system -- with the processor itself, with an application program, or with the operating system.

The 9370 Processor Console uses a specially configured IBM Personal Computer which is included with every 9370 Processor. This is done to assure the operation and integrity of each 9370 Information System. The functional and performance requirements of the 9370 Information System require the Processor Console functions to be implemented directly on the Personal Computer System hardware, bypassing normal Basic Input Output System (BIOS) conventions.

Processor console functions:

- Initialize the system by doing basic hardware verification tests and loading microcode and data from the system diskette into the processor during system start-up.
- Monitors the system by automatically checking for errors and taking corrective actions in case of malfunctions.
- Analyzes machine checks by collecting and analyzing hardware failure information when a machine check occurs.
- Handles errors by storing time-stamped detailed error information and reference codes on the system diskette in case of malfunction.
- Supports manual operations by allowing the operator to do manual operations, such as display and alter storage contents, or set the time for automatic power on.
- Remote Access allows the processor console to be operated over telephone lines.
- Remote Operation Facility allows the processor console of one IBM 9370 System to operate the processor console of another 9370 System.

9335 Direct Access Storage Subsystem

The 9335 Direct Access Storage Facility provides large-capacity, high-performance disk storage devices and associated control functions. They include the following function controller and DASD drive: Model A01 Device Function Controller (DFC) and Model B01 Direct Access Storage Units.

The 9335 Model A01 Device Function Controller attaches to the IBM 9370 System processors through the DASD/Tape Subsystem Controller. One Model A01 can be attached to one DASD/Tape Subsystem Controller. The Model A01 Device Function Controller controls up to four Model B01 Units.

The 9335 Model B01 Drive Unit is a fixed disk drive that supports fixed-block (FBA) record format. It has a capacity of 824 megabytes.

1589 MAGNETIC TAPE SUBSYSTEM

The Telex 1589 Magnetic Tape Subsystem is a channel attached, compact start/stop tape drive that attaches to the IBM 9370 Information System Processors and is shipped in a rack that has the same profile as the IBM 9370 system. The drive autoloads reels of industry standard 1/2 inch magnetic tape. This complementary product reads or writes data at 1,600 or 6,250 bpi. This allows an instantaneous data rate of 120KB per second at 1600 bpi or 468KB per second at 6250 bpi. There are two models of the tape drive: Model A consists of a tape control and one integrated tape unit and Model B consists of a tape unit only. The Model B must attach to the Model A. Four 1589 configurations consisting of various combinations of these basic models are available from IBM.

HIGHLIGHTS

Start/Stop Tape Drive:

- Dual-density 63/246 bytes per mm (1600/6250 bytes per inch).
- Compact design and packaging.
- Rack enclosure mounting.
- Autoloading.
- Industry standard 1/2 inch tape.
- Channel attached.
- Self-diagnosis maintenance function.
- Instantaneous data rate of 468,000 bytes per second at 246 bytes per mm (6250 bytes per inch).

DESCRIPTION

The 1589 is a compact, start/stop tape drive that uses industry standard 1/2 inch-wide magnetic tape and is shipped mounted in a rack enclosure. The Telex drive autoloads standard reels that are 7, 8.5, and 10.5 inches in diameter. The tape drive records or reads data at 1600/6250 bpi at a tape speed of 75 inches per second (ips) which allows an instantaneous data rate of 120 or 468KB per second.

Self-diagnosing maintenance functions are incorporated in the 1589. Integrated power-on testing and backup diagnostics provide individual FRU (Field Replaceable Unit) or FRU Group Isolation. The Telex Model A may attach one (1) Telex Model B Magnetic Tape Subsystem.

CHARACTERISTICS

- Data rate, instantaneous.
63 B/mm (1600 bpi) 120 KB/sec
246 B/mm (6250 bpi) 468 KB/sec
- Recording density 63/246 B/mm (1600/6250 bpi)
- Tape speed 190.5 cm/s (75 ips)
- Nominal IBG
63 B/mm (1600 bpi) 15.24 mm (0.6 in.)
246 B/mm (6250 bpi) 6.62 mm (0.3 in.)
- Nominal Read/Write Access Time*
63 B/mm (1600 bpi) 4.4 ms (Read) 3.1 ms (Write)
246 B/mm (6250 bpi) 3.4 ms (Read) 3.1 ms (Write)

*Access time is the time required to read or write the first byte of data in the block after a read/write instruction has been initiated from a stopped position in the IBG.

- Rewind time per reel
610m (2,400 ft.) 2.4 minutes

PHYSICAL SPECIFICATIONS

1589 Magnetic Tape Subsystem as mounted in a:

1.0 meter rack:

Width: 650mm (25.6 in.)
Depth: 921mm (36.3 in.)
Height: 1.0m (39.3 in.)
Weight: 218.4 Kg (480 lbs.)

1.6 meter rack:

Width: 650mm (25.6 in.)
Depth: 921mm (36.3 in.)
Height: 1.6m (62.1 in.)
Weight: 249.4 Kg (548 lbs.) Model C02
Weight: 360.8 Kg (793 lbs.) Model E02

PERSONAL SYSTEM/2 MODEL 50

Machine: 8550-021

Processor: Intel 80286, 10 MHz
Intel 80287 Math Co-Processor, 10 MHz
(Optional)

Memory: 1Mb RAM on the system board
Expandable to 7Mb

Storage: Model 50, 8550-021

- One 3½" 1.44Mb diskette drive
- One 20Mb fixed disk

Optional on Model 50, 8550-021

- Second 3½" 1.44Mb diskette drive
- External 3363 Optical Disk Drive
- 6157 Streaming Tape Drive
- 4869 External 5¼" Diskette Drive

Video: Video Graphic Array (VGA)

- 9x16 character box (720x400 text mode)
- 640x480 16 colors from more than 256K palette
- 320x200 256-colors from more than 256K palette
- 256Kb video RAM
- Analog display interface

Ports: Serial (19.2Kbps - 25-pin male)
Parallel (bidirectional - 25-pin male)
Pointing device (for example, mouse; 6-pin module)
Keyboard (6-pin module)
Display (15-pin module)

Expansion: Three expansion slots

Options: See Attachment Card and Options Table

Size: Height = 5.5 inches, Width = 14.2 inches, Depth = 16.5 inches
Weight = 21 pounds

Retail Price: 8550-021 \$3,595

Prices shown are for your information only and are subject to change without notice. Applicable taxes are not included.

PERSONAL SYSTEM/2 MODEL 60

Machine: 8560-041, 071

Processor: Intel 80286, 10 MHz
Intel 80287 Math Co-Processor, 10 MHz
(Optional)

Memory: 1Mb RAM on the system board
Expandable to 15Mb

Storage: Model 60-041
◦ One 3½" 1.44Mb diskette drive
◦ One 44Mb fixed disk
Model 60-071
◦ One 3½" 1.44 Mb diskette drive
◦ One 70Mb fixed disk
Optional on Model 60-041, 071
◦ Second 3½" 1.44 Mb diskette drive
◦ Maximum of two fixed disks
- Second 44Mb fixed disk (041 only)
- Second 70Mb fixed disk (071 only)
or one 115Mb fixed disk (071 only)
◦ Internal or external 3363 Optical Disk Drive
◦ 6157 Streaming Tape Drive
◦ 4869 External 5¼" Diskette Drive

Video: Video Graphic Array (VGA)
◦ 9x16 character box (720x400 text mode)
◦ 640x480 16 colors from more than 256K palette
◦ 320x200 256 colors from more than 256K palette
◦ 256Kb video RAM
◦ Analog display interface

Ports: Serial (up to 19.2Kbps - 25-pin male)
Parallel (bidirectional - 25-pin male)
Pointing device (for example, mouse; 6-pin module)
Keyboard (6-pin module)
Display (15-pin module)

Expansion: Seven expansion slots

Options: See Attachment Card and Options Table

Size: Height = 23.5 inches, Width = 6.5 inches, Depth = 19 inches
Weight = 47 pounds

Retail 8560-041 \$5,295
Price: 8560-071 \$6,295

Prices shown are for your information only and are subject to change without notice. Applicable taxes are not included.

4201 PROPRINTER II

The IBM Proprinter II is a new member of the Proprinter family and attaches to IBM Personal Computers, to compatible non-IBM personal computers, and to certain displays. The printer offers three software or operator selectable burst print speeds of 40 cps (Near Letter Quality), 120 cps (Emphasized-Fastfont) and 240 cps (DP mode-Fastfont). Speed is dependent on the selected print mode and pitch. Graphics and text modes may be alternately used in the same document.

The IBM Proprinter II printer offers one-button selection of quality and quiet mode. In addition, the operator may use the printer setup mode to select Fastfont, double high printing, double wide printing, 12 or 10 of spi, condensed print, emphasized print, NLQ II font, or printer reset to initial defaults.

IBM 3299 TERMINAL MULTIPLEXER

The IBM 3299 Terminal Multiplexer offers an economic solution to the proliferation of device cables. As display terminal usage becomes more prevalent in an organization, users very often encounter limitations due to overcrowding of a building's wiring/cable raceways. In addition, maximum allowable cable lengths for controllers to the display terminals can be a problem in many larger buildings.

The IBM 3299 can be used with the IBM 9370 Workstation Subsystem Controller and the IBM 3174 Subsystem Control Unit. Each multiplexer is connected to the controller via one cable and can support up to eight terminals via cables from the 3299 to each device. This can often substantially reduce the amount of cable required and can increase the distance allowed between the controller and the terminal.

Some highlights are:

- Reduced cabling requirements can result in significant cost savings in both amount of cable that is required and the cost of laying that cable.
- Overcrowded conditions in cable raceways in existing buildings can often be alleviated. For new buildings, more efficient raceway utilization can be incorporated in the design of the building.
- Terminal placement in larger buildings can now be less constrained due to the distance from the controller. With the 3299, a range of up to almost two miles is allowed depending on the cabling media used.
- The IBM 3299 Terminal Multiplexer requires no changes to existing application programs.

By designing a hierarchical building wiring scheme from local or remote controllers to wiring closets or concentration points in user areas, the cost and number of cables are reduced, relocation of devices becomes easier and the overall result may be an economical and rapid way of providing accessibility to more end users.

IBM 3864 MODEM

The IBM 3864 Modem is an advanced technology, microprocessor-based modem that enables communications products to transmit data over unconditioned non-switched (leased) telephone lines or the public switched telephone network. The standard 3864 Modem Model 1 is fully compatible with the 3834 Modem and the IBM 3868 Rack-Mounted Modem Model 2.

Operating at a speed of 4,800 bits per second (bps) or 2,400 bps backup speed, the 3864 is designed to participate in the management and control of telecommunications networks. The identification of telecommunication environment operating problems both quickly and efficiently is accomplished by either program control or by using the 3864 Modem control panel.

Highlights

The modem and supporting programs are an integral part of the problem determination functions of IBM's Systems Network Architecture (SNA). With the 3864 and the IBM Network Problem Determination Application (NPDA) Program Product, a network operator can isolate most problems to the communication controller, communication line, interface, control unit, terminal or modem. The operator is alerted to potential communication problems and can respond to system error messages, initiate diagnostic tests or review and analyze network error data, all without disrupting the normal user operations.

The IBM 3864 Modem supports synchronous data transmission, either SDLC or BSC line controls on the public switched network and on non-switched (leased) AT&T Type 3002 unconditioned lines, and provides optional four-wire switched network backup at 4,800 bps for customizing the modem include multiterminal fan-out and extended diagnostics. Tail circuit attachment, rack mounting shelf and various telecommunication cable adapters are available as accessories.

- * Model 1: Four-wire duplex multipoint or point-to-point non-switched (leased) line configuration.

- * Model 2: Two-wire half-duplex operation over the public switched network lines via incorporated FCC registered protective coupler.
- * Microprocessor design provides for digital signal processing and diagnostics.
- * Auto-answer: Automatic answering of switched network and switched network backup calls.
- * Remote speed selection for backup speed from control modem site.
- * Anti-streaming, an automatic function, can be enabled or disabled under control of a separate user setup switch.
- * Front panel address identification and selection.
- * Automatic and adaptive equalization.
- * Operator panel with operational status indicators.
- * Data scrambler to ensure even distribution of energy on communication lines, improved synchronization and improved Block Error Rate (BER) performance.
- * Automatic or operator-invoked test and status retrieval.
- * Tests for line quality and other diagnostics:
 - Local/remote modem status retrieval.
 - Local modem self-test.
 - Remote DTE interface status retrieval.
 - Remote power and modem test with extended diagnostic feature.
 - Modem/line transmit and receive tests.
 - Remote loopback test.
 - Loop test.
 - A composite analysis of received signals and test commands are transmitted at 1,200 bps service speed to ensure maximum reliability of the data and tests in degraded communication line environments. Measurement of transmission and line characteristics is performed during normal data transmission to ensure capture of intermittent and transient conditions.
- * Customer-accessible setup switches allow easy installation and reconfiguration when application requirements change.

Product differences

3864 Modem provides:

- * Multiterminal fan-out.
- * Switched network backup.
- * Multipoint control-tailed modem.

3834 Modem provides:

- * Lower cost.
- * Smaller packaging.
- * RAS improvements.
- * Extended diagnostics (standard).

SOFTWARE

IBM SOLUTION PAC: OFFICE SERIES VM EDITION

Office Series (VM Edition) is an integrated package of comprehensive office software products and services, designed to increase the productivity and effectiveness of today's managers and business professionals.

IBM SolutionPac can help your organization:

- Eliminate unproductive activities, such as "telephone tag."
- Distribute information more efficiently.
- Automate repetitive and administrative tasks.
- Minimize the amount of time spent reacting and maximize the amount of time spent creating.
- Facilitate more timely and effective decision making with more meaningful data.
- Become productive more quickly with an easy-to-learn system.

A wide range of office functions - Office Series (VM Edition) delivers powerful office functions through a set of proven IBM software products. In addition, the Professional Office System Applications Support Feature simplifies user access to each of these functions for both the host and IBM Personal Computer (PC) through a common set of menus.

Business communications - provides an on-line telephone directory, a full-screen calculator, and an electronic bulletin board for posting and viewing news items.

Data Base Query - lets office personnel search relational data bases and access current information.

Text Processing helps users write and edit letters, memos and other formal documents. These documents can then be electronically stored, printed or sent to other departmental or enterprise-wide network users.

Decision support - allows managers and business professionals to create and edit reports and graphs, and prepare statistical and financial analyses. It also permits users to prepare graphs and electronically "staple" them to on-line notes or documents for distribution within networks.

Calendar - assists managers and professionals in keeping their calendars up to date, identifying and resolving scheduling conflicts, and notifying others of meeting times and locations. It can even help reserve conference rooms and audio-visual equipment.

Electronic mail - enables timely information distribution and delivery.

IBM PC component - Office Series (VM Edition) includes an IBM PC component that allows business professionals to access VM host functions, and provides text and decision support tasks on an IBM PC. IBM PC menus, compatible with those on the host system, are provided to simplify the use of host/IBM PC functions.

A text processing program lets users write and edit letters, memos and other formal documents, while benefitting from IBM PC response times.

Decision support software helps users solve problems and make decisions by querying and entering both host- and IBM PC-based information. Users can create customized reports and displays without memorizing commands or specific program-like logic. The software includes an electronic spreadsheet that can be combined with financial planning, graphics and analysis capabilities. For added ease of use, a special feature permits English sentence-like queries on the PC.

Office Series (VM Edition) provides a wide range of services to help customers plan, install and customize a system, and train users on the use of the software.

Software defect support is available for Office Series (VM Edition) customers through a toll-free telephone number. In addition to providing a single point of contact for software questions, the IBM Support Center will also provide periodic system updates.

Packaged installation and implementation assistance - IBM Systems Integration and Professional Services offers comprehensive assistance to help customers install and use Office Series (VM Edition).

These time-saving services are available to assist departments in implementing Office Series (VM Edition) functions with a minimum of effort on a schedule that provides immediate user benefits.

Installation Assistance for the host includes:

- Installing host Office Series (VM Edition) software.
- Running sample programs and demonstrating their function.
- Providing turnover training to customer operators.
- Developing an operations guide.

Installation Assistance for the IBM Personal Computer (PC) components of Office Series (VM Edition) includes:

- Installing the IBM PC Disk Operating System.
- Installing Office Series (VM Edition) PC software.
- Installing the PC component of the Professional Office System Applications Support Feature.
- PC user file maintenance.
- Providing start-up operator training for the first IBM PC and monitoring customer training for two additional PCs.

User Implementation services include four offerings which can be ordered separately to customize and train users on Office Series (VM Edition) functions. System Support, User Software Customization, On-Site User Education, and IBM PC Software Training are designed to help users become productive in a short period of time on both host and IBM PC components.

Single point of contact for support - By dialing a single "800" number, Office Series (VM Edition) users can talk to IBM Support Center specialists and obtain defect support for both host and IBM Personal Computer (PC) software components of this IBM Solution Pac. This support is available seven days a week, 24 hours a day for IBM host software. Monday through Friday, between the hours of 8:30 a.m. and 5:00 p.m. Central time, the IBM Support Center will return calls to customers reporting PC component programs defects.

These specialists will assist over the telephone with problem determination. While on the telephone, a national product specialist will make a reasonable effort to resolve the problem immediately. If a code change is required and a solution already exists, it will be sent to you. If the problem is new, support center staff will find a solution and send it to you as soon as possible.

In addition, IBM Support Center specialists will provide periodic system updates.

Solution Pac: Office Series VM Edition is determined by the application functions selected to meet a customer's needs.

The following products are included in the IBM SolutionPac Office Series. Each program has unique functions and the synergy of their combined use provides a powerful tool for ADOT.

Office Series (VM Edition) uses the following operating systems and application software:

Host Applications

Operating system

- IBM Virtual Machine/Integrated System (VM/IS).

Business communications/administrative support (electronic mail and calendar)

- IBM Professional Office System (PROFS).
- IBM PROFS Applications Support Feature.

Text processing

- IBM DisplayWrite/370.
- IBM VM3812.

Intelligent workstation support

- IBM 3270 PC File Transfer Program.

Networking support

- IBM Remote Spooling Communication Subsystem (RSCS).
- IBM Pass-Through Facility (PVM).

Decision support

- IBM Application System (AS).

Data base query

- IBM Structured Query Language/Data System (SQL/DS).
- IBM Query Management Facility (QMF).

IBM Personal Computer Applications

Operating system

- IBM Disk Operating System (PC DOS)

Text

- IBM DisplayWrite/4

Host communications

- IBM PC Emulation Program, entry level.
- IBM 3270 PC Control Program with High-Level Language Application Program Interface.
- IBM EZ-VU II Runtime Facility

Decision support (optional)

- IBM Personal Decision Series:
 - Data Edition.
 - Plans plus Edition.
 - Reports plus Edition.
 - English Access Edition

Host data access (optional)

- IBM Host Data Base View.

VIRTUAL MACHINE/INTEGRATED SYSTEM (VM/IS)

Included in our proposed SolutionPac system solutions, IBM offers the Virtual Machine/Integrated System, or VM/IS. VM/IS is a pretested, ready-to-load, ready-to-run package of software for the IBM 9370 Information System or IBM 4381 processors. It includes IBM's Virtual Machine/Systems Product (VM/SP) operating system along with popular end-user software.

VM/IS is designed to provide users with the power and flexibility of System/370 architecture with minimal complexity. It is easy to use, and can be customized to meet the software needs of executives, secretaries, personal computer users, professionals of any kind -- virtually everyone who uses the 9370 Information System.

With VM/IS, end users throughout your organization can begin productive work almost immediately. VM/IS is based on VM, or the Virtual Machine, operating system. It provides each user with what appears to be a dedicated System/370 computer that can be tailored to that user's job and style of work.

VM is interactive, fast and efficient. It makes it easy for users to communicate across the hall, across the country or around the world. VM also supports the applications today's end users need most. And, it can run on all System/370 processors, from the smallest to the largest.

VM is the high-performance base for VM/IS software. VM/IS supports users with general functions such as system administration, text and graphics preparation, file management and application development.

Individual work groups can choose optional application packages to increase capabilities or add some other function. It is this ability to provide tailored packages that gives VM/IS its real productivity potential.

VM/IS offers application packages to support the work done by all kinds of users, all across the organization. Highlights of the packages are:

- ° Intelligent Workstation Support - When installed with companion PC programs, this package allows PC users to transfer files between their PC and a VM system. It also provides advanced VM features to those users without requiring them to learn VM commands.
- ° Engineering/Scientific Program Development Support - This package helps engineers and scientists develop programs and create graphics. It is available with FORTRAN, and includes programming utilities and high-accuracy arithmetic features.
- ° Data Base Query - Consisting of IBM's proven Structured Query Language/Data System (SQL/DS), this package allows you to create and manage a relational data base. It can be used to retrieve data, and create and print reports. Executives, engineers and other professionals can use it to control and combine the information they need from different sources.

- APL Language Support - This powerful APL2 package provides a high performance tool for problem solving, data analysis, charting, system design, and application development. APL2 also provides an easy-to-use interface that makes it possible to transfer relational data from a data base into APL2 workspaces.
- Problem-Solving Language - The IBM BASIC/VM and Pascal/VS programming languages are included in this package. Both are useful for solving everyday business problems. BASIC is popular for simple problems and calculator-like functions. Pascal is well suited for structured programming.
- Networking Support - This can be an especially important productivity tool in today's expanding data processing networks. This package provides computer network support for sending and receiving information between sites, and for logging onto remote systems. It provides for data transfer among systems in a network, message and file transfer, remote job entry, and the printing of output remote printers.
- Communications Controller Support - This package provides support for the IBM 37X5 Communication Controller. It includes Advanced Communications Function/System Support Programs (ACF/SSP) and the Emulator Program for the 3725 (EP3725). This option is intended primarily for VM/IS users on 4381 processors since the IBM 9370 utilizes integrated communications adapters.

VM/IS is designed for end users; but when they use it, the benefits can be felt throughout an organization. For example:

- Senior management will appreciate the impact VM/IS can have on the productivity of end users, and its adaptability to changing business needs and structure.
- Department heads will be pleased with the system's price/performance, its ability to provide access to the data bases of the organization, the ease with which it can be installed and used, and its considerable and flexible growth potential.
- System administrators will notice the system's easy-to-follow documentation, its load-and-go installation, its simple maintenance procedures, and its Remote System Programmer support.
- Data Processing Management will recognize the benefits of the package's affinity with System/370 and VM architectures, and its support of different types of local area networks (LANS).

From the individual end user throughout the organization, the IBM Virtual Machine/Integrated System delivers easy-to-use productivity features to the people who need them most. This versatile productivity package can help you get the most out of your high-performance IBM 9370 Information System.

APPLICATION SYSTEM (AS)

Application System is an interactive licensed program to help business people get their jobs done better and faster. Its powerful and integrated facilities make it a comprehensive system for decision support, personal computing, and generating departmental applications.

English language commands, conversational prompts, option windows, PF keys, and other facilities give AS flexible operation and help make it easy for users to:

- Collect and manage data
- Retrieve and analyze information
- Produce formalized reports
- Present information graphically
- Use statistical analyses and forecasting routines
- Develop business plans and evaluate alternatives
- Control large projects and draw critical path networks
- Create and format letters and manuals
- Develop a variety of applications for individual or general use

Key Functions, Facilities and Features

- Data management: Data can be entered and updated interactively at a terminal or loaded from another system. Data files can be combined, updated, reorganized, and summarized. Full data management facilities and data dictionary safeguard against inaccurate data entry through extensive verification and validation facilities.

In a VM operating environment, AS supports access to private AS data, CMS data files, VSAM data sets and relational data held in Structured Query Language/Data System (SQL/DS) tables. SQL/DS support provides for extra security, concurrent update, and authorized access to corporate data on tables up to 32 billion bytes in size.

- Information retrieval: The user can select the exact information desired and browse through it or display it in the most suitable form. Graphics or tabular summaries, comparisons, rankings, calculations, sorts, selects, and categorical analyses of data can be done.
- Formal reporting: The user can create formal reports using AS default formats or specify a design for tailored reports that can be repetitively generated with new data. Reports may include calculated data, statistical evaluations and modeling results, titles and headings, totals by row and column, and detailed or summary information. Upper- and lowercase letters, color and different typestyles can be used to give reports a professional appearance.
- Business graphics: With a single command, data can be converted into one of several clear and powerful business graphics: line and scatter

plots, histograms, pies, surfaces, radars, maps, and mixed charts. Skyscraper (tower) charts showing an apparent 3-D effect can be created using blocks, cylinders, wedges, or pyramids. AS will produce scaling, titles, and legends for the user, or the user's own can be specified. High-resolution graphics can be created with up to seven colors.

Interactive design using DRAW allows a syntax-free method for foil design, incorporating boxes, circles, lines, arrows, and positioning descriptive notes.

- **Statistics and forecasting:** The wide range of analytical and descriptive statistical functions built into AS include elementary statistics, correlations, regression analysis, trend analysis, time series forecasting, significance tests, four-component analyses, and more. AS also has integrated graphics for curve-fitting and linear trend analysis.
- **Business planning:** The built-in modeling facilities of AS can be used to evaluate plan alternatives. The user defines known or projected values for certain items in the business plan and specifies relationships between others. AS calculates values for all items on the basis of their interrelationships and displays results in a spreadsheet-like format. Then, the user explores "what-if" scenarios by changing values directly on the screen and allowing AS to redisplay the results with all updated values highlighted. The user can also enter goals, and AS will use backward iteration to adjust the model.
- **Project control:** AS can process arrow and precedence networks on the basis of time or resource analysis. Network drawings can also be produced on the screen or on 737X Plotters using four scales with multiple facilities for examining all or part of the network in selected detail. Free float as well as total float can be calculated. Resources can be assigned to tasks and analyzed to compare availability with usage, with a graphic display of the results. Probable completion distribution from risk analysis, by activity or globally, can also be displayed graphically. Other charts and a variety of standard project report formats can be created with this function.
- **Text processing:** The flexible AS text processing function has features such as margin justification, multiple columns, section headings, control over spacing, indenting and paging, routines for standard tasks, preparation of figure lists and indexes, and creation of boxes or frames around text. Information from reports, graphics, and other AS functions can be included with a few keystrokes. The user can create text and include data processed at the same time.
- **Word processing:** The AS MEMO facility lets users prepare memos, letters, and reports using their own format. Other features let users highlight items, produce bulleted lists, include conditional text, use different typestyles, and incorporate AS data into documents.
- **Application development:** Application System can produce results similar to those of traditional programming methods for successfully building and installing a variety of customized computer applications. Its

capabilities provide for defined PF keys; designing input screens; specifying levels of password protection for data and applications, using extensive data validation techniques, including pattern and mask functions; using arrays, logical operators, and global system values; creating and processing cyclic files; recalling command sequences with a single label; relating data from several files; prompting for values; specifying replaceable parameters; generating commands on the basis of conditions or test results; defining routines; and much more.

- Hardcopy generation: Printing of data files and screen images can be accomplished easily with a single program function key or with AS commands. AS offers a variety of printer options, including dot matrix, Displaywriter, and color printers. Superior quality printed output can be produced using the 6670 Information Distributor, allowing up to four typesets within the same document.
- National languages: AS supports operation in numerous national languages in addition to English. Any user can change from the default language to another language either at start-up or at any time during a session.
- Communication between ISPF and AS: There is a two-way interface between AS and ISPF. The user can use any ISPF facility from within AS, and ISPF dialogs can pass commands and variables to AS.
- The relational data base interface allows the user to read, write, and update SQL/DS or DB2 data bases from within AS. It gives the user the power of AS with the capabilities of a relational data base.
- The Professional Office System (PROFS) interface allows the user to file and electronically mail final-form documents produced in AS, in both text and graphic form.

Potential Benefits

- Information services departments find that AS helps meet a number of requirements:
 - User requests: Programmers and analysts can use AS to help improve productivity over what it would be if using procedural languages for developing and maintaining a variety of applications and for fast turnaround on ad hoc requests for information.
 - Prototyping: Because AS can be an effective prototyping tool, users can be involved in the early stages of application development, testing functions, and recommending more effective approaches.
 - Internal requirements: AS can be used by the I/S department to identify, track, and present its own measurement data, personnel information, and financial considerations.

- Managing DP projects: The comprehensive project control function of AS can be of significant value in helping management plan, track, and control the large development efforts and facility changes that frequently occur.
- o Application System is a single, integrated, multifunction product that can meet the sophisticated and diverse needs of a broad range of users. The ease of use inherent in AS helps foster a cohesive, self-sufficient user community.

DISPLAYWRITE/370

The DisplayWrite/370 licensed program provides word processing functions for the professional end user. It includes a full-screen text editor/formatter that provides basic and advanced text functions for creation and revision of documents. Document printing will be supported by creating print data streams. In addition, DisplayWrite/370 provides multilanguage linguistic support for automatic hyphenation, spelling verification, spelling correction assistance, grade-level analyzer, and synonyms.

Key Functions, Facilities and Features

- Easy-to-learn and easy-to-use operation characteristics
- Context-dependent HELP and tutorial
- User ability to set own defaults
- Command lists to perform special tasks
- Split screen for viewing another or the same document
- UNDO/REDO of commands and local editing
- Basic text entry and editing capabilities
- Advanced text editing capabilities
- Support for variable specification and merging
- Support for pattern letters
- Support of RFTDCA and FFTDCA document interchange
- National language support
- Multilanguage linguistic aids
- Full-screen interactive text editor/formatter supporting the 3270 Information Display System and the 3270-PC display terminal
- Optional support of the 3270 extended data stream

PROFESSIONAL OFFICE SYSTEM (PROFS)

PROFS is a licensed program that assists managers, professionals, secretaries, and support personnel in creating, communicating, retrieving, and controlling job-related information. The product also gives users the ability to access other electronic business tools such as graphics, engineering drawings, and spreadsheets. PROFS consists of VM/SP-based application programs that allow office functions to be performed on the same terminals used for interactive problem solving.

Among the capabilities of PROFS are:

- Distribution services - The convenience of sending and receiving written communications (text, graphics, drawings) locally or over long distances electronically from an unlimited number of diversified workstations
- Library services - The ability to store and retrieve notes, documents, and statistics electronically at the host for instant accessibility at the workstation
- Personal services - Assistance in scheduling appointments, maintaining personal and departmental calendars, and providing automatic reminders and unlimited access to electronic telephone directories
- Integrated information system - Providing the user with an increased ability to manage information quickly through improved communications channels
- Integrated interface to DisplayWrite/370 as an additional document preparation facility
- The PROFS PC Support Feature allows users of the IBM Personal Computer family to have access to the powerful functions of PROFS. Used in conjunction with PROFS at the host, this feature provides the intelligent-workstation user with access to many PROFS functions while using the PC.

Potential Benefits

PROFS functions as a specific productivity improver for end users:

- Decreases redundant or wasteful activities such as excessive time spent searching for documents, incomplete telephone calls ("telephone tag"), proofreading for spelling errors.
- Improves communications among end users via electronic mail functions.
- Provides single-terminal access to text and data files

- Speeds up decision cycles by providing faster access to needed information
- Broadens management's span of control by allowing information to be distributed to more people faster
- Reduces copier requirements for electronically managed documents
- Speeds up document preparation cycle from initial entry through final output, using memo preparation facilities, draft document review, and final output on quality printers

STRUCTURED QUERY LANGUAGE/DATA SYSTEM (SQL/DS)

SQL/DS is a complete, full-function, relational data base management system with integrated query and report writing facilities. It is designed for use with VSE and VM/SP systems, and is broadly compatible with DB2 in MVS environments.

SQL/DS is a licensed program that complements and extends the capabilities of IBM's data system offerings. It may be used as a base for decision support systems as well as for implementation of traditional data processing applications.

SQL/DS, with its relational data structure, supports application areas for which interactive query, report writing, and end-user data base facilities are desired. It addresses environments, such as planning and prototyping, for which data structure and application requirements are subject to frequent change. End-users and DP professionals in business, engineering, and scientific disciplines are provided direct access to data, thus allowing greater productivity.

Product Highlights:

- Relational data model.
- Structured Query Language.
- Interactive query/report writing.
- Online HELP facility.
- Interactive program development with CMS or ICCF.
- Support for applications written in COBOL, PL/I, FORTRAN, Assembler, APL2, and BASIC.
- Integrated, user-accessible catalog/active repository.
- Concurrent, online, interactive, and batch access to data for multiple users.
- Security and authorization at user and data field levels.
- Automatic, optimized access path selection.
- Support for installation-defined archive/restore procedures.
- Log archiving, selective log processing.

- Directory verification option.
- DL/I DOS/VS extract facility (VSE only).

Benefits

- A single, high-level data access language, SQL, is used for programming interactive, online query access. The same syntax is used to define data, and control user and data access.
- Basic reports can be developed without writing an application program.
- SQL/DS supports a relational model of data. Data is defined and accessed in terms of tables and operations on tables. This makes ad hoc query and data administration easy.
- The interactive data access provided by SQL/DS increases efficiency of application development. Application developers can prototype their application and data designs, report formats, and results before beginning the actual implementation.
- Users can utilize the facilities of CMS or ICCF for interactive program development, compilation, execution, and testing of SQL/DS applications.
- Macros combining commands and SQL statements can be customized by the user or standardized for individual installations. They can be used to define the terminal environment, issue a stored query, and execute one or more stored reports. An installation can also specify, save, and modify a profile of default characteristics for each authorized user.

QUERY MANAGEMENT FACILITY (QMF)

Query Management Facility (QMF) is IBM's recommended query and report generation product. It is a licensed program designed to provide interactive data base facilities. The information that is the result of a query may be used to create customized reports and charts. QMF can be highly useful to the data processing professional as a high-productivity programming tool for use in application development and prototyping.

In the VM/SP and VSE environments, QMF operates against data in Structured Query Language/Data Systems (SQL/DS). QMF utilizes Interactive System Productivity Facility (ISPF) and Graphical Data Display Manager (GDDM).

QMF provides an interface to enable users to access the relational data base SQL/DS. The following are some specific characteristics:

- Both Structured Query Language (SQL) style and Query-by-Example (QBE) style query and data manipulation capabilities.
- Data definition functions through the SQL language.
- An easy-to-specify interactive reports definition and generation capability for ad hoc queries.
- A simple set of commands that allows handling of queries, report forms, and procedures.
- An interface to the Interactive Chart Utility (ICU), to graphically present data prepared using QMF. ICU is a facility that is provided with the GDDM Presentation Graphics Feature.
- Application support facilities to allow high-level programming languages to call QMF and to integrate the applications.
- Office integration capabilities providing users the ability to insert a QMF report within a document being created or updated via PROFS, PS/TSO, XEDIT, ISPF edit, or CMS NOTE.
- Data integration via the Data Extract (DXT) end-user dialogs, providing QMF users access within their QMF sessions on both relational and nonrelational data residing on the same system or at remote locations.
- Extensive online HELP facility to assist in the composition of SQL and QBE queries, customized report generation, and chart creation.
- Resource control facilities that enable the installation to control relational data base usage.

Users of QMF can produce meaningful results utilizing only that portion of the SQL or QBE language facility and/or QMF commands that meet their needs.

FILE TRANSFER PROGRAM (FTP)

File Transfer Program Version 2 for MVS and VSE is a general-purpose program product to transfer and update all sizes of VSAM and sequential disk or tape files between VSE, and MVS based systems in a SNA network.

File Transfer Program Version 2 for VM enables the VM installation to transfer or update files between FTP Version 2 network nodes.

They both support distributed data processing and the increasing demand of powerful file transfer capabilities with high performance and ease of use.

Key Functions, Facilities and Features

- High transmission performance
- Checkpoint/restart facilities
- File handling
- Ease of use
- Data security and integrity
- FTP Version 2 supports solutions with decreased complexity, increased data availability, and enhanced local performance.
- FTP Version 2 offers file transfer with increased reliability, increased performance, ease of installation, and ease of use.

IBM SUPPORT SERVICES

IBM SUPPORT SERVICES

All of the following "other IBM considerations and support services" are available to ADOT:

- marketing representative
- systems engineering assistance
 - branch office and regional specialists
 - industry specialists
 - technical support field system centers
- systems integration and professional services
- IBM Users Groups
- Pre-installation Test Time
- Software Test Periods
- Investment Tax Credits

In addition to being a company that can provide you with a full range of hardware and software options, IBM has a complete support organization in Phoenix to work with you.

The key individual in this support organization is the IBM marketing representative. She has a two-fold job. She represents IBM to you and will make recommendations to you. Her second task is to make certain that IBM's support organization stays responsive to your needs.

The next individual in the Support Organization is the Systems Engineer. He will work with you in two ways. One way is by assisting the marketing representative in defining systems, requirements, disseminating technical information, and assisting you with installation planning, including such activities as implementation scheduling, selection of education courses, selection of software options, and definition of controls and standards. The second way is under a Systems Engineering Services contract where he produces the end product under customer direction rather than assisting you in producing the end product.

The third individual in the support organization is the Customer Engineer. A specific Customer Engineer will be given the responsibility for your installation. He will draw upon the rest of the Field Engineering Division's resources to properly service your system. Some of the resources available to him are Operations Systems Engineers, Hardware Specialists, Teleprocessing Support Center, Technical Support Center, and a Teleprocessing Databank System which contains the latest information on all maintenance experience.

Another major resource that the marketing representative has is a variety of customer education programs. These range from classes held in your facility to classes conducted in IBM Education Centers, Customer Executive education at plant sites, Industry Seminars and Systems Science Institute classes.

"IBM means service" is not a trite term to us. We firmly believe the best way to win and keep business is with an outstanding support organization.

IBM MARKETING REPRESENTATIVE

A key objective of any data processing system is to provide management with timely information on which decisions can be based. In assisting the customer in initiating these data processing programs, often covering a wide range of business operations, the IBM Marketing Representative has the responsibility to obtain agreement with the customer to help meet those customer objectives. She has the ability to work successfully with others and the leadership to guide the joint efforts of the marketing support group.

An IBM Marketing Representative will develop and communicate logical recommendations for use of IBM products for the customer's consideration. She can propose new solutions to business management problems that can be integrated into customer's operation.

Because all types of industries use IBM data processing equipment, our representatives are selected from many types of educational backgrounds. Engineering is useful, of course, but a broad liberal arts education with an exposure to mathematics or the physical sciences also is helpful.

Of course, the job does require considerable technical training. An IBM Marketing Representative undergoes training for approximately 60 to 90 weeks, beginning with classroom instruction and proceeding to job training in the field. Training actually continues throughout his IBM career.

In IBM's data processing training program, formal classwork is combined with actual experience in different business organizations. After a sound orientation in equipment and its applications, the Marketing Representative begins an extended period of practical, on-the-job training. Under the supervision of management and experienced Marketing Representatives, she helps to prepare equipment proposals and develops working demonstrations. The final step in this comprehensive training program is attendance at IBM's marketing school.

These factors are designed to assure that the IBM Marketing Representative has the experience, education and ability required for recommendation of and planning for the installation of IBM equipment.

One of the most valuable services IBM provides is that offered by the IBM Marketing Representative. She may frequently offer new ideas for better ways to conduct the customer's business. It is her responsibility also to act as liaison between the user and the IBM Corporation in all fields relevant to data processing.

The Marketing Representative will coordinate the services described below.

- Systems Engineering Assistance. She will make sure that Systems Engineers are assigned to respond to the customer's needs.
- Field Engineering. She makes sure that scheduled and unscheduled maintenance is available for IBM equipment and program systems.

- Education. She makes sure that the customer's people are offered training in the phases of data processing necessary to implement and operate the data processing system in an efficient manner.
- IBM Center Services. She helps the customer take full advantage of the pre-installation services available at IBM Centers.

SYSTEMS ENGINEERING ASSISTANCE

IBM Systems Engineers function as highly skilled members of the IBM marketing team. They work very closely with the IBM marketing representative providing the technical expertise and in-depth application knowledge so vital in this day of ever-increasing technology change. This enables IBM to be certain it is providing its customers the very best products and services available to satisfy their data processing requirements.

Among the many tasks the Systems Engineers perform as members of the marketing team are:

- Understanding customer applications and systems requirements by participating with management in planning and evaluation reviews.
- Helping to identify new application areas.
- Formulating system solutions which best satisfy customer requirements.
- Assuring the feasibility of application and equipment configuration approaches.
- Developing performance estimates for proposed applications.
- Preparing and conducting application demonstrations.
- Developing and monitoring implementation and preinstallation schedules.
- Providing advice to customers in selection of control programs, language processors, program products, utilities and other IBM programs.
- Helping to develop education plans for customer personnel.

To effectively perform these tasks, Systems Engineers receive training and experience in dealing with systems implementation problems. Typically, they are college graduates with degrees in business administration, mathematics, engineering or a physical science. They possess a high data processing aptitude and, we think, very favorable personal characteristics. They keep abreast of the rapidly changing technology of data processing by many means, including:

- Formal, structured, classroom education including advanced study at IBM development locations, at the IBM Systems Research Institute or at selected universities.
- Newsletters from a variety of functional staff groups.
- Technical journals and texts, and preliminary versions of IBM Reference Manuals.

- Seminars, meetings, workshops, symposia and professional associations.
- Making extensive use of the HONE (Hands-On-Network Environment) and SECOM (Systems Engineering Communications) terminal networks. These exclusive IBM interactive systems provide training in the latest DP developments and methods, sophisticated analytical and project management tools, interactive programming and configuration facilities, and the immediate dissemination of advanced technical data.

In addition, the Account Systems Engineer can immediately get expert assistance in any of the areas outlined previously where additional in-depth knowledge is required. This expert assistance is provided by:

- Branch Office and Regional Specialists - Other Systems Engineers within the local branch or other branches who have a designated area of specialization such as telecommunications, Storage Systems, Data Base, and certain designated program products.
- Industry Specialists - Systems Engineers either in the local branch, other branch offices, or IBM Headquarters locations for Industry Marketing Groups who have in-depth industry application knowledge who can provide you with guidance in application development and help to keep both the account team and your staff up-to-date on the newest developments within their particular industry.
- Technical Support Field System Centers - centers whose staffs provide in-depth technical support to the specialists and the account support teams for both hardware and software. They provide information on special processing techniques installation planning, coordination of integration of various software components, etc.

There is no charge associated with any of the above services.

Systems Engineers also provide or make available through the IBM Service Centers, a wide variety of services to the customer to aid in the installation and enhancement of IBM Data Processing Systems. These Systems Engineering Services may be used in cases where the customer needs assistance in detail design, programming or documentation. The IBM Systems Engineer will also provide instruction, under certain circumstances, to customer personnel on a wide variety of subjects. These services are provided for a fee on the basis of a defined scope of effort directed toward specific customer tasks.

In summary, IBM Systems Engineers are true professionals who are constantly on the leading edge of the rapidly advancing technology of the Data Processing Industry. Their experience is made available to you so that you may receive maximum benefit from your data processing investment.

SYSTEMS ENGINEERING SERVICES

Skilled assistance in the application, installation and enhancement of data processing systems is available through IBM Systems Engineering Services. With diverse academic backgrounds, extensive knowledge of data processing capabilities, and broad experience with a wide variety of computer applications, IBM Systems Engineers can do much to increase the efficiency and effectiveness of data processing applications.

Systems Engineering Services are available through Systems Engineers from your branch office or through IBM System Integration and Professional Services. These services are provided for a fee, based on a defined scope of effort directed toward specific data processing needs. The following activities are examples of services available:

- Development of program logic for application functions
- Program structuring and flowcharting
- Layouts of input/output records
- Development of program code and required Job Control Language
- Compilation, testing, and correction of programming
- Integration of tested programs into the system
- Conversion implementation
- Design and preparation of operational documentation

IBM Systems Engineering Services are modular and highly flexible to accommodate a broad range of requirements in assisting the customer. The customer retains responsibility for accomplishment and completion of his tasks.

CUSTOM CONTRACT SERVICES

IBM offers special application development services, for a fee under contract, to help meet customer needs for system design and analysis, application program development or enhancement, and systems installation and evaluation support. Custom Contract Services provides specialized project management skills and technical knowledge which can be used to accomplish those tasks which the customer may not be staffed to accomplish alone. IBM assumes project responsibility for the accomplishment of the tasks stated in the contract. Activities undertaken typically include:

- Requirements Definition
- Systems Analysis and Design
- Application Program Development
- Systems Integration and Test
- Training on the Developed System
- Performance Evaluation Support

Also included is responsibility for the performance of single or multiple tasks which are a part of the overall system development:

- Project Management Directional Support
- Development Productivity Technologies Directional Support
- Application Programming
- System Programming
- System Integration and Test

Custom Contract Services can be performed on a Best Estimate, a Fixed Price, or a Best Estimate with a Fixed Upper Limit basis. These Services are normally performed in multiple phases with each phase being estimated and priced upon completion of the preceding phase. The first phase is usually a requirements definition and design of the system while the second phase accomplishes system implementation and demonstration. Other conversion and maintenance support phases can follow if the customer desires.

EDUCATION

Training

A key consideration for any installation is the expense associated with maintaining expertise on the hardware and software. However, we would like to take this opportunity to reemphasize IBM's extensive educational offerings.

IBM Branch Support Center

One of the key considerations in this installation is that IBM has a 9370 installed in our Customer Support Center in Phoenix. You may use your pre-installation and test allowance for the proposed equipment to debug and convert your program before your own system is delivered. The IBM Customer Support Center's value for ADOT will be proven not only in areas of hardware and software, but will include some or all of the following offerings:

1. Installation Planning Seminars--a structured two-day session aimed at developing a detailed implementation plan.
2. Education--such as systems management seminars, independent study programs, and oriented education.
3. Installation Process Rehearsal--an intensive six hour session to familiarize your staff with the installation of the IPO/E.
4. Systems Engineers' Technical Guidance--availability of highly trained technical assistance with 9370's, ISP question and answers, design reviews, etc.
5. Product Information--demonstrations, seminars, and presentations on IBM products.
6. Installation Reviews--reviews which cover all aspects of implementation of 9370 Systems, both before and after installation.
7. Program and Systems Testing--ability to utilize our 9370 for testing, conversion preparation, backup, etc.

In addition to our local Branch Support Center, the IBM data processing customer education curriculum is designed to provide organized training for a wide range of users of IBM data processing equipment and program products. The training is as varied as the duties and responsibilities associated with the job requirements of your staff.

We consider our education programs and facilities to be the finest available. Our Regional Education Center is located in Los Angeles and includes the computer facilities of the Datacenter and a staff of data processing professionals. This education center, along with the others located

throughout the country, works closely with our Education Development groups and field personnel to provide the most up-to-date, comprehensive and concise courses possible:

1. Executive Education

Executive Education Courses

Offered at no charge to users of IBM equipment. In addition, special seminars may be arranged on site or at a local facility.

Chief Executive Officer's Class

This class is designed to provide top management with the grasp of data processing knowledge needed for proper direction of information systems efforts.

Data Processing Executive Institute

This course provides a cohesive overview of IBM advanced function products in a systematic manner. Optional sessions are included to address the specific needs of each attendee.

Executive Information Systems

This course focuses on defining, planning and control of information systems as a means to help achieve an organization's business goals and objectives.

2. Data Processing Staff Education

IBM education courses are based on function; therefore, instruction is offered for managers, systems analysts, programmers, and operators to learn data processing skills where they are required. Professional courses are available on one or more of the following bases:

- a. Classroom lecture.
- b. Programmed Instruction for self study.
- c. Independent Study Program - self-study courses employing a variety of media which are used by the customer to conduct his own training program.
- d. On-Site Education - available to a single customer for his own employees.
- e. In Shop Training - extensive documentation to assist customer's instructors to teach advanced topics in COBOL, etc.

3. The IBM Systems Science Institute

The IBM Systems Science Institute offers a comprehensive, management-oriented curriculum of education for data processing managers and staff and for users of data processing services.

Emphasis in Institute course is on meeting the need for better management of the data processing resources. Institute courses are designed to:

- Help develop practical management skills
- Teach specialized skills to key data processing personnel
- Present proven new approaches to solving data processing problems

The instructors on the Systems Science Institute staff have extensive experience in the field of data processing. Each course is taught by a team of instructors with a balance of experience and a variety of view-points and teaching styles.

The Institute has staff and facilities in New York, Chicago and Los Angeles. Upon occasion, this staff will conduct classes in other locations. The facilities are uniquely suited to providing an environment conducive to learning. Comfortable and well-supplied classrooms, a suite of conference rooms supporting a variety of small group activities and a library of related books and periodicals create an atmosphere in which personal growth can take place.

MAINTENANCE SUPPORT

MAINTENANCE SUPPORT

Maintenance service is provided by IBM for all IBM equipment. A description of IBM's maintenance service for hardware and software is as follows:

IBM Field Engineering

Providing the best service in the industry is the goal of the entire IBM Field Engineering division. With this objective in mind, FE services have been designed and are available to support a wide variety of maintenance and service needs for your IBM hardware and software. These services utilize the skills of qualified FE technicians who are carefully selected and well trained to help you get high levels of reliability, availability, and serviceability from your IBM products.

Your Field Engineering team has been equipped with tools to speed up and improve their diagnostic ability. These tools include special diagnostic terminals and communication lines linked to computer facilities. The technical expertise of the Customer Engineer (CE-Hardware Service) and Operations Systems Engineer (OSE) is further enhanced by a support structure that can be called upon for additional assistance. This assistance may come from a specialist in your region, from a field support center or -- quite likely -- from an engineer in the development lab that designed the product in the first place.

Because there is a broad range of service offerings to choose from, you have the added flexibility of selecting the types of service which best satisfy the need of your data processing installation. Special contracts designed to cover unique or unusual service needs can also be arranged. FE representatives are available and anxious to discuss your service requirements with you and to answer your questions about FE service offerings.

OVERVIEW OF IBM FIELD ENGINEERING SERVICES

To our customers, IBM Field Engineering service means:

Highly Qualified IBM Personnel

IBM Field Engineering personnel are highly qualified technicians who are carefully selected and well trained to help you get the most from your IBM data processing equipment. IBM Customer Engineers (CEs) are responsible for hardware maintenance and installation activities. Software service and installation guidance make available the analytical programming skills of Operations Systems Engineer (OSE), IBM Support Center representatives and change team programmers.

IBM Installation Planning Representatives (IPRs) are available to assist you in planning for the installation of IBM products. Their goal is to minimize disruptions during the installation of your IBM data processing equipment.

Service Planning Representatives (SPRs) at IBM manufacturing locations provide a liaison between local Field Engineering personnel and the engineers and programmers that develop IBM products. Their task is to ensure maximum serviceability for IBM hardware and software products.

Dispatch specialists are IBM personnel using communications equipment to respond to your calls for service. Dispatchers at IBM locations are on duty around the clock.

Sophisticated Support Facilities

IBM Field Engineering personnel are backed up by sophisticated support facilities that assist them in the performance of their goal to provide a high level of service. These support facilities include:

1. Teleprocessing Support Center:

Your IBM Customer Engineer can use the TP Support Center to check out many of your terminals as he installs and maintains them, minimizing interruptions to your operations. Via phone line from any point in the nation, your CE can instantly be connected to the center's host computer, diagnostic routines and servicing specialists for help with rapid checkouts or problem resolutions in your terminals.

2. Field Support Centers:

IBM Field Support Centers at various manufacturing locations provide direct engineering assistance to your IBM CE on difficult problems. On many products, this includes remote diagnostic capability, using RETAIN facilities, to help reduce outages.

3. FE Systems Centers:

Field Engineering Systems Centers focus on complex system environments. They offer assistance to IBM Customer Engineers and Operations Systems Engineer (OSE) in determining which unit or program in an IBM system is causing the problem.

Innovative Support Concepts

IBM support programs and facilities contribute to the level of support available from your local Field Engineering personnel. Among these are:

1. Remote Technical Assistance:

These facilities provide a wide range of support services to IBM Customer Engineers and Operations Systems Engineer (OSE).

Extensive data bases permit hardware and software symptom/fix search capability that can often help to reduce problem resolution time. Tracking facilities, such as the incident file, maintain problem related histories to permit effective problem management. Terminals are located at IBM branch offices and support centers throughout the world.

RETAIN/370 is a Customer Engineering service specifically developed as an aid to achieving high levels of availability and serviceability on System/370 and 4300s. It utilizes an advanced teleprocessing/data bank system which makes the latest information of System/370 and 4300 maintenance experience available to IBM personnel. Both hardware and software maintenance information is included in the system.

RETAIN/370 support begins when the on-site CE contacts, by dial-up facilities, the nearest technical support center after he has exhausted his available maintenance package.

The on-site Customer Engineer, in consultation with support center personnel, will determine the proper type of support required. Support may consist of data bank information or of dispatching the appropriate support personnel to the customer site.

The support personnel have direct access to a data bank of maintenance information which will be generated from system history. One feature of the data bank will be a symptom/fault file developed from information provided by individual customer engineers about problems on these systems.

In summary, RETAIN/370 provides a teleprocessing link between customer sites, strategically located technical support centers, and a central computing center which contains a comprehensive maintenance information data bank. Time is saved by reducing the need for support personnel to travel to the customer site, and by enabling all CE's to quickly obtain information on a wide variety of problems and corresponding corrective actions that have proven effective in the past.

2. Computerized Parts Logistics:

Computerized parts procedures assist in providing for the availability of IBM replacement parts you may need. Parts stocks are designed to support your needs through a computer program which manages replenishment. These stocks are backed up by emergency parts service using a computer network.

3. Radio Dispatch:

Usually our Customer Engineers are contacted by radio dispatch which gives you rapid response -- when you need it. You get the right person with the right skills to get or keep your IBM system on the air.

Outstanding Hardware Service

Providing the best service in the industry is the goal that your IBM Customer Engineer shares with the entire FE Division. Among the many types of activities that he and his FE associates perform in your office are:

1. Emergency Service:

You call for emergency service to correct malfunctions in your IBM equipment brings prompt response at any hour of the day or night.

2. Problem Identification and Correction:

Service representatives who answer your call draw on their extensive training and experience, and FE's indepth support structure, to identify the source of the problem and taken prompt corrective action to restore your IBM equipment to full operation.

3. Convenient Scheduling:

Your IBM Customer Engineer carries out a continuing program of predictive maintenance and schedules service designed especially for your needs. This helps to minimize interruptions to your work flow.

At any time, your IBM Customer Engineer can get expert assistance on problem resolution for IBM products.

Depending upon the nature of the problem and the product involved, that help will come from:

- Special Field Support Centers
- Local Branch Office Specialists
- Region Designated Support Personnel
- FE Regional Specialists

Many of the above functions will employ computer network facilities to provide timely symptom/resolution searches of its data bases. Additionally, some of these support groups can back up the CE with on-site assistance as required.

4. Installation Planning

Another service offered by Field Engineering is installation planning assistance for IBM equipment. These activities involve guidance on all aspects of physical environment, such as floor planning, air conditioning, electrical requirements, safety, and security considerations. Included are meetings with customers, contractors, power companies, and telephone companies.

This service is generally provided without additional charge for the initial installation of an IBM system or component (rental or purchased) delivered from IBM. It is also available with additional charge for equipment relocation or rearrangement.

Broad Range of Programming Services

1. IBM Support Center:

The IBM Support Center represents a major advance in the delivery of software service for many programs by placing you closer to IBM resources involved with corrective and preventive software services.

Now when a software problem occurs, you can place a tollfree telephone call directly to an IBM Support Center for assistance related to problem source identification, problem diagnosis and defect verification, APAR preparation and submission, and PTF/PUT application. This service is available at any hour of the day, seven days a week.

Two levels of support are available through the IBM Support Center. Level 1 provides assistance and performs data base searches utilizing the Software Support Facility (SSF) data base. Level 2 provides more indepth diagnostic assistance if Level 1 is unable to resolve a software problem.

For many software problems, this service can dramatically reduce the time between occurrence and resolution. More specifically, while the experience of individual customers varies, generally two thirds of all problems have been resolved quickly with assistance only by the IBM Support Center. If required, local program support assistance can be obtained from Operations Systems Engineer (OSE) through your local IBM Branch Office.

2. Local Program Support:

An IBM OSE is available for local program support assistance in those instances when a problem cannot be resolved by the IBM Support Center. When a OSE arrives at your installation, your system programmer's time can be used more effectively as a result of problem analysis done previously by the Support Center.

Beginning January 1, 1980, Local Program Support offerings were available for users of IBM Class 1 SCP's (DOS/VSE, VSI Release 7, VM/370 Release 6) and designated program products. These offerings allow you to pay separately for local program support for each processor at a fixed monthly charge, or on an hourly basis as the need arises. This provides the opportunity to match varying levels of local program support to your business needs and organizational requirements.

License fee reductions were effective January 1, 1980 for designated program products to reflect the separation of local program support costs from license charges at that time.

Two Local Program Support offerings will be available. One provides support for class 1 SCP's on your IBM processor and the other provides support for designated program products. For a fixed monthly charge, both offerings provide local OSE assistance for problem diagnosis, defect verification, APAR preparation, development of local corrections or bypasses, and for resolving problems in the installation of corrections. If you choose the SCP Local Support Offering, problem source identification assistance (the activity to identify the specific program that is causing the problem) is also provided.

Monthly Local Program Support offerings can be started at any time for an initial period of twelve consecutive months. During that period you benefit from price-protection so budgeting is simplified.

If you have multiple processors, there are additional SCP and designated program product options available to help you match local program support to your business needs. IBM will provide local program support at your central site at a reduced monthly charge for problems forwarded for resolution from other processors within your enterprise.

Other local activities provided IBM OSE's in the past continue to be provided when appropriate at no additional charge for your IBM processors. Some of these activities include installation planning assistance activities, and assistance with the preparation and cataloging of diagnostics, guidance on general procedures for problem determination, and attendance at periodic customer problem status meetings.

3. Preventive Software Service:

The only thing more important than correcting a software problem quickly is preventing the problem from occurring at all. With this in mind, significant enhancements have been made to the development, testing, and distribution of preventive service for our Class 1 SCPs (DOS/VSE, OS/VS1 Release 7 and VM/370 Release 6 and several key program products. The new process is designed to improve the productivity of your system programmer and operations personnel, and to reduce the number of problems encountered. Field Engineering plays a major role in IBM's preventive software service.

Some of the characteristics of IBM preventive service approach are:

Integrated Service

Preventive service is distributed on a System Program Update Tape (System PUT) that integrates service for key program products as well as service for the applicable SCP -- and usually on a single tape. This service has been researched against a master service data base to identify and resolve any conflicts.

Tested as one package

To ensure the highest possible quality, each integrated System PUT is tested using customer processors in actual production environments.

Customized To Customer Software Environments

System PUTs are tailored for each customer so the integrated tape you receive will match your IBM software profile. Now, both SCP and program product preventive service will be shipped directly to your offices, rather than through IBM Field Engineering locations, as in the past. This will simplify the scheduling of service application to your software system, and give you more control of the installation process.

Cumulative

Although System PUTs will be provided on a regular basis, we recognize application on each tape may not fit the operational schedules of all customers. Cumulative service on the System PUT provides the flexibility for you to skip an update and catch up later with a single service application.

4. Programming Assistance

Field Engineering will, at the customer's request, provide programming assistance for IBM programs not currently supported by Field Engineering and for customer programs. This assistance is billable and is intended to resolve critical situations where the customer is unable to find the problem or provide a solution. Programming assistance is also available to help the user in interfacing his programs with IBM programs, and to do minor programming jobs that are estimated to be of less than eight hours duration.

Flexible Service Offerings

1. IBM Maintenance Agreement

Maximize your IBM equipment availability with regular IBM service coverage.

An economical and effective IBM Maintenance Agreement for your purchased and selected lease or rental IBM equipment provides:

- IBM Maintenance service availability.
- Management of service resources to meet your needs.
- Service backed by the full resources of the FE Division.
- Service tailored specifically for the period that you need it.
- Service at a uniform monthly charge.

Bringing you the superior quality of IBM service, a Maintenance Agreement is the logical and practical protection plan for your investment in IBM equipment.

Your IBM Customer Engineer leads the comprehensive, in-depth team for service on your IBM data processing installation. Preventive as well as corrective service of your IBM hardware products is carried out primarily by your CE.

In his preventive work, he conducts a continuing program of scheduled diagnosis, adjustment, inspection and worn parts replacement. He also analyzes IBM performance reports on your equipment to resolve potential problem areas before actual trouble ever develops.

In his corrective servicing, your CE will be alerted within minutes, often by radio dispatch, when you call to report an unexpected equipment problem. Arriving quickly, he draws on a wealth of skills, special training, experience, diagnostic techniques and test equipment to resolve your problem fast.

Your CE and his local IBM branch office managers carry full responsibility for management of all the resources required to meet your needs for data processing service. They thereby relieve you of concern for stocking replacement parts, securing highly specialized servicing experts, locating special test instruments, and overall planning of effective use of these and many other needed servicing resources.

Nationwide resources of IBM's FE Division back up the service provided in your office. IBM parts distribution centers in your locale are kept stocked at a level tailored to the requirements of your installation and assure you maximum parts availability.

If your CE needs assistance on a problem in your installation, he may call upon personnel at an FE product support center. They in turn may draw on the power and speed of a worldwide computer network to help resolve your problem rapidly. Specialists to assist your CE can also be called in from the local branch office, or a branch near you, through the FE Region Office.

In order to best meet your needs, you may choose from a wide selection of service availability periods. The basic plan offers you service availability during any consecutive 9-hour period between 7 a.m. and 6 p.m., Monday through Friday.

Optionals include a choice of weekday service periods of 12, 16, 20 or 24 consecutive hours. Similar periods are available for Saturdays and/or Sundays.

Once you select the plan best meeting your needs, you obtain high-quality IBM Service availability during the period selected for a uniform monthly charge.

2. Local Program Support Agreements

Effective January 1, 1980, customers elected to obtain local program support for Class 1 system control programming on your IBM equipment for a monthly program support charge. This support is available under the Agreement for Local Program Support for System Control Programming on IBM machines. Local program support for eligible IBM licensed programs on designated processors is also available for a monthly charge under the Agreement for Local Licensed Program Support for IBM Licensed Programs. Under both agreements, the IBM Support Center can request your local FE Branch Office to dispatch a OSE if the Support Center is unable to resolve a problem or it is determined that problem resolution could be facilitated by on-site OSE support.

Both agreements provide you with the assistance of a OSE for:

Problem diagnosis (activities performed to pin-point the exact cause of a problem once the failing software component has been identified)

Assistance with APAR preparation/submission

Local fix or bypass development in a high-severity situation

Problems encountered during PTF/PUT application.

Assisting you with problem determination is an FE responsibility under the terms of either the Agreement for Lease or Rental of IBM Machines or the IBM Maintenance Agreement, or on a per-call basis. It is an assessment of whether a problem has been caused by hardware or software. This assessment includes examining the available symptoms to verify what system component has caused the problem. Problem determination is complete when the cause of the malfunction has been identified as hardware or software.

The agreement for Local Program Support for System Control Programming on IBM machines provides assistance for problem source identification. Problem source identification includes those activities performed to identify the source of a suspected programming problem. Problem source identification is not complete until the software component is identified or the examination reveals an operator error or an error in the use of IBM control programming. Problem source identification also ceases if the trouble cannot be recreated.

Under the local program support agreements, a customer with multiple systems may choose to designate a single processor for local program support. There will be a reduced monthly licensed program support charge for each additional IBM machine from which problems are forwarded to your designated service machine.

Your responsibilities under the local program support agreements are to:

- Perform appropriate problem definition activities and remedial actions prescribed by the IBM Support Center prior to the dispatch of an IBM representative.

Your responsibilities under the additional machine program support agreements are to:

- Provide problem documentation to the IBM OSE at your designated service machine location.

- Recreate the problem, if required and requested by IBM, on your designated service machine.

- Distribute, install and test corrections provided by IBM at your designated service machine location to the machine on which the problem occurred.

3. FE Contract Support Services

Contract Support Services can satisfy your service needs which are beyond the range normally provided under IBM rental, Maintenance Agreement and Warranty stipulations. The services are provided at a

firm price to permit accurate budget planning. Services available to you include:

Teleprocessing Systems Installation and Maintenance Coordination -

Available on TP systems that are controlled by an IBM CPU with IBM communications or control unit and with IBM terminals under lease or M/A, this service provides for: (1) Generation and maintenance of a schedule for installation, system integration and coordination of the testing of communications components (common carrier facilities and non-IBM modems); (2) problem determination for modems and line facilities; (3) standby assistance to the common carrier in resolving modems/lines subsystem problems; (4) contacting the common carrier for service on communications components.

Programming Service -

This service offering provides you with the additional assistance required to isolate functional problems in IBM equipment or programs because of your use of certain types of programs -- among them, altered IBM system control programming, altered IBM licensed programs, and non-IBM control programs.

Support Equipment Service -

Under this service, IBM manages the subcontract for the service work on your motor generator sets, system refrigeration units or back-up power supplies.

Other Unusual Service Needs -

Other unique or unusual service needs of your installation may also be met through special contracts.

HARDWARE MAINTENANCE

Hardware Maintenance

For rental or leased IBM equipment, all maintenance coverage for a 9 hour/5 days a week on Plan D machines is included in the rental or lease charge. The hardware configuration which follows outlines which of the proposed equipment is Plan D, and which is another plan. For all other equipment (non-Plan D) 24 hour 7 day a week maintenance is included in the rental or lease charge.

For purchased equipment, maintenance is available on a "time and materials" basis, or via an IBM Maintenance Contract. The Maintenance Contract provides for coverage 9 hours a day, 5 days a week for the basic minimum monthly maintenance charge which is listed by component on the following cost estimates. Optional periods of coverage up to and including 24 hours a day, 7 days a week are available at an additional charge. This additional maintenance coverage is calculated based on the following tables:

MONDAY-FRIDAY						SATURDAY						SUNDAY					
(Until 8:00 a.m. Saturday)						(Until 8:00 a.m. Sunday)						(Until 8:00 a.m. Monday)					
MACHINE	CONSECUTIVE HRS.					MACHINE	CONSECUTIVE HRS.					MACHINE	CONSECUTIVE HRS.				
GROUP	9*	12	16	20	24	GROUP	9	12	16	20	24	GROUP	9	12	16	20	24
A	10%	14%	18%	22%	26%	A	4%	5%	7%	8%	9%	A	5%	7%	9%	11%	12%
B	10%	16%	22%	28%	34%	B	5%	6%	8%	10%	11%	B	6%	8%	10%	12%	14%
C	10%	19%	28%	37%	46%	C	8%	9%	11%	13%	15%	C	9%	11%	14%	16%	18%
D	10%	12%	14%	16%	18%	D	4%	5%	7%	8%	9%	D	5%	7%	9%	11%	12%

* 9 hours any part of which is outside the hours of 7:00 a.m. to 6:00 p.m.

Example - Leased Plan D Machine

If 24 hour/7 day a week coverage is desired on a lease or rental Plan D machine with an MMMC of \$100/month:

24 hour Monday-Friday	18%
24 hour Saturday	9%
24 hour Sunday	12%
	39%

$$.39 \times \$100 = \$39/\text{month}$$

Example - Purchased Machine - any Plan Offering

If 24 hour/7 day a week coverage is desired on a purchased Plan B Machine with an MMC of \$100/month:

24 hour Monday-Friday	34%
24 hour Saturday	11%
24 hour Sunday	14%
	<u>59%</u>

$$\$100 + .59 \times \$100 = \$159/\text{month}$$

NOTE: Any non-Plan D leased machine receives 24 hours/7 day a week maintenance coverage included in the monthly lease charge.

WARRANTY NOTE: 24 hour/7 day a week service is provided on all new machines (leased or purchased) during the warranty period: 9370 is 12 months, I/O Devices are 90 days. Thus, there is no maintenance cost at all for 90 days and then no maintenance cost for the 9370 for an additional 9 months.

NOTE

The prices stated here are for your information only and are subject to change. Lease or Rental of IBM machines will be by the Agreement for Lease or Rental of IBM Machines signed by the Customer and IBM.

Purchase of IBM machines will be by agreement signed by the Customer and IBM. Price protection provisions are stated in the applicable agreement(s). Upon expiration of the warranty period, maintenance of purchase IBM machines will be by agreement signed by the Customer and IBM.

*Plan offering "A" machines installed under rental terms are subject to Additional Use Charges. Plan offering "C" machines are subject to a Monthly Use Charge when rented or leased, and an Additional Monthly Maintenance Charge when under an IBM Maintenance Agreement. Plan offering "D" machines installed under rental or lease terms are subject to an Additional Monthly Maintenance Charge, commencing upon the expiration of the Initial Period of Maintenance, when the customer selects one or more of the Optional Periods of Maintenance Service.

TEST ALLOWANCE

IBM offers pre-installation system time for program testing and related activities. This service is available at the Branch Support Center, and includes:

- Use of certain Program Products which are required by most customers when using systems in our local Customer Support Center in Phoenix (e.g., language processors, sorts and general purpose utilities).
- Use of any other programs (non-program products) distributed through IBM's Program Information Department which are available in the Local Customer Support Center.
- Assistance limited to start-up/restart instruction.
- Workspace and use of auxiliary equipment on an as-available basis.

The amount of pre-installation test allowance is based on the complexity of the equipment ordered.

ADOT ORGANIZATIONAL CHART

