South Dakota

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Department of Transportation

INFORMATION SYSTEMS PLAN

Transportation Information Study SD 91-14

September, 1991

Deloitte & Touche

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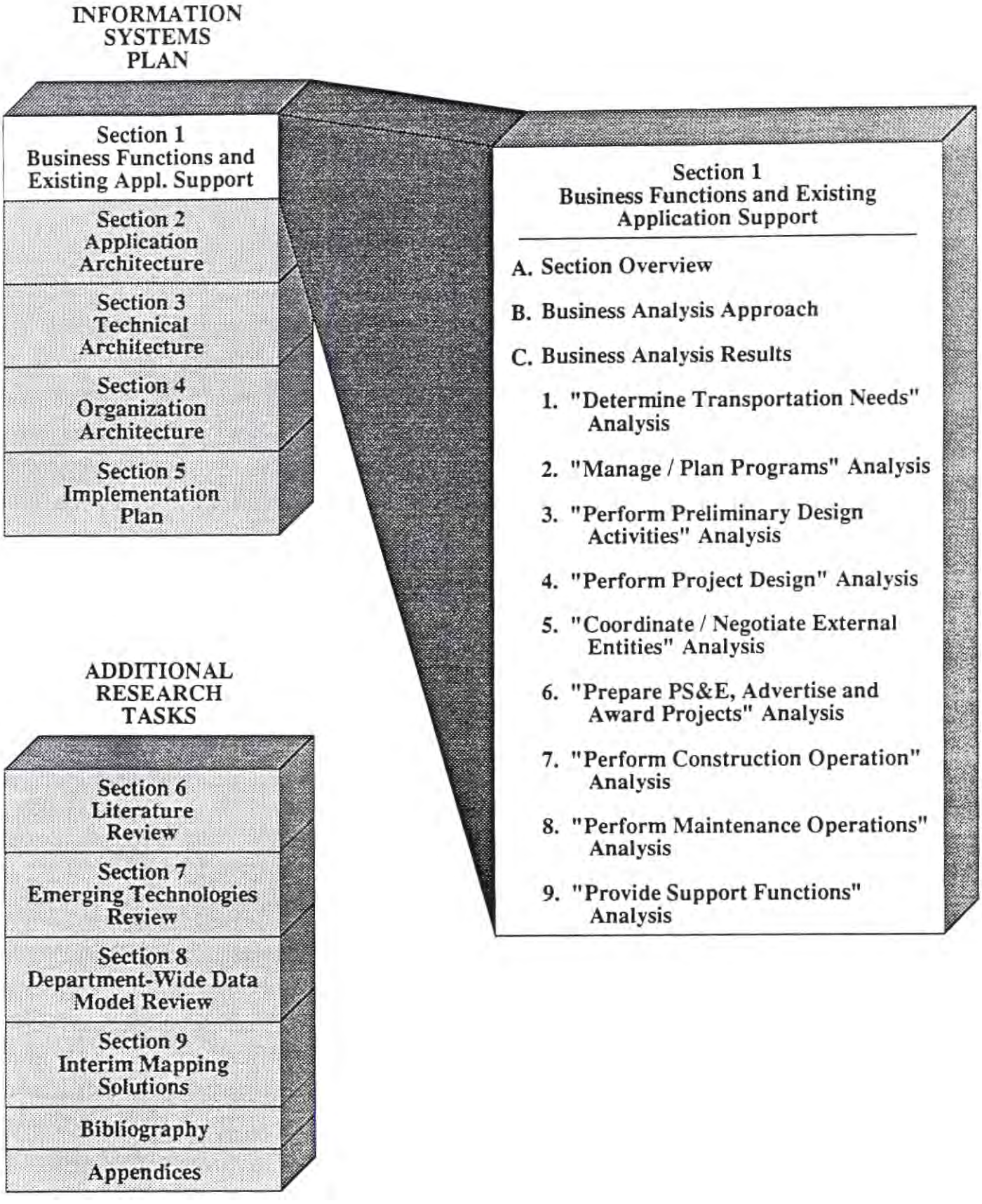
TRANSPORTATION INFORMATION STUDY SD91-14

September, 1991

SECTION 1
BUSINESS FUNCTIONS AND EXISTING APPLICATION SUPPORT



South Dakota Department Of Transportation
Transportation Information Study SD91-14
Volume 2

Section 1 – Business Functions and Existing Application Support

A. SECTION OVERVIEW

While many organizations invest substantial resources in their information systems, few organizations realize the maximum value from this investment because the objectives guiding the implementation and maintenance of the information systems are not consistent with the objectives of the business. The purpose of the information systems planning is to closely align these objectives so that the efforts and resources invested in information systems are continually focused in those areas that will provide the highest value to the business.

This section of the Information Systems Plan highlights the degree to which existing SDDOT information systems support the Department's business needs and objectives. This analysis involves both internal and external perspectives, resulting in an understanding of major business and systems issues which the Department must address. The results of this analysis provide the foundation upon which the future application, technical and organization architectures are based.

B. BUSINESS ANALYSIS APPROACH

In fiscal year 1990, the Department implemented a formalized strategic planning process. The outcome of the first full year of this process was a formal strategic business plan, developed by staff throughout the Department. As part of the planning process, the Department was required to formalize its mission, which is stated below.

SDDOT's Mission

The Department of Transportation's mission is to plan, finance, design, construct and maintain a cost–effective state transportation system to support tourism, enhance economic development and facilitate the movement of people and products in a safe, timely and efficient manner.

The mission statement focuses on factors fundamental to the Department's success. The degree of success depends largely on the Department's effectiveness in performing the primary business functions. The process of prioritizing goals, objectives, strategies and action plans not only ensures that the appropriate business functions are being performed, but also provides a yardstick against which to measure how well these functions are being performed. In order to ensure that these key business functions are performed as effectively and efficiently as possible, it is critical to provide an appropriate information systems support environment.

The Information Systems Plan links the Department's goals and objectives directly with the acquisition and implementation of the information processing resources necessary to support them. It is essential that the Department's Information Systems Plan be highly synchronized with the Strategic Business Plan.

C. BUSINESS ANALYSIS RESULTS

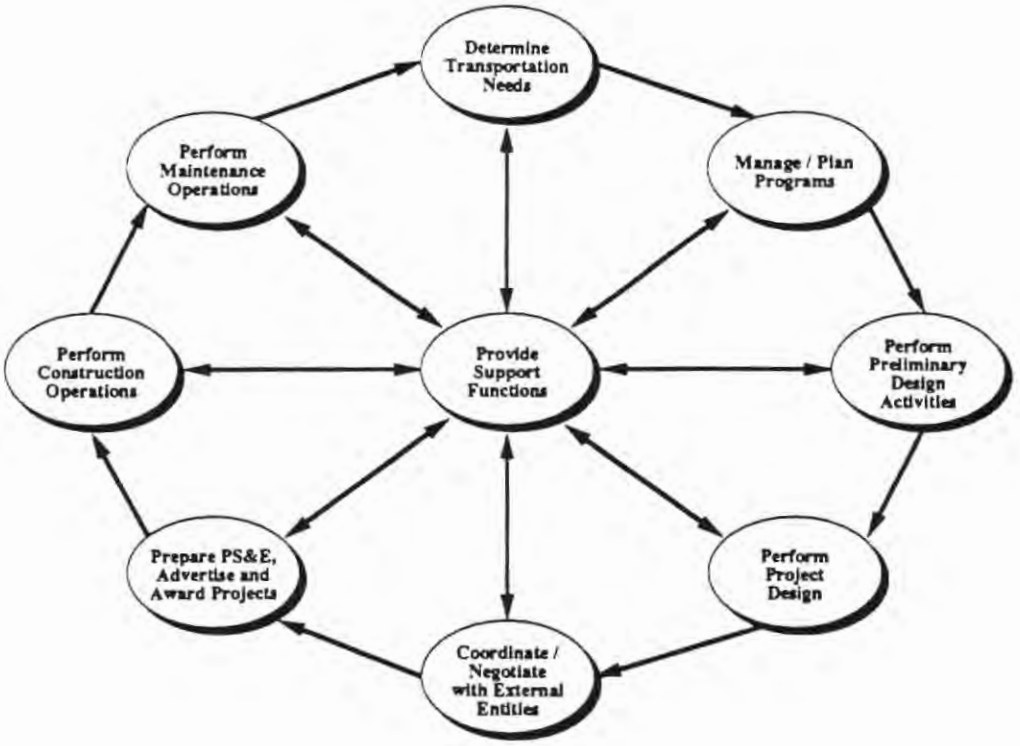
This section of the plan identifies business functions essential to the successful execution of the Department's mission. These functions were identified through a number of interviewing sessions with key personnel from each Division. After challenging the relative importance of each business function, the participants prioritized the role each function served in supporting the mission statement. The final list of primary business functions is not meant to represent a comprehensive set of business activities. It does, however, provide an appropriate framework for evaluating the information systems support provided in each of the business areas.

Over fifty primary business functions were identified in the group interview sessions. To simplify the presentation and analysis, each of the primary business functions has been logically grouped within one of the following business areas:

1. Determine State Transportation Needs
2. Manage/Plan Programs
3. Perform Preliminary Design Activities
4. Perform Project Design
5. Coordinate/Negotiate with External Entities
6. Prepare Plan Specifications & Estimate Packet, Advertise and Award Projects
7. Perform Construction Operations
8. Perform Maintenance Operations
9. Provide Support Functions.

Each business area, with the exception of "Provide Support Functions", represents a "phase" associated with the development or maintenance of the State Transportation System. The business/information needs analysis has been based on these business areas, presented throughout this section as a continuous business cycle, as depicted below.

Exhibit 1.1

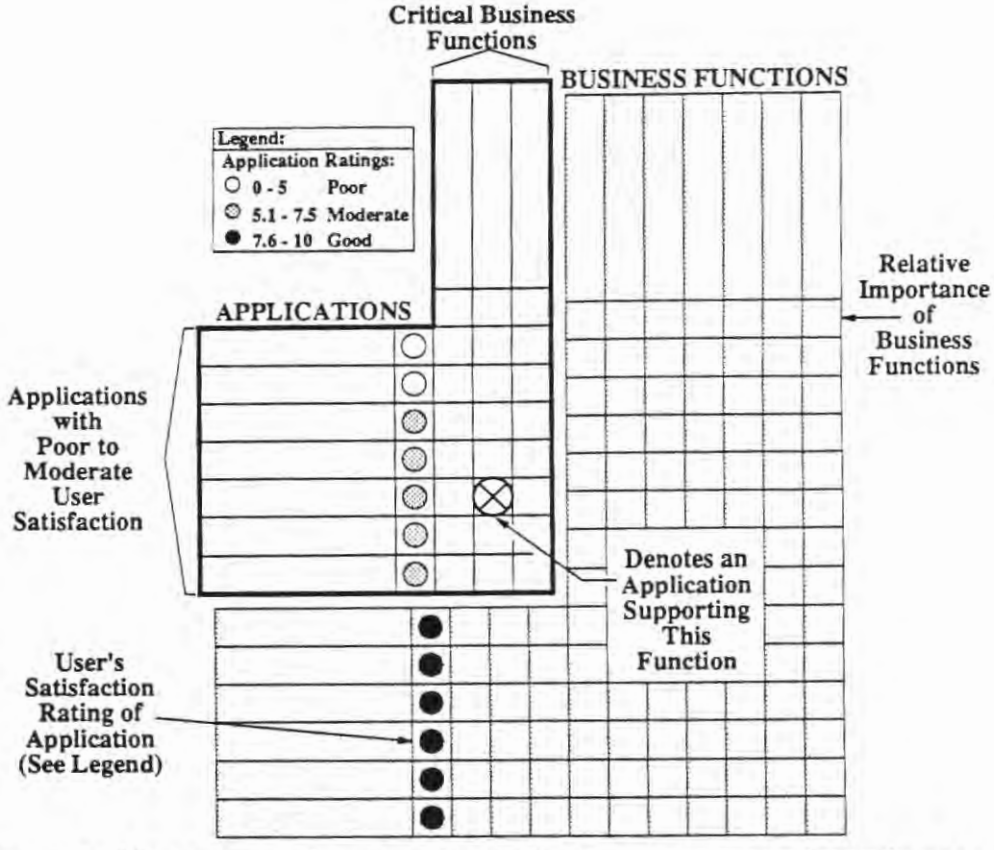


Each business area is composed of a set of primary functions. Each function has been assigned a "priority rating" which denotes the function's relative importance in supporting the Department's mission. These ratings are based on the average of responses identified in the group interview sessions. The scale used by personnel to rate the functions is provided below:

3 CRITICAL –	*The Department cannot achieve its mission without performing this function.*
2 SUBSTANTIAL –	*The Department can achieve its mission without this function, but it becomes difficult to do so.*
1 IMPORTANT –	*The Department can achieve its mission without this function. However, this function improves the degree of success with which the mission is achieved.*

The Applications Support Matrix serves as the basis for highlighting business functions which are not adequately supported by information systems technology. This matrix, described in Exhibit 1.2, illustrates which computer applications support specific business functions, and identifies the degree of user satisfaction for each computer application.

Exhibit 1.2



The data presented in each matrix was collected in numerous group interview sessions. In these sessions, each application was rated to determine the user's overall satisfaction with the application. The application ratings were based on a scale from one to ten (one being the lowest rating and ten the highest). In order to provide focus, circles with different levels of shading have been used to represent the application ratings. The

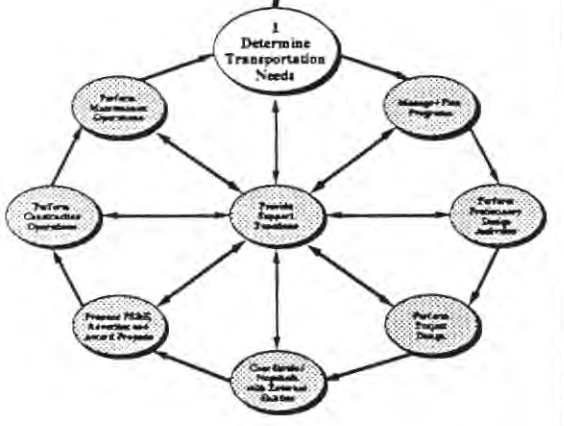
business functions and their ratings are listed on top of the matrix. After evaluating the relative importance of all business functions, an arbitrary break point was established to allow the analysis to focus on those functions most critical to the Department's business. An "X" placed in the body of the matrix denotes an application supporting a function.

The matrix identifies three action areas requiring different levels of attention. The first area (the shaded lower half of the matrix) represents business functions supported by highly rated applications. These applications are meeting the user's current needs and require no immediate attention. The second area (the shaded upper right portion of the matrix) represents less critical business functions supported by moderate to poorly rated applications. Although these applications should be addressed as resources allow, they should not receive priority over those needs identified by the third area. This third action area (the unshaded upper left portion of the matrix) identifies moderate to poor applications supporting critical business functions. Application needs in this area should receive priority. This area should be viewed as opportunities to improve the effectiveness and efficiency of the Department's business. The remainder of this section follows this approach to present the level of automated systems support existing for each business area.

1. Determine Transportation Needs

Exhibit 1.3 displays the business functions encompassed by "Determine Transportation Needs".

Exhibit 1.3



PRIMARY BUSINESS AREA 1

DETERMINE TRANSPORTATION NEEDS

Priority Rating	Function Name
2.8	Perform Highway Program Needs Assessment
2.8	Maintain Physical Roadway Inventories
2.4	Perform Safety Management
2.4	Perform Initial Project Definition
2.4	Perform Traffic Studies
2.4	Perform Conditional Roadway Testing
2.3	Perform Aeronautics Needs Assessment
2.3	Maintain Structure Inventory
2.2	Perform LGA Needs Assessment

Although many of these functions serve other purposes, they are all instrumental in the development of a comprehensive needs assessment. As a gauge of relative importance,

both "Maintain Physical Roadway Inventories" and "Perform Needs Assessment" (for the Highway Program) received a 2.8 average rating. Therefore, both of these functions were viewed as highly important to successfully achieving the Department's mission. The needs assessment is an important component in the development of the Five Year Construction Program. Without an adequate understanding of the State's needs, it is impossible to appropriately focus the DOT's resources. Likewise, without an accurate inventory of existing roadway conditions and features, it becomes extremely difficult to not only assess needs, but perform many other important Department functions (e.g., "Perform Public Relations Activities", "Perform Project Design", "Perform Safety Management", etc.).

Focusing on the two most critical functions within "Determine Needs", Exhibit 1.4 illustrates the perceived strong level of automated systems support. The physical roadway inventories are maintained through the use of several computerized files. The Roadway Environment System (RES) Files are used to maintain an inventory of the State Trunk System, while the Non-State Trunk roads are tracked in the Non-State Trunk Road Inventory.

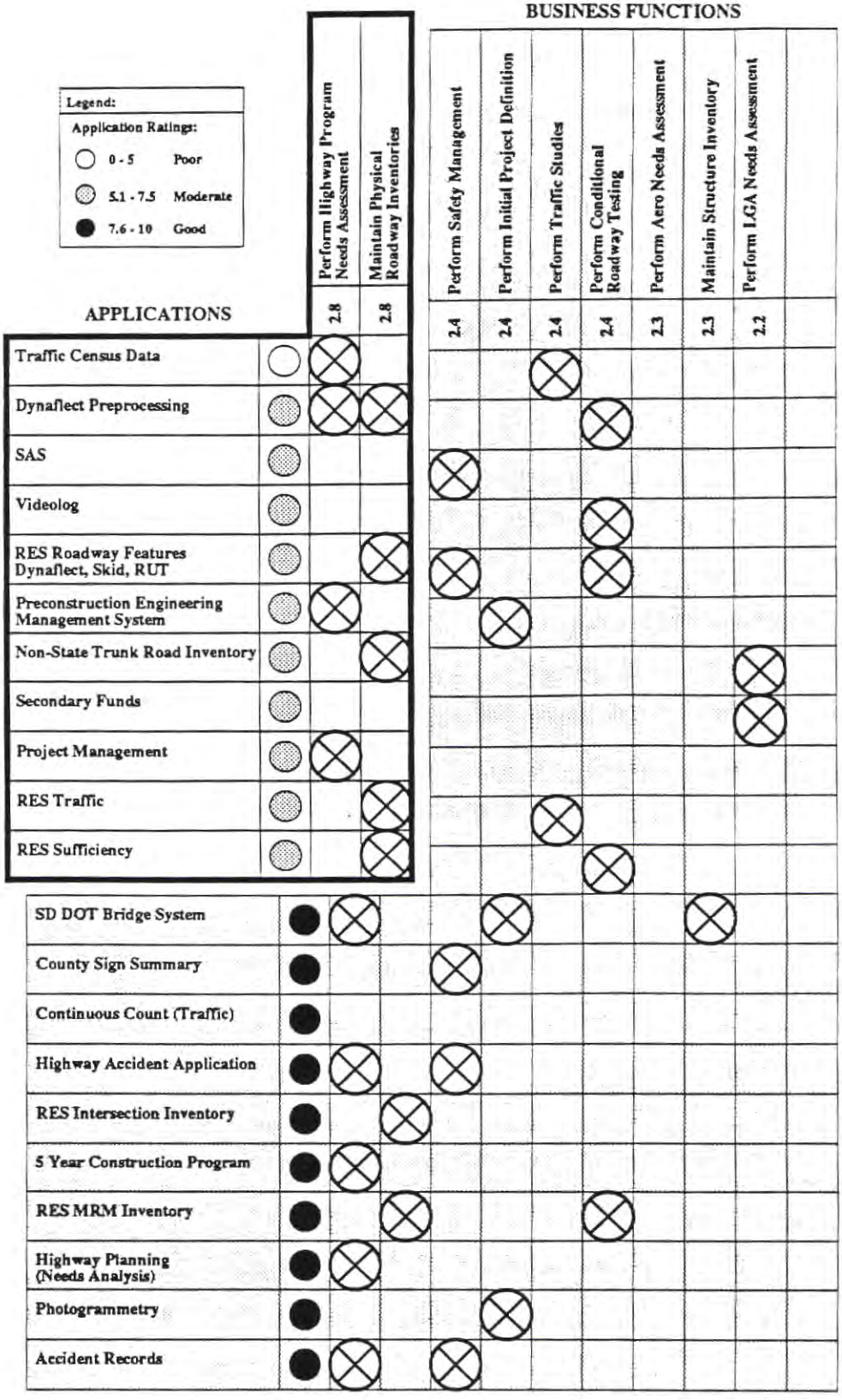
Overall, it appears that the RES files maintain an accurate inventory of the roadway, although a few exceptions were noted. The first deficiency concerns the RES Roadway Features, Dynaflect, Skid and Rut File. This file was criticized primarily due to the cumbersome process required to load conditional data from the road profiler and skid testing equipment to the mainframe.

Two other deficiencies in the RES files are As-Built changes and History. By providing the ability to more accurately reflect As-Built data and maintain history, the needs assessment process may be improved, as well as the determination of how those needs should best be addressed. These items help solidify the knowledge base required for an effective and efficient management of the State's pavements.

Another area of limited support is in ad-hoc query capability and report writing flexibility associated with RES. This is one of the primary reasons that the function "Perform Needs Assessment" is not directly supported by the RES files. Instead of using the RES files, much of the data is transferred to the Highway Planning File and 5-Year Construction Program. These programs were rated high primarily due to their flexibility in supporting the planning process. Although the "Perform Needs Assessment" function appears to be supported well by the Highway Planning File and 5-Year Construction Program, the proliferation of redundant data can lead to inconsistencies when similar questions are asked of different systems. One approach to controlling data redundancy problems is to model or diagram the Department's data, and establish a blueprint from which the Department may follow to gradually replace the computerized files or databases creating the inconsistencies.

The Non-State Trunk Road Inventory is a computerized file used to maintain an inventory of Non-State Trunk roadways. The users indicated that although an averaging method is used to capture the inventory, for reasons including the number of roadway miles, the lack of an established referencing system and the DOT's limited involvement with non-state trunk roadways, it is not feasible to maintain a precise inventory of these roadways. Overall, it appears that this file meets the users current needs.

Exhibit 1.4
Determine Transportation Needs



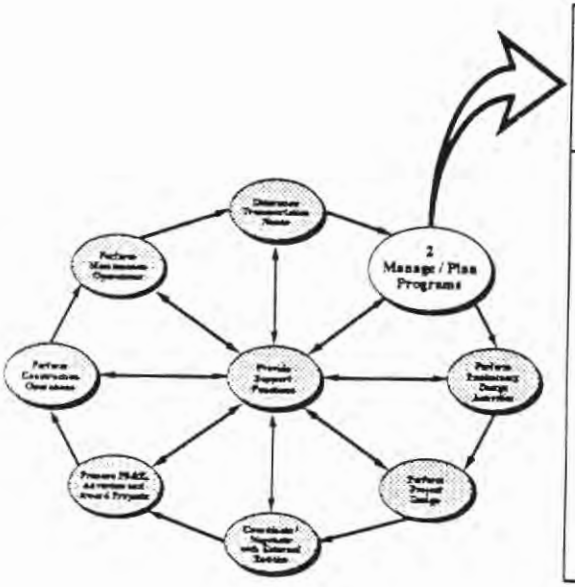
Based on this analysis, the primary systems needs are:

- Provide the ability to maintain history of inventory data
- Ensure that As–Built inventory data is captured
- Reduce the data redundancy among inventory files
- Migrate the inventory data to a data base to support flexible ad–hoc querying and report writing.

2. Manage/Plan Programs

The second business area is the process of planning for and managing the transportation programs being executed throughout different sections of the Department. This area consists of the five major functions shown in Exhibit 1.5.

Exhibit 1.5



PRIMARY BUSINESS AREA 2

MANAGE / PLAN PROGRAMS

Priority Rating	Function Name
2.9	Manage / Plan Highway Program
2.4	Manage / Plan LGA Programs
2.2	Manage / Plan RR Programs
2.1	Manage / Plan AERO Programs
1.6	Manage Rural Transit Program

The projects in the Five Year Construction Program ("Manage/Plan Highway Program") receive considerable Department attention. These projects are under the jurisdictional control of the DOT and receive a high level of State and Federal funding. The importance of this program is underscored by the 2.9 rating it received.

Exhibit 1.6 illustrates the applications currently supporting the "Manage/Plan Programs" Phase. As would be expected, the majority of computerized applications shown are supporting the planning and management of the Five Year Highway Construction Program. This function is most directly supported by the Five Year Construction Program application, which received a high overall user satisfaction rating of 8.25.

Although the application support matrix illustrates a relatively high degree of user satisfaction for individual applications supporting the design process, the matrix does not highlight several related technical and operational issues identified in the interview process. These issues include:

- Compatibility of Design Plans (CEAL verses IGrds)
- Transferability of Design Plans
- Training Requirements
- Rapid Changes of Design Platforms
- Degree of Design Decentralization.

In the fall of 1990, the region offices implemented CEAL to support the survey process. Even though the alphanumeric version of RDS is still available in region offices, CEAL has replaced RDS as the regions' design tool. Today, although both packages are capable of supporting design functions, the electronic files are not compatible. A number of issues have prompted the need for the Department to review its long term direction regarding automated design tools.

The first issue, training, is based on the money and time required to support two training programs which might ultimately inhibit the Department's ability to rotate designers between the central and field offices. To become proficient with either IGrds or CEAL requires a substantial training effort. Training for one tool will not transfer to the other tool. This requires the support of two separate training programs and develops designers with significant investments in one of the two tools. The retraining cost required to rotate designers between the central and field offices could prohibit this practice.

Difficulties also exist in transferring (via telecommunications) design plans to the regional offices. These difficulties should be somewhat relieved as fiber optic lines provide an "economical" means for transferring design plans. The file compatibility and electronic file transferring issues not only limit the ability for both regions and the central office to work on the same project design, but it also impacts the fields' ability to electronically create As-Built plans.

Another issue impacting the Department's effective use of its tools has been the rapid change of hardware and software platforms. The Department's hardware and software has been in a state of change since the introduction of IGrds. The applications were originally accessed through workstations connected to the DEC VAX. As the VAX has been phased out, the software has almost entirely migrated to stand-alone workstations. These changes have produced many improvements in the software's speed and functionality. These changes have also, however, reduced the stability of the environment to a point where it has been difficult to establish the documented methods and structured training necessary to effectively use the tools. Platform changes in the short term should be challenged to ensure that the benefits derived from incremental gains in speed and functionality outweigh potential losses in productivity and effectiveness.

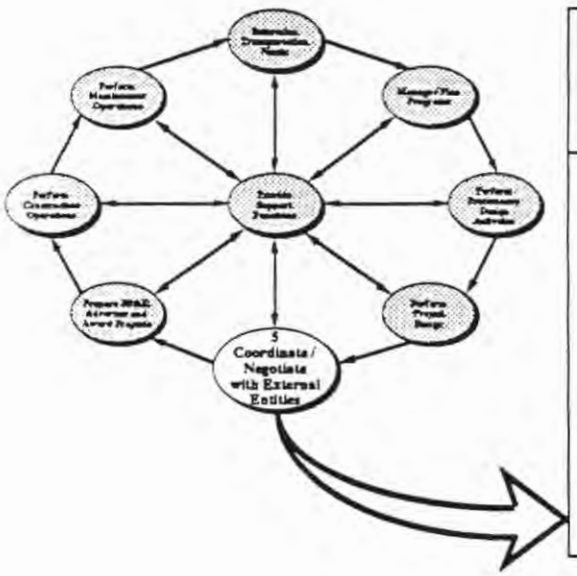
Although much has been done to increase the flow of design plans to the field, the analysis identifies several areas for which additional information support may be required or controlled:

- Compatibility of Design Plans
- Transferability of Design Plans
- CADD Training
- Geotechnical Design Support
- Short Term Stabilizing of Design Equipment.

5. Coordinate/Negotiate with External Entities

The coordination and negotiation with parties external to the Department is another bottleneck associated with the design process. Whenever the Department proposes a project affecting land owners, utility companies or railroad companies, substantial lead times are necessary to ensure successful and timely completion. Because changes or delays occurring during this phase have a direct impact on a project's letting date, all four primary business functions received a priority rating of three as shown in Exhibit 1.11.

Exhibit 1.11



PRIMARY BUSINESS AREA 5

COORDINATE / NEGOTIATE WITH EXTERNAL ENTITIES

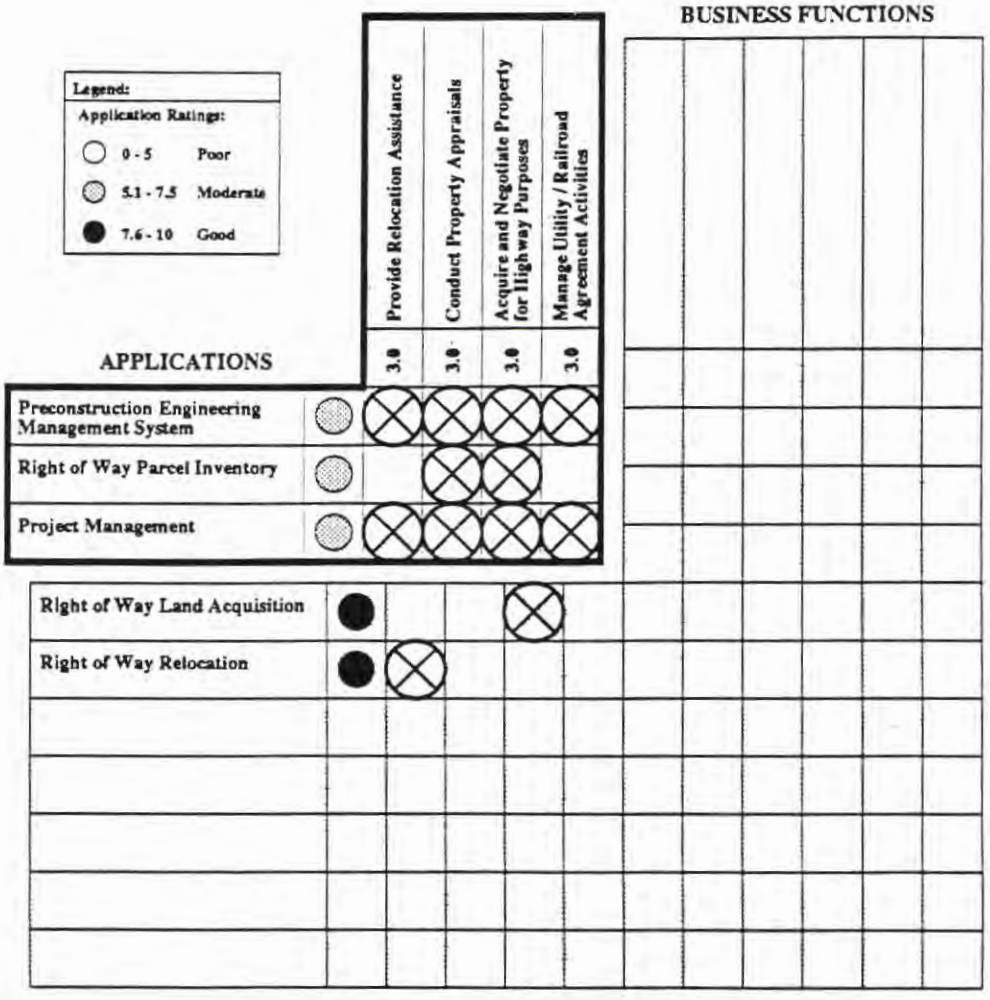
Priority Rating	Function Name
3.0	Provide Relocation Assistance
3.0	Conduct Property Appraisals
3.0	Acquire and Negotiate Property for Highway Purposes
3.0	Manage Utility / Railroad Agreement Activities

According to users and management, there appear to be few opportunities to provide additional automated assistance. The applications which have already been developed to support the right of way process have been assigned high user satisfaction ratings, as illustrated in Exhibit 1.12.

There is, however, a need for additional hardware (nine personal computers and four laptop computers) which would allow more personnel in ROW to have access to the existing applications. This equipment is already provided for in the 1992 and 1993 budgets.

In summary, it does not appear that significant additional information systems support is needed for the "Coordinate/Negotiate with External Entities" area.

Exhibit 1.12
Coordinate/Negotiate with External Entities

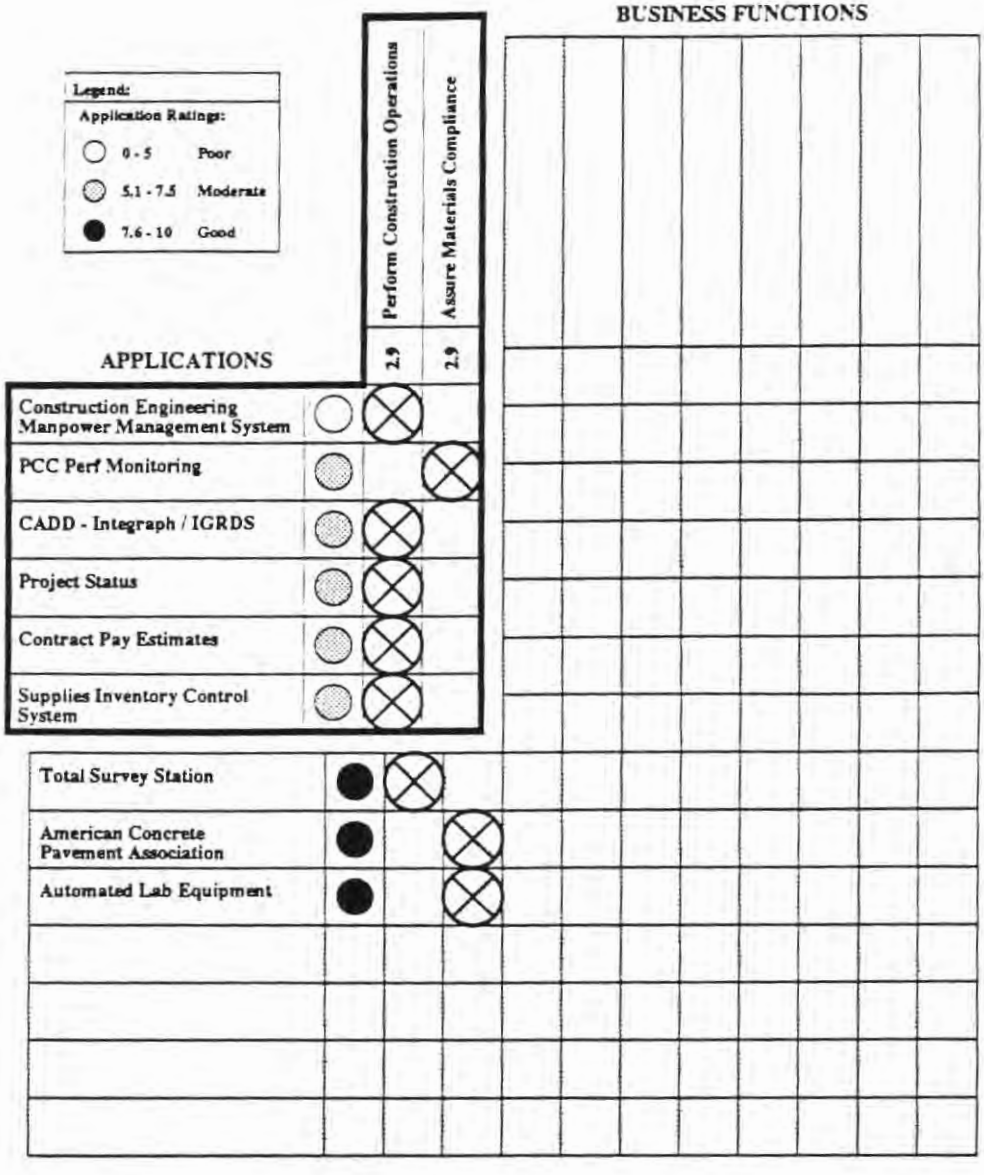


6. Prepare PS&E, Advertise and Award Projects

The Prepare PS&E, Advertise and Award Projects phase includes those activities required to successfully award a project. This area is represented by a single function as shown in Exhibit 1.13.

The first function, "Perform Construction Operations", includes the collection of construction survey data, the management of contractor administrative details, the coordination of local traffic and detour routes, the collection of construction details (e.g., material quantities and work complete) and the inspection of completed work. As shown in Exhibit 1.16, a number of applications support this function

Exhibit 1.16
Perform Construction Operations



Of these, the Construction Engineering Manpower Management System (CEMMS) is the only poorly rated application. This system was originally developed to aid in the scheduling of man hours. The system attempts to identify personnel shortages and excesses, assessing whether additional resources are required for a specific program or project. The tool may provide benefits for long–term staffing or communicating to the legislature, but does not appear to be useful as a construction project management tool.

Users and management generally agreed that no system can account for the many unpredictable variables (weather, contractor schedules, etc.) that impact projects.

Total Survey Stations and other applications capable of supporting the collection of construction surveys were also identified as support for the collection of engineering surveys (see the "Perform Preliminary Engineering" phase).

No major systems projects were identified to improve construction operations support. Minor enhancements, however, were suggested to improve the Contract Pay Estimates Application and Supplies Inventory Control System and provide automated scales to the field. These smaller projects are described in the "Minor Application Enhancements and Development" chapter of the report.

The "Assure Materials Compliance" function is a more narrowly defined area, which includes the development of material specifications, the testing of materials and the certification of materials. Few tools and applications are required to effectively support this area. The implementation of automated testing equipment has improved the productivity and accuracy of this function in recent years. Further improvements in testing equipment will yield incremental benefits as they replace dated equipment. Testing instrumentation has not been included within the scope of this planning document.

In summary, the analysis provided for the functional area, "Perform Construction Operations" did not substantiate significant additional information systems support.

8. Perform Maintenance Operations

Maintenance of the State's existing transportation system has been summarized to a single business function, "Perform Maintenance Operations", as depicted in Exhibit 1.17. As fewer new roads are built, the efficient and effective maintenance of the State's existing roadways becomes increasingly important.

Exhibit 1.17

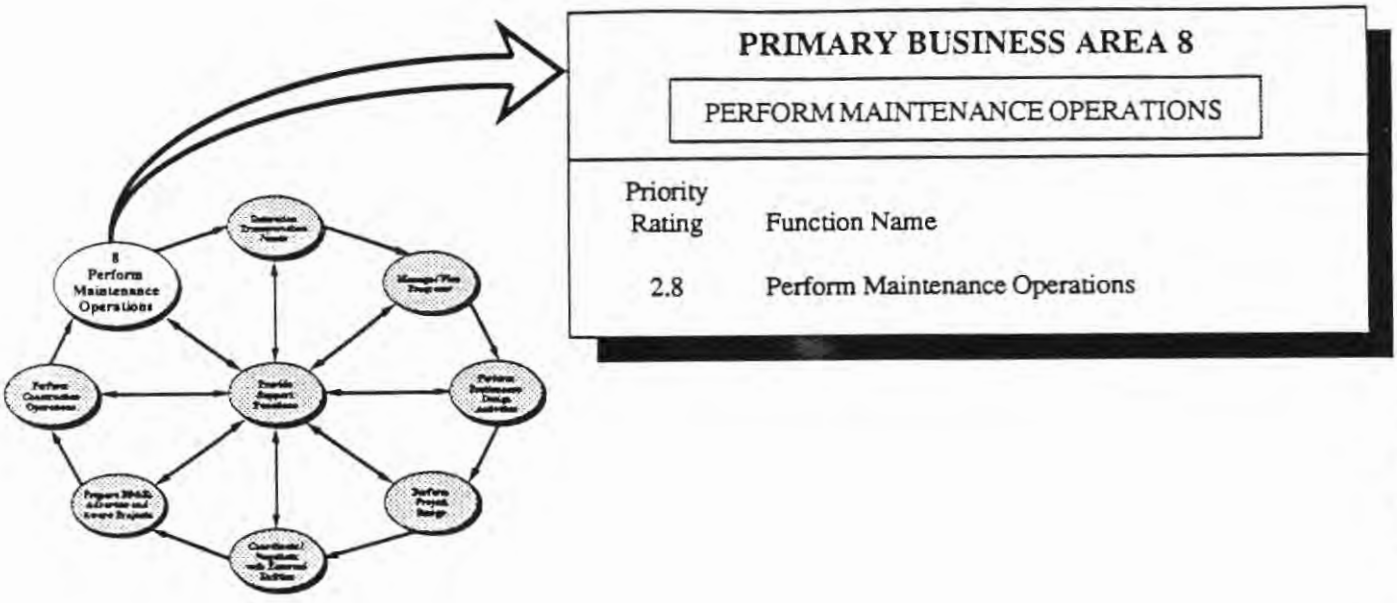
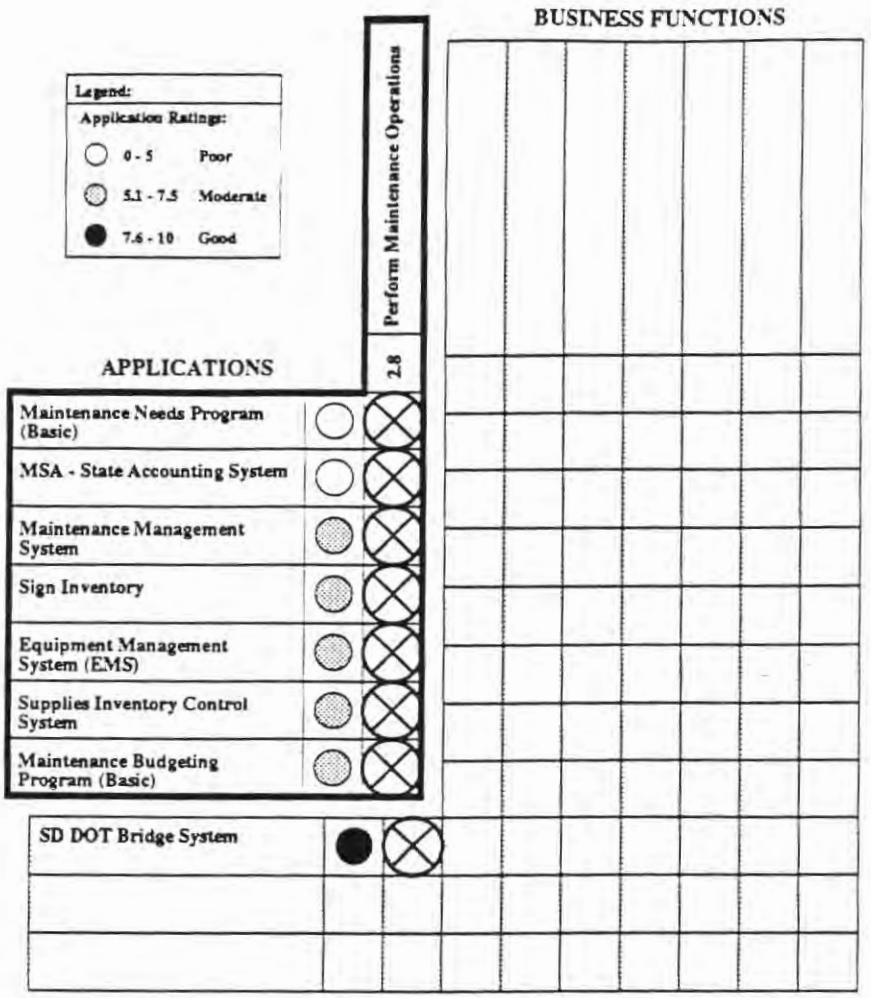


Exhibit 1.18 illustrates how well the current applications are supporting the maintenance operations.

Exhibit 1.18
Perform Maintenance Operations



The Department's maintenance function can basically be represented by a three step process:

- Determine the State's maintenance needs
- Prepare a maintenance plan considering needs, available budget and future construction schedules
- Perform the actual maintenance activities.

The first step, determining the maintenance needs, is supported by the Maintenance Needs Program. Both the Maintenance Needs and the Maintenance Budgeting Programs were developed in an attempt to automate previously manual processes. Although the Maintenance Budgeting Program received relatively high user satisfaction marks, the Needs Program was rated poor. Users generally perceived the program as too difficult to use. Because of this, many areas are still performing this activity manually.

The major application directly supporting the maintenance function is the Maintenance Management System. This system provides a central repository of the State's maintenance plan and tracks actual accomplishments through the Accounting System. Many users rated the system poorly, citing the system's inaccessibility as its major drawback. This is primarily due to the system's age and the batch technologies employed in its development. In order to access information from the system, area offices must rely on reports periodically sent from the central office.

In summary, the analysis identifies two opportunities to provide additional automated support. These include:

- A More User Friendly Needs Program
- Greater access to the Maintenance Management System.

9. Provide Support Functions

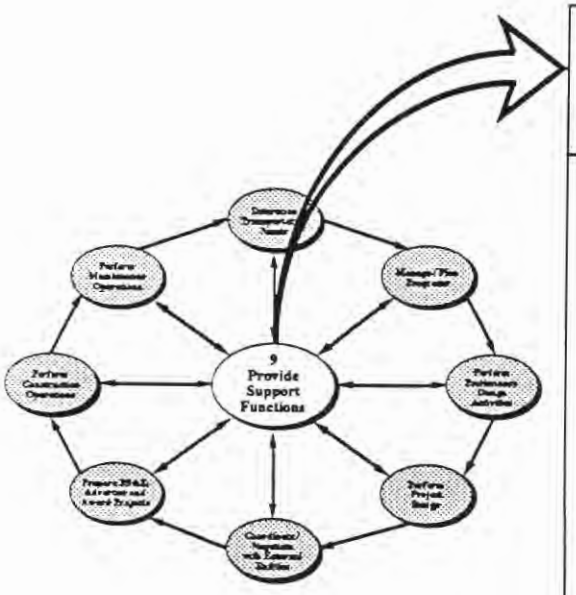
Twenty eight primary support functions were identified within the Department. These functions are necessary to provide operational support (as opposed to information systems support) for the business phases directly responsible for building and maintaining transportation systems. Some of these functions support the entire project lifecycle (e.g., "Review, Propose & Assure Compliance of Legislation and Regulations"), while others support specific functions within an individual phase (e.g., "Provide Technical Assistance to Metropolitan Planning"). Many of these functions are also performed throughout the entire organization, such as "Perform Personnel Management".

As illustrated in Exhibit 1.19, these functions vary widely in perceived Department importance (from 2.9 for "Perform Payroll/Personnel Function" to 1.3 for "Support Purchasing Function). Exhibit 1.20 highlights the three highest rated support functions:

- "Perform Payroll/Personnel Function"
- "Perform Personnel Management"
- "Perform Accounting Function"

The first two functions have a significant impact on the Department's ability to effectively maintain and manage its personnel resources. The third is a critical component in managing the Department's financial resources. As demonstrated by the ratings, these functions are essential to the efficient management and long–term success of the Department.

Exhibit 1.19



PRIMARY BUSINESS AREA 9

PROVIDE SUPPORT FUNCTIONS

Priority Rating	Function Name
2.9	Perform Payroll / Personnel Function
2.8	Perform Personnel Management
2.8	Perform Accounting Function
2.6	Conduct Research Projects
2.5	Review, Propose and Comply with Legs and Regs
2.5	Provide Data Processing Services
2.5	Inspect and Rate Bridges
2.4	Perform Project (Non-Construction) Management
2.3	Develop and Implement Policies and Procedures
2.2	Manage Capital Facilities Equipment, Property and PRMTS
2.1	Perform Budgeting
2.0	Perform Public Relations Activities
2.0	Provide Technical Assistance
1.9	Provide Finance Reporting
1.8	Assure Civil Rights Compliance
1.8	Provide Data Management
1.7	Perform Recruiting and Retention Activities
1.7	Provide Training Support
1.6	Perform Strategic Planning
1.6	Provide Internal Services
1.6	Perform Accident Records Management
1.6	Create Maps
1.5	Plan and Conduct Transportation Planning Studies
1.4	Perform Aviation Services
1.3	Support Purchasing Function

Exhibit 1.20
Provide Support Functions

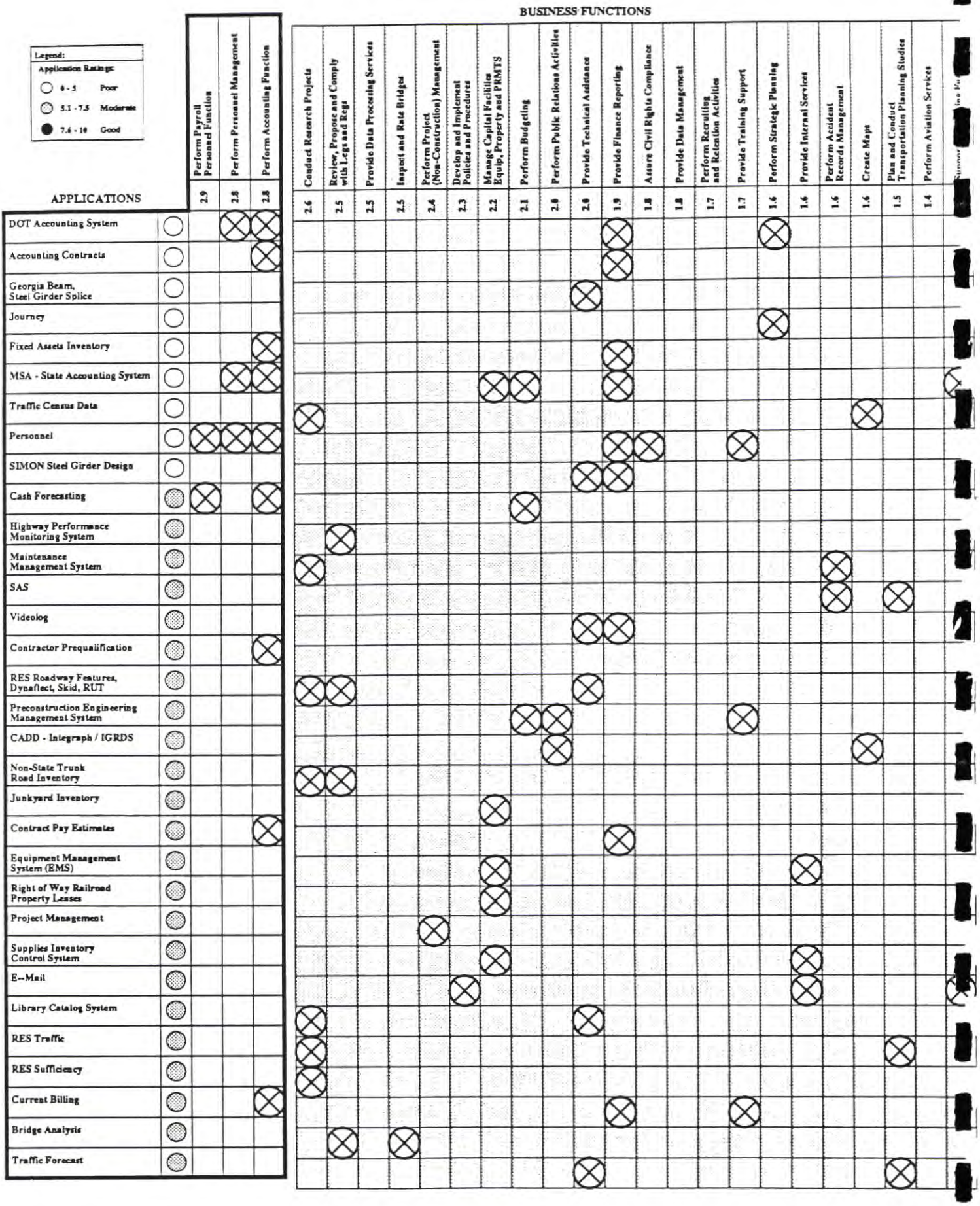
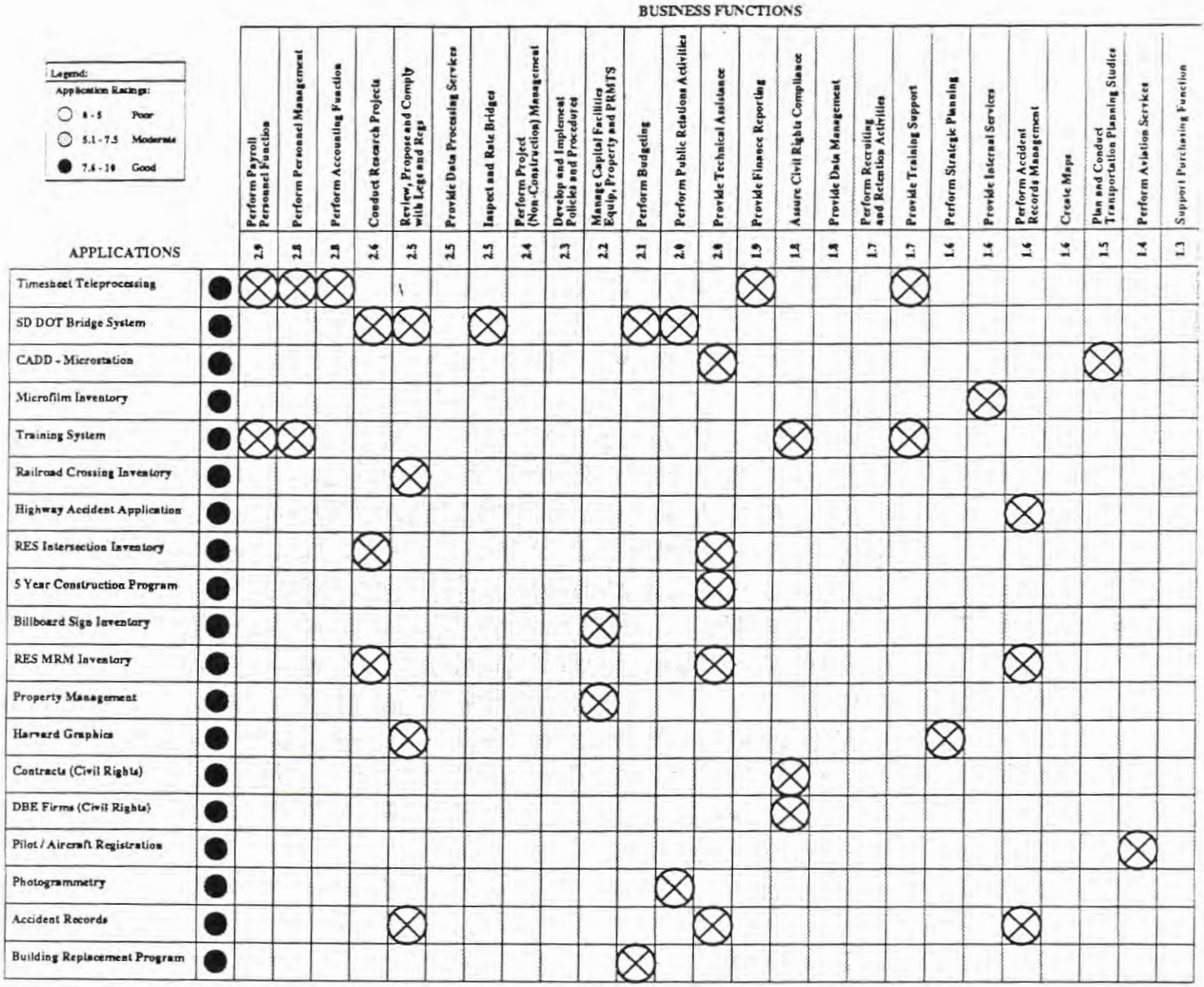


Exhibit 1.20
Provide Support Functions

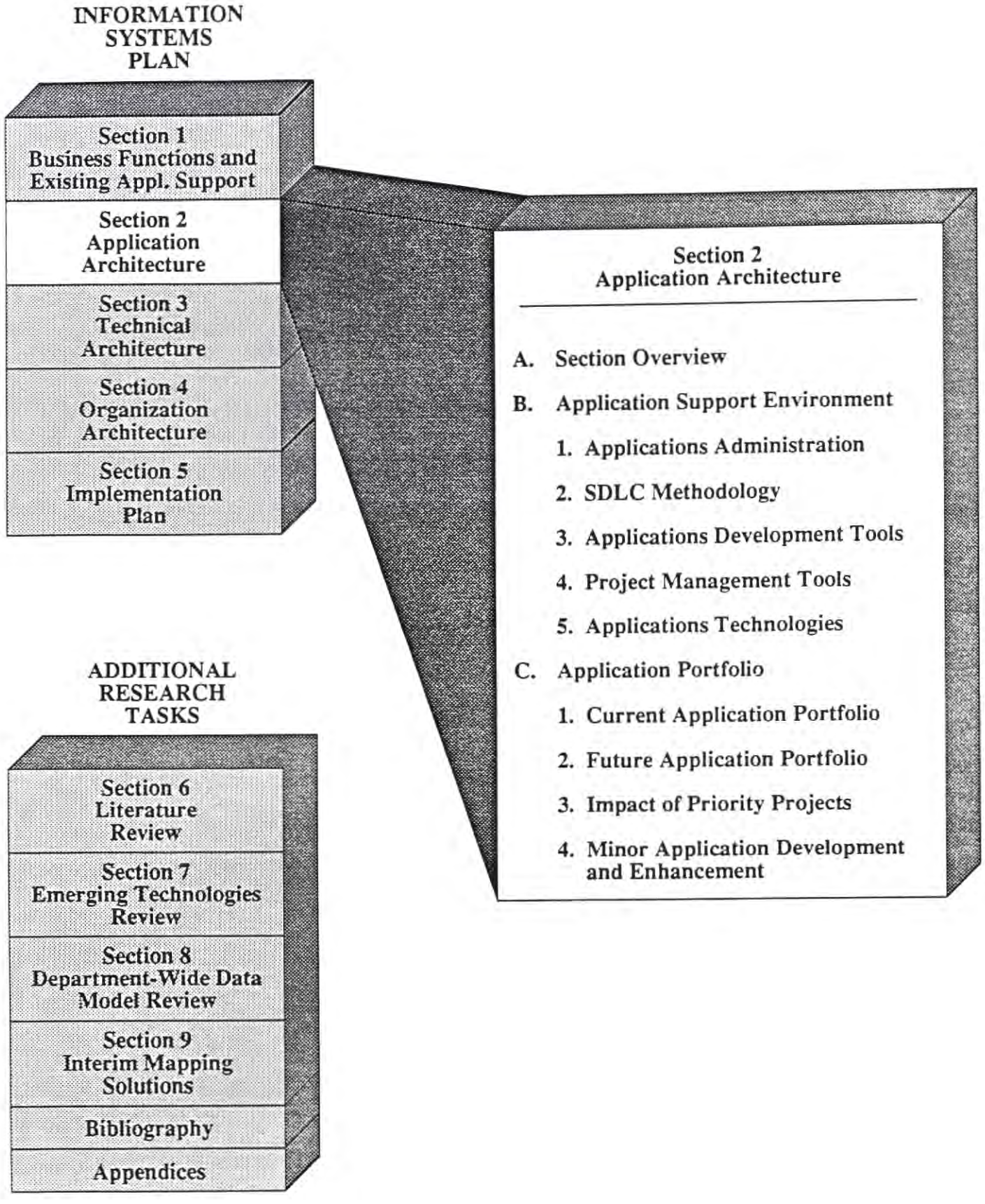


The key applications which received inadequate user satisfaction ratings are:

- Personnel System – Does not provide adequate analysis of historical data
- Cash Forecasting – Receives "unrealistic" scheduling estimates from PCEMS
- DOT Accounting – Outdated and becoming increasingly difficult to maintain.

The replacement of the DOT Accounting system is identified as a priority project in Section Two of this plan. Other enhancements have been combined into a project category referred to as "Minor Applications Development and Enhancements".

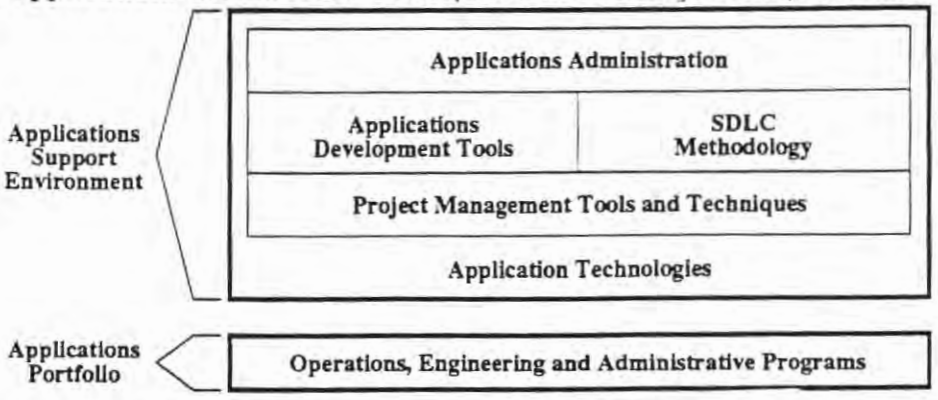
SECTION 2
APPLICATION ARCHITECTURE



A. SECTION OVERVIEW

Section 1 of this plan highlighted the degree to which the existing information systems support the business needs and objectives of the Department. The results of that analysis provides the foundation upon which future applications or proposed projects are based. This section of the plan provides the detailed descriptions of each proposed project. This section also identifies strategies which impact the Department's ability to establish an effective applications architecture. These strategies will be a key factor in the Department's ability to successfully deliver new systems throughout the 1990's.

The applications architecture is composed of two major components as depicted below.



The Applications Support Environment consists of the tools, methodologies, techniques, disciplines and technologies utilized by the Data Services area to develop, implement and maintain application systems as efficiently as possible, and is composed of five major components:

- Application Administration includes those components of the applications infrastructure which assist the organization in controlling application change. Change control is an important element of any organization. Software configuration management and data administration are two support structures which assist organizations in administering and controlling change.

- SDLC Methodology or Systems Development Life Cycle Methodology provides a formalized and structured approach for building information systems.

- Applications Development Tools are a set of computerized technologies which facilitates or automates all phases of the systems development life cycle.

- Project Management Tools and Techniques provide computerized project tracking/reporting tools, and procedures for identifying, documenting, and communicating project requirements and acceptance monitoring.

- Application Technologies include computerized tools to support applications programming.

Each of these areas is addressed in the context of the current environment as well as the proposed or future environment.

The Applications Portfolio consists of the actual applications systems that exist or should exist to support the business functions of the Department. This section describes each of the proposed priority projects that should be undertaken to improve the application portfolio.

This section concludes with an exhibit illustrating the impact of the priority projects on the business areas identified in Section 1, and a description of "Other Minor Application Development and Enhancements".

B. APPLICATIONS SUPPORT ENVIRONMENT

1.1 Current Applications Administration

Data Services is the central office within the Division of Finance responsible for Department–wide application support, and the budgeting and procurement of most types of computer hardware. The responsibility for custom development of applications resides primarily with two different areas within Data Services; Business Development and the Operational unit.

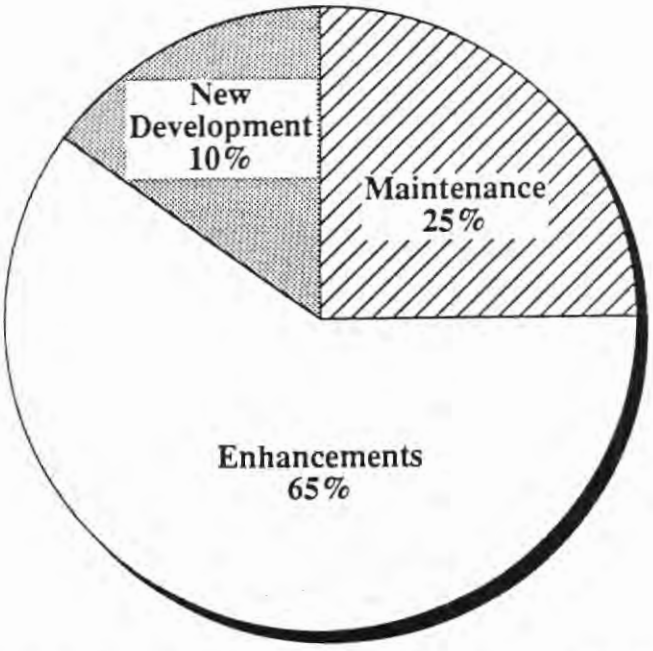
The environment for which these two areas develop applications is somewhat different. The Operational unit develops applications for the personal computer, while the Business Development area performs the majority of maintenance, enhancements and new development projects in the IBM mainframe environment, with limited personal computer applications development.

The Department describes their maintenance and development work according to the following definitions:

MAINTENANCE	–	Program changes which were required to correct program errors or bugs
ENHANCEMENTS	–	Program changes which enhance the functionality of an existing system
NEW DEVELOPMENT	–	New applications custom development or the implementation of a package.

As illustrated in Exhibit 2.1, maintenance and new development projects consume a relatively low percentage of Data Services' time (25% and 10% respectively). Enhancements consume the majority of time, averaging 65% of Data Services' time.

Exhibit 2.1
Application Work Breakdown



Requests to enhance or change applications are typically handled informally. Users initiate a request by writing a letter to Data Services or calling one of the analysts within Data Services. A manual list of these requests is maintained for tracking purposes. Once the request has been assigned to an analyst it is deleted from the list. Generally, one analyst is given the responsibility for the planning, defining functional requirements, designing, constructing, testing and implementation of a request, due to the size of the Data Services' staff.

Since the introduction of information systems at the State, the development of new systems has been generally sequential. As needs were identified, systems were designed and built to respond to specific business needs. As the computer's capabilities became better known, user expectations grew exponentially (not unlike most organizations in both the public and private sector). The Data Services area, however, did not grow in staff size relative to the increasing demands for added functionality. Therefore, projects continued to be developed in a serial fashion. Each of the systems generally were designed and developed using the concept of master files.

The rapid growth eventually led to significant data redundancy, since each application was designed to contain all of the data required by the application. This was complicated by the need to build program interfaces, so that two or more systems or applications using the same data could be maintained and appear to the users to be sharing the same data. In truth, the proliferation of redundant data quickly resulted in discrepancies among systems for a multitude of reasons, including timing differences, varying uses of the data, input errors, etc.

A recent illustration exemplifying the redundancy issue is the multiple occurrence of the "project location description" which is manually entered by different offices into the Five Year Construction Program, PCEMS, Project Management, RES MRM Inventory, and the Bridge Systems.

1.2 Future Applications Administration

In order to reduce or elimate Department–wide data redundancy, the Department should establish a strategic goal to begin the long term integration of information systems. The movement toward the integrated architecture will be an evolutionary process spanning several years. One of the primary objectives is to provide an architecture which facilitates data sharing.

In an effort to support this evolutionary process, the Department must begin to challenge any new systems implementations which sacrifice the long term integration strategy to satisfy short term objectives. In addition, the Department must implement a program of data standardization. Data modeling can provide a very effective technique for establishing data standards and better understanding the characteristics of the Department's data element requirements.

The automated tools used to support data modeling should also take into consideration issues related to the software configuration management function and version control. Software configuration management techniques allow analysts to more effectively understand and control the impact of change, by tracking "how" various applications or systems are related. Version control provides the analyst the ability to track multiple variations of an application program. As systems become increasingly integrated, the ability to maintain and track multiple versions and variations of the "base definition" will become more critical.

A Data Administrator chartered with maintaining a Department–wide data model may also lend support to the underlying Application Administration structure. A Department–wide data model contains unique data element definitions for all data elements within the Department and defines the relationship among the elements. When a new application is being designed by an analyst or by an end user, an assessment should be made by the Data Administrator to determine:

- Where the request fits into the current Department–wide data structure
- What data elements currently exist
- If existing elements can be utilized
- What new elements and relationships need to be defined.

The analyst, end user and Data Administrator should work together to resolve these questions and complete a detailed data structure for the application. This would assist the Department in reducing the data redundancy which exists in the Department today and facilitate the move towards greater data integration.

2.1 Current Systems Development Life Cycle (SDLC) Methodology

A systems development life cycle methodology is a disciplined management process that provides a structured approach for planning, delivering and maintaining information

systems. Every organization has an approach, whether formal or informal, for managing the steps associated with developing and maintaining systems. However, the traditional approaches which have been applied over the years are becoming more difficult to apply today. Managing the systems development process is becoming more complex as the size and level of systems integration increases.

The Department currently applies an informal development methodology. The Data Services analysts are largely responsible for applying the development guidelines, since the analyst is chartered with all or most of the activities associated with implementing the request.

A systems development manual was published in 1982 for Data Services for this very reason. The manual established procedures and conventions to follow when developing new software. The manual provides instructions and guidelines for the planning, requirements definition, systems design and programming phases.

2.2 Future System Development Life Cycle Methodology (SDLC)

A formalized methodology provides a structured means of gathering, processing and disseminating information in a logical format. A typical methodology consists of six phases:

- Systems Planning
- Requirements Definition
- Preliminary Design
- Detail Design
- Construction and Testing
- Implementation and Conversion.

Each phase of the SDLC produces a documented deliverable that discloses the results of work conducted during the phase. Methodologies developed in the last few years tend to be more robust and incorporate many procedures designed to accommodate Computer Aided Software Engineering (CASE) tools. Some CASE products have even incorporated formal methodologies into the tool sets. The management reporting and documentation standards built into these tools enable management to monitor progress, costs and consistency with policy associated with the project.

Documented deliverables also provide analysts a vehicle for communicating with users and managers about how the system is being designed and how it should functionally operate. This provides the users an opportunity to challenge the design and functionality earlier in the development process.

3.1 Current Application Development Tools

As indicated above, many types of development tools are available to support the development of systems. Data Services is currently utilizing Software AG's fourth generation programming language (4GL) called Natural. The 4GL is a language which supports code generation only, using significantly fewer program statements than older third generation languages (e.g., COBOL, Fortran, etc.). Other than this, Data Services is not an extensive user of automated development tools.

3.2 Future Applications Development Tools

In order to effectively support the Department's future development efforts identified in this plan, consideration must be given to implementing a CASE technology. These tools may assist the Department in automating a large part of the SDLC. CASE provides:

- Consistency in the development process by providing a data dictionary or repository, allowing project team members to maintain a single master definition of each term, element, record, table, etc.
- Pictorial representations which allow technicians to more effectively communicate with end users
- Extensive analysis capabilities ensuring consistent, high quality system designs
- Users with more input into the design process providing the ability to identify changes earlier in the system development life cycle at less expense and increasing the likelihood of user acceptance.

There are typically many components in a CASE tool which assist the designers and developers in information strategy planning, business area analysis, systems requirements definition, preliminary and detailed design, construction, testing and documentation.

4.1 Current Project Management Tools and Techniques

One of the concerns with developing a new project is being able to deliver the project on time and within budget. Project management tools provide an automated mechanism for estimating a project's length, and tracking the detailed tasks necessary to complete the project. There are currently no automated project management tools available in Data Services.

4.2 Future Project Management Tools and Techniques

Project Management Tools

In large information system projects, it becomes necessary to track all resources of a project including time, personnel and money. Project management tools provide mechanisms to estimate and track all three resources throughout the development process. With the limited number of resources in Data Services, the Department should consider project management tools to monitor these resources as efficiently and effectively as possible. This may provide Data Services a better opportunity to implement a project team concept, in which more than one analyst would be responsible for a project.

Consideration should also be given to project management packages which offer direct interfaces to CASE tools. The automated project management tools provide project status reports and periodic progress reporting.

Project Management Techniques

Another project technique useful to accelerate the requirements and design phases of a project is a group interviewing approach referred to as "joint application design" (JAD) sessions.

The use of joint application design meetings is an especially helpful technique to consider in conjunction with the SDLC. Its prime objective is to include users in systems development. JAD increases productivity by having several individuals participating in a single interviewing session so that interfaces can be identified and issues resolved earlier in the development process. JAD sessions establish commitment and foster a sense of ownership of the system being developed by the participants. The outcome of a JAD session is agreement between users and system analysts as to the design requirements of a new or proposed system.

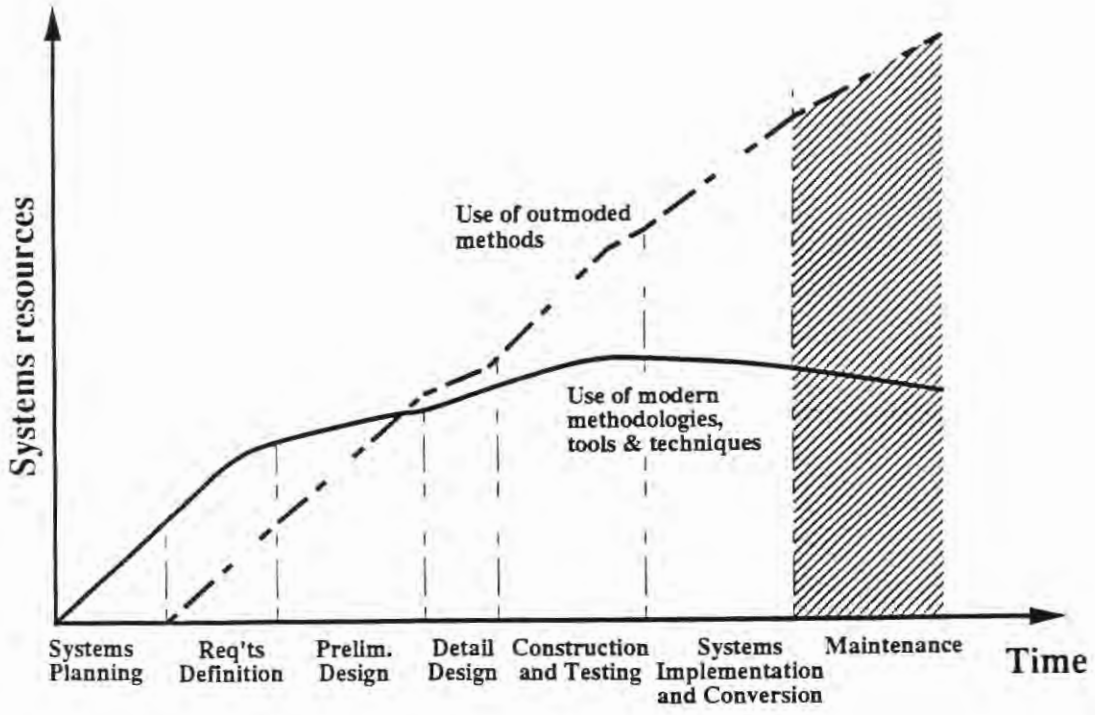
Case tools used in combination with these JAD techniques and a formalized methodology can provide substantial long term cost saving for the Department. Exhibit 2.2 illustrates the overall system resources consumed using older methodologies as compared to using modern methodologies with the support of automated tools and techniques, like CASE and JAD.

5.1 Current Application Technologies

The existing applications support technologies utilized by Data Services includes:

- ADABAS
- Basic
- COBOL
- Dbase
- Natural
- SAS
- PC/DOS

Exhibit 2.2



Source: Information Executive, Summer 1991

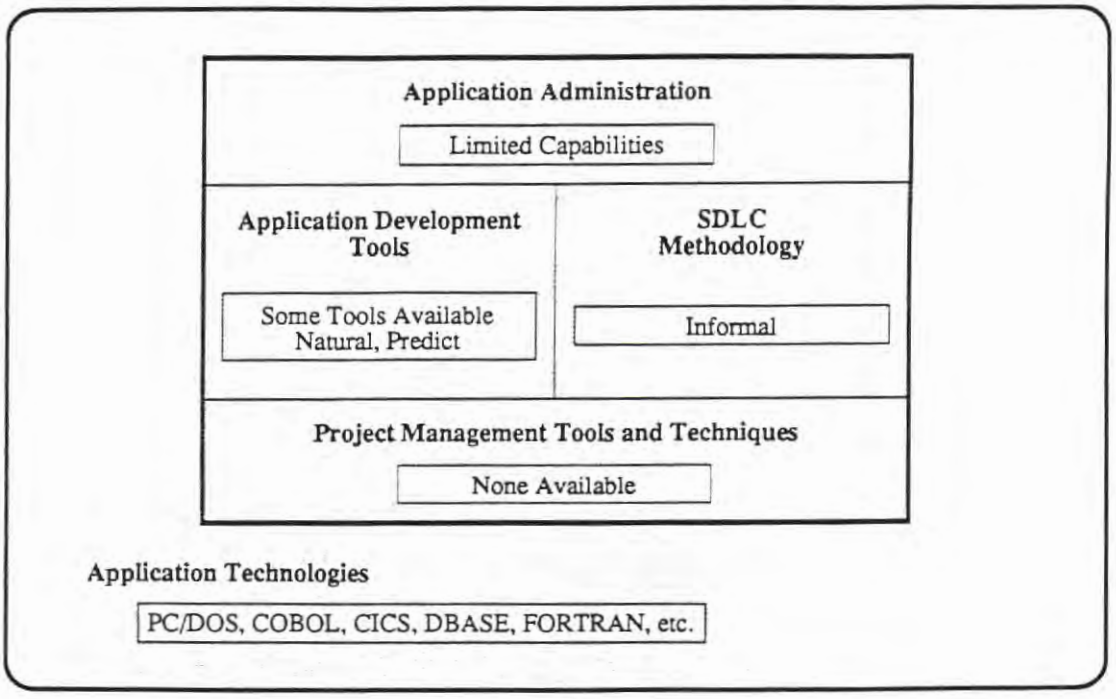
5.2 Future Application Technologies

Given the highly decentralized nature of the Department's processing capabilities, a client server environment should be considered for the long term strategic applications processing architecture. Client server environments allow applications to be segregated into components and designed on the appropriate platform. The front end of an application, the part the users interact with, may run on a personal computer to take advantage of graphic displays. The back end or the component that performs the calculations and intense processing may occur on the mainframe, thus providing the appropriate technology for each component of an application. The processing involved using this type of technology is transparent to the user but may involve additional planning and analysis by the analyst designing and developing the systems. This also supports the justification for CASE and incorporating a structured methodology into the organization.

In summary, Exhibit 2.3 identifies the evolution which should occur from the current applications support environment to the future applications support environment.

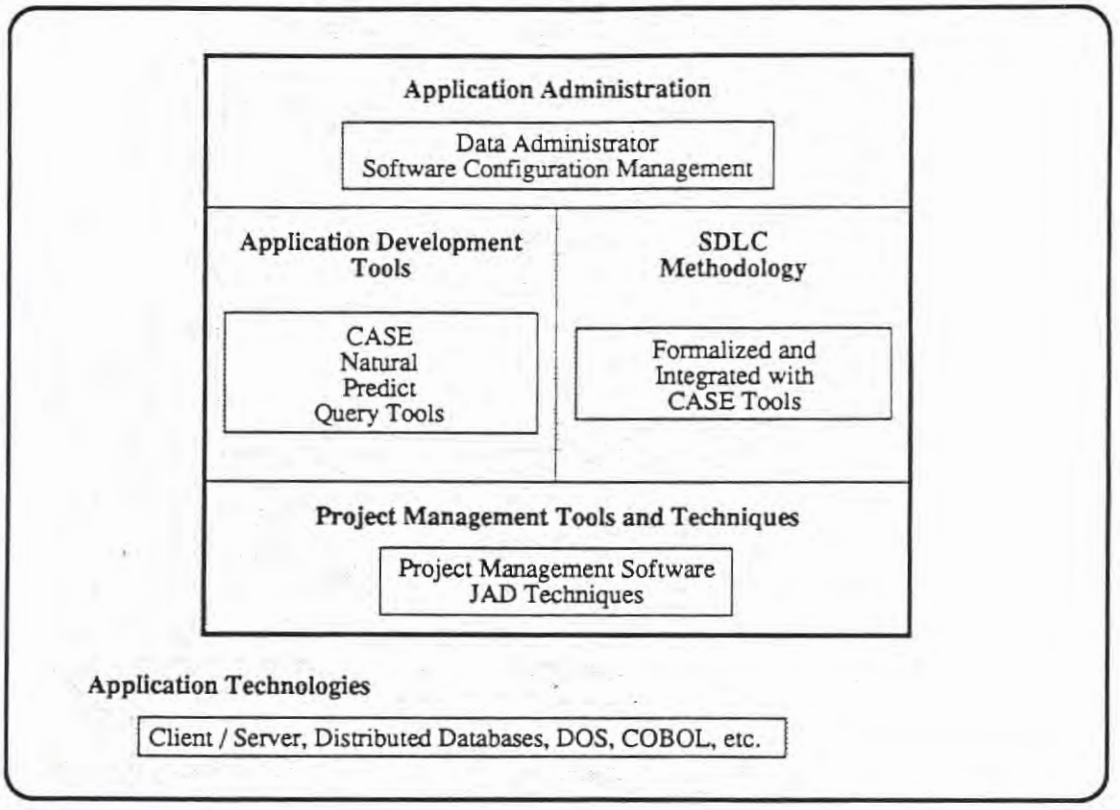
Exhibit 2.3
Application Architecture Evolution

Current Applications Support Environment



"Infrastructure" Changes Required

Future Applications Support Environment



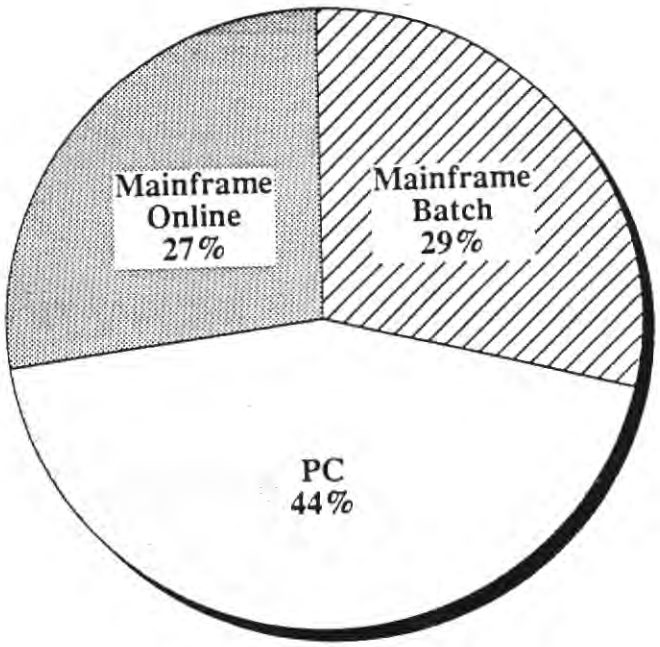
1. Current Applications Portfolio

There are approximately one hundred applications currently developed at the South Dakota Department of Transportation. Each of the applications are running in one of the following three modes:

Mainframe Online	–	The data entered is processed at the time the enter key is pressed
Batch Online	–	The data entered is processed at a predetermined time, (e.g., nightly, weekly, monthly or annually)
PC/Workstation	–	The data entered is processed at the time the enter key is pressed or the file is saved, (e.g., LOTUS and Display Write) however, data is generally available to only one person.

Exhibit 2.4 illustrates the percentage of applications running under the above defined modes.

Exhibit 2.4
Application Mode Breakdown

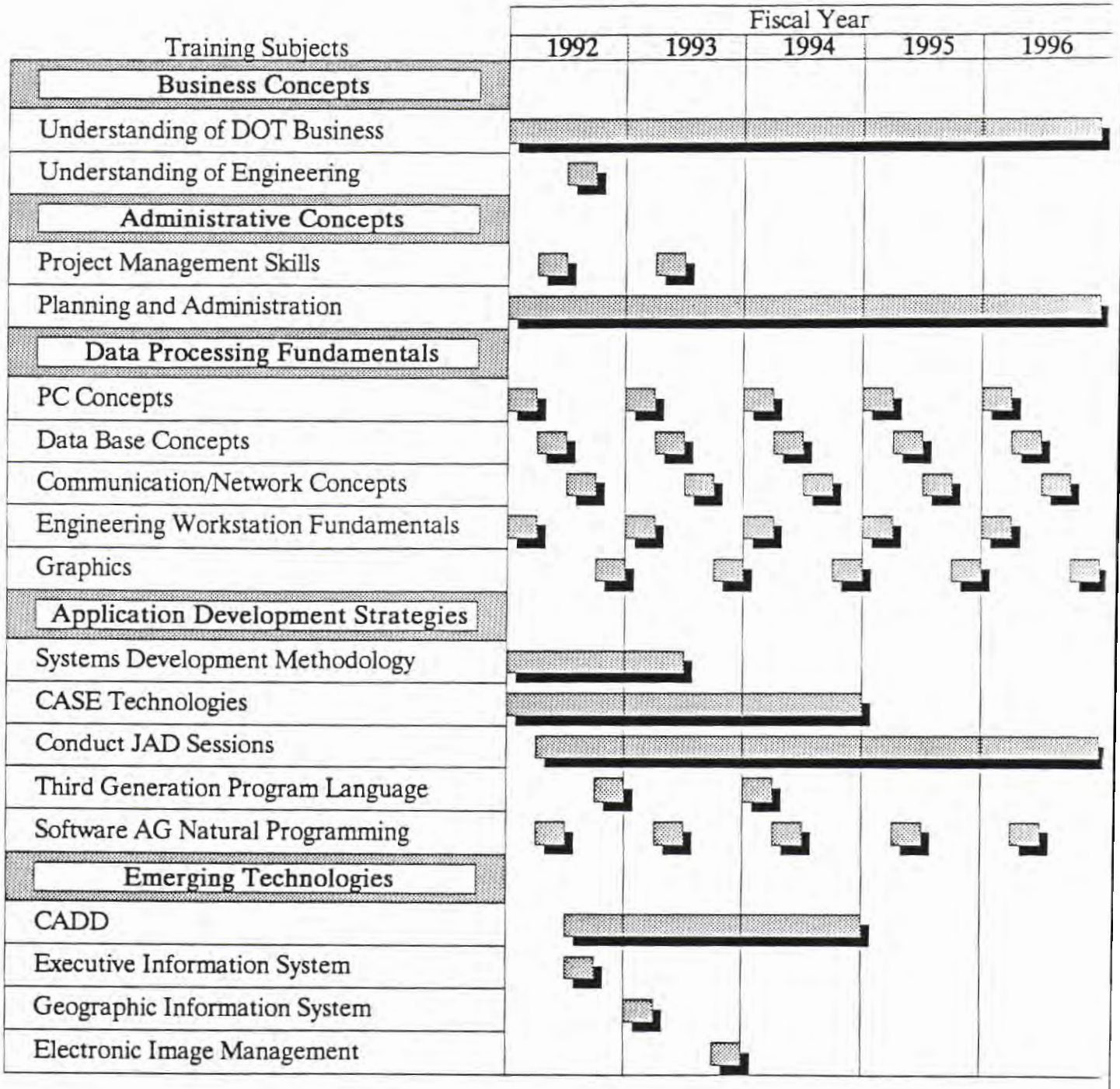


An assessment of the current applications was performed in each interview session conducted throughout the planning process. In each interview, the users completed a survey for each application for which they were familiar. A summary of these applications is included in the Appendix of this Plan. The survey contained a scale from one to ten with one representing a low score and ten the high score. There were five ratings and room for additional comments. The five ratings included:

F. TRAINING

In order to successfully implement the proposed portfolio of priority projects in an effective and timely manner, Data Services' management and staff will require additional technical training. Exhibit 4.7 provides a time phased training plan which appropriately supports the implementation of the next section of the plan. Consideration has been given to the orientation of new employees and the "ramp time" required when introducing new technologies. Consideration has also been given to the ongoing education required of current Data Services staff and management.

Exhibit 4.7
Training Schedule



Section 6 – Literature Review

A. SECTION OVERVIEW

The South Dakota Department of Transportation faces many challenges in addressing the long term deployment of information system resources in support of its overall business objectives. Information systems within the South Dakota Department of Transportation have become increasingly critical to day–to–day operations. This is due in part to the increasing Federal reporting requirements necessary to substantiate funding. It is also due to increasing demands to operate more efficiently and effectively. These demands come at a time when workloads are on the rise, and projects continue to grow in size and complexity [NCHRP, Number 173]. The unveiling of the Surface Transportation Assistance Act of 1991 will add to management's concerns, as the need for timely, accurate and concise information becomes increasingly important to support effective decision making.

In light of the rapidly changing environment, a factor critical to the Department's success in meeting strategic goals and objectives will be its effective and committed implementation of the recommendations outlined in the strategic information system plan. The strategic planning process is designed to link the Department's business objectives, directly with the acquisition and implementation of the information processing resources necessary to support those objectives.

Over the years, varying degrees of formal and informal information systems planning has occurred within the Department. A majority of this planning has focused on the technical hardware/software aspects of the information processing environment. Therefore, by design, the Department has emerged from a very simplistic centralized computing environment, to one which is very complex and substantially decentralized. In many aspects, the technical configuration is relatively "state of the art".

The American Association of State Highway and Transportatiuon Officials (AASHTO), has published a survey [AASHTO, 1990] designed to assess the current computer technical environments of the AASHTO member departments. Two reports were published as a result of the survey which included :

- The current status of AASHTO member departments technical and applications environments
- The results relating to the strategic directions of AASHTO member departments and AASHTO computer software contractors.

The following findings are extracts from the "Report on the Survey of Current AASHTO Departments Computer Technical Environments, and Combinations of AASHTOWARE and Platforms," dated January, 1990.

- Departments which require in–house developed products to utilize a standard database:

  Twenty–five (25) Departments required the use or interface to a standard database, and thirteen (13) did not. Futhermore, of the respondents, ADABAS is used by 18% of the departments as is DB2.

- Departments utilization of design software in large, medium and workstation environments:

			Install's
Large Environement–	IGrds	16.9%	13
	CEAL	3.9%	3
	Other	79.3%	51
Medium Environment–	IGrds	84.3%	59
	CEAL	8.6%	6
	Other	7.1%	5
Workstation Environment–	IGrds	75.2%	551
	CEAL	23.6%	173
	Other	1.2%	9

- Departments utilizing various forms of networks

  Sixty–nine (69%) of the respondents have some type of network which connects technical and management workstations.

In the AASHTO report on "Strategic Directions of AASHTO Departments and AASHTOWARE Contract Service Providers", January, 1990, the survey results indicated that there appears to be limited interest in changing installed AASHTOWARE products to different midrange and mainframe environments. Considerable interest existed in installing products in the personal computer and Unix workstation environments. Movement towards these environments would likely benefit the South Dakota Deparment of Transportation given the broad base of personal computers which already exists within the Department.

In regards to the use of formalized methodologies and Computer Aided Software Engineering (CASE) tools, all contractors indicated that methodologies are being applied, and several contractors indicated CASE tools were being investigated for their value in the requirements definition and design specification phases of new software development. Recommendations in both of these areas are included in the Applications Section of this report.

In a survey of SD DOT management, information was solicited regarding the perceived "degree of current information systems automation" and the relative position relating to other State Transportation Departments. Overall, management indicated that South Dakota has a high degree of computerization (7.5 on a scale of 1–low to 10–high), and is well ahead of other DOT's in the area of computerization (7.7 on a scale of 1–behind, 5–equal to, and 10–ahead of).

These results appear to indicate that the proliferation of personal computers have had a significant impact on the Department's information systems users. In actuality, the applications environment remains "structurally" antiquated. This has been primarily caused by the use of the master file concept when developing applications. Systems using this approach to maintain data files require each application to contain all

the information required by that application (see section 2, Applications Architecture). Common problems which result from this design approach include:

- Data entry becomes redundant. The same data is entered into many different systems
- Redundant data often conflicts in value among systems
- Systems require interfaces which lead to timing and cut–off difficulties due to the batch nature of the interfaces
- The integrity of data becomes suspect.

When the integrity of data becomes questionable, users typically begin to place little trust in the overall information systems environment, and generally become much less efficient in their day–to–day operations.

B. DATA INTEGRATION

The progression toward applications and data integration should serve as one of the Department's primary long term objectives regarding information systems development. In an attempt to review many of the issues associated with this integration issue and compile the results of individual State efforts, the American Association of State Highway and Transportation Officials authorized the Transportation Research Board to undertake a project to synthesize various sources of information regarding this topic. The results from this project have been published in a National Cooperative Highway Research Program [NCHRP, Highway Data Synthesis] publication series which highlights:

- The benefits of integrated data
- Organizational considerations
- Computer hardware and software considerations
- Content, organization, and linkage of integrated highway information systems.

The report effectively illustrates many of the organizational and technical issues surrounding the integration issue, and summarizes the following key characteristics attributable to successful integration implementations:

- High degree of coordination among agency personnel to reduce duplicate or inconsistent use of data
- Data entry physically located at the source of data versus a centralized location
- Timely reporting
- Extensibility of the database maintaining the inventories
- Employment of user friendly, state–of–the–art technology with built–in expandability.

Many of the fundamental requirements necessary to support the environment described above exists in the Department. However, the integration process requires precursory steps which include the modeling of the Department's data. This is necessary to gain greater control of the information systems and data.

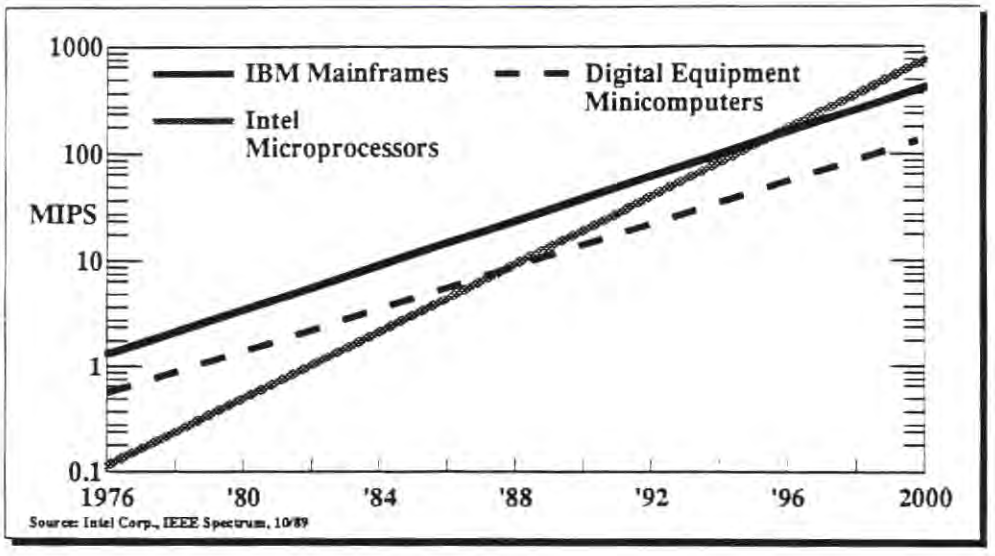
There are many approaches to data modeling. Most approaches ultimately support the same objective, which is to model the business and provide a roadmap or blueprint for future information system development projects. As described in the video presentation of "Data Architecture" by QED Information Sciences, the changes are not required until the business changes, the applications age to the point where significant operational inefficiencies occur, or new technologies provide a cost effective replacement.

In a recent NCHRP report [NCHRP, Number 173], Jenks noted that information technology has been applied to many aspects of the DOT business, however, executive decision making support has been limited. This trend appears to be less prevalent within the South Dakota Department of Transportation, largely due to the extensive use of the personal computers by executive and middle management.

C. PERSONAL COMPUTERS (PC's)

The Department should also begin developing applications which take greater advantage of the substantial processing capabilities of the personal computers. This will further assist the Department in realizing the benefits associated with its present technical configuration. The substantial advances of the personal computer processing capabilities are illustrated in Exhibit 6.1. This exhibit associates the growth in PC, minicomputer and mainframe processor speeds in terms of Million Instructions Per Second (MIPS).

Exhibit 6.1



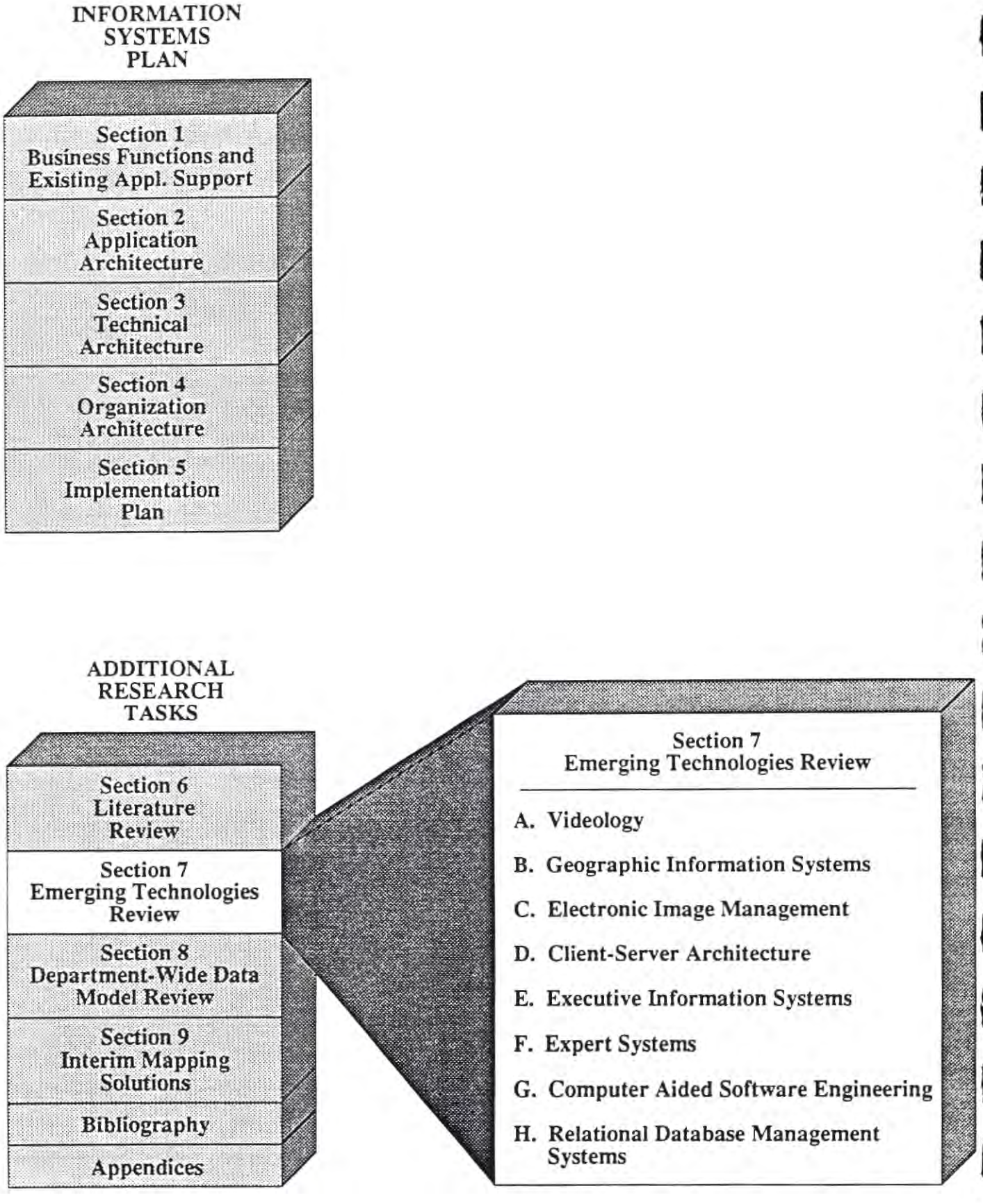
D. CONCLUSIONS

The Department faces many challenges in delivering information technologies in support of the overall business goals and objectives. The Information Systems Planning process should

serve as a significant step in assuring that the Department is moving in a direction consistent with its overall mission. Furthermore, the careful planning of future information systems development and implementation of technology to deliver these systems will aid the Department in:

- Funding the development and maintenance of information systems in a manner consistent with the business benefits they provide
- Managing the change in technology in a manner that will support the overall business needs and direction of the organization
- Planning and developing new systems in an integrated fashion based upon a projected global view of the information systems necessary to support the business
- Equipping the information systems organization with the appropriate methodologies, tools and techniques that will allow them to effectively support the business objectives of the organization
- Utilizing technical and end–user personnel in the development of the information systems in an efficient and cost–effective manner.

SECTION 7
EMERGING TECHNOLOGIES REVIEW



A. VIDEOLOG

For years film based systems have been available, allowing images of a State's roadway system to be accessed from the office. Many physical limitations associated with film, however, have limited the effectiveness of such systems. Now, rapid advances in Videologging (the marriage of video and optical disc technologies), may allow these systems to become a key component in storing characteristics of the transportation system. The capabilities of a videologging system and potential opportunities associated with the technology are immense. Many significant benefits are associated with videologging, including:

- The use of laser dics as a storage medium allows a large number of images to be stored on a single disc. With flexible indexing, any image can be accessed within seconds.

- The use of optical disc technologies also allows related scanned images to be accessed from the videolog screen.

- By allowing a computerized application to manage the videolog's image data, access can be provided to tabular data relating to specific figures within the images. These databases can be tied by a common key based on a geographic referencing system (MRMs, Latitude/Longitude, etc.).

- The cost of storage (laser discs versus film) can be greatly reduced by a videologging system. Film required for photologging can average between $4 and $5 per mile, while the volume provided by laser disc storage can reduce the cost to $1 per mile.

The Research office is prototyping a system which will eventually be installed initially in each of the region offices. After the initial implementation in the regions and the operational and administrative procedures are reconciled, the system use will likely expand significantly into many areas of the Department's operations.

B. GEOGRAPHIC INFORMATION SYSTEM (GIS) & AUTOMATED MAPPING

Although many definitions of GIS exist, applications built under this technology are basically designed to capture, manipulate, display and analyze spatially referenced data. A GIS has complex query capabilities coupled with a tight integration of spatial and tabular databases making it a powerful tool for dealing with geographic information.

GIS fundamentally redefines how geographic referenced data is managed, analyzed and presented. As this technology matures, it is becoming much less costly, less technically complex, and provides much easier access to data and simplified analysis. The functional capabilities will, in the long term, cross most Departmental boundaries and provide an accurate model of the State's transportation network.

Automated mapping packages are often marketed as simplified Geographic Information Systems. Although these applications do have many characteristics in common with a true GIS, these systems lack the topological relationships required for complex spatial querying. They provide the ability to interpret a feature's shape and location and can associate attribute data from the database with the feature, but can not assimilate how different features on a map are related.

An initial implementation of a narrowly defined GIS project has been identified and further described in the future applications portfolio section of this Plan.

C. ELECTRONIC IMAGE MANAGEMENT (EIM)

The implementation of an image management system, as further described in the priority projects section, would provide the ability to capture information directly from paper, digitizing the image for storage on optical disk devices for future retrieval. Imaging allows multiple users to access the same document simultaneously. This approach to document storage can provide significant benefits in environments like the Department which store enormous amounts of original documents. This capability can also have a dramatic effect on the work flow of the Department's business.

Many of the documents currently stored on microfiche may provide opportunities for imaging. The following have been identified as opportunities for imaging: Plans, pre-letting packets, accident record forms and material certifications. It is expected that other EIM opportunities will also be identified in the future.

The average cost of entry-level and mid-range systems has been declining while the functionality and growth potential has been increasing. From 1990 to 1991, overall average price for small and large systems decreased by 11% and 17% respectively.

D. CLIENT-SERVER ARCHITECTURE

In a client server environment, both the PC (or workstation) and the server process information. The client (or PC representing the user machine requesting information) typically generates a query through a "front end" application. The application sends the query to the server which can perform one of two functions:

- Process the data because it happens to be the machine where the queried information resides
- Send information up to a higher communication layer to look up the location of the requested server and invoke the appropriate communication services to send the request across platforms as necessary. The query is then processed at the server where the data resides by a "back end" application. The information is then sent back to the appropriate client so it can be displayed to the user.

Benefits of a client server environment include:

- Spreading applications across a network of components without sacrificing performance
- Reduced network traffic since the data is processed on the server where the data resides rather than sending all the data across the network to the PC or workstation for processing.

E. EXECUTIVE INFORMATION SYSTEM (EIS)

Executive Information Systems (EIS) are designed to provide management easy access to information required to make complex business decisions. EIS provides the vehicle to gain access to this type of information via concise, predefined queries.
EIS is not new to the State of South Dakota. Information Processing Services (IPS), with the assistance of outside contractors, has developed an Executive Information System for the Governor. This system will allow the Governor to monitor the progress of all Departments in meeting the goals established by the strategic business planning process.

IPS plans on eventually providing all agencies access to the Executive Information System. However, it is unclear as to the timing or availability of IPS assistance. Furthermore, it remains unclear as to whether the State's EIS solution can meet the DOT's business requirements.

A project providing for the Department's EIS needs has been defined in the applications architecture section of the Information Systems Plan (section II).

F. EXPERT SYSTEMS

Expert systems apply automated programs to a specialized body of knowledge. These systems combine both problem solving and knowledge support components to apply the specialized expertise of an expert in the field to specific situations. By allowing the retention of this specialized knowledge in a structured, rule based format, expert systems can support effective decision making.

The following are examples of existing systems used in other DOTs:

- Retaining Wall Design
- Interactive Graphic Transit System Design Process
- Contingency Transportation Planning
- Hazardous Waste Site Characterization
- Disaster Planning and Management

G. COMPUTER AIDED SYSTEMS ENGINEERING (CASE)

While computerized automation of business processes has occurred over the last thirty years, only in the last five to seven years have computerized tools and methodologies evolved to facilitate the development of new systems.

Computer Aided Software Engineering (CASE) products are tools that provide automated graphics and analysis support for computer systems developers. These tools exist for virtually every phase of the systems development life cycle. The implementation of CASE technology offers data processing professionals a complete diagramming, analysis and reporting system to help automate the production of information systems.

The scope of CASE functionality is quite broad. These tools offer:

- Planning – Providing the capabilities to formally document and report business functions, organizational entities, critical success factors, applications and the relationships which can be defined among this data.
- Design Aids – Many tools support the capturing and documentation of system functional requirements, functional process descriptions, data descriptions, screen/report layouts; and facilitate prototyping. These utilities assist the development teams in communicating the functional specifications of an application early in the development cycle.
- Analysis Tools – Providing substantial analytical approaches to ensure the development of highly structured application designs.
- Database Tools – Providing a set of comprehensive facilities which support the design, development, prototyping and tuning of an integrated database management system.
- Programmer Productivity Aids – Automating the generation of computer program code.
- Testing – These utilities generally provide a series of programs designed to supplement, enhance, audit, and document the programming and systems test phases of a project.
- Documentation – Providing a comprehensive set of utilities which automate the documentation of the entire system.

There are substantial benefits associated with CASE technology, many of which are inherent in the capabilities described above. Regardless of the tool selected, users should recognize:

- Greatly enhanced ability to communicate design and functionality via graphics
- Improved documentation of projects, programs, data, etc.
- Improved overall designs requiring less ongoing maintenance
- Significant productivity gains in the long run.

H. RELATIONAL DATABASE MANAGEMENT SYSTEMS

The database management system (DBMS) marketplace has, historically, been dominated by the hierarchical type DBMS's. Recently, the relational DBMS has become the leading DBMS technology of choice in the industry.

The Relational DBMS's allow users to store and manipulate data according to the relationships which are defined among data, with little regard to the physical location of the actual data. Hierarchical DBMS's, in contrast, require a more structured database design. Therefore, users of a hierarchical database require more information about the physical structures of the database.

Both the relational and hierarchical databases utilize data elements referred to as "keys", in order to identify specific types or classes of data. However, due to the inherent structure of the relational DBMS, these databases offer somewhat greater flexibility in accessing and maintaining data.

Primary Advantages of a Relational Database

- In relational databases, there is no "positional" or location dependency between the data (relations). As a result, requests for data do not have to specify any preferred structure and therefore can be nonprocedural, i.e., access is greatly simplified. This provides substantial power and ease of use for users by providing access to "sets" of data in contrast to one record at a time. As such, the operations required to gain access to data tend to reflect what the end result should be rather than describing how the end result should be produced. This also allows the DBMS to perform the retrieval and update rather than requiring the user to understand the procedural detail.

- In a relational database, the details of the storage structure and access strategy are removed from the user interface. Therefore, this DBMS provides both simplified access and flexibility in maintenance of the database.

- Due to the recent popularity of relational database products, a greater array of proprietary applications software is becoming available in the marketplace. This is true for both package applications, as well as programmer productivity tools.

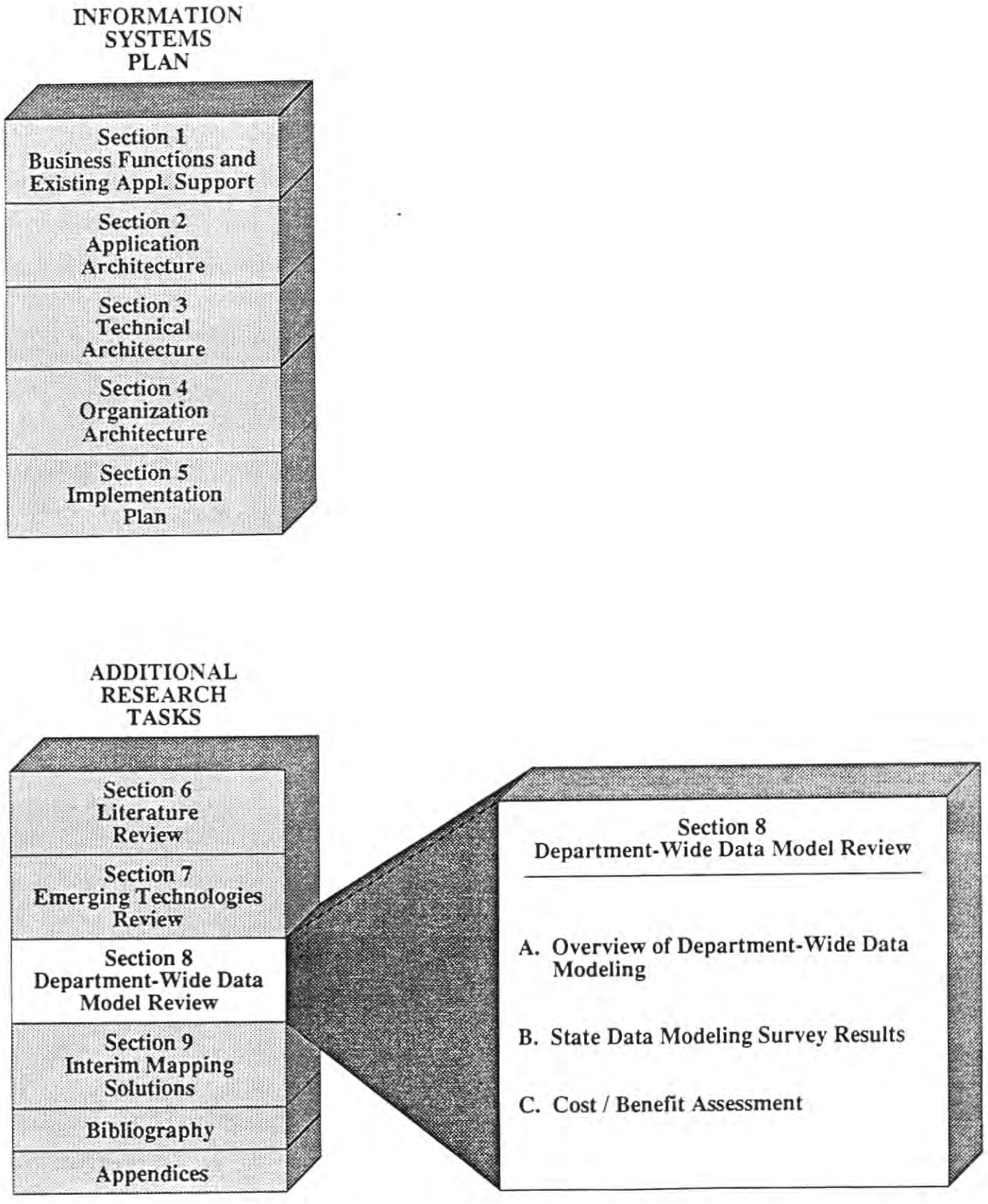
Primary Disadvantages of a Relational Database

- Historically, the performance of the relational DBMS has not been comparable with nonrelational products. However, significant improvements continue to be made in this area.

- In order to take advantage of the relational database flexibility, the development of a relational database requires extensive planning and design.

One of the primary objectives in relational database design is to help define data structures which remain stable as the database grows. Well defined data structures avoid unnecessary maintenance problems, and should not require restructuring because of new application needs (although they may require extensions). This same design approach can, however, and should apply to relational, hierarchical and network type DBMS environments. Extensive database planning and design is desirable for all three data models. The penalty for poor design is typically loss of data independence, which results in unnecessary maintenance to the original database design, or unnecessary programming to accommodate the design flaw.

SECTION 8
DEPARTMENT-WIDE DATA MODEL REVIEW



A. OVERVIEW OF DEPARTMENT–WIDE DATA MODELING

"Why Data Modeling?"

One of the most critical assets of an organization is the data it owns. Data, like personnel or financial assets, should be managed as an organizational resource. As with any important resource within an organization, effective management of that resource can produce significant gains in organizational efficiency and effectiveness.

In the past, however, data has not generally received this level of recognition within an organization. In the last three decades, data has often belonged to the application that used it. In those applications, data was defined, structured and accessed so that it optimized the performance of the single application. As future applications were built, interfaces to that data were required or data was reentered into the new application. This was, and continues to be the single greatest cause of systems complexity. ["Confronting Complexity", Paul Winters]

Two major problems associated with this approach to systems development have surfaced:

- The complexity of the systems environment has made existing applications more difficult to maintain and enhance. The development of new applications also has become more difficult, due to the increasing number of interfaces required.

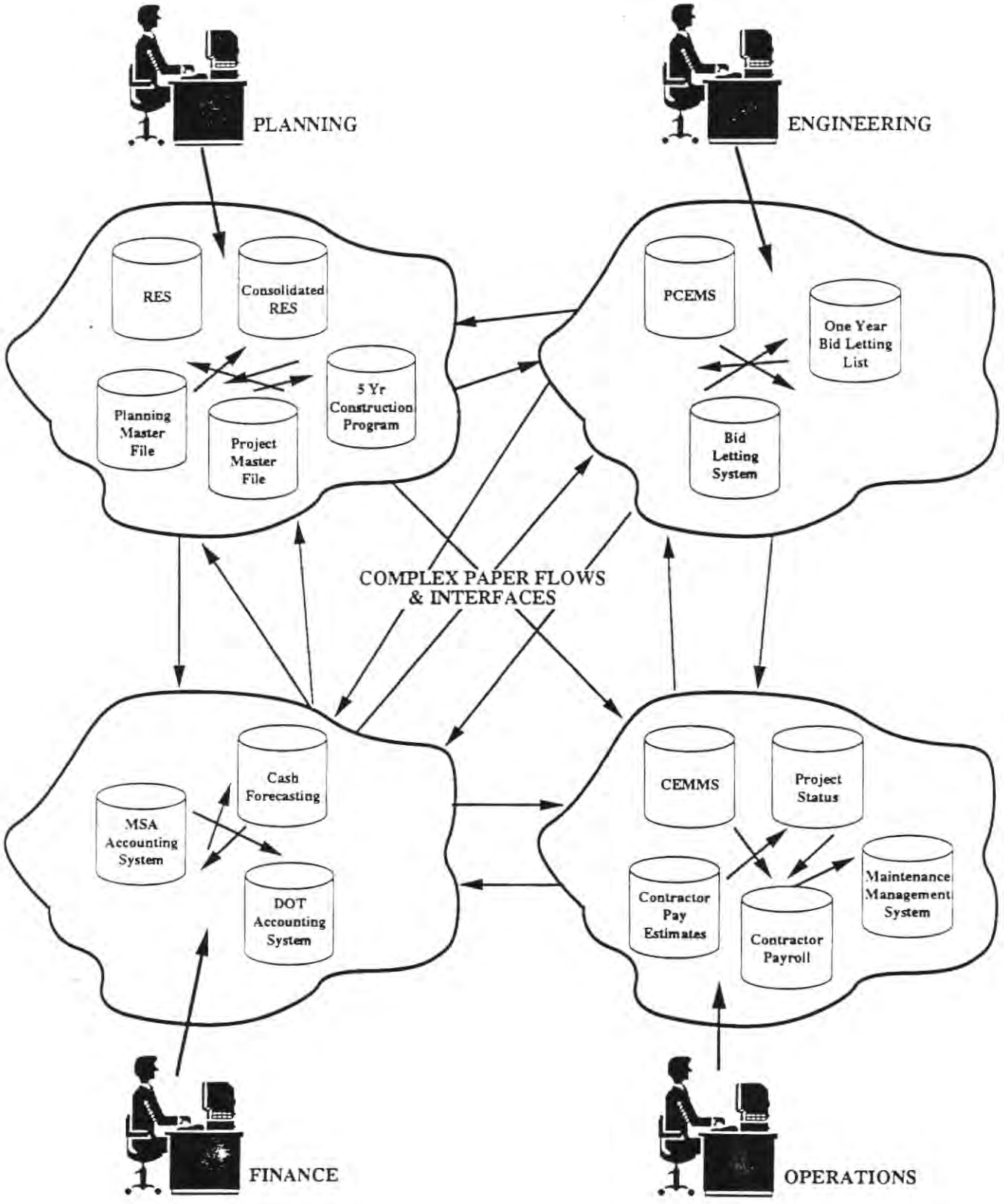
- Different representations of the same information may currently exist throughout the Department within different applications. This duplication leads to considerable confusion. Redundant efforts and wasted storage resources may also be required to maintain data in multiple locations.

As a result, a well planned and tightly integrated information systems architecture has become less of an option and more a necessity for establishing order and control in the investment of information systems resources. This architecture can be compared to a set of design plans. Building a roadway requires planning, surveying, designing and drafting before any construction can begin. The plans reduce the complexity associated with a project by concisely communicating a roadway's design. In a similar manner, a Department–wide data model reduces the complexity involved with building integrated computer systems.

"What is Data Modeling?"

As mentioned above, applications have traditinally been developed within functional

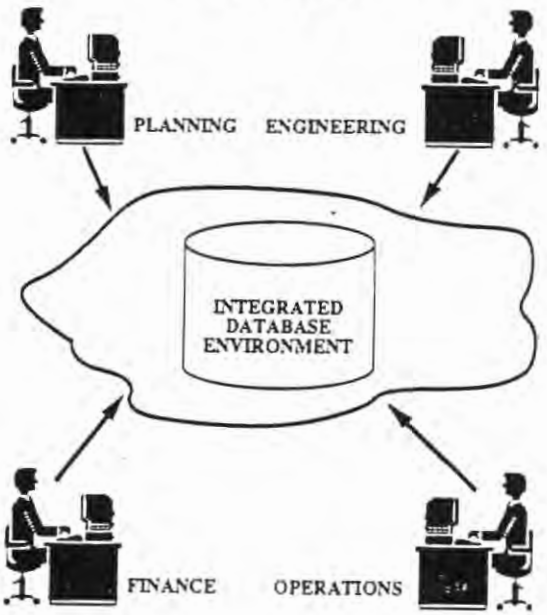
Exhibit 8.1


PLANNING
ENGINEERING
RES
Consolidated RES
Planning Master File
Project Master File
5 Yr Construction Program
PCEMS
One Year Bid Letting List
Bid Letting System
COMPLEX PAPER FLOWS & INTERFACES
Cash Forecasting
MSA Accounting System
DOT Accounting System
CEMMS
Project Status
Contractor Pay Estimates
Contractor Payroll
Maintenance Management System
FINANCE
OPERATIONS

areas to meet specific business needs. Complex interfaces and paperflows are then required to reconcile inconsistencies between systems. Over time it becomes increasingly difficult to keep systems synchronized. Exhibit 8.1 illustrates this situation within the Department using many of the systems that are potential candidates for redundant data.

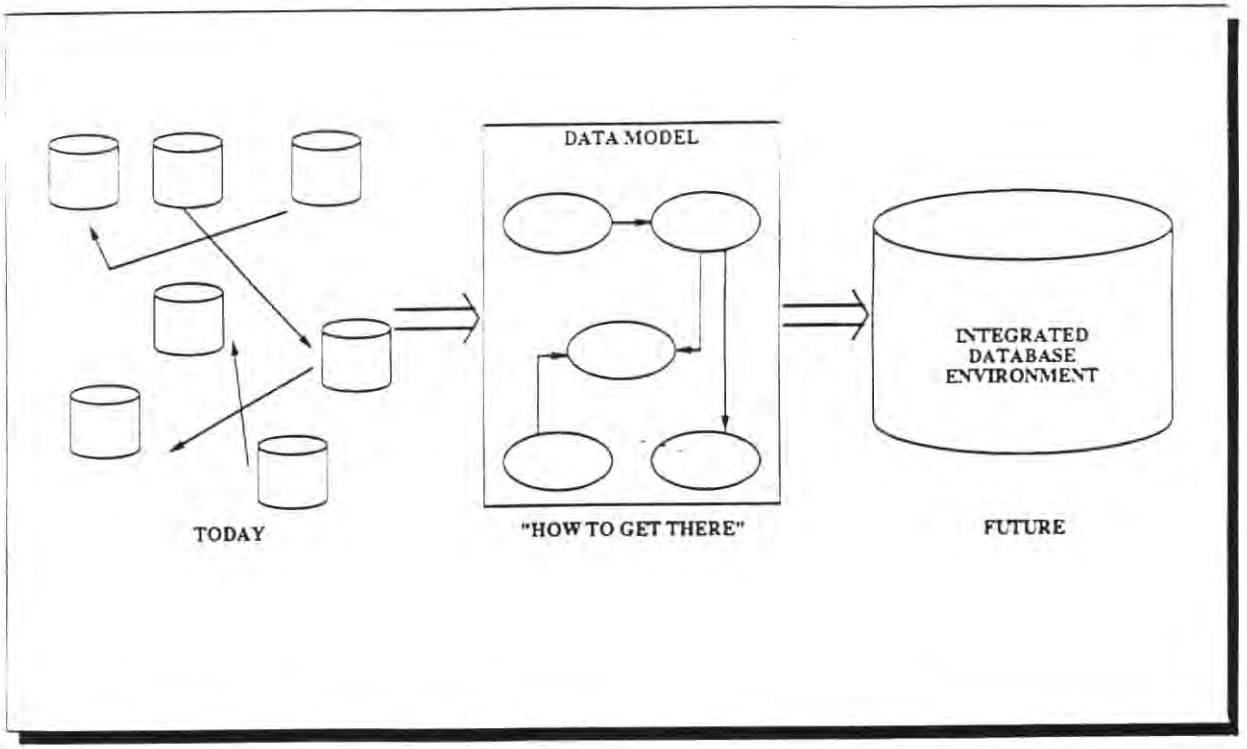
Integrated databases can eliminate data redundancies between systems. Under this design philosophy, data is no longer copied into multiple systems. Instead, applications access a common database of shared data. Because data items are only maintained in one place, an integrated database can eliminate the need for complex paper flows and interfaces. Exhibit 8.2 illustrates the concept of an integrated database. The Integrated Database Environment depicted in the exhibit is somewhat of an over–simplification of the actual technical environment, but constitutes a fair representation of the general integrated concept. In reality, the integration may physically be implemented as a "distributed database," residing on potentially many computers.

Exhibit 8.2



An effective tool for controlling redundancies and allowing the migration towards an integrated database is the Department–wide data model. Data modeling is essentially the process of developing a logical representation of a business' data and the relationships between that data. This representation identifies all data required by an organization (especially shared data) and provides a structure capable of supporting the different business needs throughout the organization. Within this model, data redundancy is significantly reduced. As existing files are migrated to an integrated database, the logical representation can then be modified to compensate for physical requirements of the database management system to be used by the organization. By migrating shared data to an integrated database, the need for complex interfaces and paperflows decreases. The data model is essentially the roadmap for achieving an integrated database environment as illustrated in Exhibit 8.3.

Exhibit 8.3



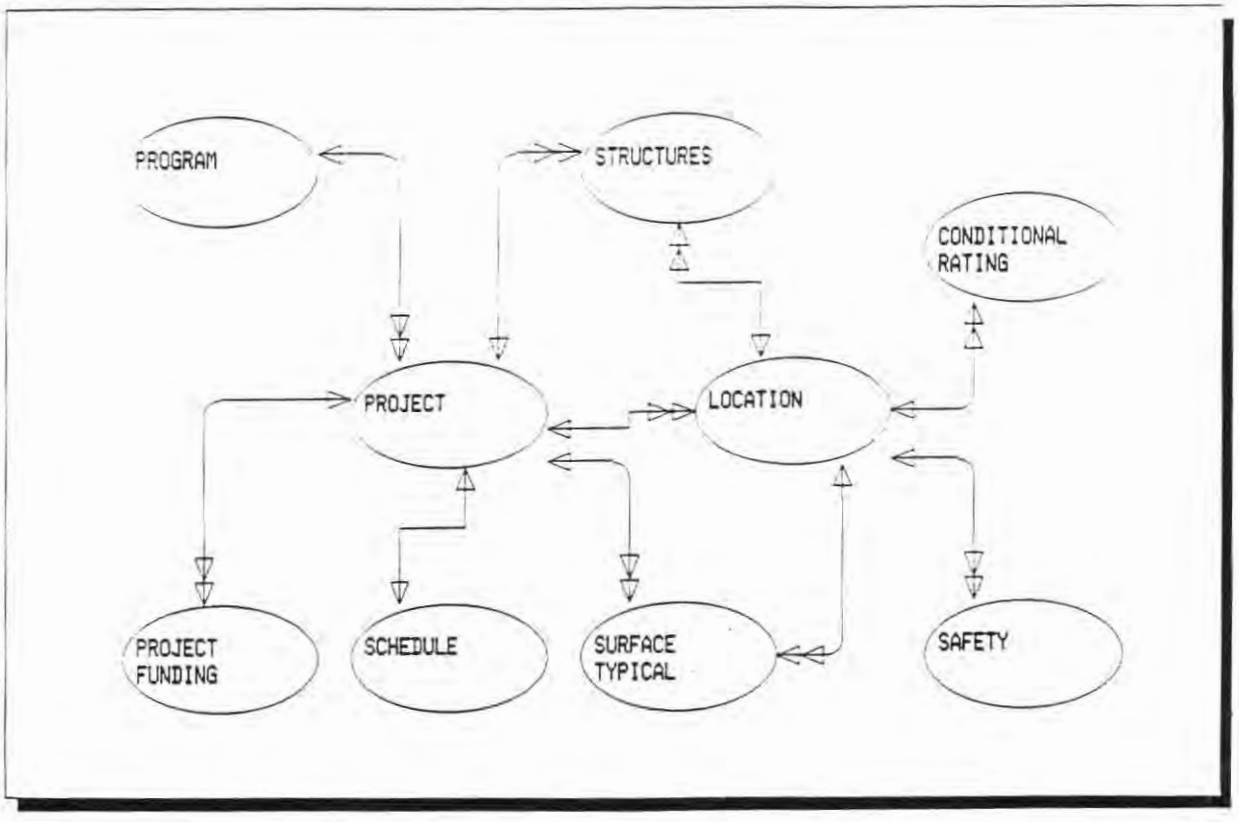
Because of data modeling's close relationship to organizational business requirements, key decision makers throughout the organization must be involved to ensure the model accurately reflects the needs of the business. This involvement also helps upper management realize the model's true value as a general management tool and not just as a data processing tool.

Because the organization is a dynamic entity that changes continuously, the model must be flexible enough to allow the data and relationships to evolve. This will likewise reduce the cost and time required to keep systems current with changing business requirements.

"Producing a [Department–wide] data model may at first appear to be a large task with little apparent value. However, with the information systems environment rapidly evolving into use of CASE tools and tighter integration of systems, having a single, [Department–wide] data model can save months or years of effort spent on 're–inventing the wheel', and on validating new designs and points of integration with other systems. ["Using corporate data models saves time, effort", Tom Caldwell]

As an illustration of what level of detail might be expected in the preliminary data model for the South Dakota Department of Transportation, Exhibit 8.4 depicts a small part of the conceptual model used in another State Transportation agency. At the conceptual data model level detail, data is grouped into categories referred to as data entities. These data entities are represented as ovals in the exhibit model.

Exhibit 8.4



B. STATE DATA MODELING SURVEY RESULTS

Several State DOTs are experiencing the problems associated with older, non-integrated application systems. In an attempt to gain tighter control over these problems, many State Transportation Departments are performing data modeling exercises, allowing a more integrated view of Department-wide data.

Many of the States recently completing these projects were surveyed. The survey results are provided below. The insight provided by other States' experiences, should help evaluate the feasibility of creating a Department-wide model for SDDOT.

ALASKA

Project Scope:	All data required for capital projects (from when obligated funds are requested until project is closed)
Staffing:	2 internal staff
Duration:	1.5 years
Tools Used:	Data Station (Tool combining AutoCADD and Oracle)
Benefits:	The main benefit is cost avoidance. The data model should reduce time spent rewriting systems.

ALBERTA

Project Scope:	Conceptual, enterprise–wide data model
Staffing:	4 internal staff and 3 external consultants
Duration:	2 years
Tools Used:	IEW
Benefits:	The data model will help the Department move towards integrated systems.
	The data model will aid in the future development of SAA compliant systems.

CALIFORNIA

Project Scope:	High–level data model included as part of an information needs assessment.
Staffing:	6 team members total (internal & external)
Duration:	3.5 months
Tools Used:	Foundation
Benefits:	The project exposed data redundancy.
	The model will eventually help solve the Department's data integrity problems.

COLORADO

Project Scope:	Conceptual model for data required by Operations, Project Development and Construction.
Staffing:	3 internal staff
Duration:	1 year, part–time (could have been completed in 3–6 months, full–time)
Tools Used:	Metadata database
Benefits:	The project improved Departmental communication.
	The project increased awareness of the amount of data being collected by the Department. The process has solved the "Who has the right data?" problem.
	The model will help reduce redundant data collection efforts.

DELAWARE

Project Scope:	Conceptual, Department–wide data model.
Staffing:	3 users plus internal IS personnel and 1 external consultant
Duration:	9 months
Tools Used:	IEF

Benefits: The model helps determine project priorities based on data dependencies.
The model promotes integration and sharing of data.

The results of the survey reflect the many different approaches to data modeling. Basically, depending on how deeply and broadly the business is modeled, the process can take anywhere from weeks to months to even years. The benefits most noted by States reinforce the gains to be realized through integration and data sharing.

C. COST/BENEFIT ASSESSMENT

Recommended Project Scope

In order to create a logical data model representing the optimal structure for the Department's data, it is important to identify the location of existing data. The decentralized development of stand-alone PC applications will make this task more difficult. By beginning the data modeling efforts with the development of an automated "inventory" of the Department's data, a conceptual model will be easier to develop and manage. This high-level representation of the Department's data can then be expanded on a project by project basis to eventually provide a fully integrated, Department-wide logical data model.

This approach will allow the Department to immediately gain a better handle on the location and definition of existing data. One of the primary benefits afforded by limiting the scope of initial data modeling efforts to the development of a conceptual model, is that this model can be developed much quicker than a fully normalized logical model. This will allow the development of future applications to benefit much earlier from the knowledge provided by the data model.

Based on this definition of data modeling for the Department, the following costs and benefits have been prepared.

Incremental Costs

The "Department-Wide Data Model" project defined within the Information Systems Plan's portfolio of priority projects provides the cost estimates for a data modeling effort with the scope presented above. In addition to this project, data modeling will be required during each systems development project. This will help define a fully normalized, logical data model, eventually allowing migration to an integrated physical database. Data modeling should become an ongoing responsibility of the organization. Many of the associated costs are absorbed by the infrastructure requirements of a data administrator and the costs associated with each priority project. Therefore, only the incremental cost associated with the development of a physical data inventory and conceptual data model are used for data modeling's cost/benefit analysis. Key project estimates for the data modeling priority project are provided below:

Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	4	5.25	6.5
DATA SERVICES FULL TIME PROJECT STAFF	1	1.75	2.5
USER INVOLVEMENT		■	

Legend: ☐ Low ☐ Med. ■ High

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES	$155,000	$265,000	$340,000
HARDWARE		$0	
PACKAGE SOFTWARE		$0	
TOTAL ESTIMATED INCREMENTAL COSTS	$155,000	$265,000	$340,000

Tangible and Intangible Benefits

Although both tangible and intangible benefits are realizable in the long term, it is difficult to tie specific dollar amounts to these benefits. For the purposes of a cost/benefit analysis and additional planning information, these values have been estimated. It is important, however, to also consider the non-quantified benefits presented below in order to realize the full implications of the data modeling exercise.

	Low	Expected	High
ANNUAL PRODUCTIVITY IMPROVEMENTS	$45,000	$64,000	$100,800

Assumptions: ➪ Productivity improvements are based on increased productivity in the Data Services Section. The estimates assume an average base salary of $30,000, 60% time involvement, a range of impacted resources between 10 to 14, and productivity gains of 25% ("Low"), 30% ("Expected") and 40% ("High").

These gains should not be expected for 18 to 24 months due to the learning curve associated with most CASE approaches.

Tangible Benefits

- A Department-wide data inventory, coupled with a conceptual data model, will reduce the time required for database design efforts during individual development projects.

- Department-wide data models can save valuable programming time, since they eliminate the need to re-define data requirements for systems already in use.

- Properly designed data models can provide "data structure stability", reducing or eliminating the need to rewrite applications as operations change.

- The integration provided by a Department-wide data model will reduce the time spent reconciling data inconsistencies between systems.

- The integration provided by a Department-wide data model will reduce, if not eliminate, the rekeying of redundant data into different systems throughout the Department.

Intangible Benefits

- Department-wide data models help organizations assess systems and their impact.

- Department-wide data modeling encourages a discipline which focuses management on a coherent business vision, mapping this vision to all aspects and levels of the business.

- A Department-wide data model can be a critical factor in the successful integration of application systems.

- A Department-wide data model can assist the Department in establishing priorities for development projects.

- A Department-wide data model can help expose data redundancies to solve data integrity problems.

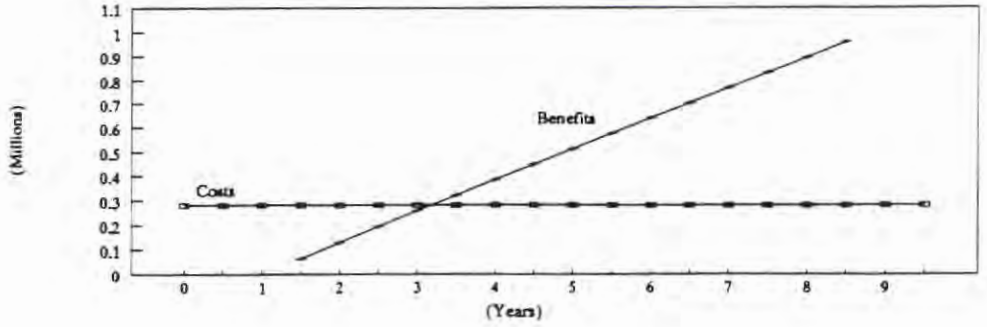
- A Department-wide data model can help establish order and control in the investment of information systems resources, by providing insight into the resources required to implement new systems.

- A Department-wide data model can open up communication channels at all levels. It can show how much data is being collected, determine who retains the correct data and develop common definitions for data elements and entities.

- Fundamentally, data modeling improves an analyst's understanding of the business, resulting in more responsive systems being implemented.

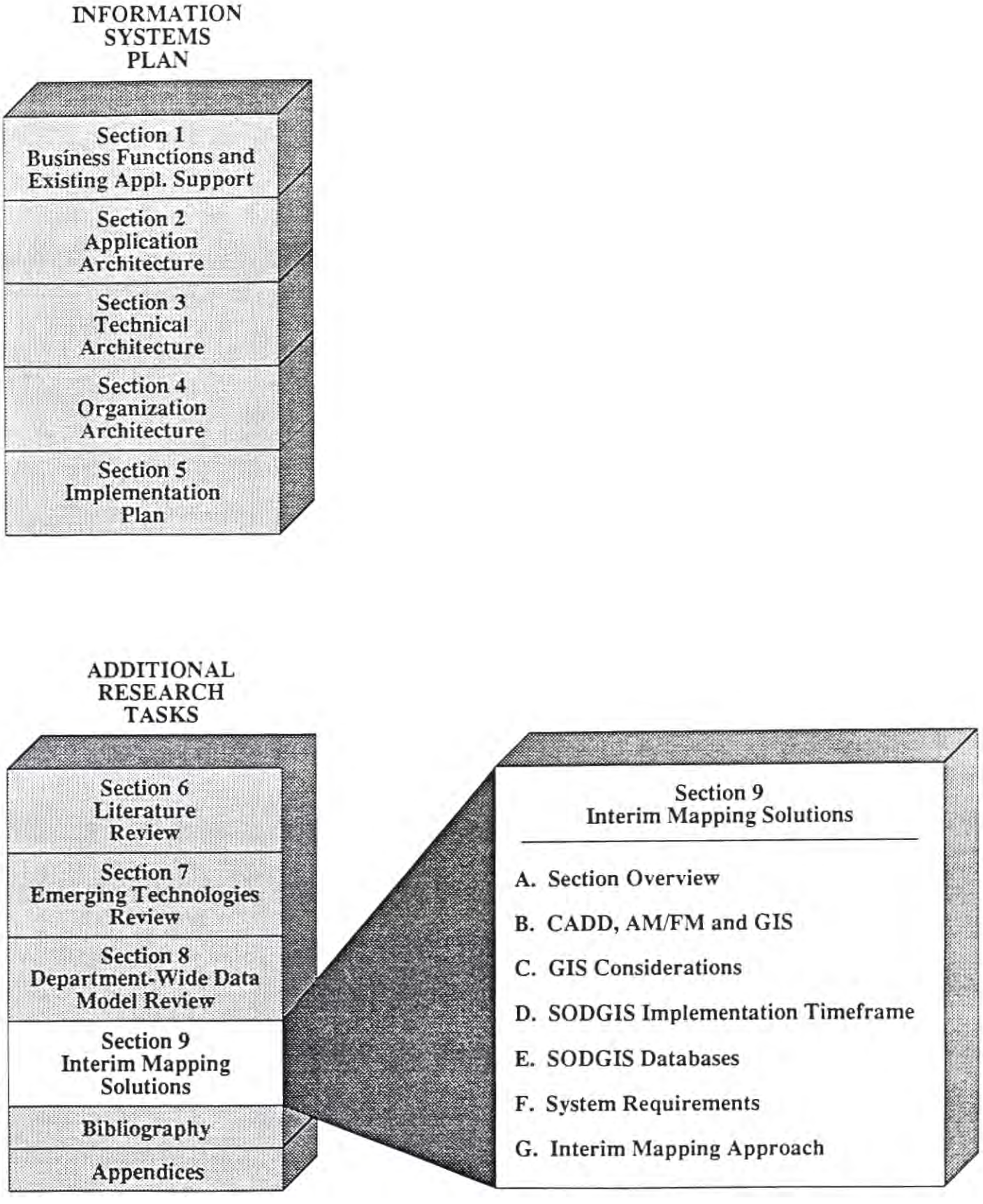
Based on the quantified cost and benefit estimates provided above, the Department should be able to recapture its investment in approximately 3 1/2 years. The following exhibit graphically depicts this payback by illustrating the initial "Expected" $265,000 investment versus the annual cost benefits beginning 1 1/2 years after the initial cost is incurred.

Exhibit 8.5



Although the costs associated with data modeling will be an ongoing concern of the organization, the long term benefits of data modeling should far outweigh its costs.

SECTION 9
INTERIM MAPPING SOLUTIONS



A. SECTION OVERVIEW

One of the primary business functions identified by users in the strategic information systems planning process was the need to effectively communicate with the public. The Department must also be able to effectively disseminate information regarding the Department's operations and various transportation statistics to the Governor and Legislature. Following are a few examples of the information routinely distributed:

- Location and type of projects let to contract within a specific period of time
- Location of transportation system needs and how those needs are addressed within the 5 Year Construction Program
- Highway system (e.g., interstate, high volume arterial, low volume principal arterial, minor arterial and state secondary) mileage and location.

This type of information is often instrumental in gaining the support, legislation and funding required to build and maintain the State transportation system. Because of the geographic nature of this information, maps are often used as the Department's communication medium.

The Planning and Programs Office currently meets this need by manually preparing maps with the computer aided drafting tool, Microstation. The software package Harvard Graphics is also used to prepare tables, charts and graphs. Substantial technological advances, however, have made many new tools available which may improve the effectiveness and efficiency with which ad hoc mapping functions are performed. This section presents many of the different technologies that may be applicable for meeting the Department's communication/mapping needs both in the short and long term.

B. CADD, AM/FM and GIS

Three primary technologies are currently being used by different States to manage spatial data. As these technologies become increasingly sophisticated, the lines differentiating each begins to blur. The following definitions note the key differences of each:

- CADD (Computer aided design and drafting)

  Many transportation departments now have some form of CADD tools to aid in the design of bridges and roadways. These tools have dramatically increased productivity over former manual methods. These tools allow draftsmen to easily generate detailed drawings, illustrating different scales and perspectives of a given object (e.g., bridges, roadway sections, intersections, etc.). Although CADD tools can be used to produce maps, its limited database and query capabilities make it highly inflexible and inadequate for geographic querying.

- AM/FM (Automated Mapping/Facilities Management)

  Automated mapping packages are often marketed as simplified Geographic Information Systems. Although these applications do have many characteristics in common with a true GIS, they lack the topological relationships required for complex spatial querying. Simply stated, these systems can interpret a feature's shape and location and can associate attribute data from the database with the feature, but can not assimilate how different features on a map are related. Thematic mapping packages (packages producing maps pertaining to a single topic, theme or subject) are also now available, providing limited definition of topological relationships.

- GIS (Geographic Information Systems)

  Although many definitions of GIS exist, applications built under this technology are basically designed to capture, manipulate, display and analyze spatially referenced data. A GIS has complex query capabilities coupled with a tight integration of spatial and tabular databases making it a powerful tool for organizations dealing with geographic information.

There are a number of automated mapping and basic GIS packages currently available for under $5,000. Although these packages would require the maintenance of map–based data, they could significantly reduce the time required for an individual to manually generate maps with Microstation (the computer aided drafting package currently used within the Department), while increasing the flexibility with which the maps are created. Other factors, however, must be considered when evaluating acceptable mapping solutions for the Department's communication needs.

C. GIS CONSIDERATIONS

In order to effectively evaluate alternatives, the Department must determine its future requirements of a geographic based system. A true Geographic Information System requires many years and a substantial staffing and budgetary investment to develop. The State's inter–agency GIS project may, however, provide the Department access to a Geographic Information System map base earlier and at a lower investment than would have been otherwise feasible.

The State has already made a strategic investment in GIS. An inter–agency core group including the following eight Departments has been established to provide for the implementation of a South Dakota GIS (SODGIS).

- Agriculture
- Education
- Game, Fish & Parks
- Health
- Revenue
- School & Public Lands
- Transportation
- Water & Natural Resources

There are many benefits associated with joint development of a Geographic Information System. The three most prevalent benefits are listed below:

- Cost Sharing

  Although each Agency may require different types of data and varying levels of accuracy, they all share a common geography. By sharing the costs associated with digitizing one set of base maps, each agency will not have to bear these costs independently. These start–up costs can account for a significant percentage of the implementation costs and often prove to be prohibitive if not shared by many parties.

- Consistency and Information Sharing

  By driving each Agency's GIS applications from a common system using a common map base, more information can be integrated and shared throughout State government.

- Reduced Learning Curves

  By sharing the risk associated with building initial applications under a new technology, many Agencies will be able to develop their own applications leveraging off the experience gained through inter–agency development efforts.

The Department of Transportation's primary investment up to this point has been in the digitization of base maps. These digitized maps are a critical component of a map–based information system, and provide an excellent investment in the Department's future use of GIS. However, due to the potential variability in the Department's digitized map's coordinate systems, some risk exists that the map base may not adequately serve all of the Department's uses of GIS. Recently, Clark County, Nevada went through an automated process of edge matching maps [Geo Info Systems, July/August 1991], which might serve as a valuable reference if this becomes necessary. A key factor in determining the viability of the map base is establishing the data accuracy requirements, which should be addressed early in the Department's GIS project.

Other critical components include the tabular database which ties attribute data to features on each map and the hardware/software platform which provides tools to effectively manage the data. Although perhaps not at the same level of detail, any automated mapping solution (whether it be an AM/FM package or a GIS solution) will require these components. Because of the reduced investment and risk afforded by the SODGIS project, consideration must be given to understanding the implementation timeframe associated with the State's SODGIS effort.

D. SODGIS IMPLEMENTATION TIMEFRAME

The State's SODGIS project outlines a three stage implementation effort spread over five years.

- Stage 1 (year one) – interim organization/system start–up

  This stage provides for the development of an organizational structure capable of supporting the State–wide Geographic Information System. It also provides for implementation of the initial hardware/software setup. Development of key digital coverages (1:500,000 and 1:100,000) and database conversion required to serve priority needs will also begin.

- Stage 2 (years two and three) – system development

  Stage 2 continues to provide for the digitization of the map base (1:100,000 and 1:24,000). Applications designed to meet the needs of the eight core Agencies will also be developed during this stage. Expansion of the hardware/software system will also be required.

- Stage 3 (years four and five) – final development

  This stage will see the system expand to the regional and local levels. Existing map maintenance will continue as well as further digitization of the State at the 1:24,000 level. The hardware/software system will continue to expand as additional applications are developed. Planning for the next five years of SODGIS will also be required.

The implementation of the appropriate databases and hardware/software platform are two components impacting the Department's decision to provide an interim mapping solution.

E. SODGIS Databases

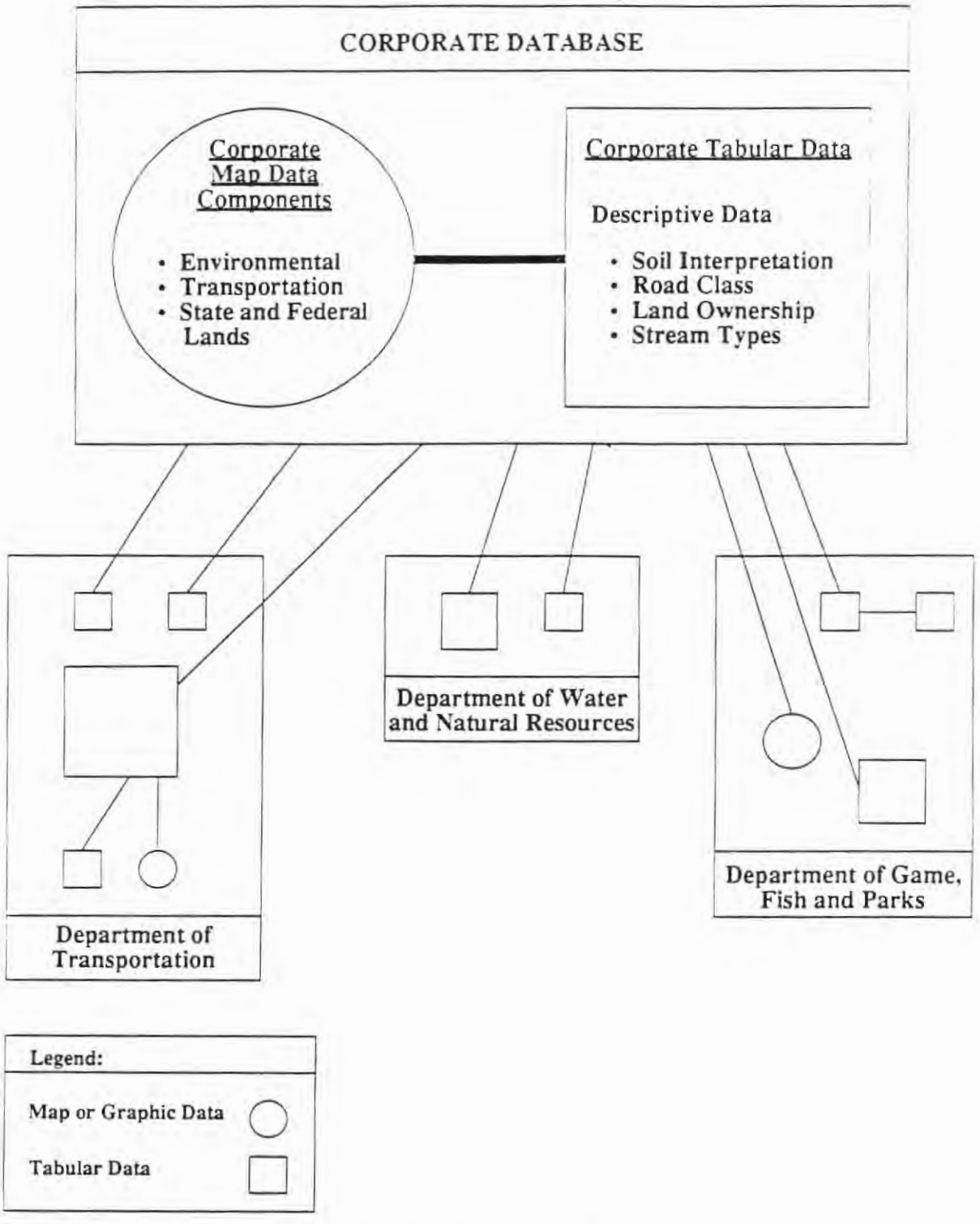
Exhibits 9.1 and 9.2 illustrate the SODGIS project's concept of "Corporate" and "Satellite" databases. Although some of the maps generated by the Department as communication aids require a scale of 1:24,000, the majority of maps are at the 1:100,000 scale or greater. It is expected that these maps will be available by the end of 1992. As noted in the SODGIS implementation plan, in years two and three additional hardware and software will be purchased to expand the GIS to all core Agencies.

Based on these two components, a foundation capable of supporting application development should exist before the end of 1992. Additional assistance from ongoing SODGIS application development should also be available at this time.

F. SYSTEM REQUIREMENTS

Although the State's SODGIS project may provide substantial opportunities, SDDOT still must evaluate the package selected by the State project, and assess that system's ability to meet the Department's long term needs. This will require the documentation of key system requirements. A few basic GIS considerations to remember when evaluating automated mapping/GIS software packages are the following:

Exhibit 9.1



Source: Phase 2 South Dakota GIS Design and Implementation Plan

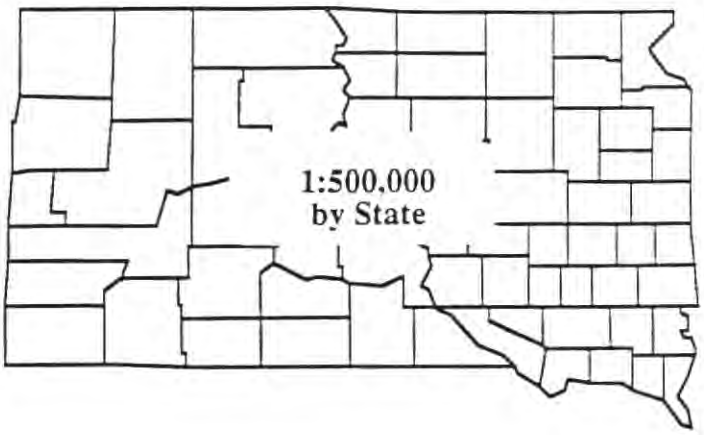
Exhibit 9.2
Three Level State GIS

Level 1

Source Scale: 1:500,000

Example Data

- County Boundary
- Cities and Towns
- State Administered Highways
- School Districts

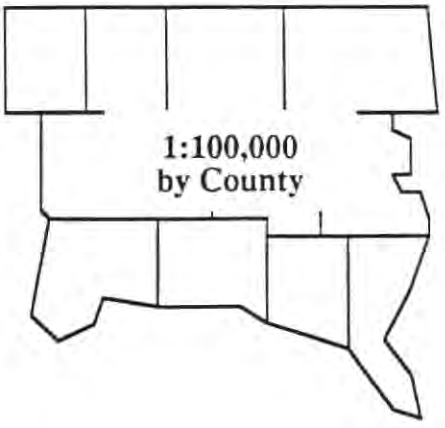


Level 2

Source Scale: 1:100,000

Example Data

- Streams
- State Recreation Areas
- State and County Roads
- Census Blocks

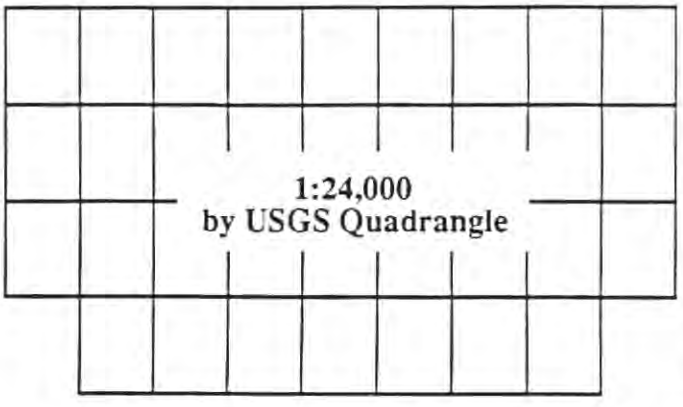


Level 3

Source Scale: 1:24,000

Example Data

- Soil Survey
- Landuse
- Wetlands
- Land Ownership



Source: Phase 2 South Dakota GIS Design and Implementation Plan

- Interfaces to Existing DBMS

  One of the big advantages of a powerful GIS is the ability to automatically interface existing tabular databases. In addition to proprietary databases built into the product, many vendors offer automated interfaces with leading database management systems. A product capable of interfacing the Department's existing ADABAS, Dbase III and Dbase IV files would reduce the cost and data redundancy inherent in maintaining a separate database for the GIS.

- Supported Data Structures

  Vector, Raster, TIN and Quadtree are the primary data structures commonly used to maintain digital line data.

- Input Data Formats

  A vendor's ability to accept a wide–variety of input formats can reduce the Department's internal responsibility to digitize maps. The national TIGER and DIME files represent external sources of these maps, easily importable by many packages.

- Flexibility of Output

  Based on the Department's needs, a package's flexibility when producing hardcopy output should be considered. Different sizing options and supported output devices are included in this area.

- Availability of Powerful Query Tools

  Many products allow querying through ad hoc query tools and fourth generation languages. The availability of these tools should be considered when evaluating a package.

- Dynamic Segmentation

  An important consideration specific to the way DOT 's use geographic data is the ability to identify sections within a highway. This ability has only recently been provided in commercially available software packages. Because of the importance of this feature in relation to the Department's maintenance of data, the concept of dynamic segmentation is expanded upon in the following paragraphs.

Dynamic Segmentation

Many traditional GIS applications are designed to deal with whole geometric shapes, like polygons and lines. But, it becomes very difficult to manipulate or analyze data based on portions of that shape. This presents a problem for State Transportation Departments because most of their data deals with portions of a line segment. Functional classifications,

pavement types, pavement thicknesses, number of lanes, etc. all occur on a section within a line. They are not consistent throughout the entire length of the highway.

This limitation forces several line segments to be defined graphically, maintaining different map bases centered around a different theme (one for each different type of data). These maps can then overlay each other to customize maps based on specific queries. However, the maintenance of the base maps is still a manual and tedious process. Basically, a map base must be maintained mirroring many of the Department's tabular databases.

Dynamic segmentation allows a common referencing system to be defined, tying tabular data to reference points identified within a line on a map. Since tabular data can now reference sections within a line, no longer must maps be manually updated to reflect changes in the tabular database. This has powerful implications on the efficiencies to be gained through automated mapping. The following three scenarios illustrate the impact:

- CADD

  Using a CADD system, maps must be manually re-drawn to fit each specific situation.

- AM/FM and traditional GIS (without dynamic segmentation)

  Maps consistent with tabular databases must be maintained. Maps built around single themes (e.g., functional classifications, construction project locations, etc.) allow overlaying of multiple maps. Querying based on this principal automatically generates flexible maps.

- GIS (with dynamic segmentation)

  Data intelligence on maps allows referencing systems to be established within line segments. This provides the ability for tabular databases to drive queries and eliminates the need to maintain maps mirroring the tabular data. Base maps, however, illustrating roadways and different land features still must be maintained. These maps are required by all GIS users.

G. INTERIM MAPPING APPROACH

When considering the communication requirements of the Department, the recent advances in the GIS industry, and the progress of the SODGIS council, it appears appropriate and timely for the Department to begin preparing for the implementation of a GIS. An interim solution may divert the Department's focus from the long term solution and prohibit or reduce the opportunities for synergy provided by the inter-agency council.

The following steps are recommended to meet the Department's interim mapping requirements while supporting the long term GIS strategic direction. These steps are also provided with the Geographic Information System priority project in the Information Systems Plan.

- Development of a DOT GIS Specialist:

  In order to take greatest advantage of GIS, the Department must first understand its requirements and the applications best suited for its use. This requires that one person be assigned to lead the charge in the GIS area. This individual should strive to understand the technology and its uses, how other DOTs are using GIS and the long-term implications for the Department. This individual should begin assuming an active roll in the SODGIS Inter-Agency Council.

- Map Base Digitization:

  The appropriate map base will need to be digitized before application development can begin. The Data Inventory Section of Planning should continue helping with the digitization effort.

- Hardware and Software Selection/Implementation:

  This phase provides for the selection and implementation of the appropriate hardware/software platform required for the development of an initial mapping system. This platform should accommodate future growth to support the Department's long term GIS strategy.

- Initial Application Development:

  An automated mapping application designed for the Planning & Programs section of Planning is an appropriate initial implementation effort. This application is recommended for the following reasons:

  - The mapping function is currently being performed manually
  - Although not formally documented, the system requirements could be readily defined
  - The level of precision required is low (primarily 1:500,000)
  - The scope of the project is small, dealing with only a few well defined files
  - Once complete, the application could be easily modified for use by Accident Records.

  This application, while meeting the Department's short term mapping needs, will also provide experience for continued application development within the DOT.

- Continued Application Development:

  After the successful implementation of the initial mapping system, a framework should exist supporting future GIS application development. These development efforts may also leverage off the application development promised by the SODGIS project.

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APPENDICES

APPENDIX A

Appendix A presents a table containing a summary of the results of the SDDOT application systems survey. The Degree of Satisfaction column contains the average of the survey responses on a scale of 1 (low) to 10 (high). The Ease of Use column contains the average of the survey responses also on a scale of 1 (low) to 10 (high). The Age column indicates the number of years the application has been in production. The Online, Batch, and PC columns indicate the primary orientation of the system.

APPENDIX B

Appendix B presents additional detail from the application systems survey. It contains a brief description of each of the systems, indicates the number of users that responded regarding the system, and shows the mean, standard deviation and range of responses for each of the five factors surveyed.

APPENDIX A

Application Name	Application Prefix	Degree of Satisfaction	Ease of Use	Age	Online	Batch	PC
5 Year Construction Program	HZ24	8.25	7.75	4			X
Accident Records	PS01	9.00	7.50	8		X	
Accounting Contracts	HZ17	4.00	6.00	1			X
American Concrete Pavement Assoc		8.00	9.00				X
AutoCAD		8.00	7.50				X
Bid Estimating	HC08/HC09	6.40	5.60	2	X		
Billboard Sign Inventory	HL07	8.25	8.50		X		
Bridge Analysis & Rating System	HB30	7.00	4.00	+10		X	
Bridge Approach Guardrail Design		10.00	10.00				X
Bridge Configuration	HB01	5.00	4.50			X	X
Building Replacement Program		9.50	8.50				X
Cash Forecasting	HA04	5.25	5.25	15	X		
Civil Engineering Coordinate Geometry	HE01	6.67	6.33	20		X	
CLM/CEAL		7.29	4.00	1	X		
Consolidation RES Data/AdHoc Queries	HR47	8.50	8.50	12		X	
Const Eng Manpower Mgmt System	HC03	1.91	2.88	12	X		
Continuous Count (Traffic)	HR09	8.00	7.00	19		X	
Continuous Prestress	HB07	6.00	6.25	+8		X	
Contract Pay Estimate	HA05	6.87	7.13	+20		X	
Contractor Payroll	HZ16	7.14	6.57	5			X
Contractor Prequalification	HZ19	6.00	8.00	6			X
Contracts (Minority Business Enterprise)		9.00	6.00				X
County Sign Summary	HZ01	8.00	7.00	8			X
Culvert Hydraulics	HP07	8.00	7.00	+20		X	X
Current Billing	HA07	7.00	4.00	+20		X	
Darwin	AASHTO						X
Disadvantaged Business Enterprise Firms		9.00	9.00				X
DOT Accounting System	HA01/02/14	3.67	6.57	+20	X		
E-Mail		7.25	7.63				X
Equipment Management System (EMS)	TC03	7.06	6.00	3	X		
Field Instrumentation Processing		5.00	6.00				X
Fixed Assets Inventory	HA15	4.75	4.00	10		X	
Geodimeter	HP01	10.00	6.00	+20		X	X
Georgia Beam	HB09	7.00	6.33			X	X
Georgia Bent Analysis	HB04	7.56	7.33			X	X
Guardrail Dsgn & Cost Analysis/Culverts		10.00	10.00				X
Highway Accidents	HY41	8.00	8.00	12		X	
Highway Construction Projects		5.00	4.50				X
Highway Performance Monitoring System	HR15	5.50	4.50	11	X		
Highway Planning & Research		7.25	5.75		X		
Highway Planning (Needs Analysis)	HR46	8.50	8.50	14	X		
Hydraulics	HX01	8.00	6.33	20		X	X
IGrds		6.00	5.67				X

APPENDIX A

Application Name	Application Prefix	Degree of Satisfaction	Ease of Use	Age	Online	Batch	PC
Journey	JS01	4.50	7.00	2	X		
Junkyard Inventory	HL07	6.67	8.00	6			X
Library Catalog System	MZ01	7.50	7.50	3			X
Maintenance Budgeting Program		7.50	7.50				X
Maintenance Management System	HM01/HM02	5.54	4.82	20		X	
Maintenance Needs Program		1.50	1.50				X
Microfilm Inventory	HZ11	8.00	9.50	7			X
Microstation		7.82	7.53				X
MSA State Accounting System		4.75	5.75		X		
Non–State Trunk Road Inventory	HR14	6.50	5.50	10	X		
One Year Bid Letting List		9.00	6.00	3			X
PCA Column Design & Analysis	HB03	7.89	7.67			X	
PCC Performance Monitoring							X
Personnel	HD04	5.00	5.33	20		X	
Photogrammetry	HP08	9.00	9.00	+20		X	
Pilot/Aircraft Registration	HZ14	9.00	10.00	4			X
Preconstruction Eng Mgmt System	HC04/HC05	6.35	6.13	9	X		
Project Management	HY21	7.10	7.00	8	X		
Project Status		6.83	7.33				X
Property Management	HZ20	8.67	9.33	4			X
Railroad Crossing Inventory	HR18	8.00	5.00	5	X		
Reinforced Concrete Box Culvert	HB10	7.00	10.00			X	X
Roadway Design System	HP09	7.25	5.25	10		X	
RES Intersection Inventory	HR44	8.00	6.00	15		X	
RES MRM Inventory	HR45	8.25	7.00	17	X		
RES Roadway Features	HR40	6.00	6.00	17		X	
RES Sufficiency	HR42	7.50	6.00	16		X	
RES Traffic	HR41	7.50	7.00	16	X		
Right of Way Land Acquisition	MW04	8.00	10.00	2			X
Right of Way Parcel Inventory	HW03	7.00	8.00	12	X		
Right of Way Railroad Property Leases	MW03	8.33	9.00	4			X
Right of Way Relocation	HW02	7.00	6.00	13	X		
Roadside Cost Analysis for Bridges	AASHTO	8.00	10.00				X
Secondary Funds	HA06	7.00	4.00	11		X	
SD DOT Bridge System	HM39	7.67	6.83	1	X		
Sign Inventory	MM42	6.10	5.80	5			X
SIMON Steel Girder Design	HB02	5.00	3.00			X	
STABL4		8.50	7.00				X
Supply Inventory Control	HM04	7.20	5.00	10		X	
Surface Design System	HS06			20			
Timesheet Teleprocessing	HA12	7.67	7.50	10	X		
Total Survey Station		7.67	7.33				X
Traffic Census Data	HZ05	5.00	4.00	6			X
Traffic Forecasting		7.00	6.00				X

APPENDIX A

Application Name	Application Prefix	Degree of Satisfaction	Ease of Use	Age	Online	Batch	PC
Training System	HT01	8.00	7.67	+20	X		
Truck Offtracking Model	HE02	8.00	4.00	5		X	
Truck Weight	HR01	5.00	4.00	+20		X	
Two & Three Column Bent	HB05					X	
Vehicle Registration Information	HR00			15		X	
Videolog		6.00	6.00				X

APPENDIX B

5 YEAR CONSTRUCTION PROGRAM

This application was developed on the PC to assist the Planning Division with the input of cost, description and location information for construction projects. The information is manually keyed into the system from information that exists in other Planning files.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	4	8.25	0.83	7–9
Level of Integration	4	2.50	0.87	1–3
Degree of Functionality	4	7.00	1.58	5–9
Ease of Use	4	7.75	1.30	6–9
Completeness of User Documentation	4	6.75	1.79	4–9

ACCIDENT RECORDS

The Accident Records application is a batch application which collects information from the South Dakota Motor Vehicle Traffic Accident Report. Law enforcement officers fill this out when an accident occurs. This information is stored and is available to provide Natural Reports to numerous offices inside (Data Inventory, Materials and Surfacing, Operations, Roadway Design, Traffic Engineering) and outside (Federal agencies, General Public, Local Police agencies, Office of Highway Safety, South Dakota Highway Patrol) of the Department of Transportation.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	9.00	1.00	8–10
Level of Integration	1	6.00	0.00	6
Degree of Functionality	2	9.00	1.00	8–10
Ease of Use	2	7.50	2.50	5–10
Completeness of User Documentation	2	7.50	2.50	5–10

ACCOUNTING CONTRACTS

This PC application is used by the Finance Division to maintain the status of all formal DOT contracts. The maintenance contracts are not part of this system.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	4.00	0.00	4
Level of Integration	0			
Degree of Functionality	1	4.00	0.00	4
Ease of Use	1	6.00	0.00	6
Completeness of User Documentation	1	8.00	0.00	8

AMERICAN CONCRETE PAVEMENT ASSOCIATION (ACPA)

This PC application is used by Materials and Surfacing to assist them with pavement design. This is an older application and Materials and Surfacing plans intends to replace it with package called Darwin.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	8.00	0.00	8
Level of Integration	0			
Degree of Functionality	1	7.00	0.00	7
Ease of Use	1	9.00	0.00	9
Completeness of User Documentation	1	7.00	0.00	7

AUTOCAD

The AutoCAD was purchased for the Aeronautics Office in order to maintain consistency between their office and the consultants assisting with the airport project. It allows Aeronautics the ability to set the project parameters such as the geometrics and lighting design and to manage the consultants work.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	8.00	1.00	7–9
Level of Integration	2	7.50	0.50	7–8
Degree of Functionality	2	8.50	0.50	8–9
Ease of Use	2	7.50	1.50	6–9
Completeness of User Documentation	2	8.00	1.00	7–9

BID ESTIMATING

The Bid Estimating application was developed two years ago to produce project detail estimates that the Federal Highway Administration requires. Project estimates include Right of Way, Utilities, Preliminary Engineering and Construction cost estimates. A standard bid item file is maintained consisting of all bid item numbers and descriptions. Road Design is responsible for maintaining and publishing this information to the Department.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	5	6.40	1.74	4–9
Level of Integration	4	5.25	2.86	2–9
Degree of Functionality	5	6.20	1.47	4–8
Ease of Use	5	5.60	2.24	2–8
Completeness of User Documentation	4	7.00	1.41	5–9

User Comments:
Enhancements need to be made to this system to allow for more data analysis.

APPENDIX B

5 YEAR CONSTRUCTION PROGRAM

This application was developed on the PC to assist the Planning Division with the input of cost, description and location information for construction projects. The information is manually keyed into the system from information that exists in other Planning files.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	4	8.25	0.83	7–9
Level of Integration	4	2.50	0.87	1–3
Degree of Functionality	4	7.00	1.58	5–9
Ease of Use	4	7.75	1.30	6–9
Completeness of User Documentation	4	6.75	1.79	4–9

ACCIDENT RECORDS

The Accident Records application is a batch application which collects information from the South Dakota Motor Vehicle Traffic Accident Report. Law enforcement officers fill this out when an accident occurs. This information is stored and is available to provide Natural Reports to numerous offices inside (Data Inventory, Materials and Surfacing, Operations, Roadway Design, Traffic Engineering) and outside (Federal agencies, General Public, Local Police agencies, Office of Highway Safety, South Dakota Highway Patrol) of the Department of Transportation.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	9.00	1.00	8–10
Level of Integration	1	6.00	0.00	6
Degree of Functionality	2	9.00	1.00	8–10
Ease of Use	2	7.50	2.50	5–10
Completeness of User Documentation	2	7.50	2.50	5–10

ACCOUNTING CONTRACTS

This PC application is used by the Finance Division to maintain the status of all formal DOT contracts. The maintenance contracts are not part of this system.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	4.00	0.00	4
Level of Integration	0			
Degree of Functionality	1	4.00	0.00	4
Ease of Use	1	6.00	0.00	6
Completeness of User Documentation	1	8.00	0.00	8

BRIDGE CONFIGURATION

This application is useful for complex skewed bridge computations for slab and girder elevations. The application is available on the mainframe and on the PC but is rarely used, even for steel bridges.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	5.00	2.00	3
Level of Integration	2	3.50	2.50	1
Degree of Functionality	2	5.50	1.50	4
Ease of Use	2	4.50	0.50	4
Completeness of User Documentation	2	3.00	2.00	1

BUILDING REPLACEMENT PROGRAM

This PC application maintains information on the age, serviceability and condition of buildings. It is used by the Secretary of Transportation to determine what buildings need to be replaced and to provide documentation to the Legislature for funding.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	9.50	0.50	9–10
Level of Integration	0			
Degree of Functionality	2	9.00	1.00	8–10
Ease of Use	2	8.50	1.50	7–10
Completeness of User Documentation	1	6.00	0.00	6

CASH FORECASTING

This online application monitored by the Finance Office, estimates the cash balance for the next five years. It contains all revenue and expenditure estimates, including Administrative, Right of Way, Preliminary Engineering, Construction and Maintenance costs. It estimates the cash balance for the next five years. The system receives history data from the accounting transaction period file, and construction costs and dates for projects from the Project Management master file.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	4	5.25	2.86	2–9
Level of Integration	5	7.60	1.02	6–9
Degree of Functionality	4	5.00	3.00	2–8
Ease of Use	4	5.25	2.17	2–8
Completeness of User Documentation	4	4.50	1.50	3–6

User Comments:
The accuracy of the forecast is contingent on data from other systems which is not current or correct.

APPENDIX B

BILLBOARD SIGN INVENTORY

This online application was designed as a federal requirement to track all billboards along the right of way of Interstate and Primary highways. A yearly fee is to be paid to the Department for each sign. This application generates the permits and invoices for each sign owner, maintains the information on which fees have been paid and determines which fees are over-due. Agents in the regions and central office are responsible for updating the information.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	4	8.25	0.43	8-9
Level of Integration	2	6.50	1.50	5-8
Degree of Functionality	4	7.00	1.73	4-8
Ease of Use	4	8.50	0.50	8-9
Completeness of User Documentation	4	8.50	0.50	8-9

BRIDGE ANALYSIS AND RATING SYSTEM (BARS)

This batch application was purchased from Control Data in 1972 and is now licensed through AASHTO. The system is used to perform load analysis ratings for state and county bridges, determine overloads and update the Bridge Inventory file . This system does not interface with the SD DOT Bridge System or handle all structure types.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	7.00	0.00	7
Level of Integration	1	2.00	0.00	2
Degree of Functionality	1	7.00	0.00	7
Ease of Use	1	4.00	0.00	4
Completeness of User Documentation	1	7.00	0.00	7

BRIDGE APPROACH GUARDRAIL DESIGN

This PC application is used by the Regions who design the surfacing projects. It helps to determine the correct length of guardrail required on a bridge approach. The application needs to be enhanced due to guardrail design changes.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	10.00	0.00	10
Level of Integration	0			
Degree of Functionality	1	10.00	0.00	10
Ease of Use	1	10.00	0.00	10
Completeness of User Documentation	1	10.00	0.00	10

CONSTRUCTION ENGINEERING MANPOWER MANAGEMENT SYSTEM (CEMMS)

This application provides staffing activity requirements by project showing the planned and actual man hours used. The objective of this application is to improve the quality and efficiency of construction engineering management. It points out the need for construction engineering personnel and can determine if the need for employees is increasing or decreasing in a region or if a construction project will require more or fewer personnel.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	11	1.91	1.16	1–4
Level of Integration	6	2.33	2.56	1–8
Degree of Functionality	11	1.73	0.96	1–4
Ease of Use	8	2.88	2.32	1–8
Completeness of User Documentation	6	3.33	3.30	1–8

CONTINUOUS COUNT (TRAFFIC)

This batch application is maintained in the Data Inventory Office. The information is collected throughout the year and a summary report is published annually. The data from this application updates the permanent site information in the Roadway Environment System Traffic file. The information is used to answer design, construction or reconstruction questions that pertain to traffic information.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	8.00	2.00	6–10
Level of Integration	2	8.00	2.00	6–10
Degree of Functionality	2	7.00	3.00	4–10
Ease of Use	2	7.00	3.00	4–10
Completeness of User Documentation	2	7.00	3.00	4–10

CONTINUOUS PRESTRESS

This application was acquired from Texas. It designs or analyzes precast prestressed concrete girder bridges. It will handle AASHTO type I through IV sections or non-standard sections having the same general configuration. It can be used for two to five span bridges.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	4	6.00	2.12	3-8
Level of Integration	3	3.67	0.47	3-4
Degree of Functionality	4	5.00	1.87	3-8
Ease of Use	4	6.25	1.48	4-8
Completeness of User Documentation	4	5.50	2.06	3-8

CONTRACT PAY ESTIMATE

This batch application provides reports for contractor payments. Every two weeks the project engineers determine what work the contractor has accomplished and then estimate his payment. This information is sent to the Finance office where the application is updated.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	13	6.87	2.06	4-10
Level of Integration	9	4.27	2.45	2-9
Degree of Functionality	13	6.67	2.21	3-10
Ease of Use	13	7.13	2.63	2-10
Completeness of User Documentation	12	6.21	2.37	3-10

User Comments:
This application could be made available to the area offices so they could input the information directly into the computer eliminating paper flow, rekeying of information by the Finance Office and speeding up payment to contractors.

CONTRACTOR PAYROLL

This PC application consists of project data, along with the names of contractors and subcontractors working on a project. It tracks a contractors payroll submittals to ensure compliance with federally regulated labor standards on federal aid projects.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	5	7.14	1.73	7-8
Level of Integration	3	5.50	1.12	4-7
Degree of Functionality	5	7.43	1.29	6-9
Ease of Use	5	6.57	2.82	3-9
Completeness of User Documentation	4	7.33	1.37	6-9

APPENDIX B

CONTRACTOR PREQUALIFICATION

This PC application provides an inventory of all prequalified contractors for the Department.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	6.00	0.00	6
Level of Integration	0			
Degree of Functionality	1	3.00	0.00	3
Ease of Use	1	8.00	0.00	8
Completeness of User Documentation	1	5.00	0.00	5

CONTRACTS (MINORITY BUSINESS ENTERPRISE)

This PC application tracks the Minority Business Enterprise for each project. This data is maintained by the Civil Rights Office.

	Users	Mean	Standard Deviation	Range
Degree of Satisfaction	1	9.00	0.00	9
Level of Integration	1	1.00	0.00	1
Degree of Functionality	1	9.00	0.00	9
Ease of Use	1	6.00	0.00	6
Completeness of User Documentation	1	2.00	0.00	2

COUNTY SIGN SUMMARY

This PC application is used by consultants and counties to track traffic signs in each county and to generate a sign improvement plan.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	8.00	0.00	8
Level of Integration	0			
Degree of Functionality	1	7.00	0.00	7
Ease of Use	1	7.00	0.00	7
Completeness of User Documentation	1	7.00	0.00	7

APPENDIX B

CULVERT HYDRAULICS

This application can be run on the mainframe or the PC. It calculates the size of the drainage pipe needed for drainage areas less than 150 acres.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	3	8.00	0.82	7–9
Level of Integration	3	1.33	0.47	1–2
Degree of Functionality	3	8.33	0.47	8–9
Ease of Use	3	7.00	1.63	5–9
Completeness of User Documentation	3	5.67	1.70	4–8

CURRENT BILLING

This batch application handles the project billing to the federal government. The billing information comes from the DOT Accounting System.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	7.00	2.00	5–9
Level of Integration	2	6.50	2.50	4–9
Degree of Functionality	3	8.00	0.82	7–9
Ease of Use	2	4.00	2.94	5–7
Completeness of User Documentation	3	6.00	2.16	3–8

DARWIN

Materials and Surfacing plans to replace the American Concrete Pavement Association package with this application. This package assists with surface design, overlay design and costing information.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	0			
Level of Integration	0			
Degree of Functionality	0			
Ease of Use	0			
Completeness of User Documentation	0			

APPENDIX B

DISADVANTAGED BUSINESS ENTERPRISE FIRMS

This PC application tracks all certifications required for Disadvantaged Business Enterprises. The Civil Rights Office maintains this application.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	9.00	0.00	9
Level of Integration	1	2.00	0.00	2
Degree of Functionality	1	10.00	0.00	10
Ease of Use	1	9.00	0.00	9
Completeness of User Documentation	1	2.00	0.00	2

DOT ACCOUNTING SYSTEM

This application consists of files and types of transactions that update the Departments accounting information. Information which is fed into this system consists of Central Accounting (MSA), Timesheet activity, supplies inventory and computer billing.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	6	3.67	1.80	1–6
Level of Integration	5	7.60	1.36	5–9
Degree of Functionality	6	3.33	2.05	1–7
Ease of Use	7	6.57	1.92	3–9
Completeness of User Documentation	5	3.20	2.04	1–7

E–MAIL

This PC application allows a group of microcomputers connected together over a Local Area Network to send messages, files and programs from one user to another. It also allows communication to users on other Local Area Networks, such as other government agencies and the DOT Region and Area Offices.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	8	7.25	0.97	5–8
Level of Integration	6	4.50	0.76	3–5
Degree of Functionality	8	6.50	1.87	3–9
Ease of Use	8	7.63	0.70	7–9
Completeness of User Documentation	6	6.83	1.07	5–8

APPENDIX B

EQUIPMENT MANAGEMENT SYSTEM (EMS)

This online application consists of four primary files: equipment inventory, equipment usage (miles driven), commodities (gas and oil) and repairs. The inventory data is entered by the Operations Division, while the equipment usage, commodities and repair data is provided through batch update by the accounting timesheet system.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	16	7.06	1.64	4–10
Level of Integration	10	7.40	1.91	4–10
Degree of Functionality	17	7.00	1.94	4–10
Ease of Use	15	6.00	2.25	2–9
Completeness of User Documentation	12	7.00	1.63	4–10

FIELD INSTRUMENTATION PROCESSING

This PC file contains slope measurements that Materials and Surfacing uses when performing tests.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	5.00	0.00	5
Level of Integration	0			
Degree of Functionality	1	7.00	0.00	7
Ease of Use	1	6.00	0.00	6
Completeness of User Documentation	1	7.00	0.00	7

FIXED ASSETS INVENTORY

This application tracks all fixed asset sources over three hundred dollars. The Department uses two Fixed Assets Inventories; the Departments system and the MSA accounting system. The Department was mandated several years ago to keep the MSA Fixed Asset system current.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	4	4.75	2.68	2–9
Level of Integration	2	4.50	1.50	3–6
Degree of Functionality	4	4.25	2.28	2–8
Ease of Use	2	4.00	1.00	3–5
Completeness of User Documentation	1	4.00	0.00	4

APPENDIX B

GEODIMETER

The hardware is currently being used for this product instead of the software. It is used by the Survey section to process distance and angle data to determine survey stationing and alignment. The data is collected through the location survey, then manually loaded into the Geodimeter process. The output is studied to help locate errors and provide ability for corrections before the information is loaded into IGrds.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	10.00	0.00	10
Level of Integration	1	6.00	0.00	6
Degree of Functionality	1	10.00	0.00	10
Ease of Use	1	6.00	0.00	8
Completeness of User Documentation	1	9.00	0.00	9

GEORGIA BEAM

This application runs on the mainframe and the PC. It is a continuous beam analysis program providing major analysis for both girder and slab continuous superstructures. It handles all vertical bridge loading but no horizontal loads. Old templates are edited in a word processor to provide input to the system. The program does not allow grouping by AASHTO's combinations of group loads.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	9	7.00	1.63	4–9
Level of Integration	7	4.86	2.29	1–7
Degree of Functionality	9	7.22	1.87	4–9
Ease of Use	9	6.33	1.76	3–8
Completeness of User Documentation	9	6.56	1.77	2–8

GEORGIA BENT ANALYSIS

This application runs on the mainframe and the PC. It is a frame bent program for girder bridges originally developed by Georgia and enhanced in–house. It handles bents having two to four columns. It does not provide AASHTO combination loads or group loading and will not account for ice loads.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	9	7.56	0.68	6–8
Level of Integration	6	5.50	1.80	2–7
Degree of Functionality	9	7.67	0.82	6–9
Ease of Use	9	7.33	1.05	5–9
Completeness of User Documentation	9	7.22	1.03	5–8

APPENDIX B

HIGHWAY CONSTRUCTION PROJECTS

This PC application is used by the Planning and Program Office to keep history of general project information including the contractor who was awarded the contract and the award amount. The application contains much of the same information as the 5 Year Construction Program. The information can be retrieved by year, county, region or section of highway.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	5.00	2.00	3–7
Level of Integration	2	1.50	0.50	1–2
Degree of Functionality	2	4.50	0.50	4–5
Ease of Use	2	4.50	0.50	4–5
Completeness of User Documentation	2	2.50	0.50	2–3

HIGHWAY PERFORMANCE MONITORING SYSTEM (HPMS)

This online file is maintained by Data Inventory. The Federal Highway Administration requires documentation on the vehicle miles traveled and the number of miles in the state when determining the level of funding for South Dakota. The information for this system comes directly from the Roadway Environment System Traffic file, the Non State Trunk Inventory file and from independent studies conducted in the field.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	5.50	0.50	5–6
Level of Integration	2	3.50	1.50	2–5
Degree of Functionality	2	5.00	0.00	5
Ease of Use	2	4.50	0.50	4–5
Completeness of User Documentation	2	5.50	1.50	4–7

HIGHWAY PLANNING AND RESEARCH

This online application was developed due to Federal reporting requirements. It is maintained in the Planning Division and tracks the financial information for all highway planning projects.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	4	7.25	1.64	6–10
Level of Integration	2	7.00	3.00	4–10
Degree of Functionality	4	6.75	2.17	4–10
Ease of Use	4	5.75	2.95	3–10
Completeness of User Documentation	3	5.67	3.30	2–10

APPENDIX B

HIGHWAY PLANNING (NEEDS ANALYSIS)

This online application, maintained in the Planning Division, collects Roadway Environment System, rural weighted accident and bid item cost information and combines it with manually supplied data to create comprehensive highway planning information. This information is used to assign project priority and ranking and to produce the following reports: Needs Analysis, Project Analysis, Cost Update, Roadway Serviceability and Project Funding Year.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	8.50	1.50	7–10
Level of Integration	2	7.00	1.00	6–8
Degree of Functionality	2	9.00	1.00	8–10
Ease of Use	2	8.50	1.50	7–10
Completeness of User Documentation	2	8.00	2.00	6–10

HYDRAULICS

There is a mainframe and PC version of this application. The PC version tends to be easier to use and contains more functionality. There are two PC applications: HEC2, the water surface profile model and WSPRO, the Federal Highway Model. The mainframe version would be utilized more if it could validate check points.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	3	8.00	0.82	7–9
Level of Integration	3	2.67	1.25	1–4
Degree of Functionality	3	7.33	0.47	7–8
Ease of Use	3	6.33	0.94	5–7
Completeness of User Documentation	3	7.00	1.41	5–8

IGR

The Interactive Graphics Roadway Design System is used to design and draft the majority of the Department's roadway projects. Although this software currently resides on the DEC VAX, it is being migrated to stand–alone workstations.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	3	6.00	2.16	3–8
Level of Integration	3	5.00	0.82	4–6
Degree of Functionality	3	7.00	0.00	7
Ease of Use	3	5.67	0.94	5–7
Completeness of User Documentation	3	5.33	1.25	4–7

APPENDIX B

JOURNEY

This is an online IPS application designed to track all traveling resources to coordinate ride sharing. The DOT personnel generally do not use this system since they tend to make many stops when out in the field instead of driving to one destination.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	4.50	1.50	3–6
Level of Integration	2	2.00	1.00	1–3
Degree of Functionality	2	2.50	0.50	2–3
Ease of Use	1	7.00	0.00	7
Completeness of User Documentation	1	7.00	0.00	7

JUNKYARD INVENTORY

This PC application was designed to maintain an inventory of all junkyards in the state of South Dakota. This is a federal mandate and a South Dakota law.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	3	6.67	0.47	6–7
Level of Integration	1	5.00	0.00	5
Degree of Functionality	3	5.67	1.89	3–7
Ease of Use	3	8.00	0.82	7–9
Completeness of User Documentation	3	8.00	0.82	7–9

LIBRARY CATALOG SYSTEM

This PC application was designed to catalog the research library. It expedites the Research Office's ability to locate information and aids research project studies.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	7.50	0.50	7–8
Level of Integration	2	3.50	0.50	3–4
Degree of Functionality	2	7.50	0.50	7–8
Ease of Use	2	7.50	0.50	7–8
Completeness of User Documentation	2	3.00	0.00	3

APPENDIX B

MAINTENANCE BUDGETING PROGRAM

This PC application was written to expedite the Operation Division's preparation of the annual maintenance budget.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	7.50	2.50	5–10
Level of Integration	2	5.50	2.50	3–8
Degree of Functionality	2	10.00	0.00	10
Ease of Use	2	7.50	2.50	5–10
Completeness of User Documentation	2	7.50	2.50	5–10

MAINTENANCE MANAGEMENT SYSTEM (MMS)

This batch application is primarily within the Operations and Planning Divisions. The application is interfaced with the accounting systems to maintain information required to monitor progress to the yearly maintenance plan.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	13	5.54	2.65	1–9
Level of Integration	10	5.40	2.65	1–10
Degree of Functionality	13	5.46	2.76	1–9
Ease of Use	11	4.82	2.66	1–8
Completeness of User Documentation	6	5.43	3.62	1–10

User Comments:
The system is old yet there is little awareness of it. Some of the Foremen believe the numbers on the reports is how much money there is left to spend, which is not true since the system is not tied to the cash budget. The system tends to be cumbersome to use.
The system needs to contain more current data

MAINTENANCE NEEDS PROGRAM

This PC application was written for the Operations Division to provide the ability to collect and maintain maintenance need information in a consistent format. The application performs calculations and determines workloads. This information is then used in the Maintenance Budget Program to help determine the annual maintenance budget.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	1.50	0.50	1–2
Level of Integration	1	1.00	0.00	1
Degree of Functionality	2	2.00	1.00	1–3
Ease of Use	2	1.50	0.50	1–2
Completeness of User Documentation	2	3.00	0.00	3

APPENDIX B

MICROFILM INVENTORY

This PC application is used by Internal Services to microfilm all information pertaining to a project. The information includes plans and all correspondences, and can be retrieved by project number. Internal Services is looking to expand this application to accommodate personnel and accident records information.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	8.00	0.00	8
Level of Integration	1	4.00	0.00	4
Degree of Functionality	2	8.50	0.50	8–9
Ease of Use	2	9.50	0.50	9–10
Completeness of User Documentation	1	8.00	0.00	8

MICROSTATION

This computer aided drafting software is used throughout the Department for project drafting activities. It is also currently used to generate maps within the Planning Division.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	17	7.82	1.46	3–9
Level of Integration	10	6.00	1.95	3–9
Degree of Functionality	17	7.59	1.24	5–8
Ease of Use	17	7.53	0.98	6–9
Completeness of User Documentation	17	7.29	1.23	5–9

MSA STATE ACCOUNTING SYSTEM

This application was written and is maintained by IPS yet the Finance Office has the ability to input information into the system. The MSA and DOT accounting systems are not very compatible, MSA runs on a monthly time period while the DOT system runs on a four week time period. Many of the transactions codes are not maintained by both systems causing difficulty in keeping the two systems synchronized.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	4	4.75	1.09	3–6
Level of Integration	4	3.50	1.12	2–5
Degree of Functionality	4	5.25	1.48	3–7
Ease of Use	4	5.75	0.43	5–6
Completeness of User Documentation	2	4.00	0.00	4

User Comments:
I use the budget and activity reports. They are difficult to read and are not very useful in managing the budget.

It would be better if it would be more compatible with DOT's accounting system.

Enhancements for better roll ups would have been helpful many times to provide quick response to management questions.

The application needs to be cleaned up and more user friendly. There is no reason the entire voucher data entry can not be on one screen.

NON–STATE TRUNK ROAD INVENTORY

This online application is maintained in the Data Inventory Office to store county, city and township road data. It contains and reports on the following types of information: mileage, surface type, Average Daily Traffic, functional class and jurisdiction.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	6.50	1.50	5–8
Level of Integration	2	3.00	0.00	3
Degree of Functionality	2	6.50	0.50	6–7
Ease of Use	2	5.50	1.50	4–7
Completeness of User Documentation	2	7.00	0.00	7

APPENDIX B

ONE YEAR BID LETTING LIST

This PC application is used in the Project Development Office to assist with the scheduling of project lettings. The application receives one year of data from the 5 Year Construction Program file and has the ability to sort this information by letting date and delete projects that have been withdrawn from the current year letting schedule.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	9.00	0.00	9
Level of Integration	1	2.00	0.00	2
Degree of Functionality	1	7.00	0.00	7
Ease of Use	1	6.00	0.00	6
Completeness of User Documentation	1	8.00	0.00	8

PCA COLUMN DESIGN AND ANALYSIS

This application provides column analysis needed to determine ultimate loads. It is not used for design but ensures that the design will meet safety requirements. The input to the application is moments and axial loads.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	9	7.89	0.57	7–9
Level of Integration	6	6.17	2.19	2–8
Degree of Functionality	9	7.56	0.50	7–8
Ease of Use	9	7.67	1.05	6–10
Completeness of User Documentation	9	8.00	0.82	7–10

PCC PERFORMANCE MONITORING

This Dbase PC application used by Materials and Surfacing contains the Portland Concrete Cement design specifications. The information has not been kept up to date, therefore, the Planning Division is researching the availability of software to support this function.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	0			
Level of Integration	0			
Degree of Functionality	0			
Ease of Use	0			
Completeness of User Documentation	0			

PERSONNEL

This is an IPS batch application that contains information on all state employees.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	4	5.00	2.74	1–8
Level of Integration	3	4.00	1.63	2–6
Degree of Functionality	4	3.50	2.69	1–8
Ease of Use	3	5.33	1.70	3–7
Completeness of User Documentation	3	6.67	1.25	5–8

User Comments:
Necessary information by Offices within the DOT is not available.

Would like to have more and accurate history information.

Would like to see state employees grouped by agency they work for rather than just classified as a state employee.

PHOTOGRAMMETRY

Aerial pictures are used to determine elevations of a project. This batch application is used to verify the accuracy of these aerial pictures. Survey crews take random elevations readings that are compared to the elevations determined by the aerial pictures.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	9.00	0.00	9
Level of Integration	1	9.00	0.00	9
Degree of Functionality	1	9.00	0.00	9
Ease of Use	1	9.00	0.00	9
Completeness of User Documentation	1	9.00	0.00	9

APPENDIX B

PILOT/AIRCRAFT REGISTRATION

This PC application was written for the Aeronautics Office to maintain aircraft and pilot registration information.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	9.00	0.00	9
Level of Integration	1	9.00	0.00	9
Degree of Functionality	1	8.00	0.00	8
Ease of Use	1	10.00	0.00	10
Completeness of User Documentation	1	9.00	0.00	9

PRECONSTRUCTION ENGINEERING MANAGEMENT SYSTEM (PCEMS)

This online application is a scheduling, monitoring and human resource management system used to help with the preconstruction process. It is capable of scheduling each activity of all the projects in a work program, taking into consideration staffing requirements and availability of the various work centers (Squads). PCEMS is capable of showing the impact projects have on each other as well as the impact that the workload for the various activities has on each squad. It can display when, where and how many person–hours will be required for any given time period.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	23	6.35	2.08	1–10
Level of Integration	11	5.50	2.36	2–9
Degree of Functionality	23	6.68	2.05	3–10
Ease of Use	23	6.13	2.33	3–10
Completeness of User Documentation	21	6.14	2.32	1–10

User Comments:
PCEMS is a viable manpower planning tool, however at present it contains unrealistic letting dates, does not show updated schedules in a timely manner and overschedules staffing.

APPENDIX B

PROJECT MANAGEMENT

This online application was designed to eliminate redundant record keeping by consolidating all project data into one system for use by all DOT Offices. The system is able to track a project's current information from its initial conception to its final completion. The application includes the following type of information: general descriptions, development, cost, construction program, funding sources and work authorizations. The application consists of three subsystems: the Project Master which consists of the state's highway projects, the State Cash Flow which contains the state's revenue and expenditure requirements for the projects and the Federal Funds status which keeps track of the amount of federal funds authorized for the state.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	10	7.10	1.64	5–10
Level of Integration	8	7.13	1.76	3–9
Degree of Functionality	11	7.27	1.54	5–10
Ease of Use	11	7.00	2.00	3–10
Completeness of User Documentation	10	6.90	1.97	3–10

PROJECT STATUS

This PC application is used in the Construction Office to track projects. Status reports are generated to evaluate a variety of needs including contractor performance and the finaling process.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	6	6.83	1.46	4–8
Level of Integration	5	5.40	1.74	3–8
Degree of Functionality	6	6.33	1.49	4–8
Ease of Use	6	7.33	1.25	5–9
Completeness of User Documentation	6	6.33	1.49	4–8

PROPERTY MANAGEMENT

This PC application was designed for the Operations Division to track the inventory of property and generate invoices to tenants who reside on the property.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	3	8.67	1.25	7–10
Level of Integration	2	8.00	1.00	7–9
Degree of Functionality	3	8.00	2.16	5–10
Ease of Use	3	9.33	0.47	9–10
Completeness of User Documentation	3	7.33	3.09	3–10

APPENDIX B

RAILROAD CROSSING INVENTORY

This online application is used in the preparation of the 5 Year Construction Program. Counties and Cities perform the majority of queries to extract funding information.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	8.00	0.00	8
Level of Integration	0			
Degree of Functionality	1	6.00	0.00	6
Ease of Use	1	5.00	0.00	5
Completeness of User Documentation	1	9.00	0.00	9

REINFORCED CONCRETE BOX CULVERT

This application resides both on the mainframe and the PC. It aids box culvert design by providing moments, sheet values and pavement thickness. The program is used by both Bridge Design and outside consultants. Its use is sometimes restricted due to specific limitations of the software. The program also cannot handle separate live and dead loads and can not apply different working load methods.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	7.00	0.00	7
Level of Integration	1	1.00	0.00	1
Degree of Functionality	1	7.00	0.00	7
Ease of Use	1	10.00	0.00	10
Completeness of User Documentation	1	2.00	0.00	2

ROADWAY DESIGN SYSTEM (RDS)

This batch application is a comprehensive earthwork system designed to include: performing control survey calculations, computing and plotting horizontal and vertical roadway alignments, plotting cross–sections, computing earthwork quantities for up to six roadways at one time and storing design criteria and calculations on tape for later use.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	4	7.25	0.83	6–8
Level of Integration	4	7.00	0.71	6–8
Degree of Functionality	4	7.00	0.00	7
Ease of Use	4	5.25	1.92	3–8
Completeness of User Documentation	4	7.00	0.71	6–8

APPENDIX B

ROADWAY ENVIRONMENT SYSTEM INTERSECTION INVENTORY

This batch application identifies all intersections where more than one highway meets on the state system. The type of information includes type of intersection and intersecting highway.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	8.00	0.00	8
Level of Integration	1	8.00	0.00	8
Degree of Functionality	1	8.00	0.00	8
Ease of Use	1	6.00	0.00	6
Completeness of User Documentation	1	7.00	0.00	7

ROADWAY ENVIRONMENT SYSTEM MILEAGE REFERENCE MARKER INVENTORY

This online application consists of a complete inventory of Mileage Reference Markers along the state highway system including the exact mileage from the beginning of the highway to each marker. It is used by all the other Roadway Environment System files to identify the location of data on a highway.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	4	8.25	1.09	7–10
Level of Integration	2	6.00	1.00	5–7
Degree of Functionality	4	8.50	1.12	7–10
Ease of Use	4	7.00	2.12	5–10
Completeness of User Documentation	3	6.67	2.87	3–10

ROADWAY ENVIRONMENT SYSTEM ROADWAY FEATURES INVENTORY

This batch application consists of an inventory of roadway features for highways on the state trunk system. The application includes such information as: route, guardrail, right of way alignment, lanes, shoulders, soil, dynaflect, roughometer and pavement friction.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	6.00	0.00	6
Level of Integration	1	5.00	0.00	5
Degree of Functionality	1	6.00	0.00	6
Ease of Use	1	6.00	0.00	6
Completeness of User Documentation	1	7.00	0.00	7

APPENDIX B

ROADWAY ENVIRONMENT SYSTEM SUFFICIENCY INVENTORY

This batch application is an inventory of rating for highways on the state trunk system. The ratings pertain to highway condition, safety and service.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	7.50	0.50	7–8
Level of Integration	2	6.00	1.00	5–7
Degree of Functionality	2	8.00	1.00	7–9
Ease of Use	2	6.00	1.41	5–7
Completeness of User Documentation	2	5.00	2.00	3–7

ROADWAY ENVIRONMENT SYSTEM TRAFFIC INVENTORY

This online application maintains an inventory of traffic data for the highways on the state trunk system. It includes such data as: functional class, load class, directional distribution, percent trucks, peak hour, design hour, 20 year projected average daily traffic and current average daily traffic.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	7.50	0.50	7–8
Level of Integration	2	5.50	1.50	4–7
Degree of Functionality	2	5.50	0.50	5–6
Ease of Use	2	7.00	1.00	6–8
Completeness of User Documentation	2	7.50	1.50	6–9

RIGHT OF WAY LAND ACQUISITION

This PC application contains the names, addresses, project number and parcel number of all people the DOT has bought land from for Right of Way purposes. The DOT Legal Office refers to these names when selecting juries in current Right of Way cases.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	8.00	0.00	8
Level of Integration	0			
Degree of Functionality	1	9.00	0.00	9
Ease of Use	1	10.00	0.00	10
Completeness of User Documentation	1	10.00	0.00	10

APPENDIX B

RIGHT OF WAY PARCEL INVENTORY

This online application stores information associated with the appraisal, negotiation, review and acquisition of parcels of land due to DOT construction projects. This system was designed due to federal reporting requirements and produce the following type of reports: documentation of payment of settlement and documentation if settlement exceeded appraisal amount.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	7.00	0.00	7
Level of Integration	0			
Degree of Functionality	1	8.00	0.00	8
Ease of Use	1	8.00	0.00	8
Completeness of User Documentation	1	8.00	0.00	8

RIGHT OF WAY RAILROAD PROPERTY LEASE

This PC application was designed for the Operations Division to track the inventory of railroad property and generate leases, licenses and invoices for each tenant who lease right of way on this property. This application contains data on leases for grain elevators and licenses for utility or pipe lines which are located on state owned railroad Right of Way. This application also maintains the information on which fees have been paid and determines which fees are over-due.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	3	8.33	1.25	7-10
Level of Integration	2	7.50	1.50	6-9
Degree of Functionality	3	9.00	0.82	8-10
Ease of Use	3	9.00	0.82	8-10
Completeness of User Documentation	3	8.33	1.25	7-10

RIGHT OF WAY RELOCATION

This online application was designed due to federal reporting requirements to store information about relocation expenses due to DOT construction projects.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	7.00	0.00	7
Level of Integration	0			
Degree of Functionality	1	8.00	0.00	8
Ease of Use	1	6.00	0.00	6
Completeness of User Documentation	1	7.00	0.00	7

APPENDIX B

ROADSIDE COST ANALYSIS FOR BRIDGES

This PC application, procured from AASHTO is used by Materials and Surfacing to help determine whether to install guardrail for a bridge. It compares the cost of installing and maintaining a section of guardrail with the cost of leaving the obstacle unprotected.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	8.00	0.00	8
Level of Integration	0			
Degree of Functionality	1	8.00	0.00	8
Ease of Use	1	10.00	0.00	10
Completeness of User Documentation	1	3.00	0.00	3

SECONDARY FUNDS

This batch application tracks the initial allocation and the current balance of funds. It reports on the funding status of Secondary and Urban funds by project broken down by county or city.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	7.00	0.00	7
Level of Integration	0			
Degree of Functionality	1	6.00	0.00	6
Ease of Use	1	4.00	0.00	4
Completeness of User Documentation	1	4.00	0.00	4

SOUTH DAKOTA DOT BRIDGE SYSTEM

This online application maintains an inventory of bridge components and can be updated in the central or region offices. It is a newly developed system and was designed due to federal regulations. An annual tape is produced and submitted to the Federal Highway Administration with the required information.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	6	7.67	0.75	7–9
Level of Integration	4	6.75	1.09	5–8
Degree of Functionality	6	7.50	1.38	5–9
Ease of Use	6	6.83	1.86	4–9
Completeness of User Documentation	5	7.40	1.02	6–9

APPENDIX B

SIGN INVENTORY

This PC application was developed for each region to maintain independent traffic sign information. The Federal Highway Administration is promoting this to allow proper and timely replacement of signs.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	10	6.10	1.64	4–8
Level of Integration	4	5.00	1.87	3–8
Degree of Functionality	10	5.90	2.17	2–9
Ease of Use	10	5.80	2.23	2–9
Completeness of User Documentation	9	6.56	1.71	4–8

SIMON STEEL GIRDER DESIGN

This batch application was developed to optimize the utilization of steel girders. Although US Steel initially developed the software, Wisconsin has now assumed responsibility for its maintenance. The program is primarily used to determine preliminary sizing for steel girders. AASHTO is currently publishing new design specifications that may require the replacement or enhancement of this package.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	5.00	0.00	5
Level of Integration	1	1.00	0.00	1
Degree of Functionality	1	4.00	0.00	4
Ease of Use	1	3.00	0.00	3
Completeness of User Documentation	1	5.00	0.00	5

STABL4

This PC application performs slope stability calculations per the Federal Highway Administration parameters.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	2	8.50	0.50	8–9
Level of Integration	0			
Degree of Functionality	2	8.00	2.00	6–10
Ease of Use	2	7.00	2.00	5–9
Completeness of User Documentation	1	5.00	0.00	5

APPENDIX B

SUPPLY INVENTORY CONTROL SYSTEM

This mainframe application, updated in the field, keeps track of maintenance equipment parts. Each area office has a warehouse of parts that it supplies to mechanics to keep the snowplows and graders in running order. Operations in the central office is responsible for the final edit of the data and for running batch reports. The reports are sent to the field from the central office at the end of each week and upon request.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	5	7.20	0.75	6–8
Level of Integration	3	6.33	2.49	3–9
Degree of Functionality	5	7.20	1.17	5–8
Ease of Use	5	5.00	1.79	3–7
Completeness of User Documentation	4	7.50	2.06	5–10

TIMESHEET TELEPROCESSING

This online application allows for entry of DOT timesheet information. In addition to providing payroll data, this application provides distribution data needed by the Construction Engineering Manpower Management System and the accounting system.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	3	7.67	1.25	6–9
Level of Integration	3	7.67	1.89	5–9
Degree of Functionality	4	7.50	2.06	4–9
Ease of Use	4	7.50	2.06	4–9
Completeness of User Documentation	4	6.75	1.79	5–9

APPENDIX B

TOTAL SURVEY STATION

This PC application allows 90 percent of drainage, topography, alignment and cross section survey data to be collected using this method. Bridge design uses the drainage survey data for Hydraulics, topography survey data is loaded to the VAX by project members and the alignment and cross section data gets used by the Road Design System on the IBM mainframe.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	6	7.67	1.37	5–9
Level of Integration	6	7.50	1.26	5–9
Degree of Functionality	6	7.83	1.34	5–9
Ease of Use	6	7.33	1.11	5–8
Completeness of User Documentation	5	6.60	1.02	5–8

TRAFFIC CENSUS DATA

This PC application contains traffic data from the Roadway Environment System Traffic file along with additional elements. All the data is reentered into this system rather than downloaded for the RES Traffic file. Materials and Surfacing, Region Engineers, designers, Road Design and Urban Systems use this information since it is easier to access than the RES Traffic data.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	5.00	0.00	5
Level of Integration	1	4.00	0.00	4
Degree of Functionality	1	5.00	0.00	5
Ease of Use	1	4.00	0.00	4
Completeness of User Documentation	1	4.00	0.00	4

TRAFFIC FORECASTING

This PC application models both street segments and intersections to produce a network or site impact model which forecasts the amount of traffic for peak hour or ADT. The type of employment and housing are the key variables used for the trip generation formula.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	7.00	0.00	7
Level of Integration	1	3.00	0.00	3
Degree of Functionality	1	8.00	0.00	8
Ease of Use	1	6.00	0.00	6
Completeness of User Documentation	1	9.00	0.00	9

APPENDIX B

TRAINING SYSTEM

This online application maintains a listing on all DOT approved classes and who has completed each class. The Timesheet Teleprocessing application automatically updates the attendees once the class has been set up in the system. Online retrieval is available to any DOT personnel interested in the application.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	3	8.00	0.00	8
Level of Integration	3	7.67	0.47	7–8
Degree of Functionality	2	8.00	0.00	8
Ease of Use	3	7.67	0.47	7–8
Completeness of User Documentation	2	8.00	0.00	8

TRUCK OFFTRACKING MODEL

This batch application determines how a truck will maneuver corners given certain design parameters. The wheel tracks are traced and a plot is generated for use by the design engineers.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	8.00	0.00	8
Level of Integration	1	3.00	0.00	3
Degree of Functionality	1	8.00	0.00	8
Ease of Use	1	4.00	0.00	4
Completeness of User Documentation	1	8.00	0.00	8

TRUCK WEIGHT

This batch application produces a Truck Weight Study every two years which contains the location and the number of trucks exceeding weight limits. The study is distributed to outside agencies such as the Highway Patrol.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	1	5.00	0.00	5
Level of Integration	1	5.00	0.00	5
Degree of Functionality	1	5.00	0.00	5
Ease of Use	1	4.00	0.00	4
Completeness of User Documentation	1	7.00	0.00	7

TWO AND THREE COLUMN BENT

This batch application is a frame bent program for slab bridges developed within the Bridge Division over ten years ago. It was originally developed as a temporary solution, but has never been replaced. The program is cumbersome, but produces sound results. It is limited in certain instances since it will not handle group and ice loads.

	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	0			
Level of Integration	0			
Degree of Functionality	0			
Ease of Use	0			
Completeness of User Documentation	0			

VEHICLE REGISTRATION INFORMATION

This batch application compiles statistics of vehicle registration information. The personnel responsible for this system pull data from several small systems and manually compile the data that is input into this application. This system is closely related to Department of Revenue information.

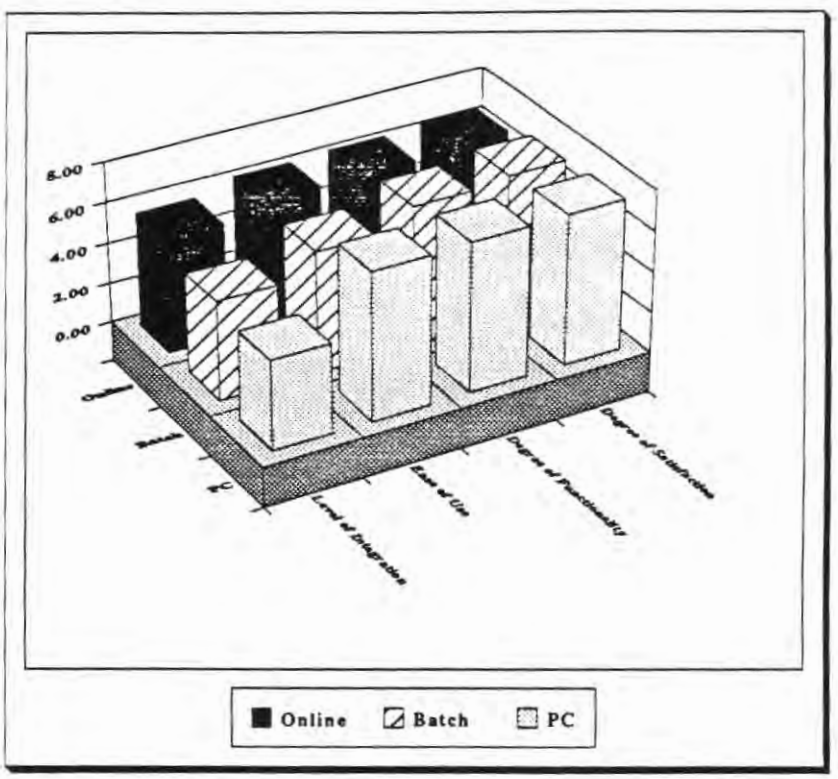
	Users Surveyed	Mean	Standard Deviation	Range
Degree of Satisfaction	0			
Level of Integration	0			
Degree of Functionality	0			
Ease of Use	0			
Completeness of User Documentation	0			

- Degree of User Satisfaction
- Level of Application Integration
- Degree of Functionality
- Ease of Application Use
- Completeness of User Documentation.

Based on the analysis of all surveys collected, the users appear to be relatively satisfied with many of the current applications. Exhibit 2.5 provides an illustration of the averages of the "Application Support Survey". As indicated in the application support summary graph, it appears that:

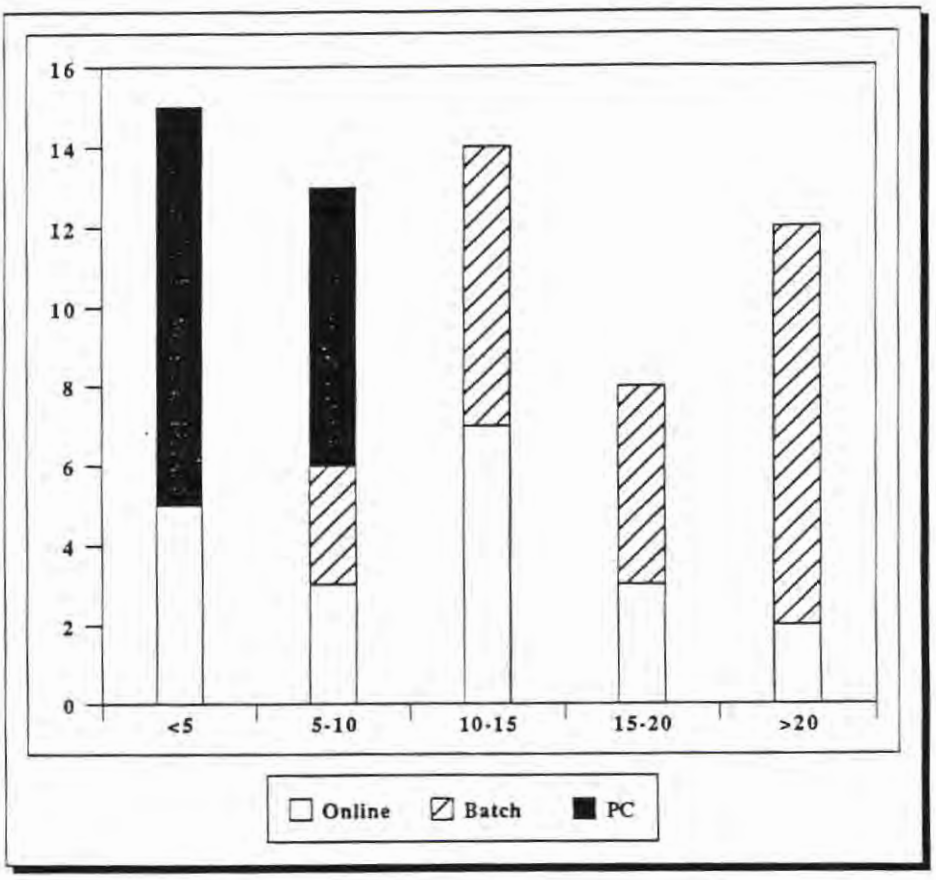
- Online and batch mainframe applications are rated higher than PC applications in "level of integration"
- The online and PC applications are generally easier to use than batch applications
- PC applications typically have a higher degree of functionality than online and batch systems.

Exhibit 2.5
Application Support Survey



The higher "functional" ratings assigned to the personal computer applications may be attributed to the age of the applications. Exhibit 2.6 illustrates the age of applications by applications processing mode. Twenty years ago most systems were designed in batch mode. There has been a slow progression to design online functionality into existing batch applications. During the past few years Data Services has been adding online functionality to a number of existing batch applications.

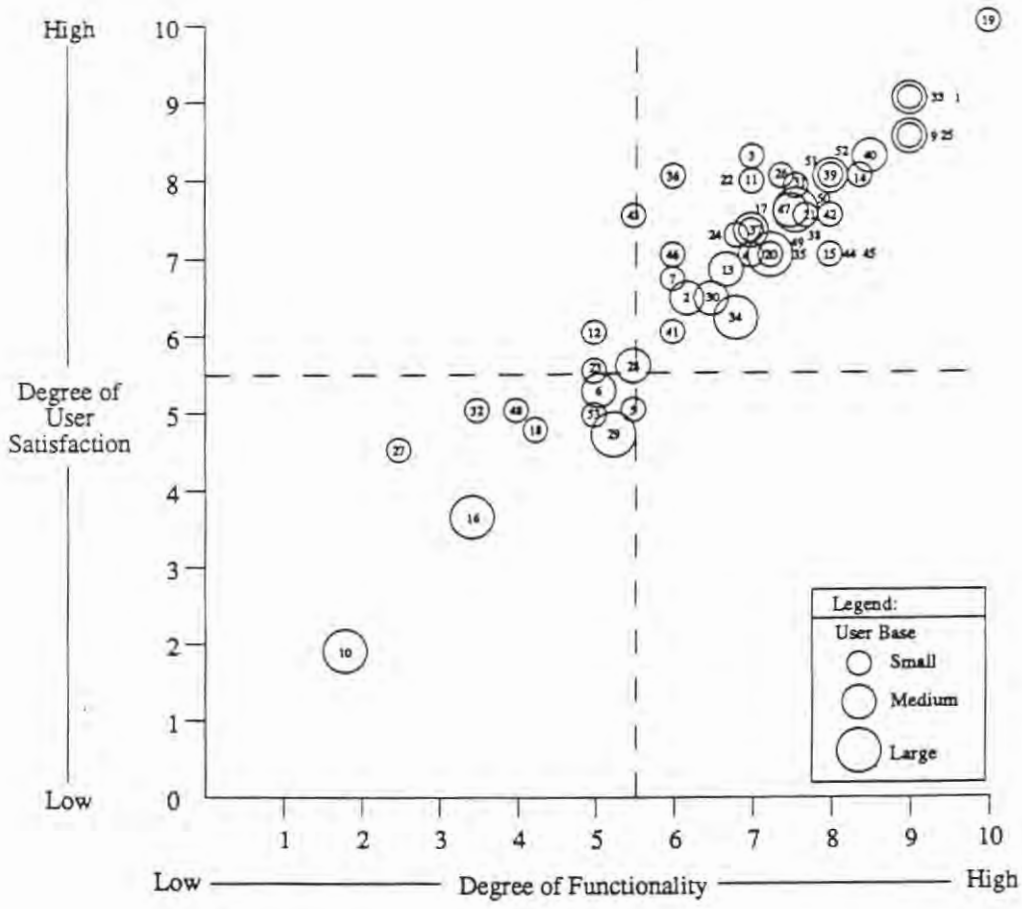
Exhibit 2.6
Age of Applications



Exhibits 2.7 and 2.8 provide an overall assessment of the degree of user satisfaction and perceived application functionality. The two exhibits represent mainframe and PC applications respectively. Each circle indicates an application, and the size of the circle represents the relative size of the user base.

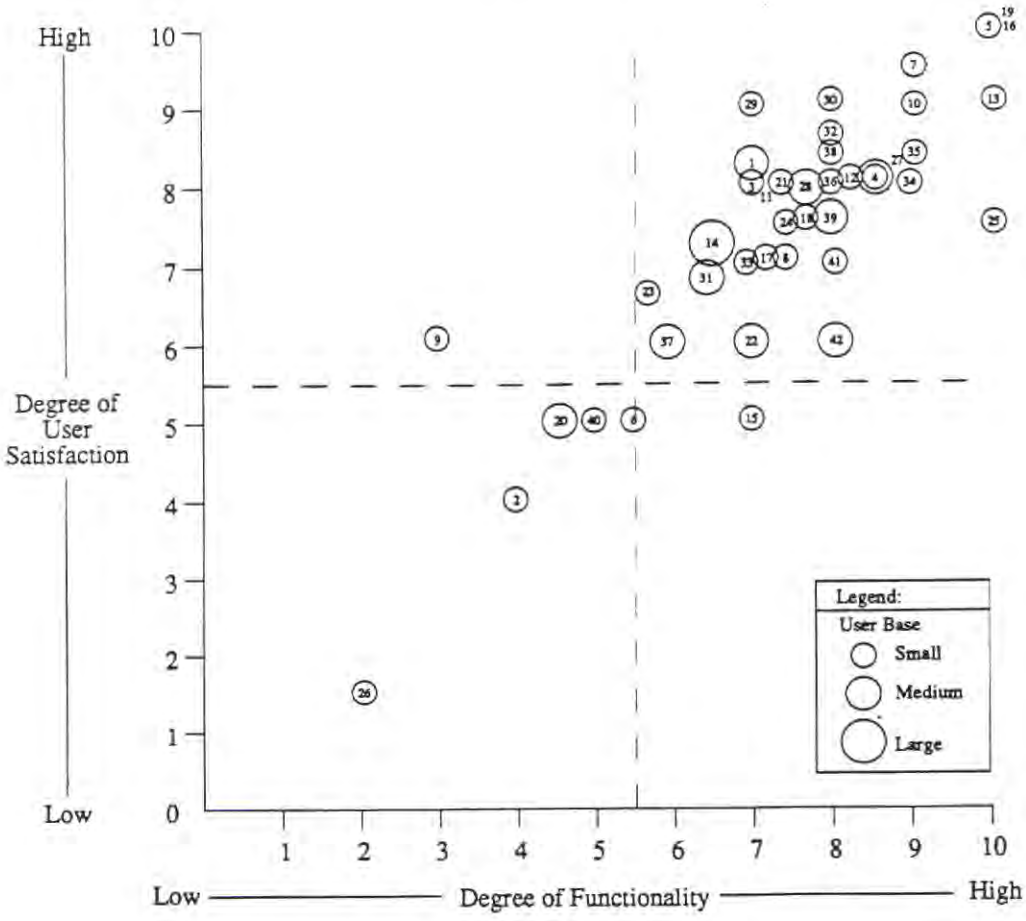
Exhibit 2.7 indicates that the majority of the mainframe based applications have a relatively moderate to high degree of functionality and user satisfaction. Those applications which appear to fall short in these ratings are:

Exhibit 2.7
Mainframe Applications



1 Accident Records
2 Bid Estimates
3 Billboard Sign Inventory
4 Bridge Analysis & Rating System
5 Bridge Configuration
6 Cash Forecasting
7 Civil Engineering Coordinate Geometry
8 CLM/CEAL
9 Consolidation RES Data/AdHoc Queries
10 Const Eng Manpower Mgmt System
11 Continuous Count (Traffic)
12 Continuous Prestress
13 Contract Pay Estimate
14 Culvert Hydraulics
15 Current Billing
16 DOT Accounting System
17 Equipment Management System (EMS)
18 Fixed Assets Inventory
19 Geodimeter
20 Georgia Beam
21 Georgia Bent Analysis
22 Highway Accidents
23 Highway Performance Monitoring System
24 Highway Planning & Research
25 Highway Planning (Needs Analysis)
26 Hydraulics
27 Journey
28 Maintenance Management System
29 MSA State Acccounting System
30 Non-State Trunk Road Inventory
31 PCA Column Design & Analysis
32 Personnel
33 Photogrammetry
34 Preconstruction Eng Mgmt System
35 Project Management
36 Railroad Crossing Inventory
37 Reinforced Concrete Box Culvert
38 Roadway Design System
39 RES Intersection Inventory
40 RES MRM Inventory
41 RES Roadway Features
42 RES Sufficiency
43 RES Traffic
44 Right of Way Parcel Inventory
45 Right of Way Relocation
46 Secondary Funds
47 SD DOT Bridge System
48 SIMON Steel Girder Design
49 Supply Inventory Control
50 Timesheet Teleprocessing
51 Training System
52 Truck Offtracking Model
53 Truck Weight

Exhibit 2.8
PC Applications



1 5 Year Construction Program
2 Accounting Contracts
3 American Concrete Pavement Assoc
4 AutoCAD
5 Bridge Approach Guardrail Design
6 Bridge Configuration
7 Building Replacement Program
8 Contractor Payroll
9 Contractor Prequalification
10 Contracts (Minority Business Enterprise)
11 County Sign Summary
12 Culvert Hydraulics
13 Disadvantaged Business Enterprise Firms
14 E-Mail
15 Field Instrumentation Processing
16 Geodimeter
17 Georgia Beam
18 Georgia Bent Analysis
19 Guardrail Design & Cost Analysis/Culverts
20 Highway Construction Projects
21 Hydraulics
22 IGrds
23 Junkyard Inventory
24 Library Catalog System
25 Maintenance Budgeting Program
26 Maintenance Needs Program
27 Microfilm Inventory
28 Microstation
29 One Year Bid Letting List
30 Pilot/Aircraft Registration
31 Project Status
32 Property Management
33 Reinforced Concrete Box Culvert
34 Right of Way Land Acquisition
35 Right of Way Railroad Property Leases
36 Roadside Cost Analysis for Bridges
37 Sign Inventory
38 STABL4
39 Total Survey Station
40 Traffic Census Data
41 Traffic Forecasting
42 Videolog

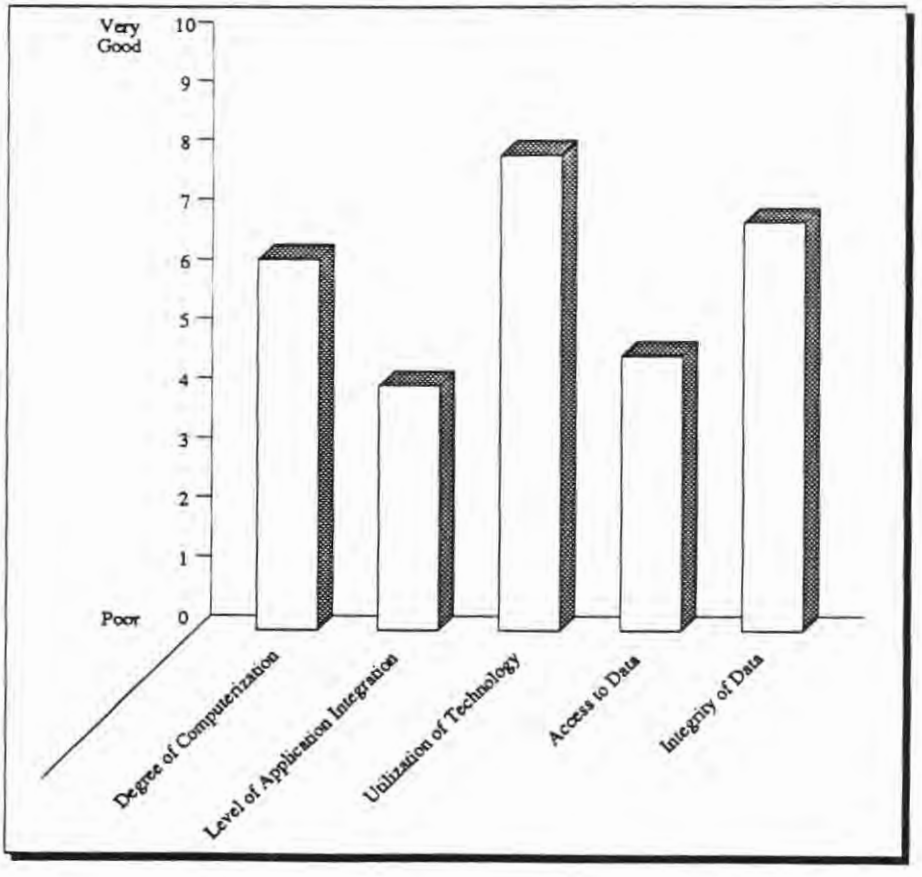
- Bridge Configuration (5)
- CEMMS (10)
- DOT Accounting (16)
- Fixed Assets (18)
- HPMS (23)
- Journey (27)
- Maintenance Management System (28)
- MSA State Accounting (29)
- SIMON Steel Girder (48)
- Truck Weight (53)

Exhibit 2.8 shows that a greater percentage of PC applications received moderate to high ratings for functionality and overall user satisfaction. Based on the diagram, the Department may consider including the "Maintenance Needs Program", and "Accounting Contracts" applications as part of the ongoing enhancements and developments projects identified as part of the future applications portfolio.

Management's assessment of the current applications is depicted in Exhibit 2.9. This exhibit illustrates that the areas of "application integration" and "access to data" are perceived by management as moderate to poor.

These observations emphasize the need to reexamine the Department's approach to developing systems in a stand–alone fashion, versus utilizing a Department–wide data model to provide the appropriate level of integration as new systems are designed and developed.

Exhibit 2.9
Executive Management Assessment of Current Applications



2. Future Applications Portfolio

Based on the results of the analysis presented in Section 1, the following priority projects have been identified to improve the information systems support provided for SD DOT.

- CASE/Structured Methodology
- Department–Wide Data Modeling
- Automated Design Direction
- Pavement Management Historical Database
- Metrics Implementation Planning
- Executive Information System
- Bridge Design System
- Enhanced Pavement Management System
- Geographic Information System
- Electronic Image Management
- Bridge Management System
- Bid Estimating
- Accounting Systems

Although the majority of these projects involve the implementation of new business applications, the first two projects are projects that will "modernize" the Data Services area and provide a more integrated foundation from which to proceed with the remaining projects. Therefore, the first two projects should be viewed as important to the successful implementation of the subsequent priority projects.

The remainder of this section presents the description and estimates associated with each project.

Format Used in Defining Priority Projects

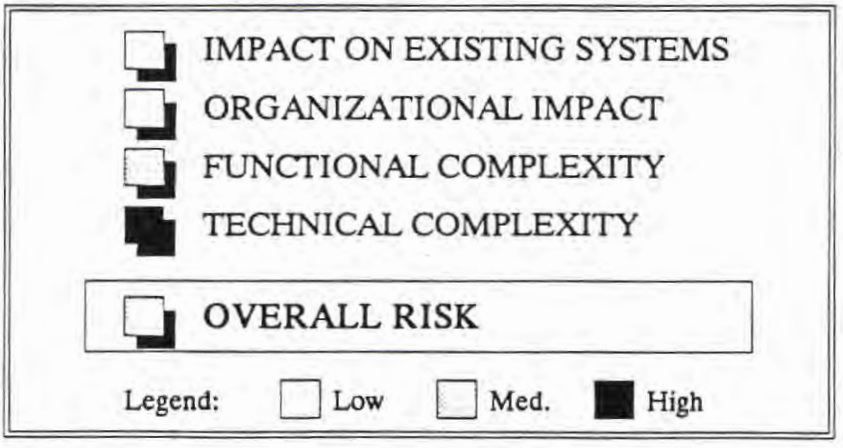
Each of the priority projects have been defined according to the following format:

PROJECT NAME

Project Summary

This area provides a brief overview of the project.

Project Scoping & Complexity



This area addresses key project scoping and complexity variables which impact the project's overall risk. A definition of each variable follows:

IMPACT ON EXISTING SYSTEMS

This variable identifies the project's affect on the Department's existing computerized systems and is generally a function of the level of integration that currently exists among the systems. As this variable's rating increases, the overall complexity of the project also increases.

ORGANIZATIONAL IMPACT

This variable identifies the project's affect on the Department's operational units. As more offices are affected or procedures are changed, the project's scope and complexity increases.

FUNCTIONAL COMPLEXITY

This variable identifies the complexity of system features encompassed by a project. If many complex functions must be provided within an application, the project's functional complexity would be high.

TECHNICAL COMPLEXITY

This variable identifies the complexity of the technologies to be utilized by an application. Necessary hardware, software and communications platforms are considered. This variable also addresses Data Services' implementation experience with the project's required technologies.

OVERALL RISK

A project's overall risk is determined by averaging the preceding variables. By assigning numerical values of 1, 2 and 3 to low, medium and high ratings respectively, averages can be easily calculated. All fractional ratings were rounded up to the nearest whole number.

Project Estimates

The estimates provided in this section are planning values intended to illustrate the order of magnitude investment required by a project.

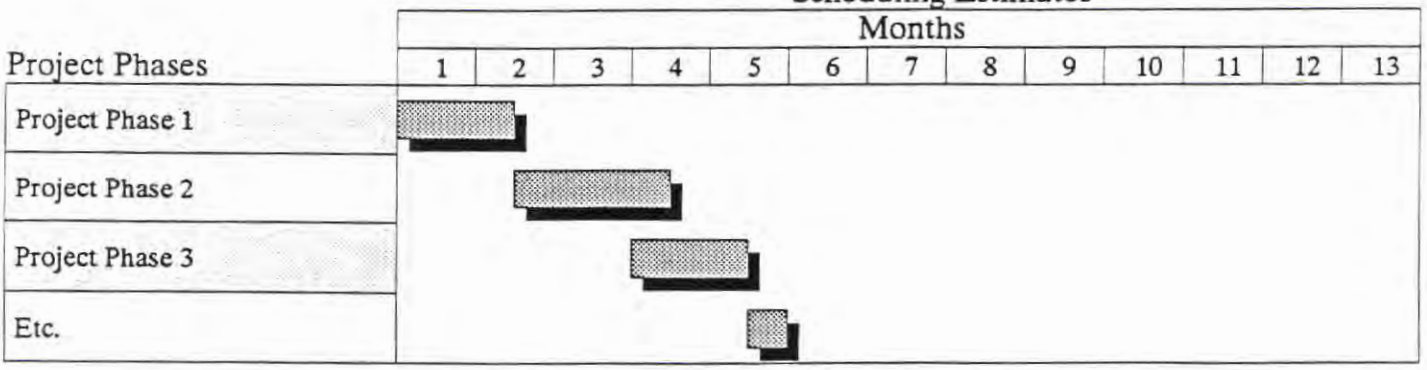
This table is used to provide project staffing estimates. The skill sets required are specified by project management, systems analysis and programming. Many projects assume the availability of experienced internal resources to perform many or all of the project activities. If available internal resources are unable to provide the required technical skills set to complete a project, external assistance may be required. Such changes to the staffing estimates, however, will impact the cost estimates provided near the end of each project.

Staffing Estimates

Project Phases	Internal			External		
	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
Project Phase 1						
Project Phase 2						
Project Phase 3						
Etc.						

The "Scheduling Estimates" table illustrated below provides a high level estimate of the project schedule. It is useful for illustrating estimated phase dependencies and overall project duration.

Scheduling Estimates



High, low and expected estimates are provided for a project's duration and resource involvement. The expected estimates are most often based on the project staffing and scheduling estimates. The assumptions used to determine these values are also provided.

Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)			
DATA SERVICES FULL TIME PROJECT STAFF			
USER INVOLVEMENT		☐	

Legend: ☐ Low ☐ Med. ■ High

The cost estimates provided for each project reflect a relatively broad order of magnitude. Many unknown variables exist which could significantly impact each project. Therefore, an attempt has not been made to identify complex cost computations based on detailed planning values. However, in order to facilitate the overall prioritization process, the following baseline assumptions have been made to better understand the commitments required to implement the plan and achieve the desired results.

- No travel or out-of-pocket expenses have been included in the contract services estimate.
- Productivity percentages are based on references identified in the literature review.
- The use of Data Services and other Department personnel is assumed to be a sunk cost and is not included in any cost estimates.
- Salaries and office budgets used in calculating productivity improvements are based on the FY92 estimates reported April 1, 1991.
- Hardware, software and application package estimates are based on averages, but can vary substantially based on functionality, platform, etc.

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES	$	$	$
HARDWARE	$	$	$
PACKAGE SOFTWARE	$	$	$
TOTAL ESTIMATED INCREMENTAL COSTS	$	$	$

Assumptions: ⇨ *A list of cost assumptions*

Tangible and Intangible Benefits

⇨ *A list of both tangible and intangible benefits associated with the project.*

	Low	Expected	High
ANNUAL PRODUCTIVITY IMPROVEMENTS	$	$	$

Assumptions: ⇨ *A list of productivity assumptions*

☐ Tangible Benefits

Legend: ☐ Low ☐ Med. ■ High

An attempt has been made to estimate the tangible benefits at an order of magnitude level. The assumptions underlying these estimates are also provided. To summarize the benefits listed, an overall degree of the project's tangible and intangible benefits are provided using the low/medium/high scale.

Project Summary

While computerized automation of business processes has occurred over the last thirty years, only in the last five to seven years have computerized tools and methodologies evolved to facilitate the actual development of new systems.

Computer Aided Software Engineering (CASE) products are PC based tools that provide automated graphics and analysis support for systems developers. These tools exist for virtually every phase of the systems development life cycle. The implementation of CASE technology would offer Data Services a complete diagramming, analysis and reporting system to help automate the production of information systems. The technology would improve Data Service's ability to deliver more timely and higher quality systems in a more cost effective manner.

The objective of this project is to acquire the proper methodology and tools to support the systems development and maintenance activities and to train the appropriate personnel in the use of the methodology and tools. The following steps will be critical to the successful implementation of future development projects.

- Evaluation of Technological and Environmental Design

  The project must begin with an understanding of Data Services ' existing methodologies and system delivery strategies. This will aid in the selection of a methodology and tool(s) best suited to the environment.

- Evaluation of Methodologies

  This phase provides an objective evaluation of commercially available methodologies.

- Selection of Methodology

  This phase provides for the acquisition of a methodology best suited to the Department's system development strategies.

- Methodology Training

  After selection of a methodology, sufficient training is required to ensure understanding of its basic principles and concepts.

- Evaluation of CASE Tools

  This phase provides for the objective evaluation of available CASE tools. The Department should strongly consider tools providing flexibility, growth and full life cycle support.

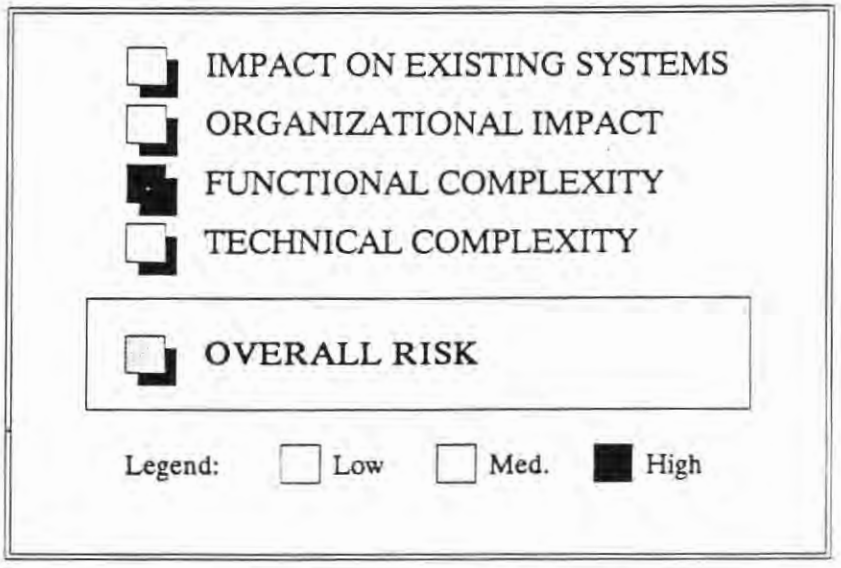
- Selection of CASE Tool(s)

  This phase consists of the selection of a CASE tool to support the Department's long term development and maintenance needs.

- CASE Training

  CASE involves new approaches to the development and maintenance of systems. In order to realize the benefits of CASE, Data Services personnel must be properly trained in the use of the tools.

Project Scoping & Complexity



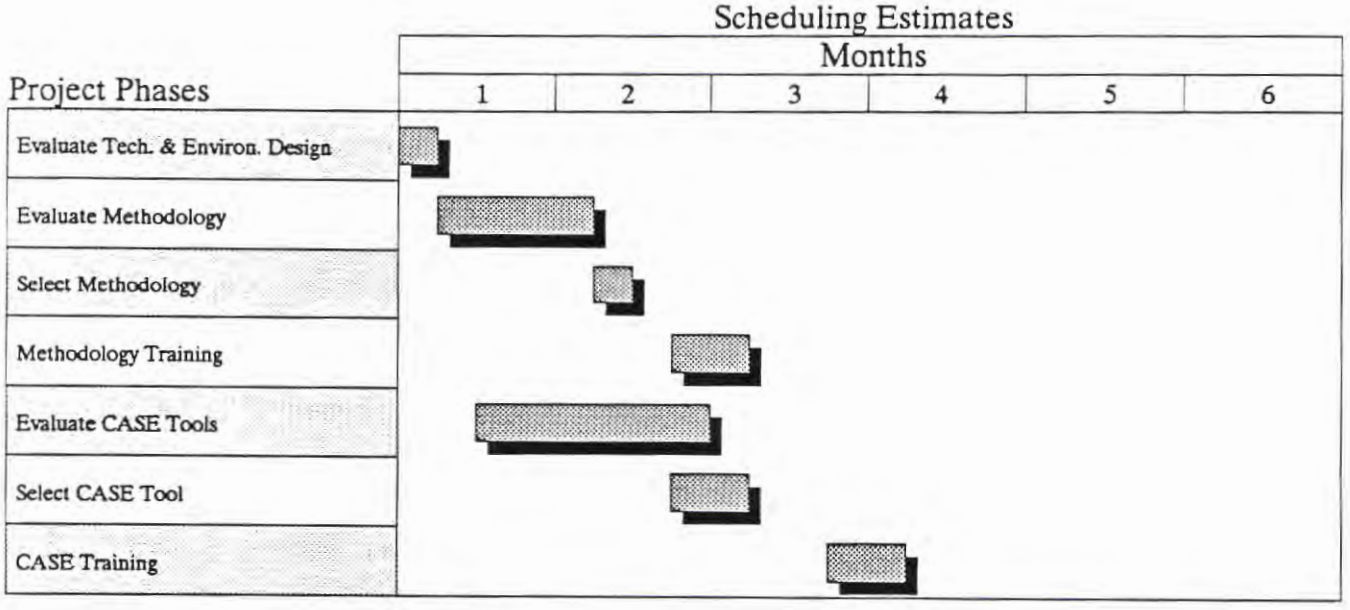
The overall risk expected by the implementation of CASE tools and a structured methodology is moderate. This is based on the following factors. This project provides for the procurement of tools and methods supporting Data Services and not the development of applications supporting the Department's operations. Furthermore, the implementation of CASE tools will not impact the existing applications systems. Therefore, both the existing systems impact and the organizational impact are expected to be low. The tools do incorporate a number of complex functions. The understanding of these functions will be important during the evaluation and selection of CASE tools. CASE tools can be easily implemented on stand–alone PCs, making the technical complexity very low. Based on these factors, the overall risk is estimated to be moderate.

Staffing Estimates

Project Phases	Internal			External		
	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
Evaluate Tech. & Environ. Design		1		1		
Evaluate Methodology		2		1	1	
Select Methodology	1/2	2		1		
Methodology Training	ALL				1	
Evaluate CASE Tools		2		1	1	
Select CASE Tool	1/2	2		1/2		
CASE Training	ALL				1	

External Staffing Roles: Many powerful CASE tools and complex methodologies exist in today's marketplace. While CASE tools encompass a broad range of functionality, structured methodologies can also encompass a vast collection of concepts and philosophies. It is important to understand these in order to adequately evaluate their ability to meet the Department's system development needs. Because of Data Services' limited exposure to these tools, the assistance of consultants is recommended. The consultants' key responsibilities would include assistance in determining key evaluation criteria applicable to Data Services' environment and long term direction and guidance evaluating and selecting an appropriate methodology and CASE tool. Contract services are also expected to cover the training necessary for an effective implementation.

Scheduling Estimates



Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	2.5	3.5	4.5
DATA SERVICES FULL TIME PROJECT STAFF	.5	2	2.5
USER INVOLVEMENT		☐	

Legend: ☐ Low ☐ Med. ■ High

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES	$35,000	$75,000	$150,000
HARDWARE	$20,000	$33,000	$47,000
PACKAGE SOFTWARE	$30,000	$50,000	$150,000
TOTAL ESTIMATED INCREMENTAL COSTS	$85,000	$158,000	$347,000

Assumptions:

- Contract services "Expected" estimate is based on estimates provided for project staffing and project management.
- Contract services "Low" estimate assumes project management services only.

Tangible Benefits

- Users have more input into the design process providing the ability to identify changes earlier in the system development life cycle at less expense and increasing the likelihood of user acceptance.
- CASE provides for significant efficiencies in maintaining systems.
- CASE improves systems development productivity by as much as 100%.
- CASE can support the automatic generation of programming code.
- CASE enhances the Department's ability to build "portable" software, reducing the need for rewrites when hardware/software platforms change.
- CASE can accelerate the systems development lifecycle.
- CASE automates the production of software documentation.

	Low	Expected	High
ANNUAL PRODUCTIVITY IMPROVEMENTS	$45,000	$64,800	$100,800

Assumptions:

- "Low" estimate assumes 25% productivity gain for 10 Data Services personnel. "Expected" estimate assumes 30% productivity gain for 12 Data Services personnel. "High" estimate assumes 40% productivity gain for 14 Data Services Personnel.

■ Tangible Benefits

Intangible Benefits

- CASE instills consistency in the development process by providing a data dictionary or repository, allowing project team members to maintain a single master definition of each term, element, record, table, etc.
- CASE provides the structured environment required to accommodate changes in information systems personnel.
- The pictorial representations available in CASE products allow technicians to more effectively communicate with end users.
- CASE provides extensive analysis capabilities ensuring consistent, high quality system designs.
- CASE assists in the integration of development steps (methodology) and the development tools.

■ Intangible Benefits

Legend: ☐ Low ☐ Med. ■ High

Project Summary

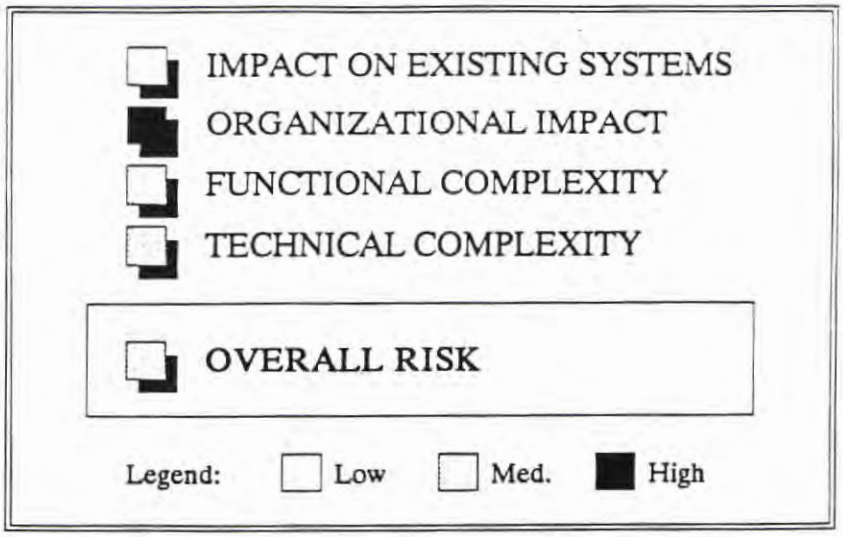
The Department maintains and utilizes a large and diverse body of data. This data physically resides on different computers in various locations throughout the Department. The distributed nature of these systems has resulted in multiple occurrences of the same data items. This has created inconsistencies between systems. Furthermore, the proliferation of personal computers and stand–alone applications has resulted in the Department's inability to properly coordinate data sharing. This project is designed to bring structure and control over the Department's data.

Fundamentally, data modeling is the process of developing a logical representation of the Department's data. However, there are many approaches to this process. A data model typically illustrates groupings of similar data, referred to as entities, and the associations between these entities. The proper structuring of data entities will promote data stability, data sharing and data access. This structure will also reduce the need to rewrite applications as the Department's operations change.

Due to the broad scope of data modeling, this preliminary project should focus on establishing a better understanding and control of the Department's existing data. This can be accomplished by developing a centralized (and automated) data inventory. In addition to locating the existing computerized data throughout the Department, this inventory will also serve as input to the creation of a conceptual data model, identifying high–level data entities. The conceptual model will provide the framework necessary for future development of a comprehensive logical model. The logical model will encompass not only the Department's existing computerized data, but also additional data required to meet ongoing business requirements. Because of the level of effort required to develop the Department–wide logical model and the timeliness of the data items captured, it is recommended that this not be developed as part of this initial project, but rather as part of subsequent systems projects as different business areas are addressed. Therefore, this project should consist of the following phases:

- The preparation of CASE tool standards
- The determination of data characteristics to be collected (e.g., ownership, historical requirements, etc.)
- The identification of the Department's data and creation of the CASE tool dictionary
- The data analysis and identification of subject databases
- The preparation of the conceptual data model

Project Scoping & Complexity



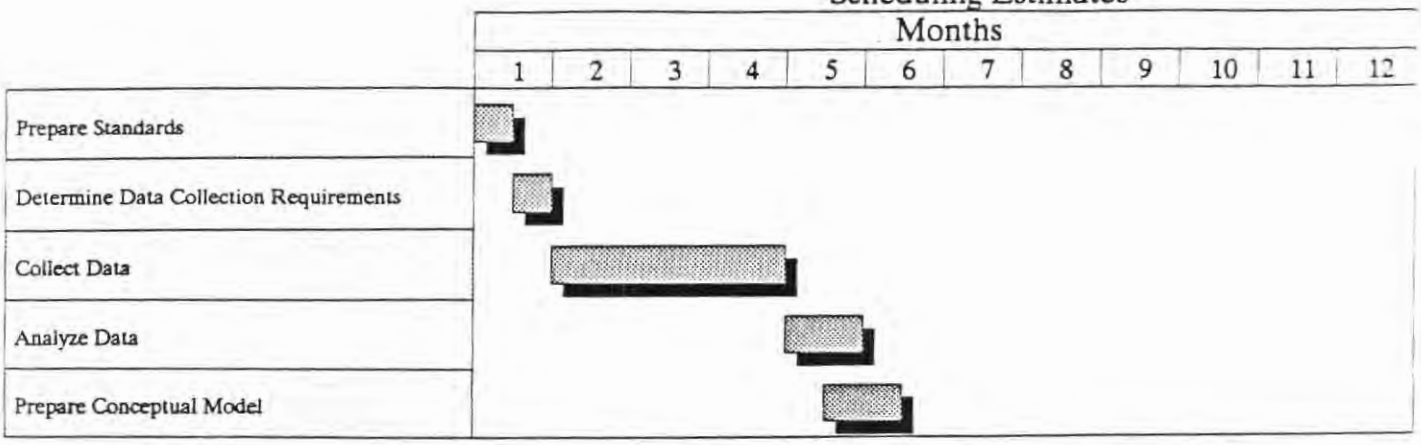
The overall risk expected with the development of a Department-wide data model is moderate. This is based on the evaluation of the scoping and complexity variables. Although the long term impact of data administration on existing systems can be substantial, this initial project will not impact current applications. Because of the large number of individuals maintaining data throughout the Department and the potential for data redundancy, the organizational impact of identifying data and potentially determining ownership is very high. Although data modeling is not exceedingly complicated, the principles and concepts may be unfamiliar. Therefore, the functional and technical complexity were estimated to be moderate. Based on these ratings, the project's overall risk is expected to be moderate.

Project Estimates

	Staffing Estimates					
	Internal			External		
Project Phases	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
Prepare Standards	1/2			1	1	
Determine Data Collection Requirements	1/2			1	1	
Collect Data		2		1	1	
Analyze Data		2		1	1	
Prepare Conceptual Model		2		1	1	

External Staffing Roles: CASE tools encompass a vast number of functional capabilities. Regardless of the CASE tool chosen, consultants can help Data Services understand how to effectively apply the tool to inventory the Department's data. This will include identification of the CASE tool functions required by the project and the development of specific standards detailing how those functions are to be used. Consultants should also play the role of mentor, transferring knowledge throughout the project, so that Data Services can continue to effectively use the tool and data modeling principles into the future.

Scheduling Estimates



Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	4	5.25	6.5
DATA SERVICES FULL TIME PROJECT STAFF	1	1.75	2.5
USER INVOLVEMENT		■	

Legend: ☐ Low ☐ Med. ■ High

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES	$155,000	$265,000	$340,000
HARDWARE		$0	
PACKAGE SOFTWARE		$0	
TOTAL ESTIMATED INCREMENTAL COSTS	$155,000	$265,000	$340,000

Assumptions:

- This project assumes the identification of existing, computerized data and the development of a conceptual data model.
- The "Low" contract services estimate assumes full time assistance of one analyst only.
- The "Expected" contract services estimate assumes full time assistance for one analyst and one project manager.

Tangible Benefits

- Department–wide data models can save valuable programming time, since they eliminate the need to redefine data elements already being used in other systems.

- Properly designed data models can provide "data structure stability", reducing or eliminating the need to rewrite applications as operations change.

	Low	Expected	High
ANNUAL PRODUCTIVITY IMPROVEMENTS	$45,000	$64,000	$100,800

Assumptions:

- Productivity improvements are based on increased productivity in the Data Services Section. The estimates assume an average base salary of $30,000, 60% time involvement, a range of impacted resources between 10 to 14, and productivity gains of 25% ("Low"), 30% ("Expected") and 40% ("High").

  These gains may not be fully realized for 18 to 24 months due to the learning curve associated with most CASE tools.

☐ Tangible Benefits

Intangible Benefits

- Department–wide data models help organizations assess systems and their impact.

- Department–wide data modeling encourages a discipline which focuses management on a coherent business vision, mapping this vision to all aspects and levels of the business.

- A Department–wide data model can be a critical factor in the successful integration of application systems.

- A Department–wide data model can assist the Department in establishing priorities for development projects.

- A Department–wide data model can help expose data redundancies to solve data integrity problems.

- A Department–wide data model can help establish order and control in the investment of information systems resources, by providing insight into the resources required to implement new systems.

- A Department–wide data model can open up communication channels at all levels. It can show how much data is being collected, determine who retains the correct data and develop common definitions for data elements and entities.

Fundamentally, data modeling improves an analyst's understanding of the business, resulting in more responsive systems being implemented.

Intangible Benefits

Legend: ☐ Low ☐ Med. ■ High

Project Summary

As noted in the "Business Functions" section, it is vital that design plans be produced as efficiently and accurately as possible. Although much has been done to increase the flow of design plans to the field, additional steps should be taken to ensure long-term productivity gains. This project's goal is to address those steps by formalizing the Department's long-term strategic direction regarding automated design. The project must also provide the hardware, software and training structure necessary to support that direction.

Survey Tools

The Department has made significant progress in automating the survey area over the last few years. In 1987, Total Survey Stations were introduced throughout the regions. Although it has taken time to become proficient with the new tools, many of the Department's engineers feel the stations have increased survey accuracy and efficiency.

A newer technology, Digital Terrain Modeling (DTM), appears to provide additional benefits. Although DTM will again require increased training and new processes for surveying, it should alleviate the need to regenerate cross sections. This will drastically reduce the amount of resurveying required for shifts in alignment. In time, DTM should provide further productivity gains and enhanced analysis capabilities, such as automated cut and fill analysis.

This implementation, however, is a long-term strategy. Although CEAL currently has the ability to support DTM, the potential implementation of different design tools to meet the Department's long term needs may require the investigation of alternate tools to allow the use of DTM. DTM will also require different methods for surveying and a long-term investment in training. Therefore, even though DTM's eventual implementation can be justified, it should be a slow, well planned transition from present tools and survey methods.

Design Tools and Issues

Between 1980 and 1985 the roadway design function was primarily supported by the mainframe Roadway Design System (RDS). In 1986, the Department implemented the interactive graphics version of the application, IGrds, in the central office. In the fall of 1990, the region offices implemented CEAL to support the survey process. It was originally provided to allow field personnel to view survey data before sending it into the central office. Although the alphanumeric version of RDS is still available in region offices, it has never been used extensively. However, realizing the potential design capabilities of CEAL, region designers have begun using CEAL for design purposes. Both IGrds and CEAL have provided benefits to their respective users. The incompatibility of the two products, however, has prompted users and management to raise concerns. The two most noticeable issues are training and transferability of designs between the tools.

The training concerns are associated with the money and time required to support two training programs. The second issue, transferability of designs, hinders the ability of the central office and regions to work on the same project design. Designs created on RDS/IGrds are not currently transferable to CEAL.

Independent of the tool(s) chosen to support the design process, other issues impact the Department's ability to productively use the tools. In order to maximize the efficiencies that might be realized in using the automated design tools, additional training is required. The Department realizes the impact recent employee attrition has had on experience levels. With engineers averaging fewer than five years of experience, it is difficult to leverage on the limited knowledge base. Although this is a problem in itself, coupling this with heavier workloads increases the pressure to produce and limits the time allotted to training.

Another issue which appears to be preventing the Department from fully realizing the benefits associated with automated design tools is the rapid change of hardware and software platforms. The applications were originally accessed through workstations connected to the DEC VAX. As the VAX is being phased out, the software has almost entirely migrated to stand alone workstations. In the future, it is expected that many of these workstations will be networked. These changes have produced many improvements in the software's speed and functionality. By the same token, however, they have reduced the stability of the environment to a point where documented methods and structured training have had a difficult time keeping pace. Short term changes should be challenged to ensure that incremental speed and functionality benefits derived from change outweigh losses in productivity and effectiveness.

IGrds, CEAL and Digital Terrain Modeling may all affect the future of the design process. But this process is critical to the success of the Department which must operate as efficiently and effectively as possible. In order to ensure that long-term support is provided for this function, this project encompasses the following activities:

- Long Term Design Workload for regions:

  Before a decision can be made affecting the Department's strategic direction for automated design tools, management must determine the design workload to be carried by the regions. The higher the level of decentralized design, the more urgent the need to move toward one automated design tool. Realizing the impact of this decision, the outcome of this activity should be a formal statement of the Department's philosophy concerning centralized versus decentralized design.

- Automated Design Tool Direction:

  In order to address the Department's long-term automated design direction, the requirements of these tools should first be documented. This will provide a framework with which to evaluate tools capable of meeting the Department's needs. The following are viable alternatives to consider when evaluating available tools.

  Alternative 1: Continue to use both IGrds and CEAL.
  If the flow of design work to the regions does not increase, the Department may consider maintaining the existing configuration. Although this will continue to require investment in two training programs, the lack of major projects in the field will lower the investment in CEAL.

The Department may also investigate the possibility of interfacing the two products, allowing designs to be transferred.

Alternative 2: Use IGrds as the primary design tool
If the regions are to continue performing design functions, this strategy would require the procurement of the hardware and software necessary to provide IGrds to the regions. CEAL may still be used by the regions, but only as an aid to the survey process. Due to the Department's current investment in IGrds hardware and software and current strategies, this is viewed as the most likely alternative. Therefore, all project estimates have been based on the continued use of IGrds.

Alternative 3: Use CEAL as the primary design tool.
This alternative would require that the central office convert to CEAL as the primary design tool. This would require substantial retraining and potential procurement of different hardware and software.

Alternative 4: Use other software as the primary design tool.
This alternative would require the implementation of an entirely new design package. This option could require a significant investment in hardware, software and training.

After evaluating all available options, considering potential costs and benefits of each, a tool or set of tools should be selected.

⇨ Implementation Plan for DTM:

The Department understands the benefits that can be gained by the implementation of DTM. However, the Department still must determine the technology's long-term implications and plan for DTM's eventual implementation.

⇨ Provide Field Update Capabilities for As-Built Plans:

There are many benefits which may be realized by the ongoing maintenance of as-built plans. For example, it is important to understand the actual construction of a roadway in order to accurately analyze design performance or a contractor's adherence to specifications. A reliable inventory of as-built data could also reduce the need for extensive surveying work on certain types of projects. Because of more immediate priorities, this data is often not captured. In the future, the Department's design tools may allow field engineers to easily reflect construction changes electronically. If this capability is not provided, the Department should provide a process to ensure the accurate capture of as-built changes. Because of its dependence on other decisions, this component is not included in the project estimates.

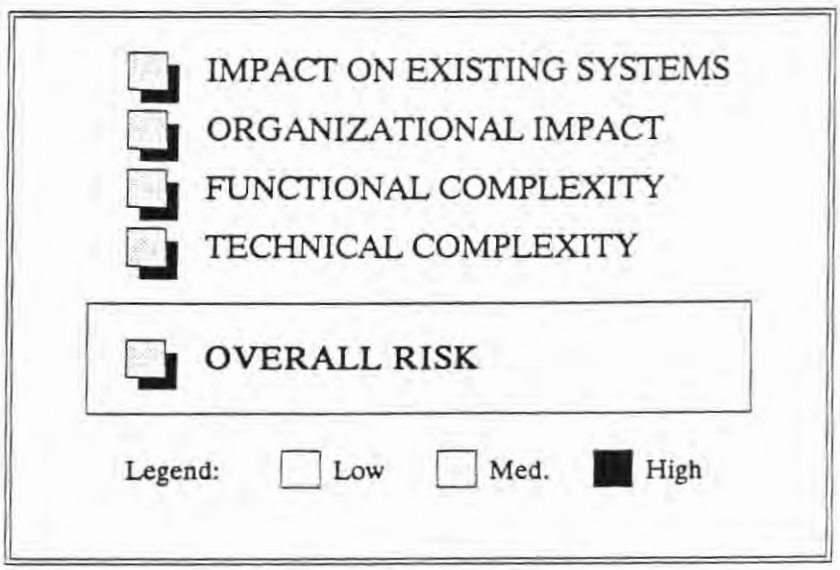
- Provide Adequate Training Support for Automated Tools:

  In order to achieve greater efficiencies which are afforded using automated design tools, additional training is required.

- Provide a Stable Hardware Platform to Support Automated Tools:

  As mentioned above, without a stable design environment, it is difficult to develop the structured methods and training necessary to support automated design tools. The incremental benefits gained in speed and functionality can not continue to overcome the benefits foregone by this strategy.

Project Scoping & Complexity



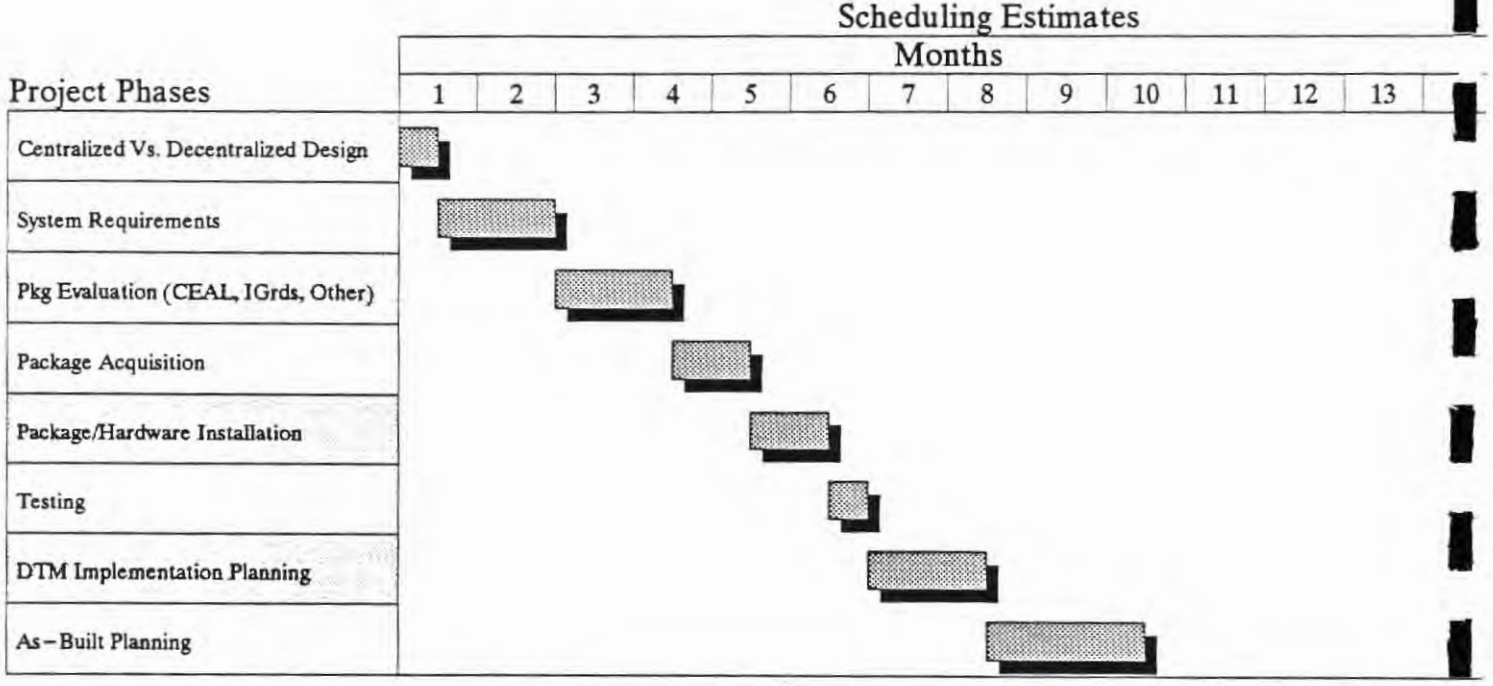
Based on the Department's investment in IGrds and existing strategies, this project assumes the selection of IGrds as the primary design tool. With this assumption in mind, this project's estimated overall risk is moderate. The Department has been using IGrds for over five years now. The alphanumeric version, RDS, has been in use for over ten years. If the Department determines the implementation of an entirely new tool is necessary, the corresponding risk increases dramatically. Even with the large-scale implementation of CEAL as primary design tool, the unfamiliarity with the tool would increase the risk.

The impact to existing systems is expected to be moderate. Although the actual implementation of DTM and provision for as-built updates are beyond the scope of this initial project, the long-term implication of this project will affect the Department's design strategies. The organizational impact is also expected to be moderate. This is because of the extensive training required in both the central and region offices. Although the Department has been using the automated design tools for a number of years, the functional and technical complexity required to understand these tools is notable. Taking these factors into consideration, moderate project risk is estimated.

Project Estimates

Project Phases	Staffing Estimates					
	Internal			External		
	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
Centralized Vs. Decentralized Design	1					
System Requirements	1/2	1				
Pkg Evaluation (CEAL, IGrds, Other)	1/2	1				
Package Acquisition	1/2					
Package/Hardware Installation	1/2	1				
Testing	1/2	1				
DTM Implementation Planning	1/2	1				
As–Built Planning	1/2	1				
Design Tool Training	1/2	1				

External Staffing Roles: The primary responsibility of consultants for this project would be to assist in the development of a structured training program and conduct initial training workshops supporting the design tool(s) chosen by the Department.



Note: *The scheduling of "As–Built Planning" and "DTM Implementation Planning" are constrained by available personnel resources. Both could begin after the selection of a primary design package if sufficient resources are available.*

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES		$0	
HARDWARE		$0	
PACKAGE SOFTWARE		$0	
TOTAL ESTIMATED INCREMENTAL COSTS		$0	

Assumptions:

- The government's metric requirements may cause operational impacts felt throughout the organization. Although some of these issues must be addressed by this project, the project's goal is to concentrate on the conversion's impact on automated systems.

  Because of the organizational implications associated with a metric conversion, user involvement may include liaisons from different areas assigned to the project part–time during the identification and evaluation of alternatives.

Tangible Benefits

- By ensuring compliance with Federal guidelines, the Department may avoid Federal penalties tied to funding.

	Low	Expected	High
ANNUAL PRODUCTIVITY IMPROVEMENTS		$0	

☐ Tangible Benefits

Intangible Benefits

- Developing an implementation plan for conversion to metrics would assist the Department in performing a timely conversion, when required.
- Developing an implementation plan should reduce the risk of future confusion and disorder which might otherwise come with the conversion.

☐ Intangible Benefits

Legend: ☐ Low ☐ Med. ■ High

Project Summary

Executive Information Systems (EIS) are designed to provide management easy access to information required to make complex business decisions. EIS provides the vehicle to gain access to this type of information via concise, predefined queries.

EIS is not new to the State of South Dakota. Information Processing Services (IPS), with the assistance of outside contractors, has developed an Executive Information System for the Governor. This system will allow the Governor to monitor the progress of all Departments in meeting the goals established by the strategic business planning process.

IPS plans on eventually providing all agencies access to the Executive Information System. However, it is unclear as to the timing or availability of IPS assistance. Furthermore, it remains unclear as to whether the State's EIS solution can meet the DOT's business requirements.

This project provides for the development of an EIS environment capable of supporting future growth. It also provides an initial application meeting the requirements of the Secretary's Office. The project includes the following activities:

- Preliminary Identification of EIS Needs and Assessment of State's Direction

  The DOT should evaluate the State's EIS package and its ability to meet key DOT needs. The feasibility of the package's hardware and software requirements (DOT compatibility) must also be evaluated.

- Determination of DOT's EIS direction

  After an assessment of the State's EIS direction, the Department must determine whether to adopt that package or proceed with the evaluation and selection of an alternate package. This project scope assumes the Governor's commitment to a State-wide EIS system will provide a package meeting the DOT's needs. If this assumption proves incorrect, it is important to realize that an alternate package must be selected.

- Acquisition of EIS Software

- EIS Planning

  This phase initiates application development. It encompasses project planning and review of required technology concepts with all team members.

- Identification of EIS Needs

  This phase include interviewing sessions with executive management and support staff. The outcome will be an agreed upon set of query screen designs and data requirements.

Scheduling Estimates (Continued)

Project Phases	Months													
	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Design Tool Training														

Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	6	18	18
DATA SERVICES FULL TIME PROJECT STAFF	1	1.5	2
USER INVOLVEMENT		■	

Legend: ☐ Low ☐ Med. ■ High

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES	$30,000	$50,000	$50,000
HARDWARE	$0	$100,000	$100,000
PACKAGE SOFTWARE	$0	$15,000	$15,000
TOTAL ESTIMATED INCREMENTAL COSTS	$30,000	$165,000	$165,000

Assumptions:

- These estimates assume implementation of IGrds as the Department's primary design tool. The "Low" estimate assumes the design workload for the regions will decrease. Thus, IGrds will not be implemented in the field. The "High" estimate assumes the workload will continue to increase. Thus, IGrds will be implemented in the field. The "Expected" column assumes the "High" scenario is most probable. Although the implementation of IGrds is assumed as a basis to provide cost estimates, it is not a recommendation. The goal of the "Automated Design Tool Direction & Training" project is to recommend the design platform capable of meeting the Department's needs.

- The contract services estimates assume the retention of a technical resource (either provided by the design tool's vendor or an independent consulting firm) to provide training.

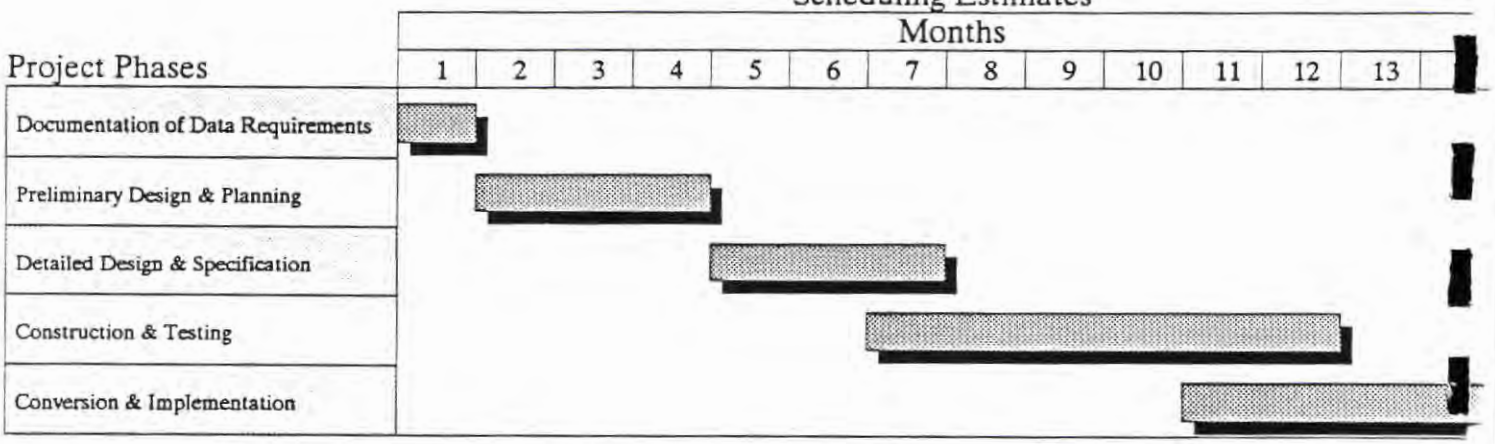
Project Estimates

Staffing Estimates

Project Phases	Internal			External		
	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
Documentation of Data Requirements	1	1		1	2	
Preliminary Design & Planning	1/2	2		1/2	2	
Detailed Design & Specification	1/2	2		1/2	2	
Construction & Testing	1/2	1	1	1/2	1	
Conversion & Implementation	1/2	1	1	1/2	1	

External Staffing Roles: Although many of the data requirements for this project are already known, the effort necessary to design and construct the historical database are expected to be substantial. In order to provide for the timely development of a database capable of driving the Department's future pavement management needs and preventing the further loss of historical data, it is recommended that outside consultants be retained. The primary responsibilities of consultants would be the following: to ensure adequate documentation of data requirements, to aid in the development of screen and report designs, to assist the development of a logical and physical data model and to assist the development of detailed design specifications. External resources may also help ensure the design is properly implemented by assisting throughout the construction and implementation phases. Since this may be the first Department project to utilize CASE technologies, external resources will assist the Data Services' area in understanding how the new technologies can appropriately be applied, avoiding many of the pitfalls which sometimes plague larger CASE projects. This may include assisting Data Services in establishing CASE tool design standards.

Scheduling Estimates



Project Summary

Metric reporting requirements are Federally mandated as part of the Omnibus Trade and Competitiveness Act of 1988. The Department of Commerce is requiring compliance by the end of fiscal 1992. This and other federal metric requirements may have a dramatic effect on the Department's operations.

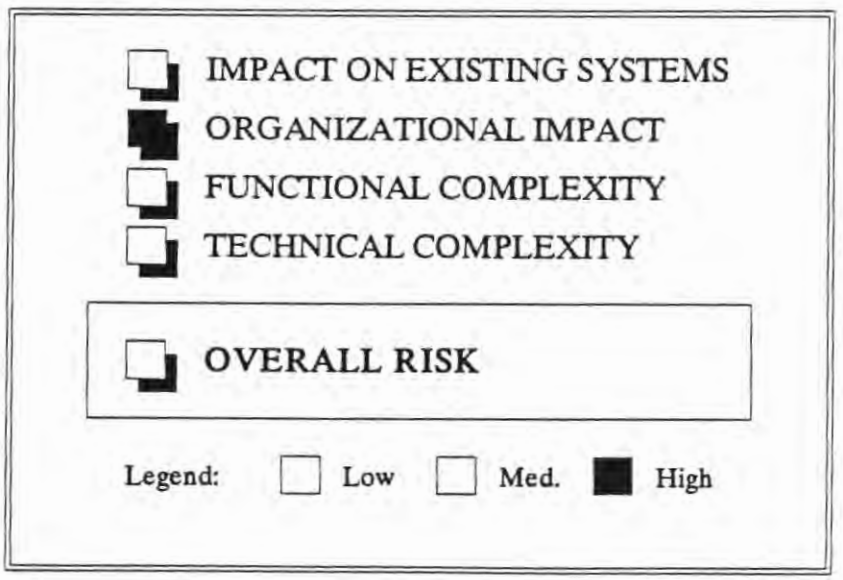
In order to avoid federal penalties and inefficiencies caused by an unplanned conversion and revision of newly developed systems, the Department should review existing legislation and evaluate its impact.

This project would provide for conversion planning to metrics by performing the following activities:

- Investigate all current and proposed legislation, documenting potential DOT requirements.
- Identify processes impacted by the requirements and evaluate the Department's alternatives.
- Formally document a plan providing for the implementation of metrics if a conversion is required.
- Review and modify the plan as requirements are better defined.

The metrics implementation plan should allow the Department to anticipate conversion requirements. The following project estimates account for the metric planning process as they relate to existing data and do not include the actual conversion or implementation timeframes.

Project Scoping & Complexity



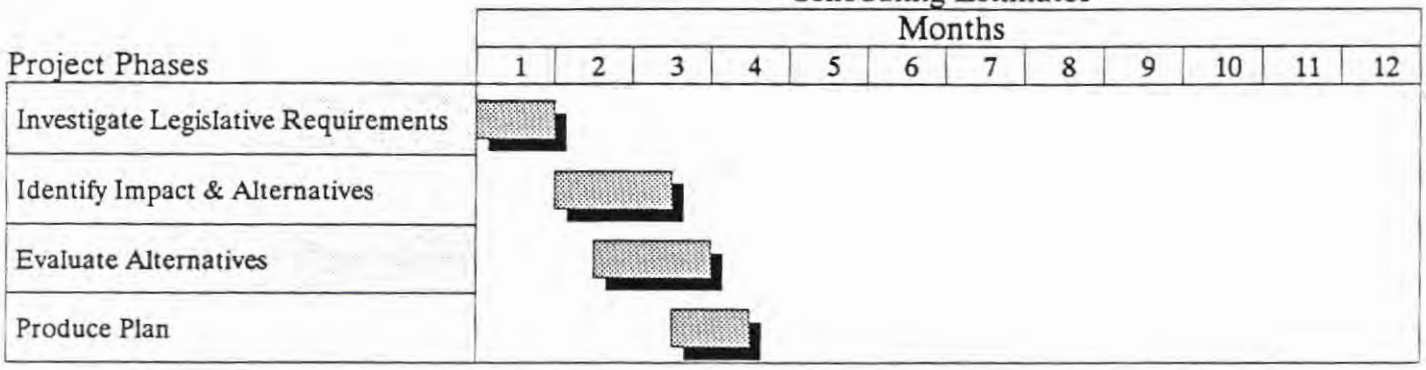
Because this project deals with planning for metrics and not the actual conversion, the project's risk is estimated to be low. "Organizational Impact" is the only variable of significance. Although this project focuses on the conversion's impact on automated systems, many operational issues will need to also be addressed.

Project Estimates

Staffing Estimates

Project Phases	Internal			External		
	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
Investigate Legislative Requirements	1	1				
Identify Impact & Alternatives	1	1				
Evaluate Alternatives	1	1				
Produce Plan	1/2	1				

Scheduling Estimates



Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	2.5	3.5	4.5
DATA SERVICES FULL TIME PROJECT STAFF	1.5	2	2.5
USER INVOLVEMENT		☐	

Legend: ☐ Low ☐ Med. ■ High

- Data Analysis

  This step provides for analyzing the EIS system's data requirements.

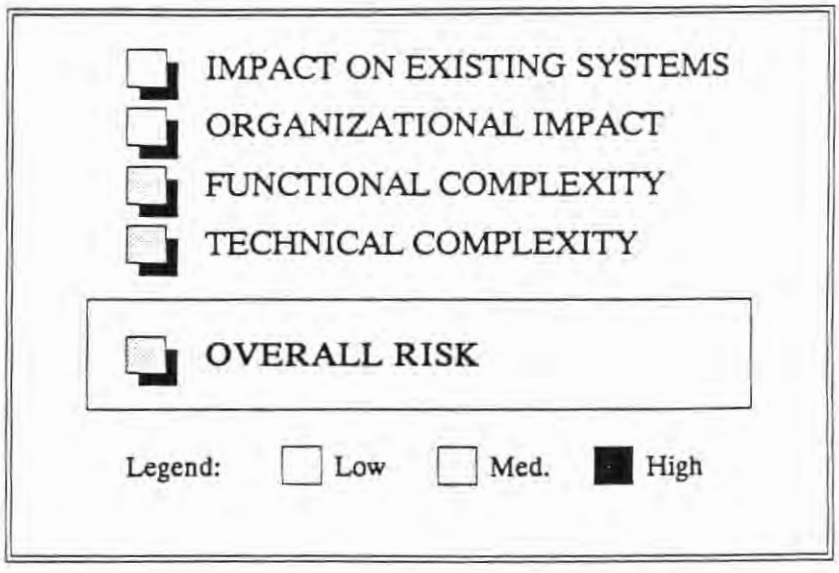
- Development of Extraction Routines

  Interfaces to existing data must be developed to allow timely access to accurate data.

- EIS Construction & Implementation

- EIS Training

Project Scoping & Complexity



The overall risk associated with the implementation of an EIS system is expected to be moderate, based on the ratings of the following variables. The system's primary source of data is through interfaces to existing systems. Although the EIS must consider the location and characteristics of these data sources, it should not alter those files or the systems accessing them. Therefore, "Impact on Existing Systems" should be low. An EIS has the long–term capability of impacting all management levels throughout the organization. This initial implementation, however, will concentrate on the needs of the Secretary and those personnel directly supporting his needs. Therefore, the "Organizational Impact" also should be low. Although the goal of an EIS is to provide easy access to meaningful information, the implementation can be complex. Consequently, the system's "Technical Complexity" is estimated to be moderate to relatively complex. Technical assistance from IPS may relieve some of this risk.

One other critical component to the management of this project's risk is user involvement. EIS requires commitment from executive management. Although many requirements can be modeled with assistance from the Secretary's support staff, this project's success depends on adequate direct input from the system's primary users.

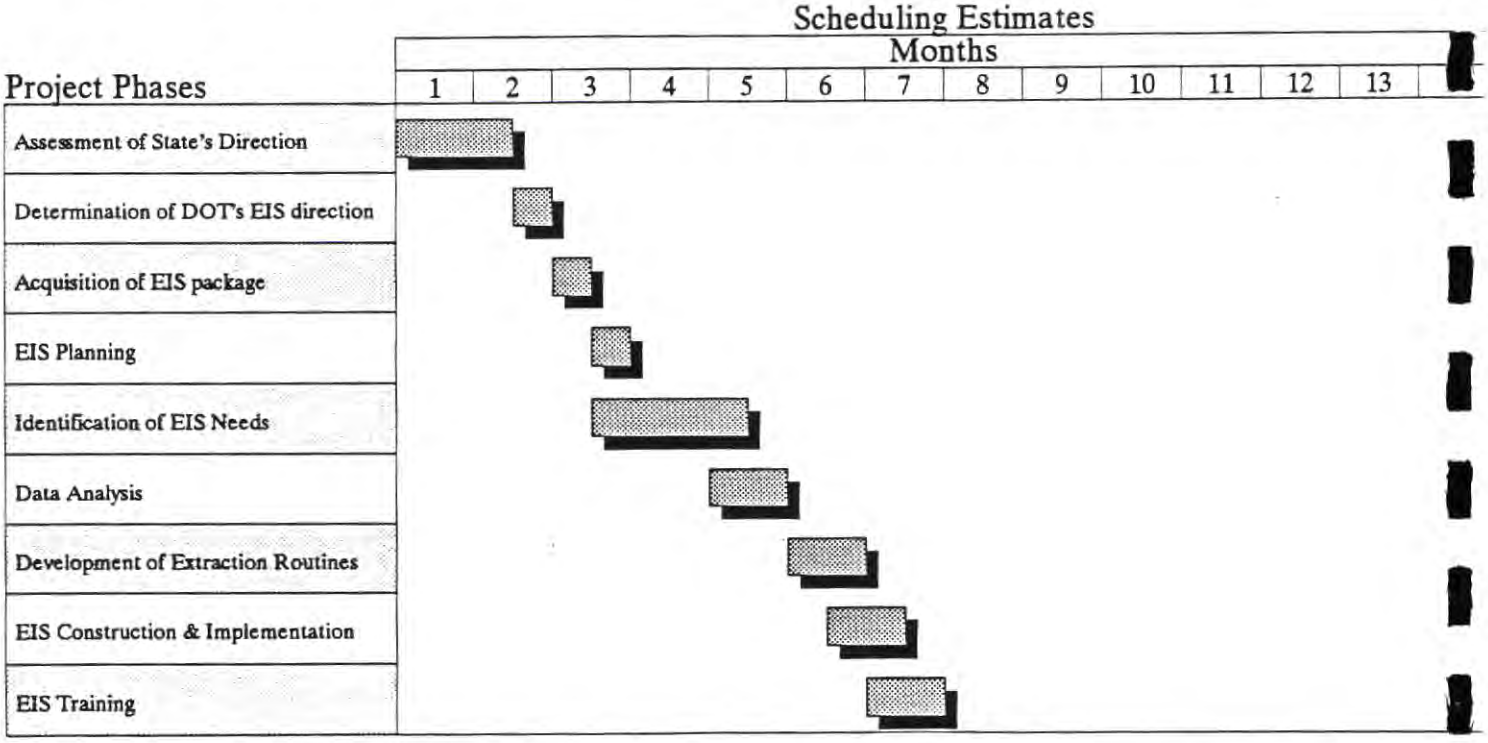
Project Estimates

Staffing Estimates

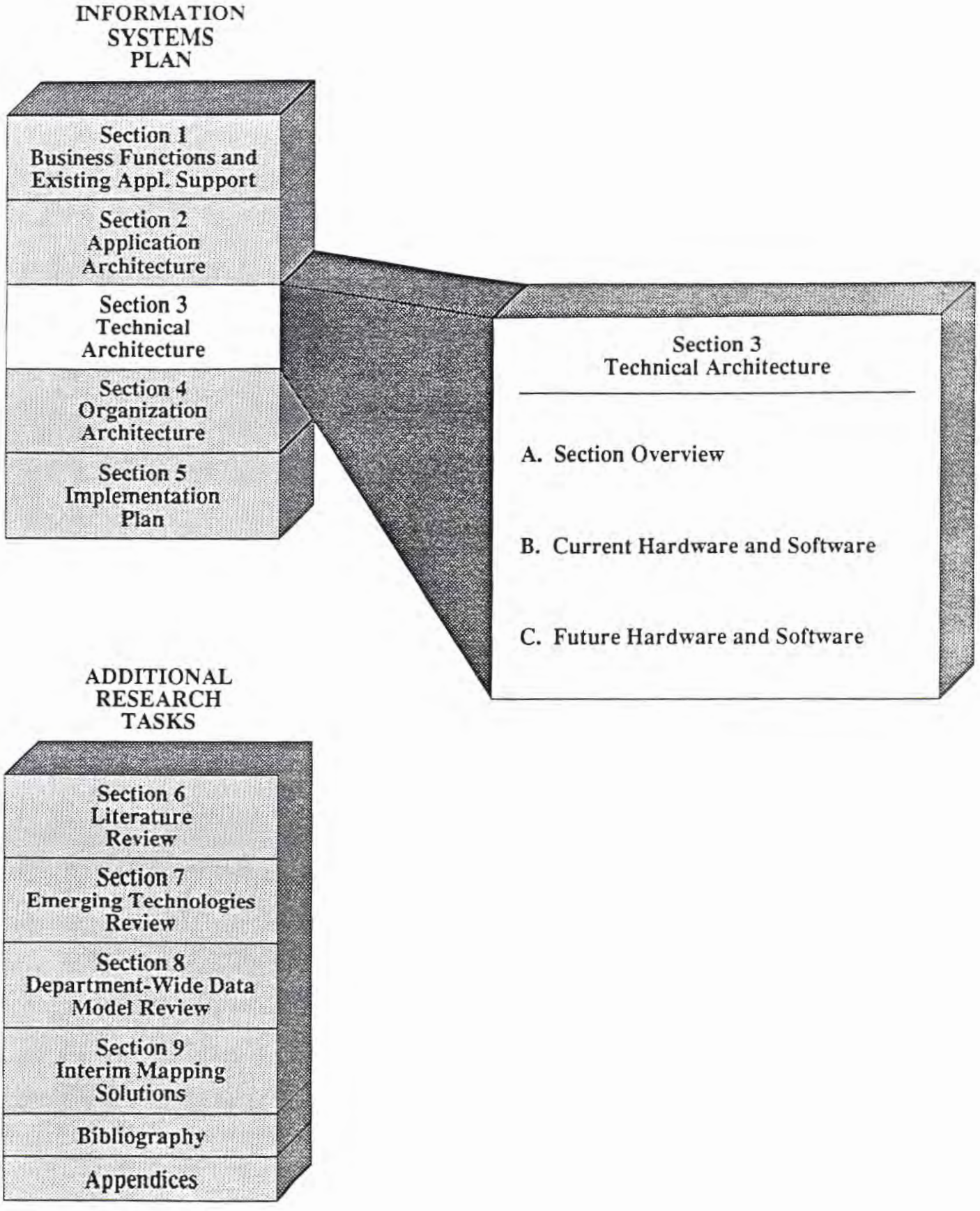
Project Phases	Internal			External		
	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
Assessment of State's Direction	1			1/2	1	
Determination of DOT's EIS direction	1					
Acquisition of EIS package	1					
EIS Planning	1/2	1		1/2	2	
Identification of EIS Needs	1/2	1		1/2	2	
Data Analysis	1/2	1		1/2	1	1
Development of Extraction Routines	1/2	1		1/2	1	1
EIS Construction & Implementation	1/2	1		1/2	1	1
EIS Training	1/2	1		1/2	1	

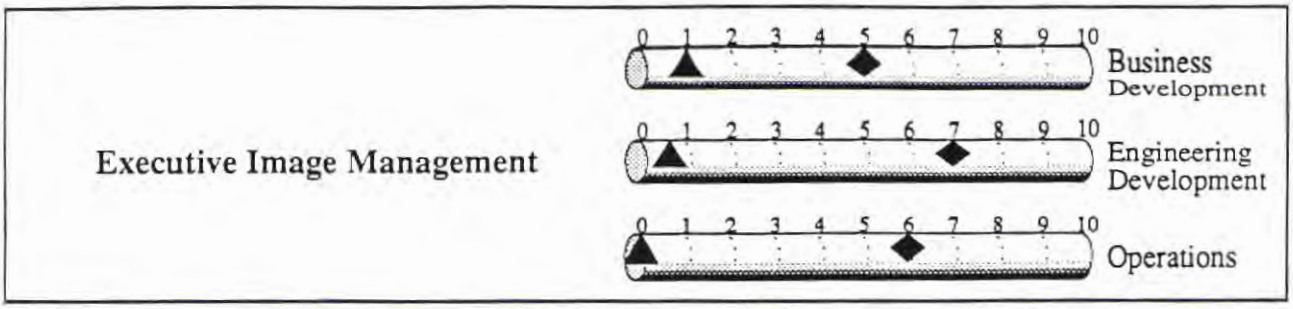
External Staffing Roles: Although IPS has gained experience implementing the Governor's Executive Information System, the DOT has limited experience with this technology. In order to ensure the effective implementation of a system capable of supporting top management, it would be beneficial to acquire the assistance of consultants. The primary responsibilities of consultants would be the following: to provide an objective assessment of the State's direction (emphasizing the ability of the State's package to support the DOT), to provide on–the–job EIS training to project team members, to lead interviewing sessions with top management, ensuring the efficient collection of required information, to assist the development of extraction routines and programs under the selected EIS software package, and to provide a training program for all users of the system

Scheduling Estimates



SECTION 3
TECHNICAL ARCHITECTURE





There appears to be several areas within the emerging technologies which each section manager perceives a lack of specific expertise. This perceived gap in expertise may be a result of the Department not committing to implementing these technologies, since no one appears to have been assigned the responsibility of pursuing and understanding these techniques (and probably have other priorities which require full time attention). It may be beneficial for Data Services to send section managers or senior staff personnel to HEEP and technology conferences such as the Association for Information and Image Management or IBM Guide User's Group.

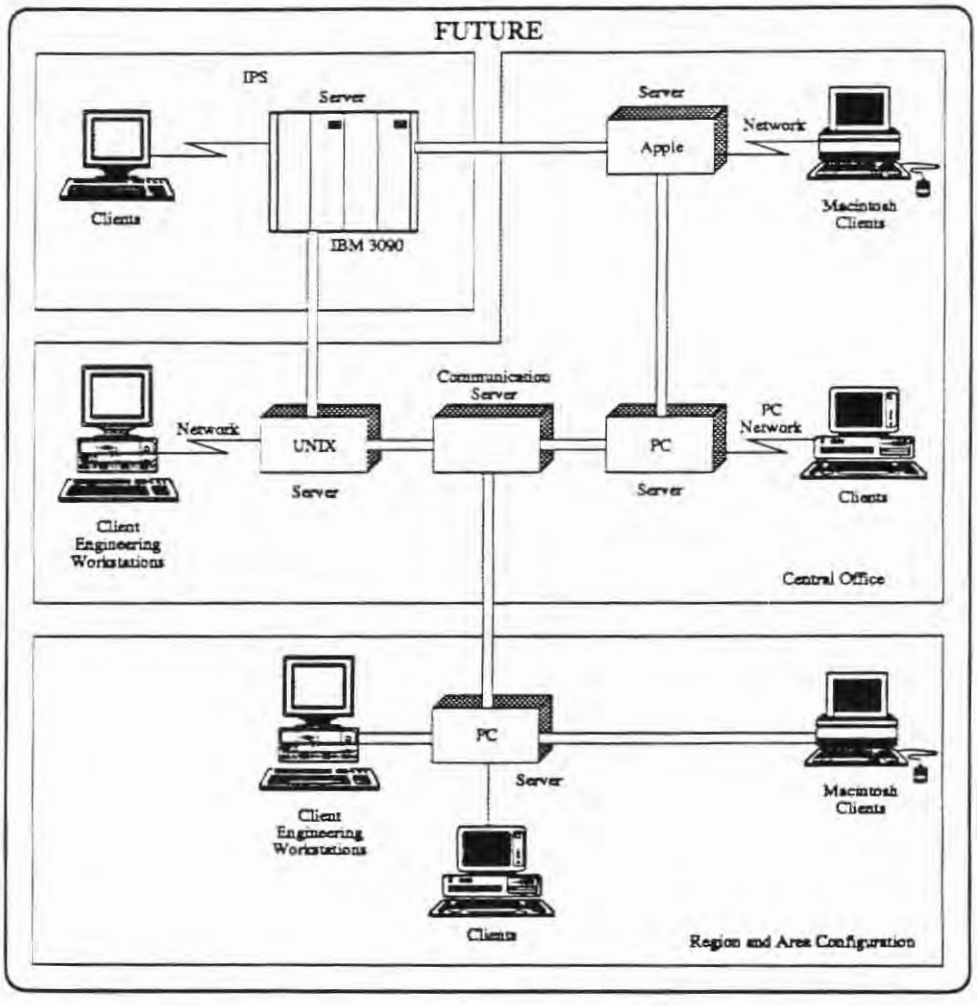
Benefits of a client server environment include:

- Spreading applications across a network of components without sacrificing performance
- Reduced network traffic since the data is processed on the server where the data resides rather than sending all the data across the network to the PC or workstation for processing.

One of the disadvantages of migrating toward stand–alone workstations and personal computers is the increased risk associated with file administration. Since file management and security are no longer part of the centralized mainframe function, alternative formal procedures must be put in place to handle version control, copying and deletion of all engineering designs.

Exhibit 3.2 illustrates a conceptual view of the future hardware architecture assuming the migration toward a client server and open communications environment.

Exhibit 3.2



Since the Region and Area Offices are also currently connected to the Central Office through the IBM mainframe, access to Department–wide data becomes available with open communications and client server technology. With the proposed installation of fiber optic cables, replacing the coaxial cables that currently connect the regions to the central office, all field offices will have the ability to efficiently transmit data. Fiber optic cables occupy less physical volume and offer increased speed at the same capacity as the current coaxial cables. This is an important strategic direction for the Department, allowing faster transmission and dissemination of data including design plans to all offices within the Department.

The data base management system (DBMS) is one of the remaining key components the future technical architecture. As mentioned above, the State's current DBMS is a product of Software AG called ADABAS. A data base management system, if properly deployed, may reduce or eliminate many of the drawbacks associated with the conventional file environment, including:

- Limited data sharing
- Difficulties with managing long records
- Insufficient security
- High programming and maintenance costs
- Data Redundancy
- Difficulties associated with changing structures.

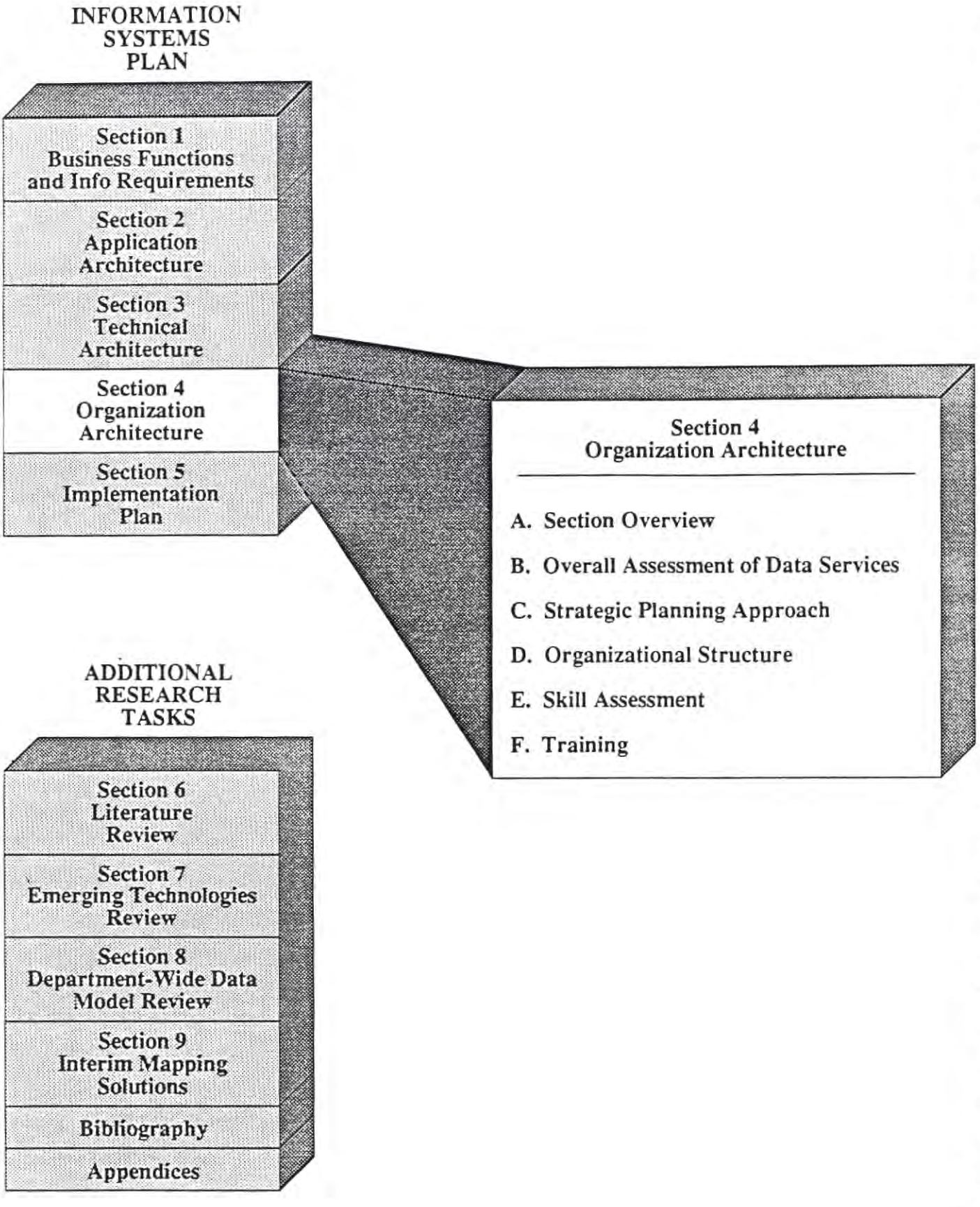
The DBMS products have changed significantly since the original implementation of ADABAS at the State. Currently, IBM's DBMS product called DB2 has gained substantial market share, and is presently the recognized leader in the industry for large IBM mainframe services. Given the substantial initiatives set forth by this Plan, the further evaluation of data base products should be considered as part of the initial infrastructure evolution. The time to evaluate DBMS alternatives should be prior to any additional implementations of priority systems. This does not preclude, however, the Department from moving forward in defining requirements or initiating design work for the priority initiatives.

In the DBMS assessment, consideration must be given to:

- Determining accurate costs and implementation timeframes associated with changing DBMS platforms
- Determining DBMS functional requirements. For example, if inventories are expected to be maintained utilizing MRM's or coordinates as an integral part of the table keys, and queries or SQL calls are based on selecting a row in the table, then the SQL "Select" statement will be based on a range, e.g., MRM's greater than X but less than Y. This type of requirement is handled less efficiently by a Relational DBMS than a Hierarchical DBMS.

- AASHTO's strategic direction in supporting multiple DBMS products
- Determining the strategic direction of other ADABAS DOT users and their DBMS direction
- Determining the frequency for which proprietary package software may be required in the future, and assessing the availability of products supporting the current DBMS (ADABAS)
- Determining the distributed data base functionality of the DBMS's and/or expected delivery dates to provide the capability
- Determining Software AG's strategic direction
- Assessing IBM's DBMS strategic direction and commitment to DB2
- Evaluating the impact and resource requirements for IPS
- Evaluating other Agency or Department interest in DB2
- Assessing the availability of user–friendly report writer and ad–hoc query facilities.

SECTION 4
ORGANIZATION ARCHITECTURE



A. SECTION OVERVIEW

This section describes the current and future organizational environment required to support the strategic information systems plan. Historically, Data Services has been responsible for establishing information systems priorities, reviewing the cost justification, and deploying the appropriate resources to implement sytems related projects. The future organization "architecture" describes a slightly revised set of responsibilities, particularly in regards to the approach used in establishing strategic project priorities. Specifically, this section addresses the:

- Overall assessment of Data Services
- Current and future approach to project planning and prioritization
- Current and future organizational structure supporting the deployment of resources
- Skills assessment of Data Services resources
- Training requirements to support the defined strategic initiatives.

B. OVERALL ASSESSMENT OF DATA SERVICES

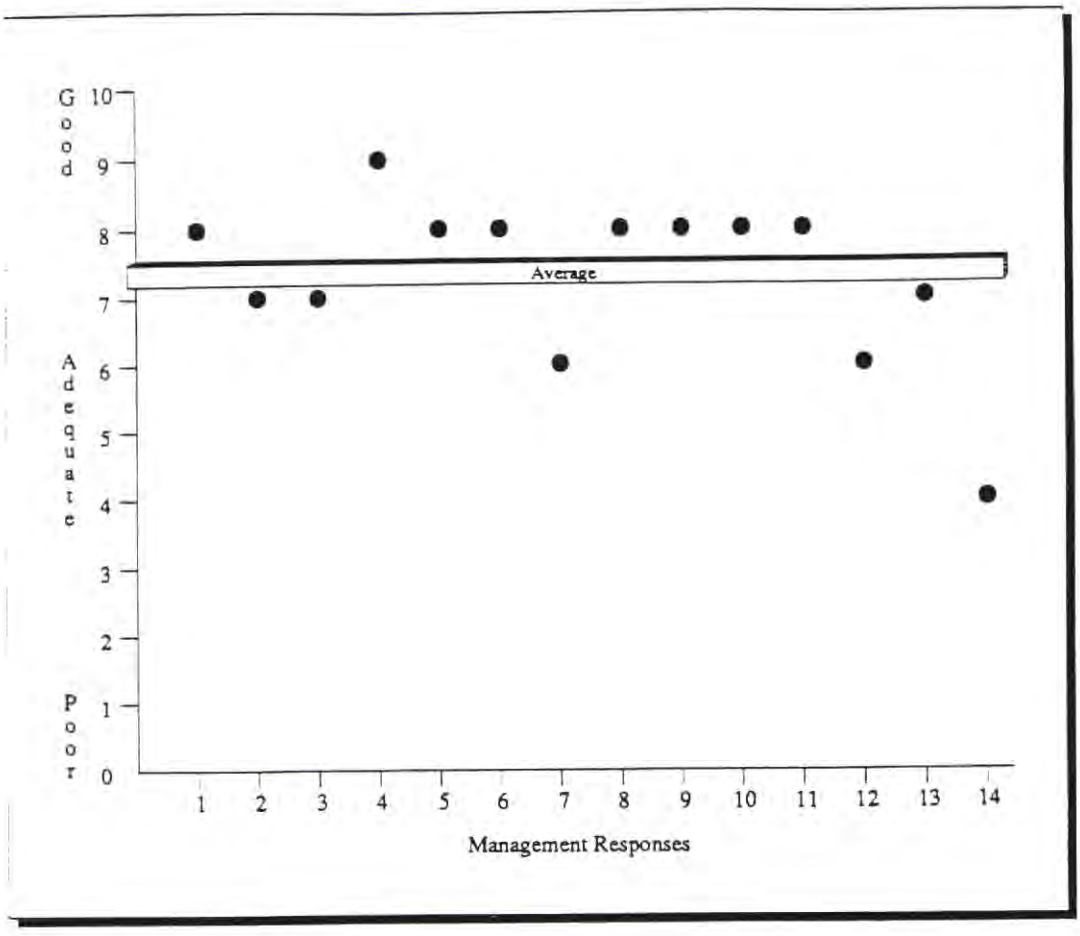
An assessment of the current Data Services organization is necessary to enable the development of an accurate future plan. Although this assessment has identified several key strengths and weaknesses, the Department's overall perception of Data Services' current support was positive.

Exhibit 4.1 illustrates the perceptions of fourteen Department managers with respect to Data Services' ability to deliver quality and timely systems. The average rating of 7.3 emphasizes the favorable view of management towards Data Services' performance.

The Department's perception of Data Services' current strengths and weaknesses are summarized as follows:

Strengths	Weaknesses
Technical Expertise	Communication
Responsive/Timely	Project Prioritization
Strong Leadership	End User Training

Exhibit 4.1
Assessment of Data Services Quality and Timliness



In the majority of end user interviews, overall response to the effectiveness of Data Services was moderate to very favorable. It is apparent from the inverviews, that the Department's user community has a relatively high degree of confidence in Data Services' current leadership and technical capabilities.

As depicted in the chart on the prior page, several areas for improvement were also identified. The first, communication, plays an important role in identifying systems needs and ensuring the proper functionality is provided to meet those needs. A concentrated effort must be made throughout the Central Office and Regions to ensure meaningful communication. Structured methodologies and procedures may provide a mechanism through which communication improvement may be attained.

The second, project prioritization, is necessary to ensure proper focus of Data Services resources. There are many approaches which can be used to improve this process. A particulary effective one is the Information Systems Planning process which provides a structured and visible approach for prioritizing and communicating those priorities throughout the Department. Both monthly and formalized annual planning processes

are important to ensure that the allocation of Data Services resources are adjusted to meet changing business needs.

Departmental responses identified user training as Data Services' third opportunity for improvement. Due to increased pressures on productivity, focus on user training has declined in the past few years. New systems and technologies (personal computers, workstations, and engineering equipment) have been acquired which require additional training. In order to realize long term productivity gains, it is important to accompany the delivery of new systems and technologies with adequate user training and support.

C. STRATEGIC PLANNING APPROACH

Data Services is currently responsible for the strategic systems planning process. This is an informal process which identifies existing user needs and develops priorities for future development. The Department's information systems can be likened to roadways. Similar to the maintenance of the 5 Year Construction Program, the Department's system needs should be assessed and reprioritized annually. This will ensure that the proper strategic systems are constructed and maintained in the future. In order to more effectively plan and prioritize projects, the Department should consider the establishment of an Information Systems Steering Committee.

The Steering Committee's primary responsibilities would include the following:

- Evaluating and prioritizing strategic systems projects (new development or otherwise)
- Evaluating investment levels (staffing and budgetary) required to implement strategic projects
- Monitoring the implementation of the Information Systems Plan
- Resolving organizational issues involved with implementation of the plan

Many of the decisions involved in the strategic planning process require a significant organizational commitment which can only be made by upper management. These decisions may also cross organizational boundaries and require the support of management from different functional areas. In order for the appropriate decisions to be made and adequate support to exist for these decisions, the Steering Committee should include participation from all Division Heads and the Deputy Secretary.

Many of the decisions and actions of the Steering Committee require technical insights which the above members may not have. For this reason, the Systems and Program Manager should participate as a non-voting member. This enables the committee to use all necessary information when making decisions and still maintain a business, rather than a technical focus when determining strategic systems needs.

Due to the constraints placed on each committee member's time by their primary roles, it is important to adequately structure the review, evaluation and prioritization of projects. Well planned quarterly or semi–annually meetings typically suffice for the Steering Committee, however, it is necessary to implement daily practices and procedures in support of these meetings.

A formal process which enables users to request Data Services resources provides an effective means of communicating needs to the committee. This process can be initiated by an end user, the Research Office or within Data Services. By identifying Data Services needs in this way, the Systems and Program Manager can produce a list of projects requiring the attention of the committee. Established guidelines can help identify those projects which may be addressed immediately by Data Services and those which must be addressed by the Steering Committee.

The Systems and Program Manager can prepare an agenda for the committee meeting based on the most strategic needs. As part of the meeting preparation process, resource requirements, resource availability, estimated timeframes and estimated costs could be defined.

In addition to new projects, the committee must also review progress on continuing projects. Again, some formal means of communicating this information will ensure the best use of committee members' time. Priority project progress can be communicated by Project Managers, Project Review Boards or the Systems and Program Manager.

Considering new Departmental needs, the resource requirements of these needs, the benefits associated with the requested projects and the progess of existing projects, the committee will be able to properly evaluate and prioritize new projects. The Systems and Program Manager, in coordination with the committee, should then update the plan to reflect progress and shifting priorities.

The strategic business planning process chartered by the Secretary provides an example which demonstrates the importance of a plan as a communications tool. The document, which is published as one unified plan, provides a common set of goals and objectives for the Department to achieve. By prioritizing and publishing these goals, a sense of direction is communicated throughout the Department.

Likewise, the information systems planning process provides an agenda for the Department to follow. By creating this 'blueprint', the Data Services priorities and expectations are communicated throughout the Department.

D. ORGANIZATIONAL STRUCTURE

Current Organization Structure

In order to provide for the timely and effective implementation of the priorities established within the Information Systems Plan, a proper organizational structure should be in place. This structure should ensure the effective deployment of resources by monitoring project progress and upcoming requirements.

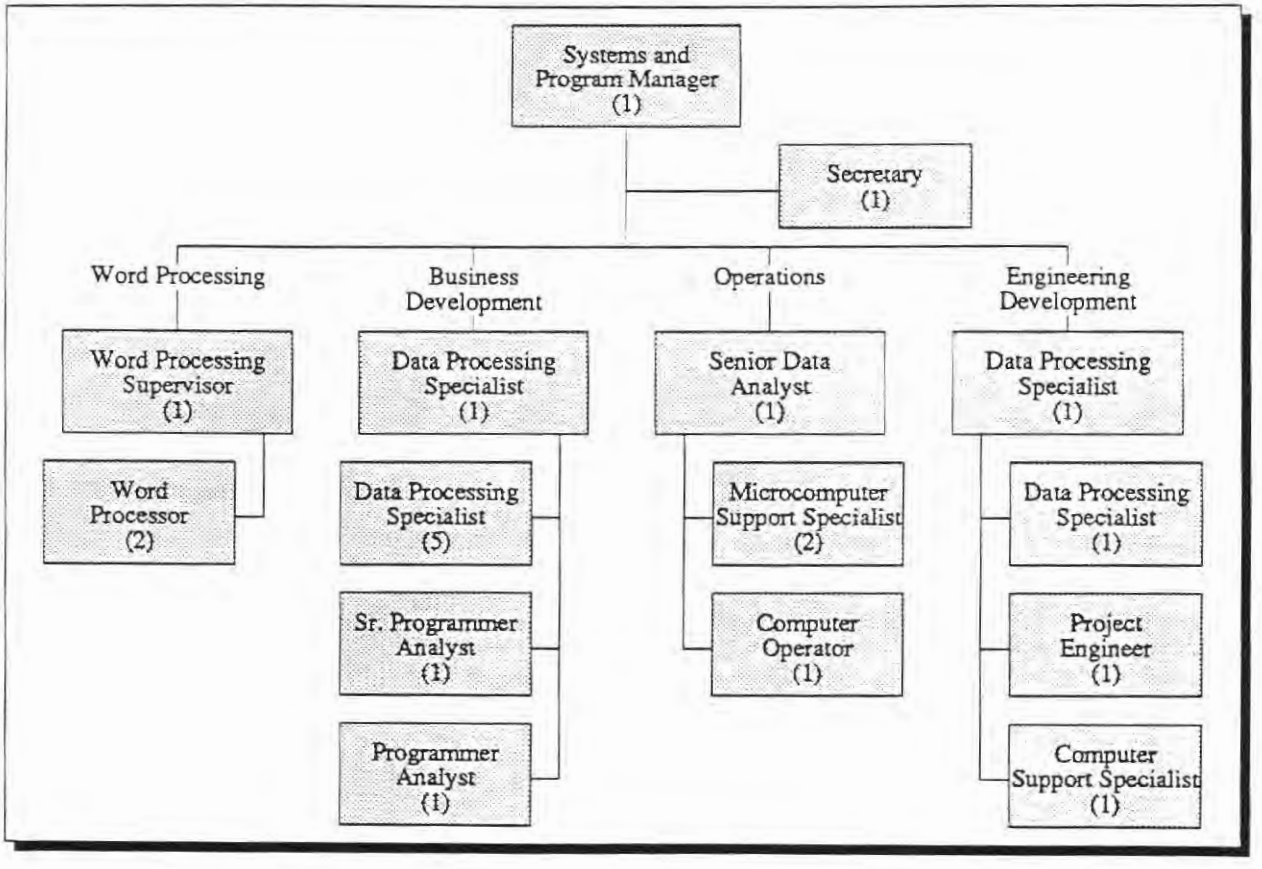
Before addressing the Department's structure, it is important to understand Data Services' relationship to the State's data processing unit, Information Processing Services (IPS). IPS controls the State's mainframe resources. They provide for the procurement and management of resources required to support the State Agencies. The service is charged back to each Agency, based on the Agency's utilization of State mainframe resources.

The Department of Transportation must allocate budget to receive this support. The Department has other resources (DEC VAX, network and stand–alone personal computers) that are controlled entirely by Data Services. Systems developed on these platforms are not subject to service fees charged by the State.

IPS' size also affords the Department many opportunities. Technologies encompassed by the State's strategic direction can provide the Department access to the same technologies at greatly reduced risk. Both hardware/software access and application development experience can be provided by IPS. This relationship impacts the strategies the Department chooses to deliver in the future.

The Data Services' organizational structure is depicted in Exhibit 4.2. Specialized branches have been developed to provide improved support in three areas: Business systems, operations and engineering systems.

Exhibit 4.2
Data Services Current Organization Structure
(21 FTEs)



Although this structure has supported past development, staffing limitations have made it difficult for Data Services to address all existing user needs. Therefore, Data Services has allowed application development and package software procurement functions to be performed outside of their organizational structure.

The increase in personal computers throughout the Department has also aided this shift in strategies. It has allowed users who understand the business area and programming concepts to generate systems without waiting for a formal development project by Data Services. In many instances this has met the Department's short-term needs, however, many other factors must be considered when employing a decentralized development strategy.

Centralized development of applications promotes a global perspective of the Department's data. Although procedures can be established allowing data throughout the organization to be identified under a decentralized strategy, a centralized strategy can ensure these structured procedures are followed.

This is one reason Data Services requires a longer development timeframe than many end users feel is necessary. If data exists in current applications, an attempt is made to provide one location for that data rather than duplicating it. This does lengthen the time required to develop systems, but it also provides a consistent definition of data items throughout the Department.

Centralized development can also increase the quality of applications. Although end users understand the business, Data Services personnel are trained in the development of computer applications. A combination of data services resources and end users ensures that an application meets the needs of the users and is technically sound.

Future Organizational Structure

Restricted FTEs throughout the Department limit Data Services ability to expand and address all of the Department's systems development and support needs. This may preclude the Department's ability to centralize its development efforts. There are steps Data Services can take, however, that will maximize the effectiveness of their current structure and staffing.

The establishment of a Department-wide data model will help Data Services understand where data resides and who maintains it. A data administrator will be required to maintain the model and provide guidance during future development efforts. A description of Data Administrator responsibilities include:

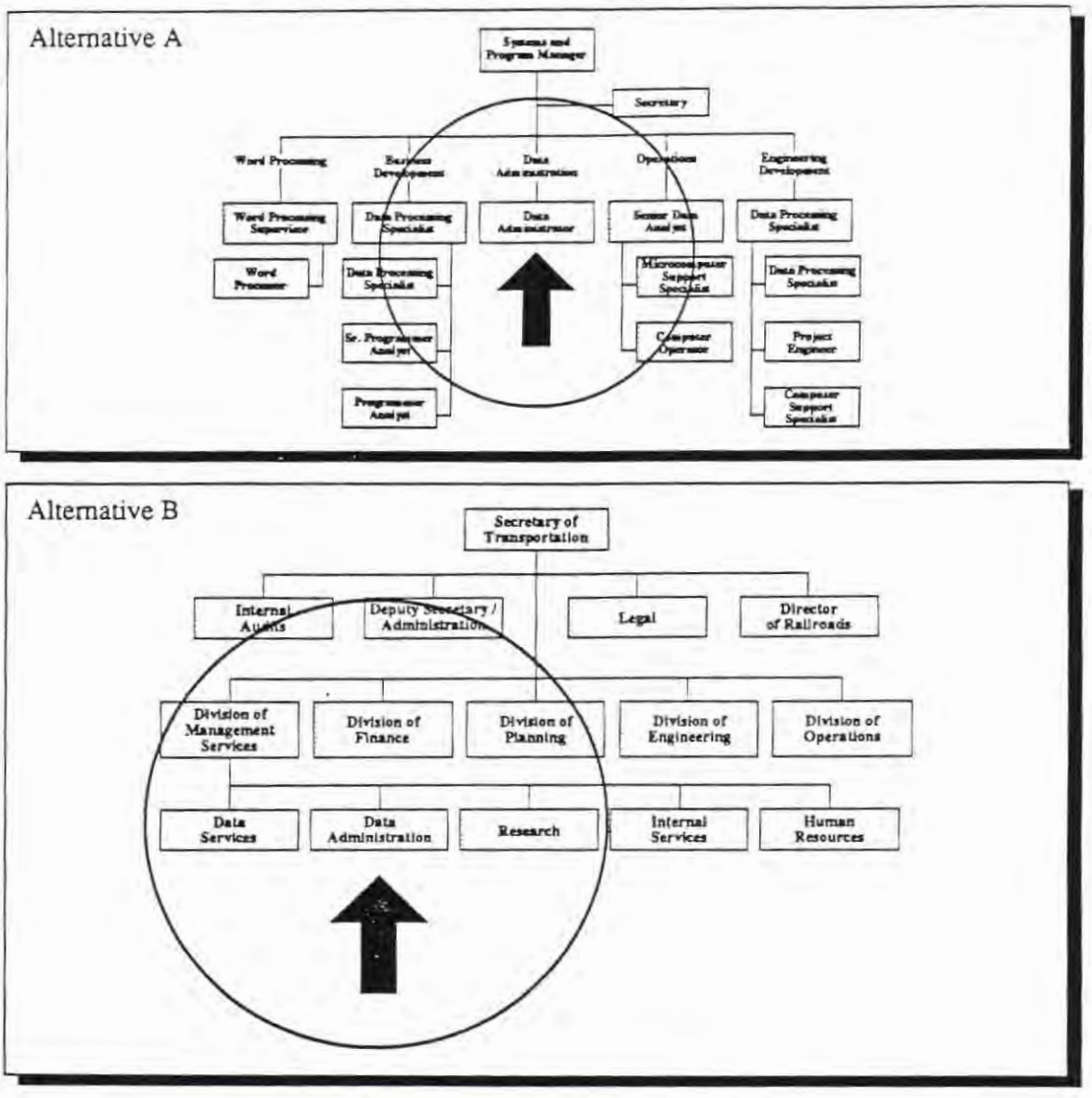
- Develop and maintain the Department-wide data model
- Maintain the corporate data dictionary
- Provide consulting services to application developers and end users
- Resolve conflicting data requirements between Offices and Divisions

- Establish and enforce standard naming conventions

- Determine the Offices and users responsible for keeping data accurate.

Exhibit 4.3 provides two alternative organization charts showing where the Data Administrator could report.

Exhibit 4.3
Organization Alternatives – Data Administrator



- Alternative A: The FTE reports directly to the Systems and Program Manager in Data Services.

- Alternative B: Create a new division within the Department entitled Management Services. This division would be comprised of Data Services, Data Administration, Research, Internal Services and Human Resources in which Personnel and Civil Rights would be included.

Data Services should assume the responsibility for guidance and direction in creating this new position. Therefore, it is appropriate for the Data Administrator report directly to the Systems and Program Manager. After the position has been fully defined and accepted as the standard practice of business within the Department, Alternative B, or potentially a different alternative, could be easily implemented.

Modifying the structure of some Data Services project teams may also increase user satisfaction with the systems developed. Including users as active members of some project teams would cultivate commitment to the process, increase desire for a successful implementation and provide a greater sense of ownership toward the system. Although users should always be involved in the systems development, their participation as full time members may not be feasible in many situations.

Users should also play an active role in defining the requirements for hardware and software which must be acquired. Allowing Data Services to retain the responsibility of negotiating and purchasing the Department's hardware and packaged software which meets the needs as defined by the users, generally produces favorable results.

IPS offers a Help Desk as a first point of contact for computer problems related to software, hardware, PC and mainframe. Data Services pays for this service regardless of its use. Not only does it make economical sense for Data Services to train DOT personnel to use the IPS Help Desk, but it may also reduce the work load of the Operations area.

Moderate growth will be necessary in order to implement the Information Systems Plan in a timely and effective manner. Exhibits 4.4 and 4.5 illustrate the moderate restructuring addressed above and the expected growth due to the implementation of this plan over the next few years. Three additional FTE's may be required in Fiscal Years 1992 and 1993 in order to provide adequate training before development begins. During Fiscal Years 1994 through 1996, additional personnel may be required to maintain the new applications that were developed and put into operation in the previous fiscal years, and to assist project teams with additional new development projects.

One additional FTE, either from Data Services or the Planning Division, will also be necessary to maintain the Geographic Information System application once it is in operation.

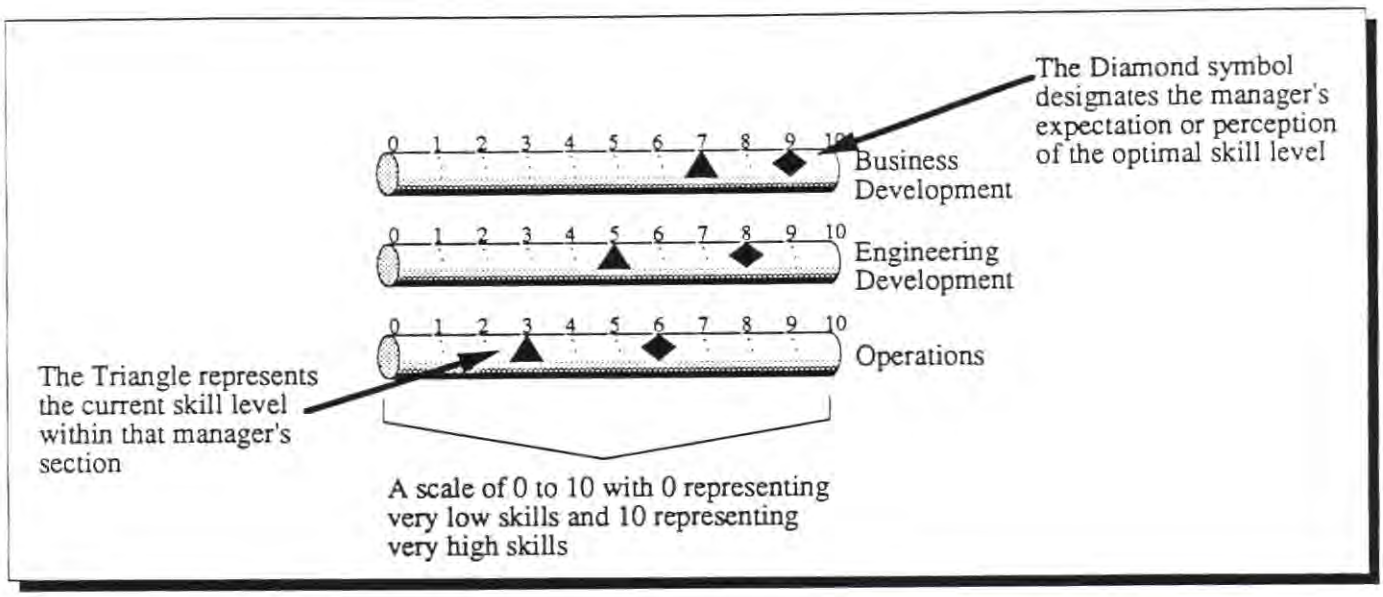
E. SKILLS ASSESSMENT

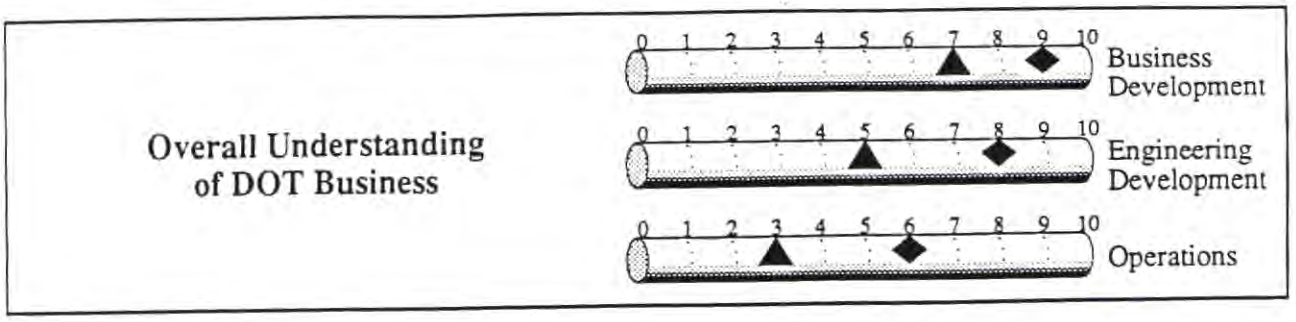
A skills survey was completed by each of the section managers within Data Services. The objective of the survey was to identify strengths and weaknesses within the Data Services area, and to assist the Department in preparing a training program which appropriately addresses any weak areas. The following pages present the results of the skills survey. The various skills have been grouped according to the following areas:

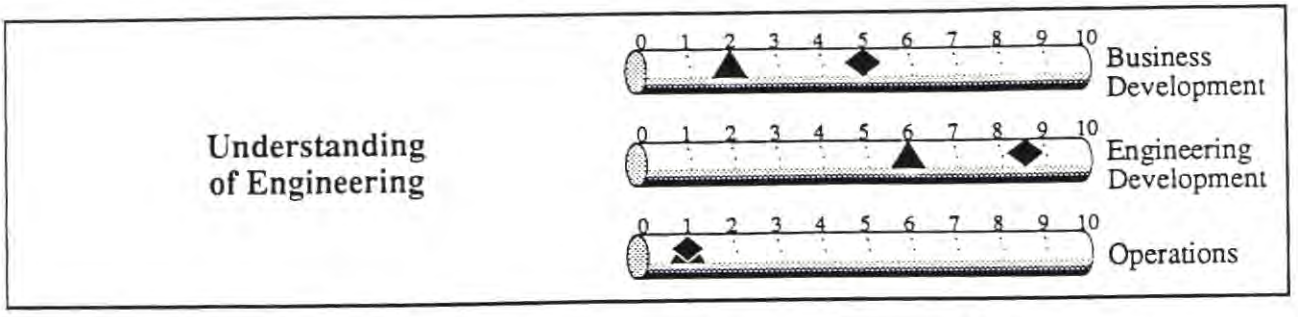
- Business Concepts
- Administrative Concepts
- Data Processing Fundamentals
- Application Development Strategies
- Emerging Technologies

Exhibit 4.6 is an example of the charts used to depict the survey results. The example indicates that Business Development, Engineering Development and Operations all have skill levels which are lower than the manager's expect or perceive are necessary. It could also be said that Operations has a larger skill deficiency than the Business Development area. Further, the overall skill requirements are lower for Operations than they are for Business Development.

Exhibit 4.6
Sample Skill Assessment Chart

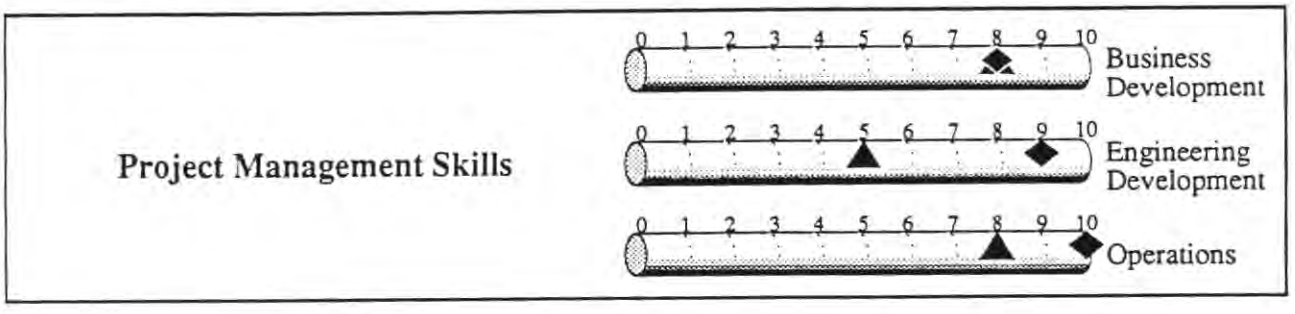


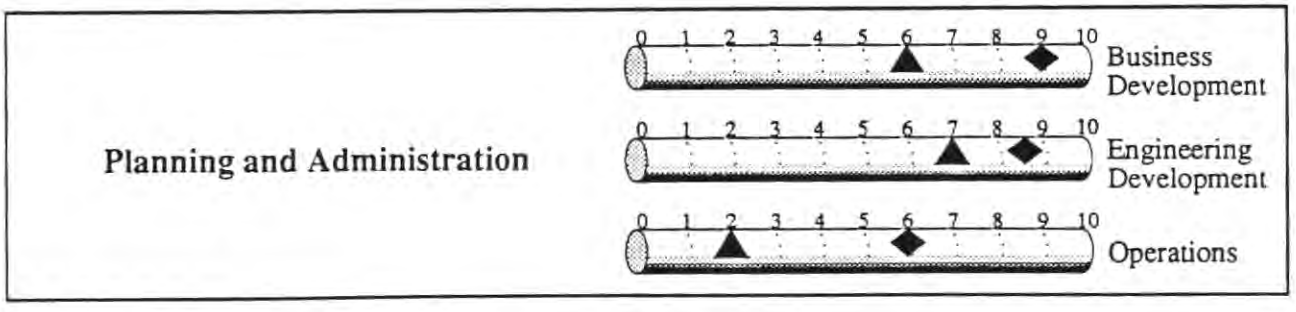




All the section managers recognize a need for improvement in their personnel in the Overall Understanding of DOT Business. Two approaches may be available to provide the Data Services staff with a higher degree of understanding of the DOT business. The first opportunity exists in supporting active participation in the regional HEEP and AASHTO meetings. The agendas for these seminars typically cover all aspects of the DOT business. The second opportunity exists in the Department's ability to adopt the Joint Application Design techniques. This interview approach provides significant insight into business issues when designing new or enhancing existing systems.

Administrative Concepts

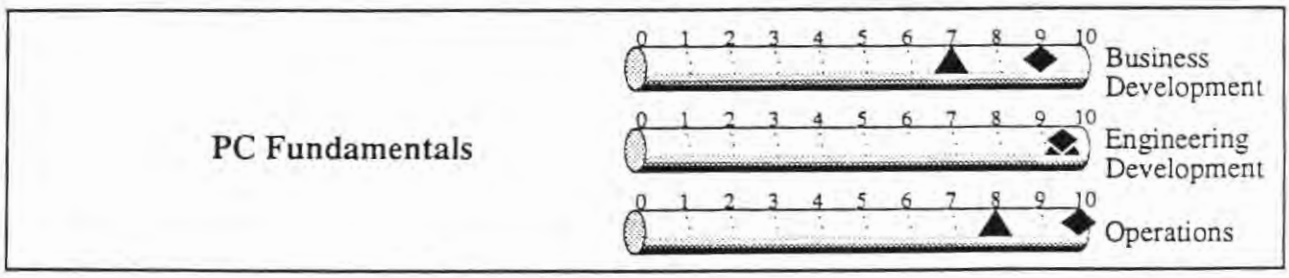


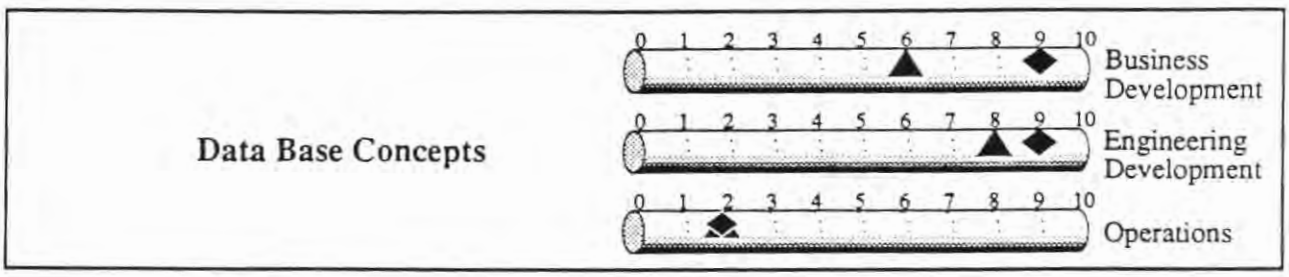


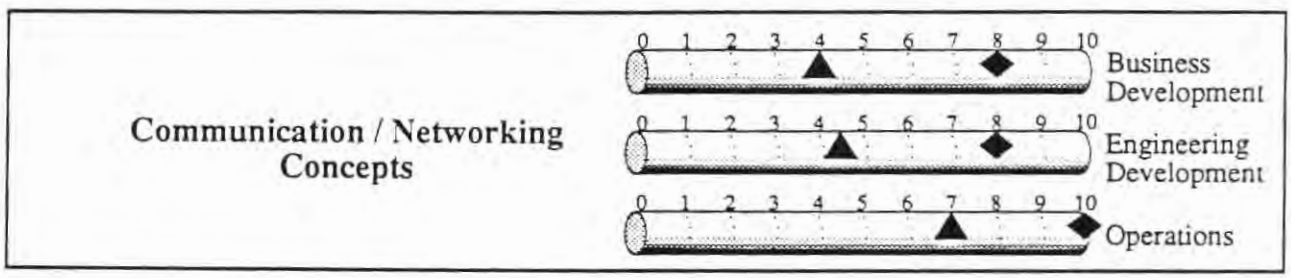
Administrative Concepts (cont.)

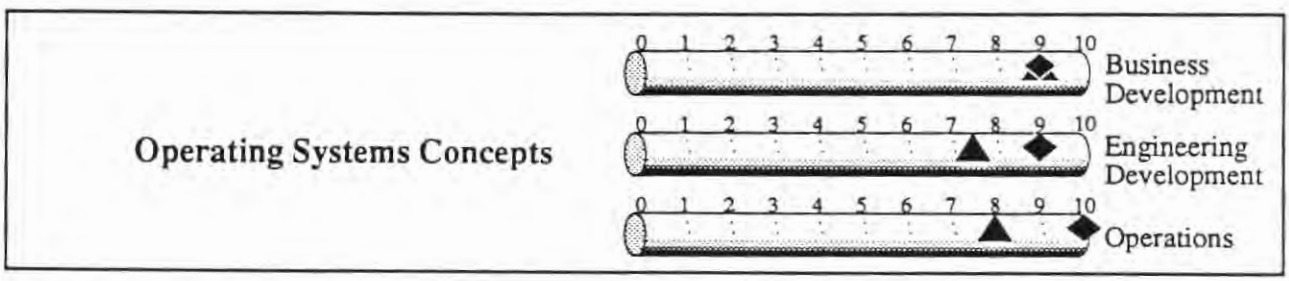
The most significant "Skill gaps" in the Administrative group appears to be Project Management skills in the Engineering section and planning skills in the Operations area. Local workshops in both of these areas might provide adequate tuning of these skills. If additional project management skills are required, the Department should consider investing in both project management software and the vendor supplied training.

Data Processing Fundamentals

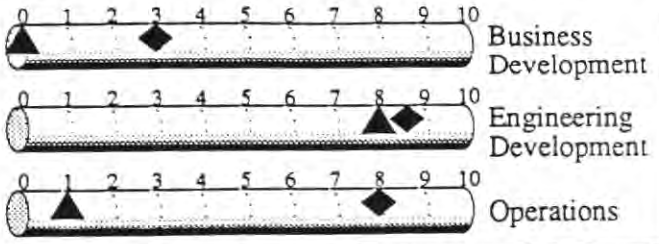




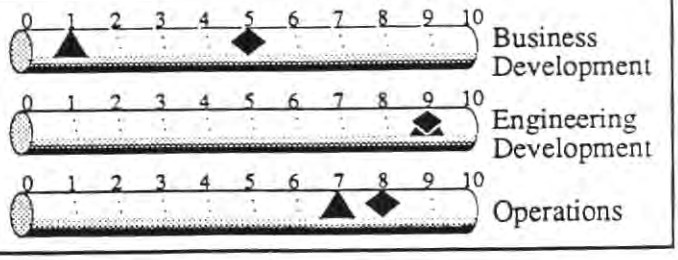




Engineering Workstation Fundamentals



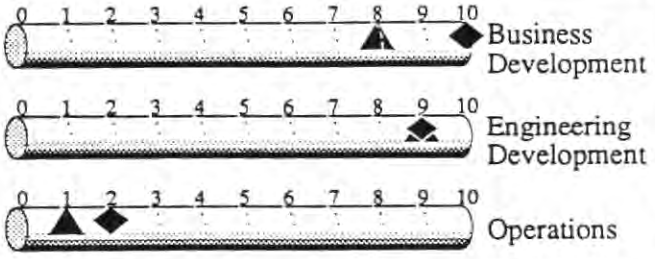
Graphics



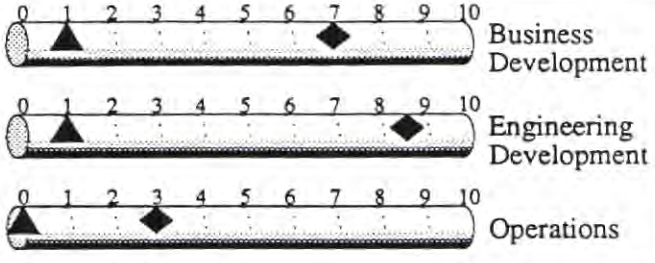
For each of the skills addressed in this set, at least one of the section managers felt very comfortable with their current level of knowledge. It may be advantageous and economical for Data Services to capitalize on this internal expertise by providing internal workshops.

Application Development Strategies

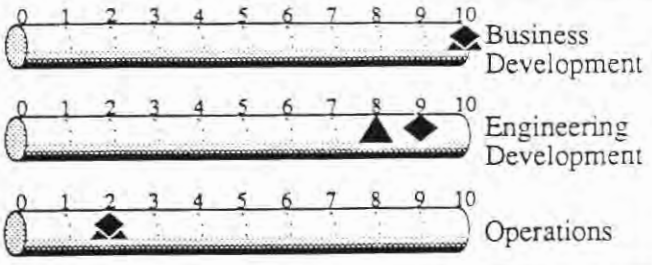
System Development Methodology Concepts



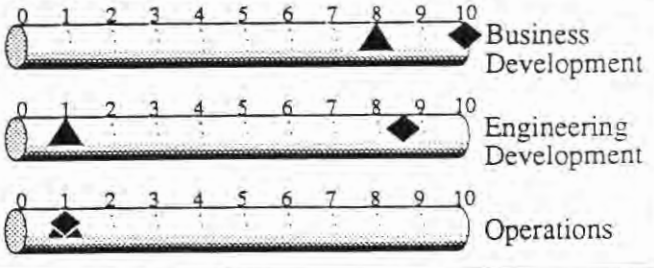
CASE Technologies



Third Generation Programming Languages



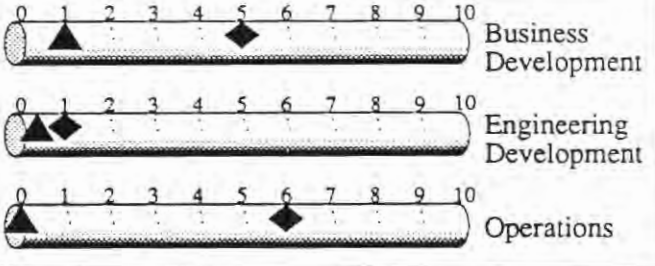
Software AG Natural Programming



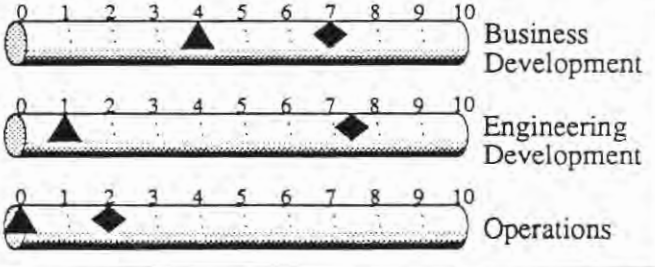
The section managers felt relatively confident with the current level of skills or did not feel they needed additional training in Systems Methodology Concepts and Third Generation Programming Languages. However, significant gaps exist in the CASE Technologies area. Similarly, the Engineering section recognizes a need to become more adapt in utilizing Software AG Natural Programming tools. These are areas in which vendors and consultants maintain a high degree of expertise. The Department should begin to invest in training to support the long term direction outlined in this strategic plan. Once again, to support the Natural Programming training, the Data Services area may want to consider internal workshops or leverage off of the IPS workshops.

Emerging Technologies

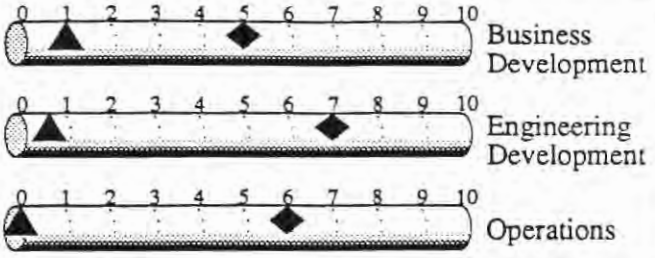
Executive Information System



Geographic Information System

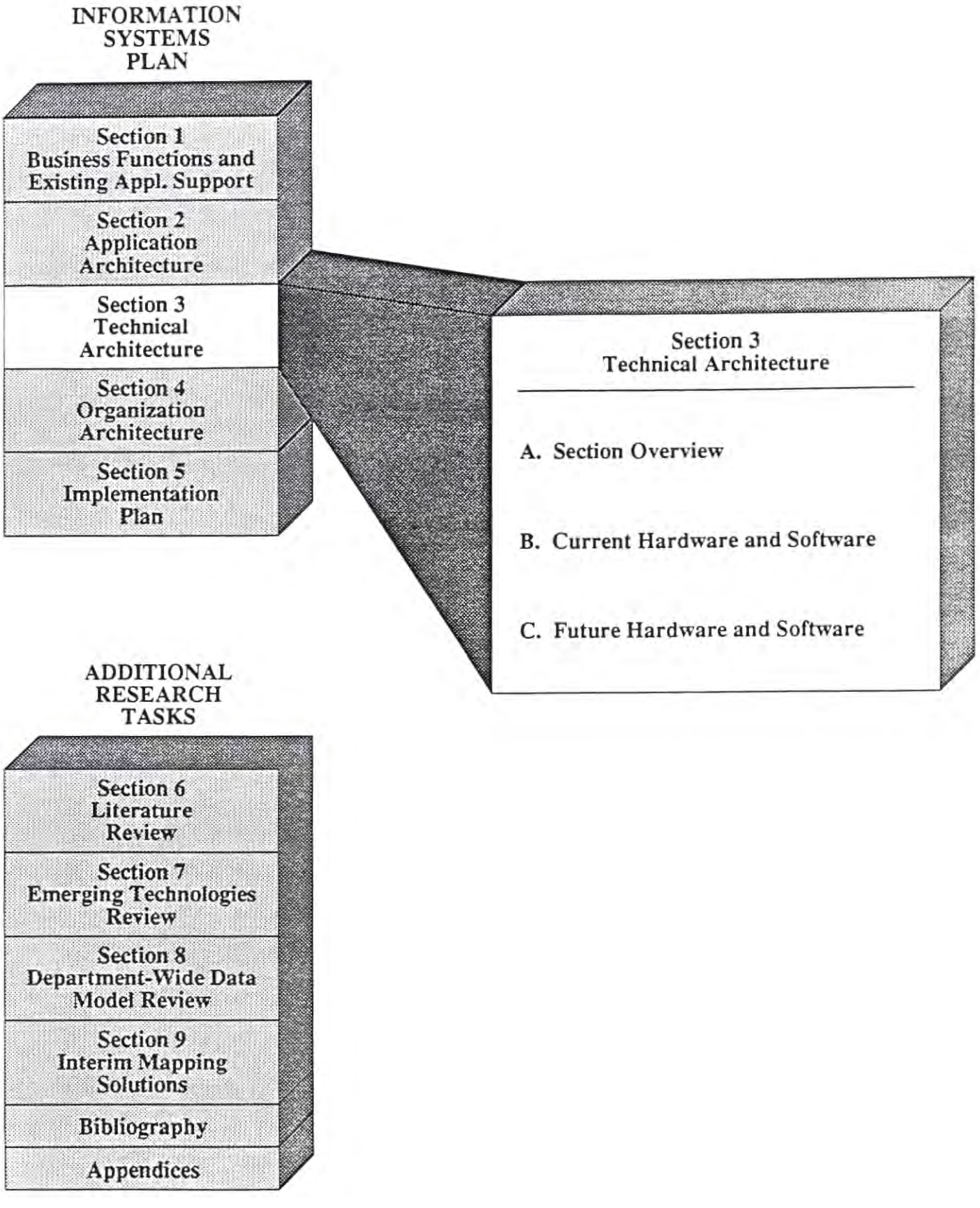


Executive Image Management



There appears to be several areas within the emerging technologies which each section manager perceives a lack of specific expertise. This perceived gap in expertise may be a result of the Department not committing to implementing these technologies, since no one appears to have been assigned the responsibility of pursuing and understanding these techniques (and probably have other priorities which require full time attention). It may be beneficial for Data Services to send section managers or senior staff personnel to HEEP and technology conferences such as the Association for Information and Image Management or IBM Guide User's Group.

SECTION 3
TECHNICAL ARCHITECTURE



A. SECTION OVERVIEW

This section of the Information Systems Plan provides a summary of the evolution of Information Systems within the Department of Transportation, and identifies the key technical components required to support the proposed applications architecture presented in Section Two.

B. CURRENT HARDWARE AND SOFTWARE

The State of South Dakota has a central computer that all state government agencies access. Information Processing Services (IPS) is the office chartered with providing computer services for state government. In the Mid 1970's, IPS installed an IBM 3033 mainframe computer to handle the State's information needs.

The Department of Transportation was one of several state agencies utilizing the centralized equipment. The original 3270 type terminals were mainly used in Data Services for program development and maintenance. By the early 1980's the Department had acquired twenty additional 3270's for the Central Office and each Region Office.

In the early 1980's, IPS upgraded its mainframe capacity to dual IBM 3033 processors due to the increasing number of users and applications running on the hardware. In 1983, the Department acquired its first Personal Computer (PC). This PC was installed in Data Services for evaluation. After the evaluation of the PC and the introduction of the 3270 emulation board, Data Services made a strategic business decision to begin acquiring PC's instead of 3270 terminals whenever new terminals were required. By 1986 the DOT had thirty PC's in the Central Office with 3270 emulation boards and one stand–alone PC in each Region and Area Office. At the same time, the Department was continuing to utilize the 3270 terminals. A VAX 11/785 mainframe and six engineering workstations were added to the Central Office Inventory in 1985 to accommodate the automated engineering technology.

In 1987, IPS upgraded its mainframe computing to the IBM 3090 series. At about the same time, the Department accelerated the purchasing and installation of personal computers. Shortly thereafter the Department began networking the PC's in the Central and Region Offices.

Today, the VAX mainframe, which is about to be phased out, and forty–one engineering workstations are connected via the Ethernet network to support the engineering function. Ethernet is a standard connection of two or more communicating devices for Local Area Networks. In the Central Office there are thirteen 3270 terminals remaining, twenty–five stand–alone PC's and thirty–three PC's with emulation boards. Two IBM Token Ring Networks support two hundred and thirty–two PC's. These networks are attached to the IBM 3090 by the INS Remote Gateway.

Each Region is equipped with one stand–alone engineering workstation, two 3270 terminals connected to the IBM 3090 and one IBM Token Ring Network supporting between fifteen to twenty–five PC's. Each outlying Area Office has one stand–alone engineering workstation, one 3270 terminal, one PC that emulates a 3270 type terminal and one stand–alone PC that is connected to its Region Office via modem. This communication link provides access to the Department's E–mail system.

The current IBM 3090 model 200J runs MVS/ESA version 3.1.3 with JES2 version 3.1.3 as its operating system. The Operating System is supported by the following key products: ADABAS, Assembler machine level programming language, CICS version 1.7, COBOL, Fortran, Software AG's Natural fourth generation programming language, RACF and TSO.

The current IBM Token Ring Network environments support MS DOS version 3.3 with Tempus Link used as the communication software between the mainframe and the PC's for uploading and downloading data.

The current architecture consists of varying hardware platforms, which include:

- IBM 3090 Mainframe
- PC Local Area Network
- VAX 11/785 Engineering Network
- Stand–alone Engineering Workstations
- Apple Macintosh.

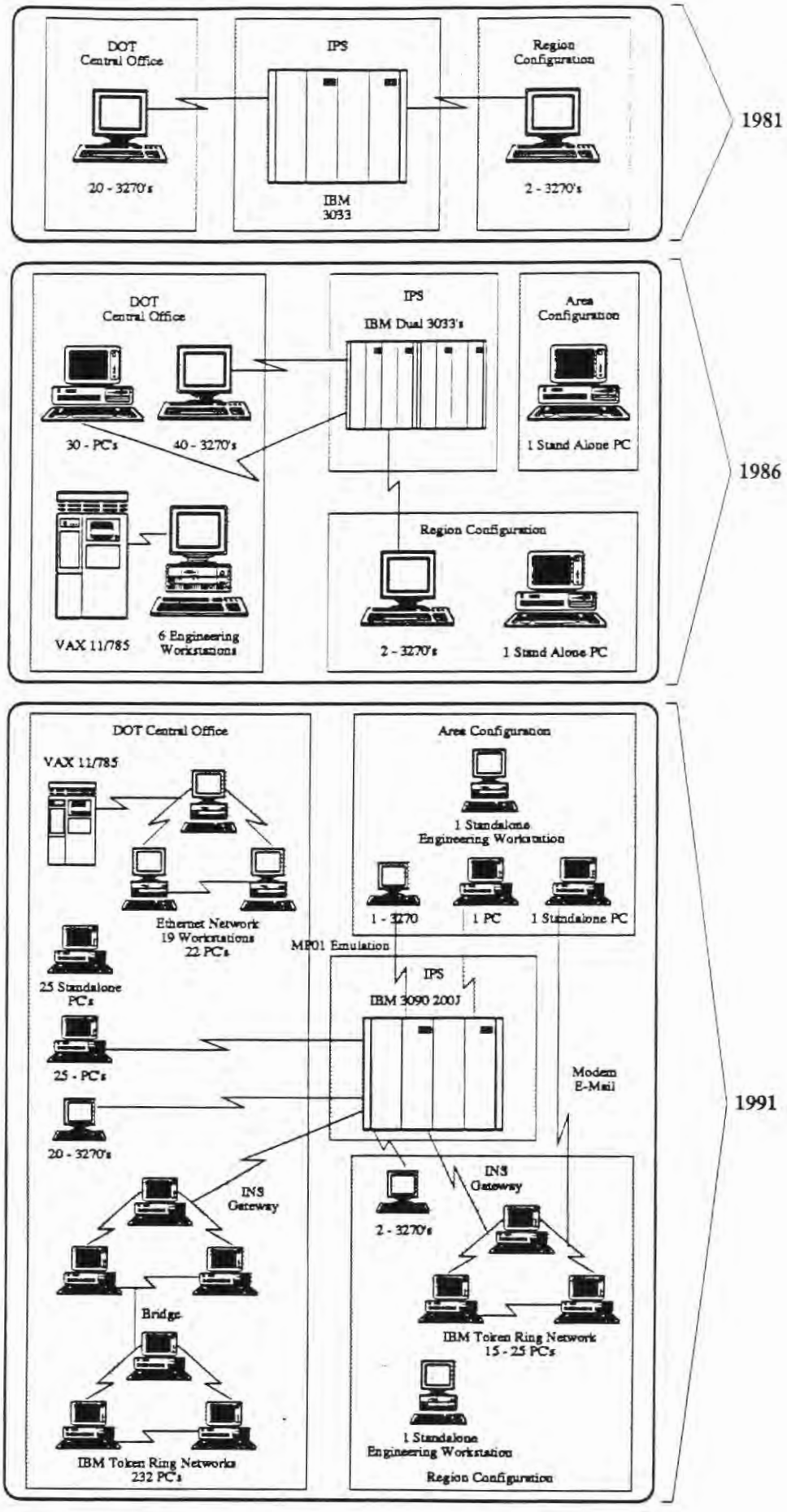
Exhibit 3.1 illustrates the significant change the Department has been involved in over the past ten years.

C. FUTURE HARDWARE AND SOFTWARE

The change in the Department's technical hardware configuration has kept pace with the overall evolution of technology, emerging from a relatively simplistic centralized computing environment, to one which is very complex and substantially decentralized. Conversely, the software and applications environment has undergone relatively little structural change over the same time period. As a result, the Department now has a relatively "state of the art" technical platform with an applications environment incapable of taking greatest advantage of the technology.

In order to begin realizing the benefits associated with the technical sophistication, the Department must:

- Continue to move toward an open communications environment, controlling the introduction of proprietary technologies which may preclude open communications in the future.


DOT
Central Office
IPS
Region
Configuration
20 - 3270's
IBM
3033
2 - 3270's
1981
DOT
Central Office
IPS
IBM Dual 3033's
Area
Configuration
30 - PC's
40 - 3270's
1 Stand Alone PC
Region Configuration
VAX 11/785
6 Engineering
Workstations
2 - 3270's
1 Stand Alone PC
1986
DOT Central Office
VAX 11/785
Ethernet Network
19 Workstations
22 PC's
25 Standalone
PC's
25 - PC's
20 - 3270's
INS
Gateway
Bridge
IBM Token Ring Networks
232 PC's
Area Configuration
1 Standalone
Engineering Workstation
1 - 3270
1 PC
1 Standalone PC
MP01 Emulation
IPS
IBM 3090 200J
Modem
E-Mail
INS
Gateway
2 - 3270's
IBM Token Ring Network
15 - 25 PC's
1 Standalone
Engineering Workstation
Region Configuration
1991

- Begin to take greater advantage of the substantial processing capabilities of the personal computers.

Open communications will continue to be critical in the Department's ability to migrate toward integrated systems.

The existence of communication layers above the existing network architecture makes it possible to communicate between every supported platform. In other words, it is the transportation medium which allows information to be routed to the different platform services.

The following list identifies logical candidates which the Department may consider for network communication packages.

- TCP/IP

  Industry standard communication software that allows file access to certain hardware platforms. The software currently supports the UNIX and MVS operating systems within the Department.

- OSI

  OSI has been researching and developing international standard communication software for the past ten years. The goal is to support interoperability to ALL hardware platforms.

- NET-WORK

  Software AG's open systems architecture software.

In order to take greater advantage of the substantial processing capabilities of the personal computers, the Department should also consider migrating towards a "Client Server" applications architecture. In a client server environment, both the PC (or workstation) and the server process information. The client (or PC representing the user machine requesting information) typically generates a query through a "front end" application. The application sends the query to the server which can perform one of two functions:

- Process the data because it happens to be the machine where the queried information resides

- Send information up to a higher communication layer to look up the location of the requested server and invoke the appropriate communication services to send the request across platforms as necessary. The query is then processed at the server where the data resides by a "back end" application. The information is then sent back to the appropriate client so it can be displayed to the user.

Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	6	7	12
DATA SERVICES FULL TIME PROJECT STAFF	1	1.5	2
USER INVOLVEMENT		■	

Legend: ☐ Low ☐ Med. ■ High

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES	$65,000	$150,000	$225,000
HARDWARE	$68,000	$68,000	$90,000
PACKAGE SOFTWARE	$12,000	$12,000	$20,000
TOTAL ESTIMATED INCREMENTAL COSTS	$145,000	$230,000	$335,000

Assumptions:

- "Low" cost estimates are based on the project definition provided by IBM's "DOT ED/MVS Project Plan" estimates. This solution would provide the Secretary with an EIS including 25–35 graphs. This project assumes the implementation of IBM's Executive Decisions product. Although this may be the correct approach, it is important to precede that project with a preliminary investigation of the Department's EIS needs and assessment of that tool's ability to meet those needs.

- "Expected" cost estimates assume the implementation of the State's EIS package. Therefore, the "Low" estimate provides an adequate initial scoping and cost. This estimate, however, assumes a preliminary phase to assess the State's system and acquire a package meeting the State's needs. It also assumes a longer timeframe for identifying EIS needs, ensuring adequate time to properly determine long–term needs considering difficult interview scheduling constraints.

Tangible Benefits

- An EIS will provide more efficient and effective use of limited executive management time.

Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	6	7	9
DATA SERVICES FULL TIME PROJECT STAFF	.5	1	1.5
USER INVOLVEMENT		☐	

Legend: ☐ Low ☐ Med. ■ High

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES	$90,000	$120,000	$150,000
HARDWARE	$70,000	$110,000	$130,000
PACKAGE SOFTWARE	$5,000	$10,000	$15,000
TOTAL ESTIMATED INCREMENTAL COSTS	$165,000	$240,000	$295,000

Assumptions:

- Contract services "Expected" estimate is based on estimates provided for project staffing, scheduling and project management.
- Contract services "Low" and "High" estimates assume the "Expected" estimate, plus or minus 25%.
- Hardware and software "Expected" estimates assume procurement of an EIM system configured with the following: 1 scanner, 1 printer, 1 display, 1 workstation, 750 MB drive and 28.8 Gbyte jukebox.
- Hardware and software "Low" and "High" estimates assume a range of acceptable configurations, providing different levels of storage and access speed.

Tangible Benefits

- Documents could be quickly and easily accessed from remote terminals (potentially even in regions and areas once the fiberoptic backbone is installed) without having to search microfilmed documents.
- An imaging system will reduce search and retrieval time.

Project Summary

Project design is vital to the successful execution of SDDOT's mission. The design of bridge structures is one of several critical functions encompassed by project design. Yet this function is currently supported by eight stand–alone software packages. Thirty to forty small BASIC programs are also used to automate routine calculations. The implementation of a BDS could integrate these applications and provide additional functionality required to keep current with leading design technologies and trends. It should also provide additional functionality in the areas of metrics, specification changes and comparative design between structures. The bridge design system provides an excellent opportunity to support this critical function through the use of automated information systems.

AASHTO, in conjunction with private contractors (Imbsen & Associates and Howard Needles Tammen and Bergendoff), has been developing a Bridge Design System (BDS) since 1986. Most SD DOT users believe the current version, release 2.6, is inadequate due primarily to the lack of a user friendly interface. Substructure and box culvert support is also lacking in the current version. Based on these deficiencies, the AASHTO development team has scheduled the development and release of 2.7 and 2.8. Release 2.8 will provide an alphanumeric menuing interface capable of providing easier input of data and access to programs. Enhanced substructure analysis and design will also be supported by Release 2.8. Box culvert design however, has not been included in scheduled enhancements thus far. The scheduled user release of this version is December of 1991.

Although minor enhancements are still required, the current version does support superstructure design (currently supported by Georgia Beam Analysis, South Dakota Prestress and Simon Steel Girder Design). If the user interface enhancements are provided, most users feel the superstructure functionality can be implemented. Although stand–alone applications supporting substructure and box culvert design may need to be acquired in the short–term, BDS will hopefully integrate all of these functions with future releases. If Release 2.8 of AASHTO's BDS is not able to provide an effective user interface, other packages currently available should be evaluated to determine if BDS is, in fact, the Department's long–term direction.

Based on current information and for purposes of preparing an "order of magnitude" cost estimate, it is assumed that AASHTO's BDS will be the Department's long–term design package. Therefore, all project estimates included below assume the implementation of AASHTO's BDS.

In order to provide for the successful implementation of a BDS package, the following steps should be included in this project:

- Documentation of System Requirements

  This project assumes that the Department's requirements of a bridge design system have already been informally defined. This phase challenges those requirements and creates a formal document to be used in the evaluation of available packages.

- Application Package Evaluation

  Although this project assumes the implementation of AASHTO's BDS, a formal evaluation of available packages should be completed. This will provide direction if future releases of AASHTO's BDS fail to meet the Department's needs. Although all phases will require involvement from the personnel in the Bridge Design Office, this phase will require a substantial involvement if packages are to be adequately identified and evaluated.

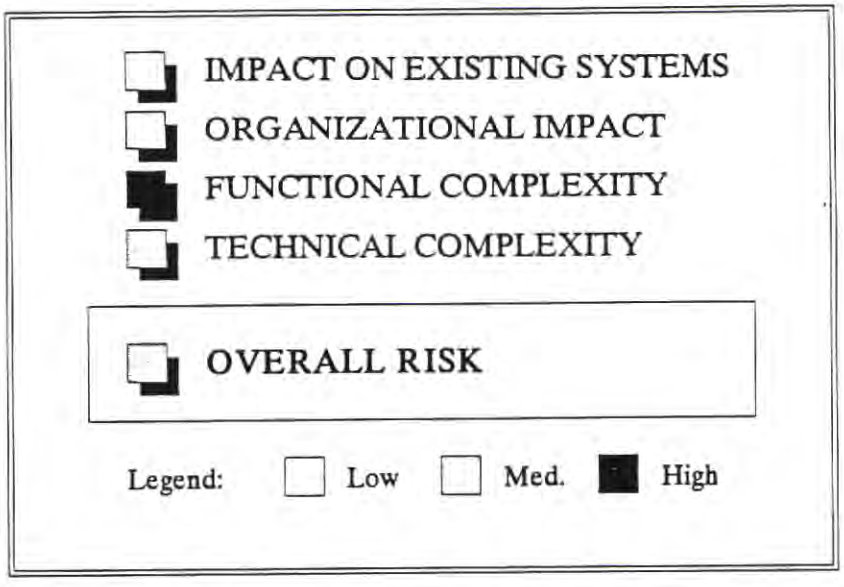
- Application Package Acquisition and Modification

- Package Installation

- Testing

- Conversion and Implementation

Project Scoping & Complexity



The scope of this project is relatively narrow, focusing on bridge design. Given this narrow scope, the "Impact on Existing Systems" and "Organizational Impact" should be low. The engineering formulas and required functionality encompassed by this system, however, is highly complex. "Technical Complexity" is estimated to be moderate based on the phased implementation of releases, potentially requiring modification or implementation of additional supporting applications. Based on these variables, the overall risk associated with the implementation of a BDS system is expected to be moderate.

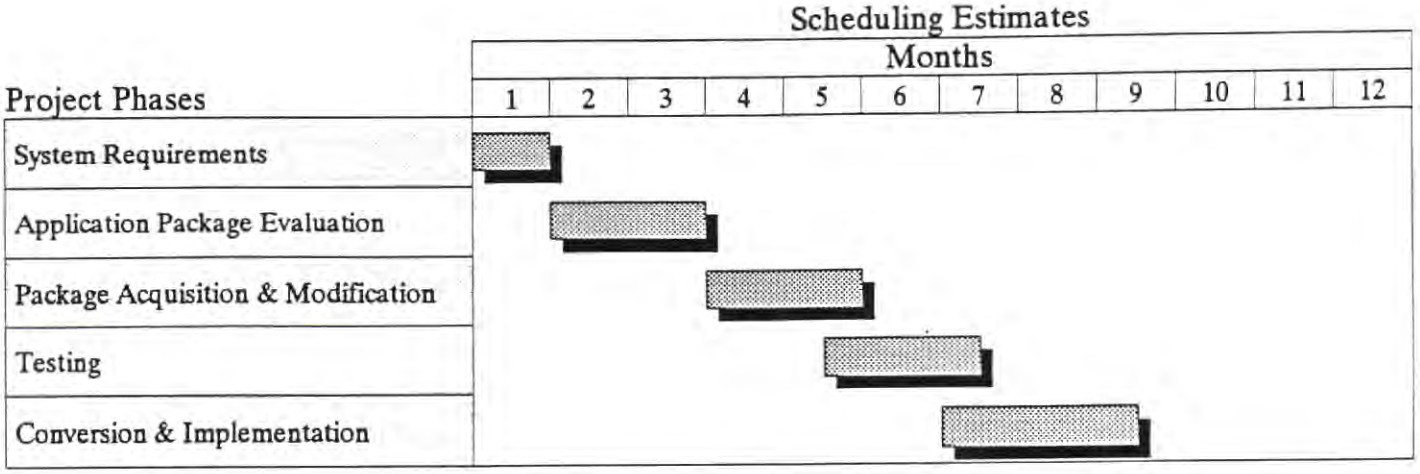
If the AASHTO BDS fails to meet the requirements of SDDOT, then the complexity and risk associated with the project may increase if custom development is required.

Project Estimates

Staffing Estimates

Project Phases	Internal			External		
	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
System Requirements	1	1				
Application Package Evaluation	1	1				
Package Acquisition & Modification	1	1				
Testing	1	1				
Conversion & Implementation	1	1				

Scheduling Estimates



Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	5	7.5	8.5
DATA SERVICES FULL TIME PROJECT STAFF	1.5	2	2.5
USER INVOLVEMENT		■	

Legend: ☐ Low ☐ Med. ■ High

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES		$0	
HARDWARE		$0	
PACKAGE SOFTWARE	$6,000/Yr	$25,000/Yr	$25,000/Yr
TOTAL ESTIMATED INCREMENTAL COSTS	$6,000/Yr	$25,000/Yr	$25,000/Yr

Assumptions:

- All project estimates assume the implementation of AASHTO's BDS.
- Project estimates assume full–time assistance of Dana Feltis as a project team member.
- "Low" cost estimate is based on yearly license fee for one copy of BDS.
- "Expected" and "High" cost estimates are based on yearly license fee for unlimited use of BDS.

Tangible Benefits

- An integrated BDS system will reduce or eliminate labor and errors caused by rekeying data into several different software packages.
- A new Bridge Design System will allow automation of many complex calculations not allowed in the current software.

	Low	Expected	High
ANNUAL PRODUCTIVITY IMPROVEMENTS	$33,300	$55,500	$88,800

Assumptions:

- Productivity improvement "Low", "Expected" and "High" estimates are based on 3%, 5% and 8% gains in the Bridge Design Office respectively.

☐ Tangible Benefits

Intangible Benefits

- The AASHTO BDS system will remain current in supporting federally mandated design specifications.
- A new Bridge Design System will allow the Department to adopt design technologies being used by other States. This will facilitate consistency and knowledge sharing.

☐ Intangible Benefits

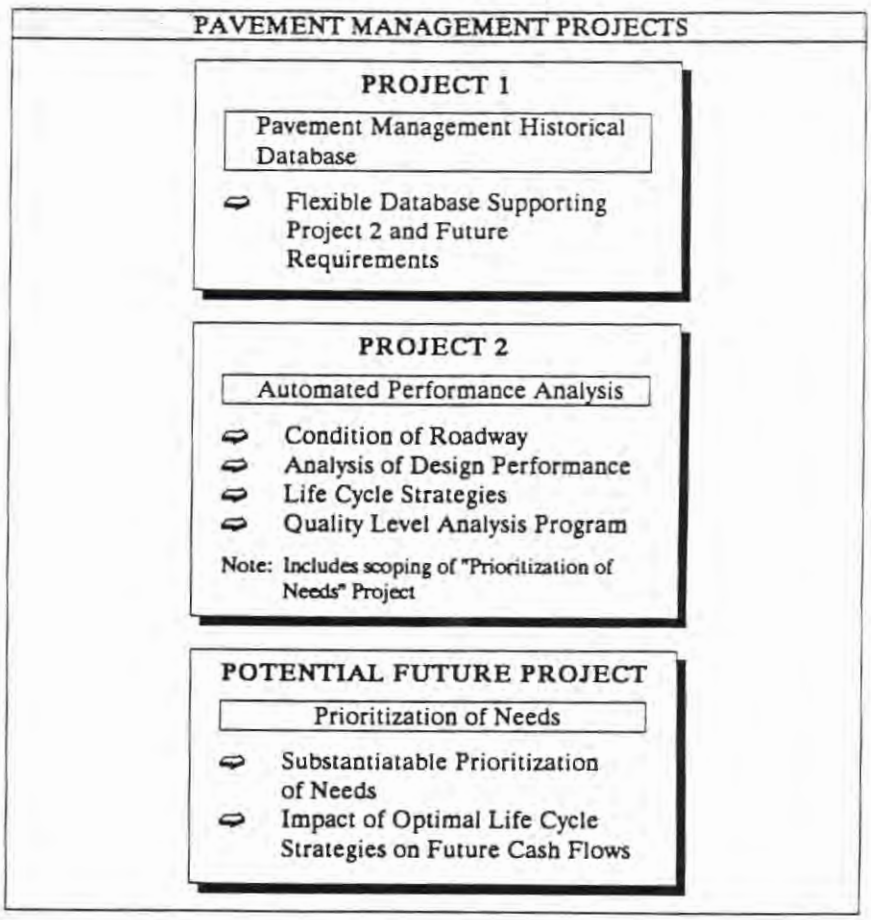
Legend: ☐ Low ☐ Med. ■ High

Project Summary

The Federal Government has placed increasing emphasis on the need for all States to implement a Pavement Management System (PMS). Although the definition is still unclear, there appear to be are many benefits associated with implementing a comprehensive PMS.

It is evident that South Dakota has many of the components required for an effective Pavement Management System. There are, however, additional components that would improve the Department's capability to analyze pavements and produce a more comprehensive program, addressing future reconstruction/rehabilitation strategies and cash flows associated with those strategies.

Shown below are three projects effectively addressing the Department's pavement management needs. The first project is addressed by the "Historical Pavement Management Database" project. The second provides automated query and analysis tools, adding meaningful input to the needs prioritization process. The final project provides for enhancements to the Department's existing needs assessment and prioritization system. These enhancements would provide for an automated prioritization based on proven formulas. It would also provide for the documentation of manual changes to the priorities and the reason those changes occurred. Although this could be a valuable third project, it is beyond the scope of the project discussed here.



The phases included in this project will provide the following components:

- Assessment of Roadway Condition

  Predefined, on-line queries would provide for the evaluation of a pavement's conditional deficiencies.

- Analysis of Design Performance

  This component would allow flexible definition of roadway sampling groups and evaluation of standard designs based on the performance of these groups over time. This analysis should provide insight into the Department's design policies.

- Life-Cycle Strategies

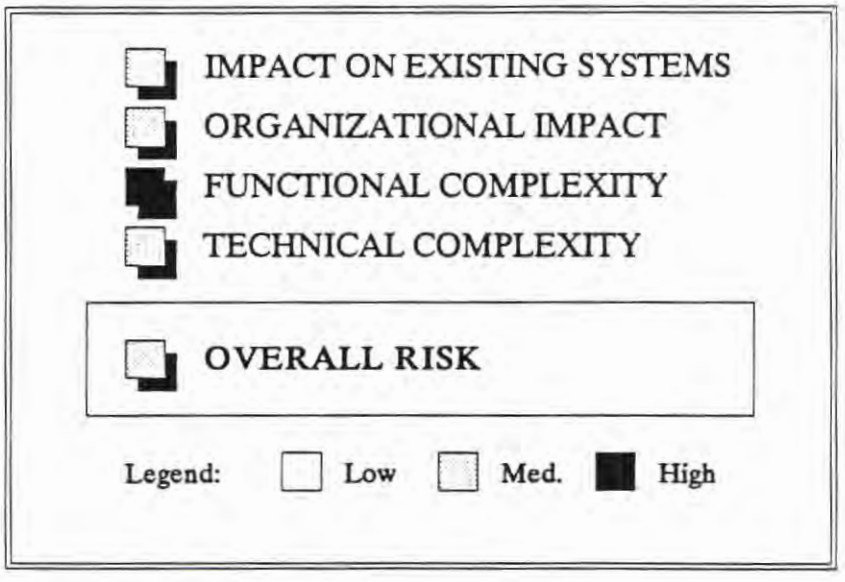
  This component will provide for the identification of optimal reconstruction/rehabilitation strategies. By comparing the equivalent discounted cost of the different strategies over anticipated remaining pavement lifes, the State can ensure the most cost-effective investment in its roadways.

- Automation of the Quality Level Analysis Program

  This component will provide a basis for evaluating contractor's past performance. This program's intent is to ensure quality by providing incentives/disincentives based on contractor performance.

In addition to these components, this project will also provide for the scoping of the future "Prioritization of Needs" project.

Project Scoping & Complexity



This project's overall risk is estimated to be moderate. This is based on the ratings provided for the four above variables. The first variable, "Impact on Existing Systems" is expected to be moderate based on all of the systems supporting pavement management activities. All of the current systems folded into the historical database must drive the system. Systems analyzing this data provide input to the needs assessment and prioritization systems. Finally, a construction program is developed to address these needs. For these same reasons, the "Organizational Impact" is expected to be moderate. This project's "Functional Complexity" provides the majority of its risk. Because of new research being performed, many of the formulas and concepts are still being challenged. This project's success depends on the adequate definition of those concepts and formulas as they apply to South Dakota's pavement management philosophy. After these issues are resolved, the system still must maintain a high degree of flexibility to accommodate the growing research in the pavement management area. Custom developed pavement management capabilities will most likely be implemented with proven technologies. However, the timing of this system's development may allow new client/server technologies to be employed. Therefore, estimated "Technical Complexity" is moderate.

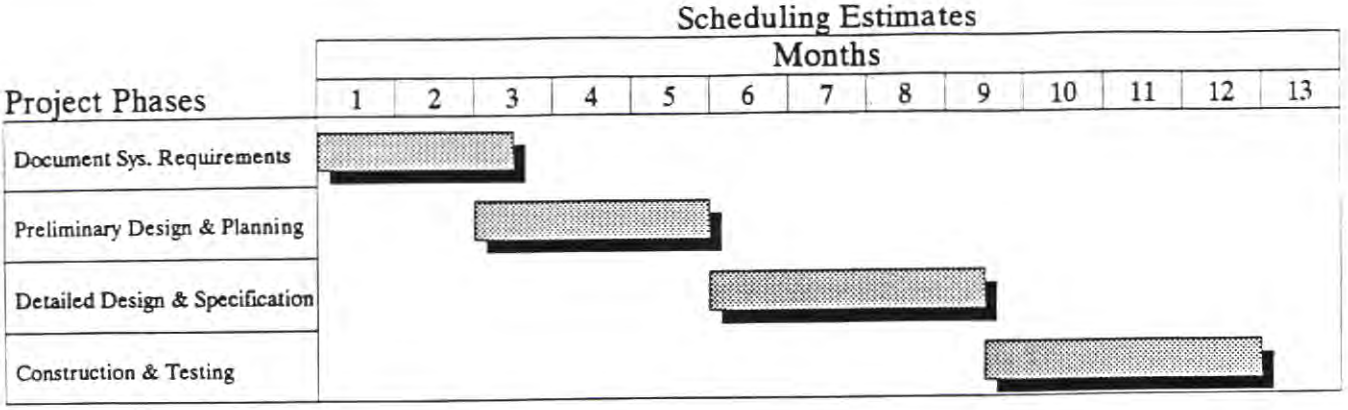
Project Estimates

Staffing Estimates

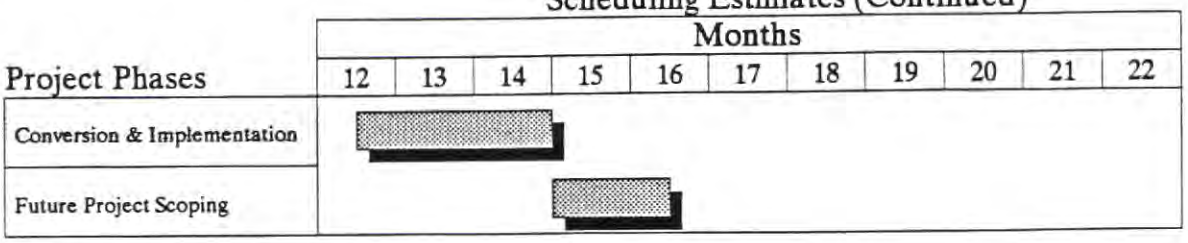
Project Phases	Internal			External		
	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
Document System Requirements	1	2		1/2	2	
Preliminary Design & Planning	1	2		1/2	2	
Detailed Design & Specification	1/2	2		1/2	2	
Construction & Testing	1/2	1	1	1/2	2	
Conversion & Implementation	1/2	1	1	1/2	2	
Future Project Scoping	1/2	1				

External Staffing Roles: It is expected that a substantial level of effort will be required to develop the applications provided by this project. This system is also expected to impact a number of organizational areas and require a significant level of functional complexity. Consultants can provide additional staffing not available to Data Services and the expertise to design and construct complex applications. Consultants would provide the following responsibilities: lead group interviewing sessions to ensure proper documentation of key system requirements, assist in the development of screen designs, identify changes in the historical database necessary to meet system requirements, monitor construction of the system, perform system testing, aid in the development of system and user documentation, provide end user training, and provide or share overall project management responsibilities.

Scheduling Estimates



Scheduling Estimates (Continued)



Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	13.5	15.5	17
DATA SERVICES FULL TIME PROJECT STAFF	1.5	2.25	3
USER INVOLVEMENT		☐	

Legend: ☐ Low ☐ Med. ■ High

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES	$540,000	$607,500	$695,000
HARDWARE		$0	
PACKAGE SOFTWARE		$0	
TOTAL ESTIMATED INCREMENTAL COSTS	$540,000	$607,500	$695,000

Assumptions: ⇨ The contract services cost estimate is based on the estimated project schedule presented above.

Tangible Benefits

- Automated pavement analysis capabilities can provide significant cost savings by determining optimal design standards for given conditions and by determining optimal reconstruction/rehabilitation strategies based on a full life-cycle approach.

- Automating manual statistical analysis will also provide productivity gains for the Department.

	Low	Expected	High
ANNUAL PRODUCTIVITY IMPROVEMENTS	$1,300,000	$2,560,000	$3,840,000

Assumptions:

- Although minor productivity gains can be made by automating current manual analysis, this project's major gains are provided through more effective analysis. If challenging past design standards or adopting more effective life-cycle strategies can trim slight percentages off the construction and maintenance budgets, substantial benefits can be gained. The above "Low", "Expected" and "High" gains are based on construction and maintenance reductions (excluding bridge projects) of 1%, 2% and 3% respectively.

■ Tangible Benefits

Intangible Benefits

- This project will provide timely access to roadway condition data allowing easier analysis and identification of roadway deterioration.

- Flexible definition of sampling groups will allow complex analysis which currently is difficult with existing systems.

- An automated Quality Level Analysis program will allow the Department to influence contractors' performance by offering incentives/disincentives based on past performance. This will ultimately ensure that better roads are constructed by encouraging contractors to adhere to specifications.

☐ Intangible Benefits

Legend: ☐ Low ☐ Med. ■ High

Project Summary

Geographic information systems (GIS) have the ability to transform the way the Department looks at its data. It is well suited to DOT business because it is designed to deal with spatially-oriented data (e.g., roadway networks, aircraft flight patterns, railroad lines, rivers, jurisdictional and political boundaries, etc). Although the technology has been around for over twenty-five years, practical applications are only now becoming available due to the improvements in computing hardware and database management systems.

There are still significant costs associated with designing and maintaining a GIS. However, the inter-agency SODGIS project may reduce the investment that would be required of any one agency developing a Geographic Information System. The SODGIS project should also reduce the learning curve for individual agencies interested in GIS by providing a testing ground for initial pilot implementations. This provides opportunity for the DOT by shortening the implementation timeframe that may have otherwise been feasible.

One of the major costs of developing a GIS is the labor required to digitize maps. The DOT has already made progress in this area by producing digital line graphs using the Tiger digital line files. These efforts provide an excellent investment in the Department's future use of GIS. However, due to the potential variability in the Department's digitized map's coordinate systems, some risk exists that the map base may not adequately serve all of the Department's uses of GIS. Recently, Clark County, Nevada went through an automated process of edge matching maps. (Geo Info Systems, July/August 1991) An overriding issue is the level of data accuracy required.

As state-wide base maps and an adequate hardware/software platform become available, the DOT should plan for the phased development of GIS applications. The initial applications should have a narrow focus to improve the Department's probability of success. After an initial pilot project or two, the opportunity will be available to develop additional GIS applications with the ultimate goal of using GIS as a department-wide query tool and as an interface to integrate applications.

The goal of this project is threefold: 1) To provide for the establishment of a hardware/software platform supporting future GIS application development, 2) Development of an initial mapping application and 3) Planning for the continued development of strategic GIS applications. This project includes the following implementation phases:

- Development of a DOT GIS Specialist:

  In order to take greatest advantage of a GIS, the Department must first understand its requirements and the applications best suited for its use. This requires that one person be assigned to lead the charge in the GIS area. This individual should strive to understand the technology and its uses, how other DOTs are using GIS and the long term implications for the Department. This individual should begin assuming an active roll in the SODGIS Inter-Agency Council. Shortly after the GIS specialist has become familiar with the interim GIS implementation, the Department may consider adding an additional FTE for "backup/coverage" in the GIS area.

- Map Base Digitization:

  The appropriate map base will need to be digitized before application development can begin. Maps are already being digitized by the Data Inventory Section of Planning. They expect to have the entire state digitized at the 1:100,000 level before the end of 1992. Although this will be an ongoing investment associated with a GIS, this investment is already being incurred. Therefore, it is not included in the project estimates provided below.

- Hardware and Software Selection/Implementation:

  This phase of the GIS project provides for the selection and implementation of the appropriate hardware/software platform required for the development of an initial mapping system. This platform should accommodate future growth to support the Department's long term GIS strategy.

- Initial Application Development:

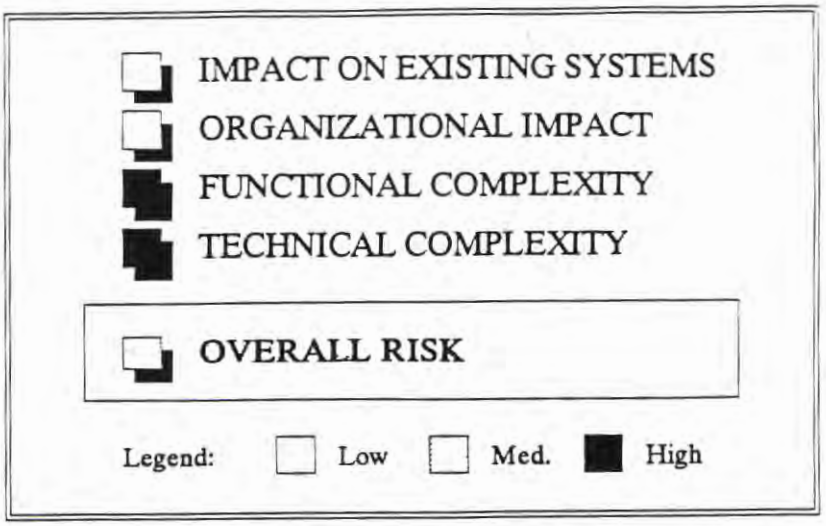
  An automated mapping application designed for the Planning & Programs section of Planning is an appropriate initial implementation effort. This application is recommended for the following reasons:

  - The mapping function is currently being performed manually
  - Although not formally documented, the system requirements could be readily defined
  - The level of precision required is low (primarily 1:500,000)
  - The scope of the project is small, dealing with only a few well defined files
  - Once complete, the application could be easily modified for use by Accident Records

- Continued Application Development:

  After the successful implementation of the initial mapping system, a framework should exist supporting future GIS application development. Future application development has not been included in the estimates associated with this project. However, a planning project to help determine which GIS applications should be developed is included in the estimates.

Project Scoping & Complexity



The overall project risk associated with the implementation of an initial GIS application is expected to be moderate. This is primarily due to the functional and technical complexity associated with Geographic Information Systems. It is also attributed to the current lack of GIS development experience within the Department. Although the long term impact of GIS on the first two scoping variables could be extensive, the development of a stand–alone mapping application has little affect on either variable.

Project Estimates

	Staffing Estimates					
	Internal			External		
Project Phases	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
Preliminary GIS Phases						
Identify GIS Requirements	1/2	1		1/2	1	
Evaluate State GIS Hardware/Software	1/2	1		1/2	1	
Acquire & Install Hardware/Software	1/2	1				
Load Base Maps	1/2	1				
GIS Training	1/2	1		1/2	2	
Initial Application Development Phases						
Mapping Requirements Definition	1/2	1		1/2	1	
Preliminary Design & Planning	1/2	1		1/2	1	
Detailed Design & Specification	1/2	1		1/2	1	
Construction & Testing	1/2	1		1/2	1	
Conversion & Implementation	1/2	1		1/2	1	
Training	1/2	1		1/2	1	

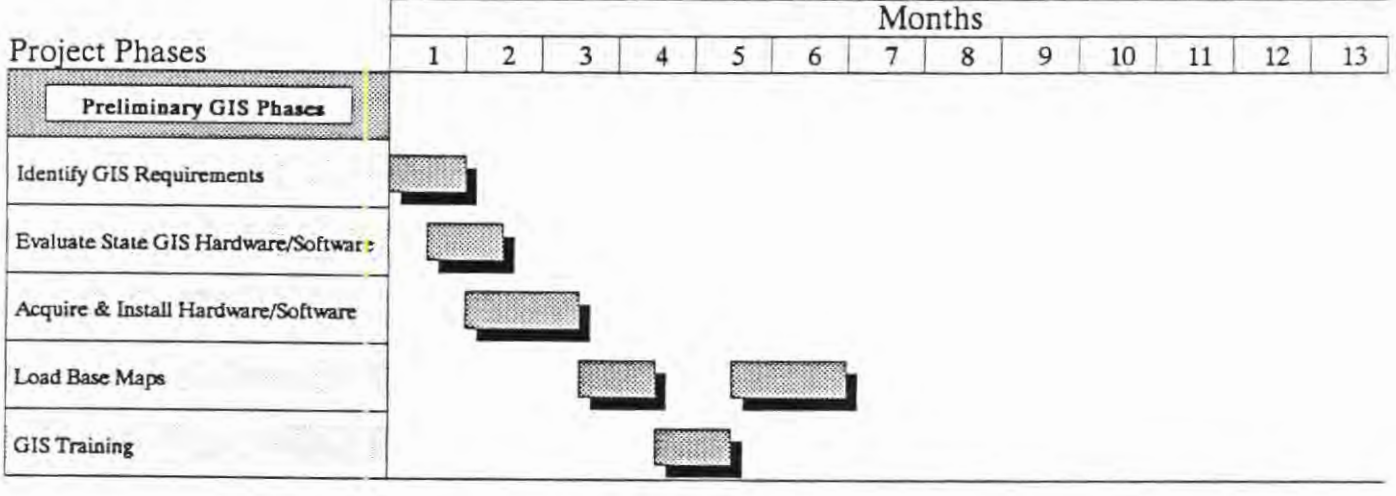
Staffing Estimates (Continued)

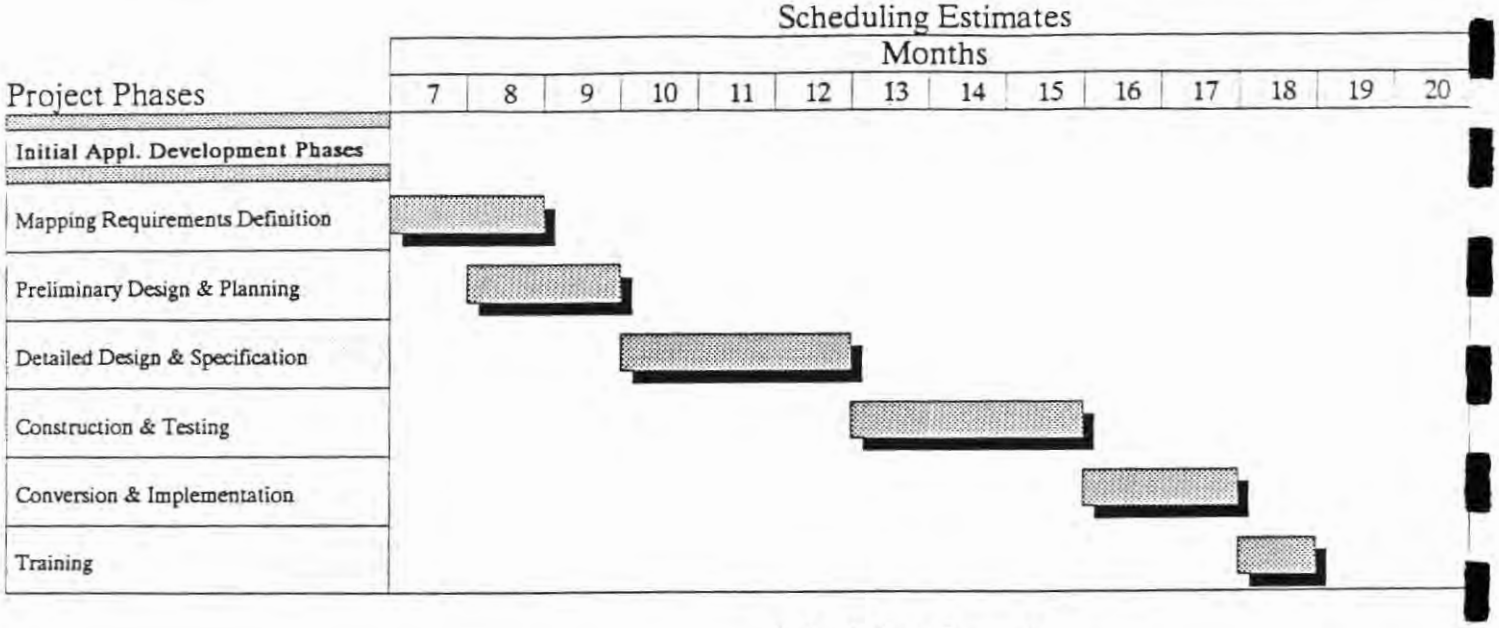
Project Phases	Internal			External		
	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
Continued Application Development Phases						
GIS Application Planning	1/2	1		1/2	1	
Subsequent Application Development	1/2	1				
On Going GIS Support						
DOT GIS Specialist		*				
Map Digitization						

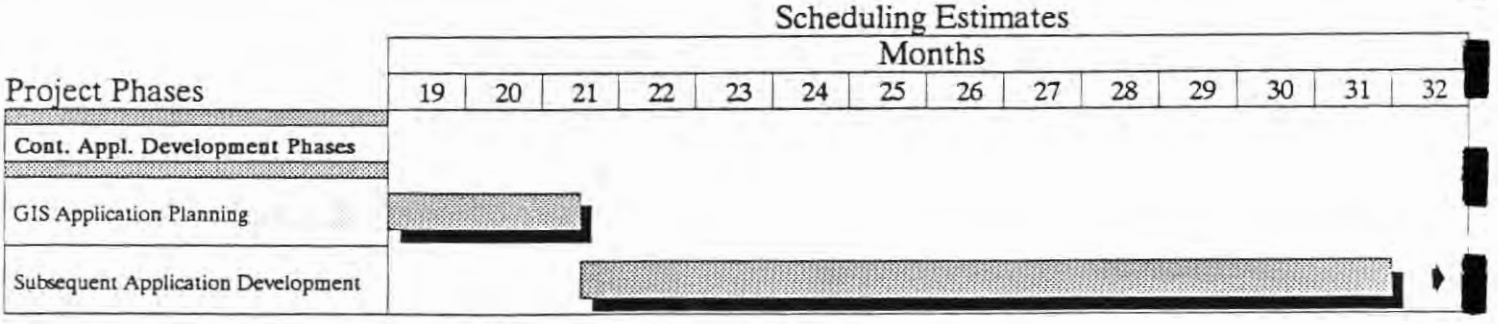
Note: All shaded activities are included in the estimates associated with this project.
** It is anticipated that the DOT GIS Specialist will not be part of Data Services staff.*

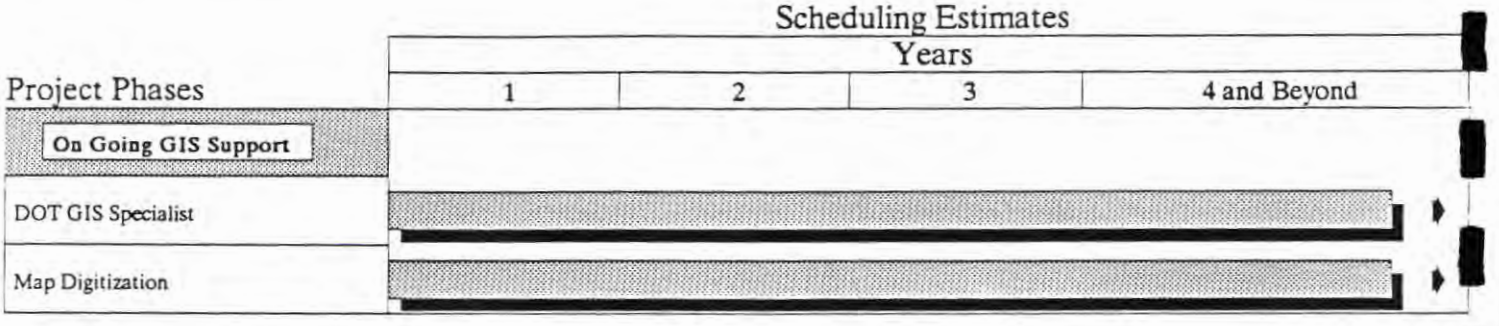
External Staffing Roles: When planning the requirements for a GIS, considerable consideration must be given to determining how much control and what level of accuracy will be required of the GIS. Failure to consider the ramifications of accuracy, spatial control and the full range of potential uses for the data, will lead to an ineffective GIS system and the loss of user confidence. The use of external resources familiar with GIS requirements planning and implementations can assist the Department in avoiding these problems associated with this reasonably complex technology.

Scheduling Estimates









Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	17	20	23
DATA SERVICES FULL TIME PROJECT STAFF	1	1.5	2
USER INVOLVEMENT		■	

Legend: ☐ Low ☐ Med. ■ High

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES	$190,000	$375,000	$490,000
HARDWARE	$20,000	$25,000	$50,000
PACKAGE SOFTWARE	$15,000	$15,000	$30,000
TOTAL ESTIMATED INCREMENTAL COSTS	$225,000	$415,000	$570,000

Assumptions:

- The project definition upon which these estimates are based assumes the three following components: 1) Establishment of a hardware/software environment capable of supporting future GIS applications, 2) Development of an initial automated mapping application and 3) Identification and evaluation of potential future GIS applications.
- This project assumes digitization of the proper map base prior to development of the automated mapping application.

Tangible Benefits

- Automated Mapping will provide significant cost savings over current mapping methods.
- Ties to existing computerized databases provided by GIS will allow powerful querying of data not allowed by the current systems. This will dramatically reduce the time needed to compile information, perform analysis and create presentation graphics, while improving the quality.

	Low	Expected	High
ANNUAL PRODUCTIVITY IMPROVEMENTS	$47,700	$59,700	$71,600

Assumptions:

- Certain offices within the Department spend a significant amount of time developing presentation materials for communicating with the Governor, Legislature and public. The "Expected" estimate assumes a 10% productivity gain by half of the Data Analysis Office within Planning & Programs. It also assumes a 10% gain in productivity by the Secretary's administrative staff and a 5% gain within the Secretary's Office.
- The estimated "High" and "Low" improvements assume the "Expected" plus or minus 20%.

☐ Tangible Benefits

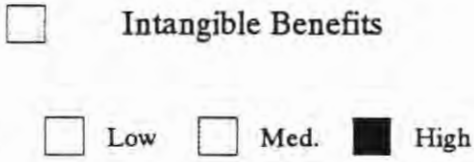
Intangible Benefits

- GIS will provide an effective means of communicating with the public, legislature and other parties outside of the DOT.

- The development of the initial system will provide a valuable graphical ad hoc query tool. This tool could provide insight into highway safety analysis, pavement management analysis and traffic analysis.

- Although there are benefits associated with the initial mapping application, greater benefits will be realized through future application development. These efforts should produce systems capable of graphical querying, where answers can be communicated via maps instead of through tabular reports. These systems may also provide the precision needed to perform automated location analysis. These applications should provide substantial productivity and effectiveness improvements.

- Due to potential State–wide participation in GIS, this project should increase the communication and coordination between State agencies.



Project Summary

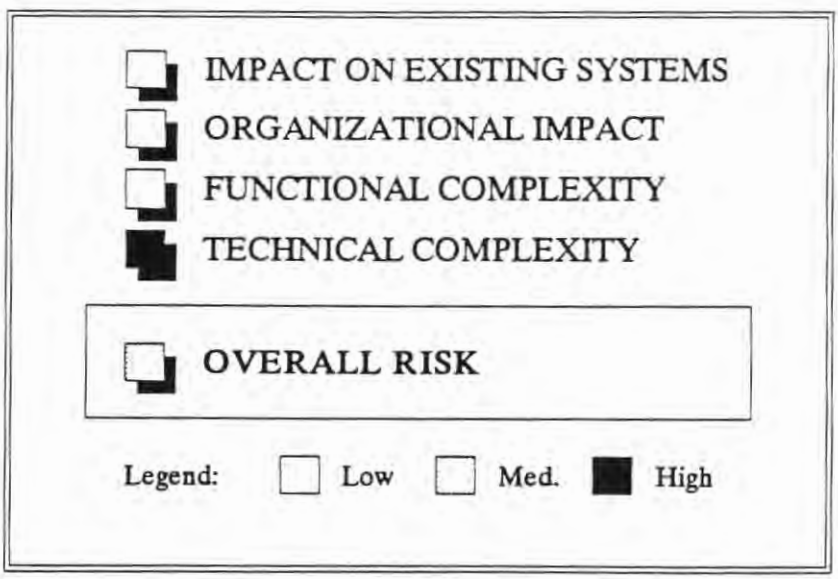
The implementation of an image management system would provide the ability to electronically store and retrieve documents. This method of document storage would provide many users simultaneous access to the same document. The technology could be applied to many areas now using microfiche. The following have been identified as opportunities for imaging: Plans, Pre-letting Packets, Accident Record Forms and Material Certifications. It is expected that other EIM opportunities will also be identified in the future.

Although there is potential for many EIM applications, this project provides for the implementation of an Accident Records imaging application. The project would need to address several key technical components, including the following:

- Converting accident record images from paper to electronic code
- Storing electronically coded images
- Displaying the images
- Manipulating and tracking images
- Printing the images
- The communications required to move images between storage devices and workstations.

The phases required to adequately address these issues and provide for an Accident Records EIM System are provided below with the project scheduling estimates.

Project Scoping & Complexity



Although this project will provide an EIM hardware and software platform supporting the Department's future EIM needs, the project concentrates on the development of an application for the Accident Records area. Because of this narrow initial focus, the project has little impact on the existing organization and its systems. The overall risk is expected to be moderate, however, due to the Department's inexperience with EIM technology.

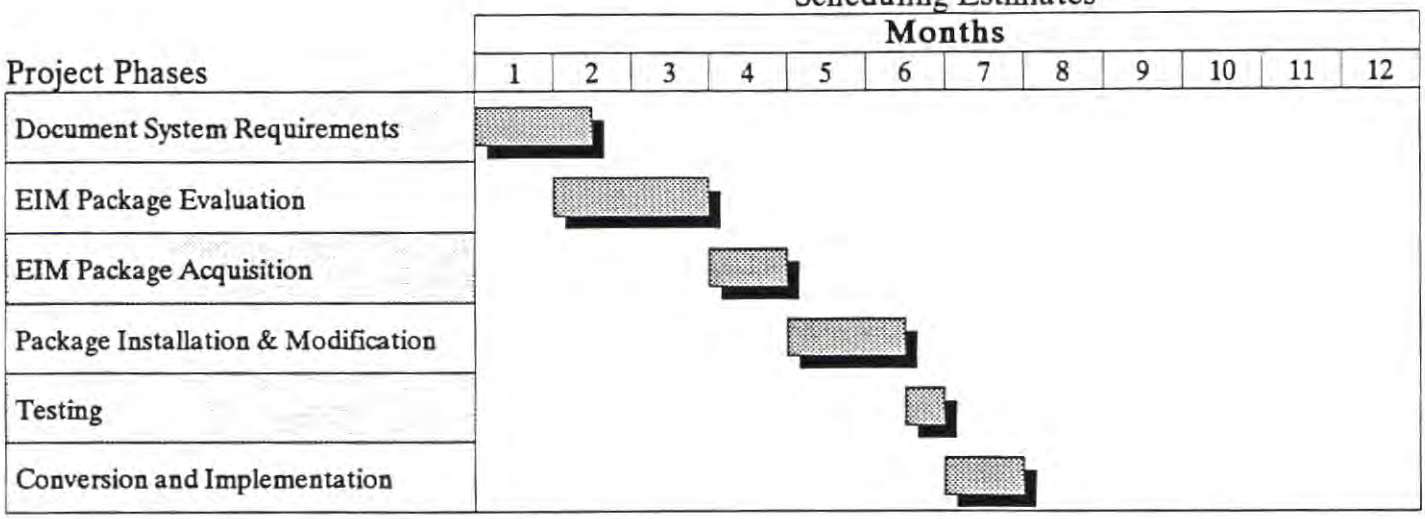
Project Estimates

Staffing Estimates

Project Phases	Internal			External		
	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
Document System Requirements		1			1	
EIM Package Evaluation		1			1	
EIM Package Acquisition		1			1	
Package Installation & Modification		1			1/2	
Testing		1				
Conversion and Implementation		1				

External Staffing Roles: Because of Data Services' limited exposure to the implementation of imaging applications, it is recommended that consulting services be retained. The primary responsibilities of consultants would include: Transfer of fundamental EIM concepts to specific Data Services staff, assistance in the documentation of EIM system requirements (emphasizing the Department's long term needs), assistance with the identification and evaluation of existing EIM packages including the selection of a specific package, and assistance with modifying the package so that it supports the Department's Accident Records needs.

Scheduling Estimates



Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	6	7	9
DATA SERVICES FULL TIME PROJECT STAFF	.5	1	1.5
USER INVOLVEMENT		☐	

Legend: ☐ Low ☐ Med. ■ High

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES	$90,000	$120,000	$150,000
HARDWARE	$70,000	$110,000	$130,000
PACKAGE SOFTWARE	$5,000	$10,000	$15,000
TOTAL ESTIMATED INCREMENTAL COSTS	$165,000	$240,000	$295,000

Assumptions:

- Contract services "Expected" estimate is based on estimates provided for project staffing, scheduling and project management.
- Contract services "Low" and "High" estimates assume the "Expected" estimate, plus or minus 25%.
- Hardware and software "Expected" estimates assume procurement of an EIM system configured with the following: 1 scanner, 1 printer, 1 display, 1 workstation, 750 MB drive and 28.8 Gbyte jukebox.
- Hardware and software "Low" and "High" estimates assume a range of acceptable configurations, providing different levels of storage and access speed.

Tangible Benefits

- Documents could be quickly and easily accessed from remote terminals (potentially even in regions and areas once the fiberoptic backbone is installed) without having to search microfilmed documents.
- An imaging system will reduce search and retrieval time.

	Low	Expected	High
ANNUAL PRODUCTIVITY IMPROVEMENTS	$44,000	$50,000	$56,000

Assumptions:

- The estimates assume a 25% productivity improvement within the Accident Records Office and a 1% ("Low"), 2% ("Expected") and 3% ("High") gain respectively within Internal Services.

☐ Tangible Benefits

Intangible Benefits

- An Accident Records imaging application will improve control of accident record document flow.
- Easy scanning of hardcopy forms will reduce the risk of document loss.
- An imaging system can improve control over unauthorized access to accident record information.
- An EIM system will allow multiple indexing (searches) of accident records.

☐ Intangible Benefits

Legend: ☐ Low ☐ Med. ■ High

Project Summary

The bridge management field is undergoing significant change. Not unlike pavement management, States are reviewing the methods used to determine bridge life, identify the proper replacement/rehabilitation strategies and establish standard designs. The FHWA is also actively encouraging States to implement bridge management systems capable of assessing and prioritizing bridge needs. The Federal Government hopes to pass regulations regarding BMS by January of 1992, requiring that all States have a fully implemented system by January of 1995. Although the Federal requirements are still unclear, the Department may need to provide a bridge management application which is fully integrated with the current bridge applications (e.g., BARS and the Bridge Inventory System).

The Federal Highway Administration has been involved in the development of a system design to aid the States in the bridge management area. Because of this involvement, the PONTAS Bridge Management System should provide a viable means of meeting federal requirements at little or no acquisition cost.

Before acquiring or developing software, the Department must determine if it will meet the new requirements. The Department's current bridge components may be capable of meeting the requirements. Given this scenario, the need for this project drops considerably. If the Department does not currently meet all or many of the requirements, the following project steps should be taken in order to assure compliance.

- Documentation of System Requirements

  By documenting an agreed upon set of requirements for the system, a foundation will be provided for evaluating available software packages. This will also force the Department to produce a common definition of bridge management for South Dakota. This process should focus on both unmet federal requirements and additional needs within the Department.

- Application Package Evaluation

  An evaluation of available packages is necessary to evaluate which one, if any, will best meet the Department's needs. This evaluation should consider the previously documented system requirements, the cost of available packages and the hardware requirements of those packages. If an acceptable package is found, the State should procure and implement the package. If not, a custom development effort should be undertaken. Because of this project's dependence on Federal requirements, the remaining project steps and the project estimates provided below assume the selection and implementation of PONTAS.

- Package Acquisition and Modification

  Because of the bridge systems already in place, the selected package

may require modification. This process should provide an adequate level of integration, reducing or eliminating redundancy between the new and existing systems.

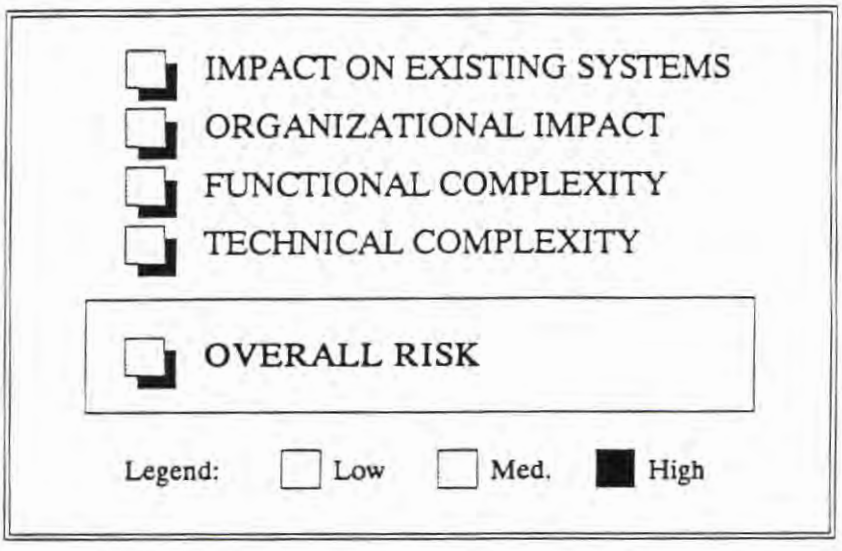
- Package Installation and Testing

  After the appropriate modifications have been made, the package should be installed and tested.

- Conversion and Implementation

  This step accounts for converting existing data and moving the application from the test environment into production. Much of the data can be expected to be converted from the existing Bridge management data files. However, new data requirements may necessitate adding or keying the additional data manually into the new system. Adequate training will also be essential in ensuring a smooth implementation.

Project Scoping & Complexity



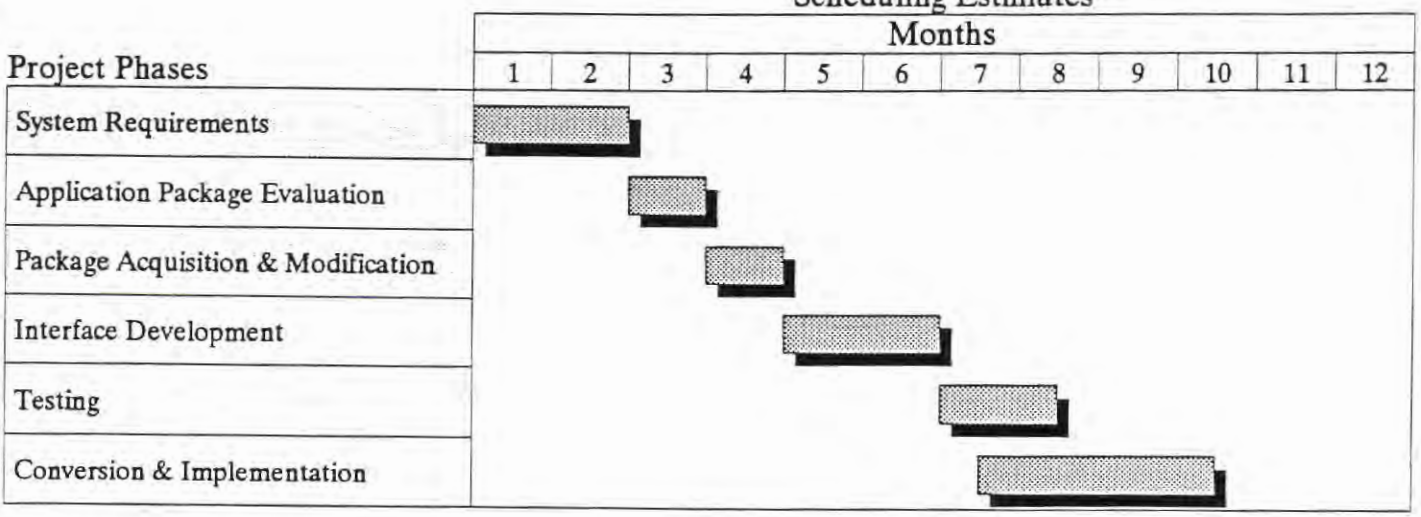
Based on the assumptions presented in the project summary, the overall risk associated with the implementation of a Bridge Management System is expected to be moderate. Primarily, only existing bridge systems will be affected. Planning applications may also be affected, depending on the Bridge Management System's impact on the current needs assessment process. This may also produce a significant organizational impact. Functionally, the programs necessary to automate many of the performance evaluations and life determinations are moderately complex. With the selection of an existing package, Data Services will be in a more difficult position to fully understand all of the programs. The overall functionality must also be understood to effectively evaluate available packages. It is difficult to estimate an implementation's technical complexity when the specific application has not been selected or developed. However, the interfaces required may be difficult. Therefore, technical complexity was viewed as moderate.

Project Estimates

Staffing Estimates

Project Phases	Internal			External		
	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
System Requirements	1	1				
Application Package Evaluation	1/2	1				
Package Acquisition & Modification	1/2	1	1			
Interface Development	1/2	1	1			
Testing	1/2	1				
Conversion & Implementation	1/2	1	1			

Scheduling Estimates



Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	6	9.5	12
DATA SERVICES FULL TIME PROJECT STAFF	1	1.5	2
USER INVOLVEMENT		☐	

Legend: ☐ Low ☐ Med. ■ High

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES		$0	
HARDWARE	$0	$5,000	$20,000
PACKAGE SOFTWARE	$0	$10,000	$20,000
TOTAL ESTIMATED INCREMENTAL COSTS	$0	$15,000	$40,000

Assumptions:

- These estimates assume sufficient internal resources available for project staffing. Therefore, no contract service costs have been included.
- The hardware costs provided are based on the requirements of the software purchases or developed. The "Low" estimate assumes the software will operate on existing hardware. The "High" estimate assumes the purchase of one workstation. The "Expected" estimate reflects upgrades to existing PC equipment.
- BMS package software costs are unknown. The "Expected" cost estimate assumes some type of participation fee. This may be a yearly fee required to receive software upgrades.

Tangible Benefits

- A Bridge Management System should provide cost savings by ensuring that the most cost–effective replacement/rehabilitation strategies are chosen to build and maintain bridges.
- By analyzing past performance of bridges, the effectiveness of different lifecycle strategies and design methods can be challenged. This should allow the Department to avoid costly over design, dangerous under design and unnecessary rehabilitations.

	Low	Expected	High
ANNUAL PRODUCTIVITY IMPROVEMENTS	$225,800	$451,700	$677,600

Assumptions:

- If more cost–effective bridge designs and comprehensive life–cycle strategies can trim slight percentages off the bridge construction and maintenance budgets, substantial benefits can be gained. The above "Low", "Expected" and "High" gains are based on bridge construction and maintenance reductions of 1%, 2% and 3% respectively.

☐ Tangible Benefits

Intangible Benefits

- The implementation of a Federally approved Bridge Management System will ensure that all Federal requirements are met.
- A Bridge Management System could improve the safety of bridges by ensuring that the bridges with the greatest need are the highest priorities.
- A Bridge Management System may allow more accurate forecasting of construction and maintenance costs.

☐ Intangible Benefits

Legend: ☐ Low ☐ Med. ■ High

Project Summary

The most formal use of bid estimating practices within the Department support the preparation of the PS&E packet and the awarding of projects. Although this was recognized as a necessary process, there are many functions within the Department felt to have more strategic importance. On the other hand, both planning and design estimates are also calculated during different phases of a project's life. By enhancing the current Bid Estimating System, the formal bid estimating process and these additional estimating efforts could be more fully supported.

This project should provide the following functional estimating capabilities:

- Provide the Ability to Evaluate Design Alternatives:

  By integrating bid estimating software with the automated design tools, preliminary costs and potential environmental problems can be identified during the design of a project.

- Provide Automatic Generation of the Project Needs List:

  This functionality will provide for the automated generation of an accurate listing of bid items and absorbed items required for a given project. This can either be provided as an enhancement to the existing Bid Estimating System or included with other estimating software added to the design tools.

- Provide Trend Analysis Capabilities for Bid Items:

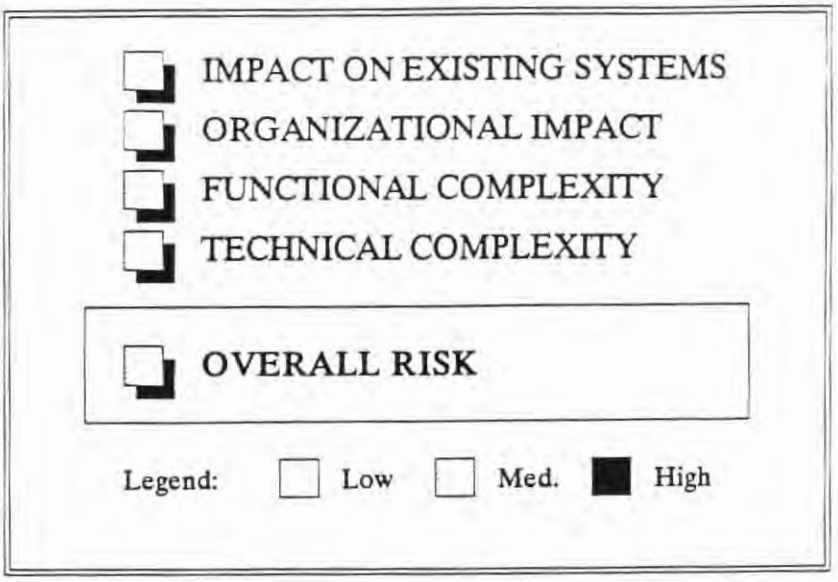
  This functionality would allow personnel in the Bid Letting Office to view the trend of bid item costs over time, providing the basis for new estimates and the ability to flag unreliable estimates.

- Provide Bid Rigging Analysis Capabilities:

  This capability would allow the Bid Letting Office to identify contractors participating in illegal bid rigging practices. It would require the ability to maintain and analyze historical contractor bidding data by geographical areas.

Because of the different efforts required to provide the above components, two separate sub-projects are required. The first sub-project, a package selection effort, will provide for the acquisition of a design estimating package, integrated with the Department's design tools. This package should also provide for the automated generation of the project needs list. The second sub-project, a custom development effort, will enhance the Department's current Bid Estimating System to provide trend analysis and bid rigging analysis capabilities. The phases required to complete each sub-project are included below with the project scheduling estimates.

Project Scoping & Complexity

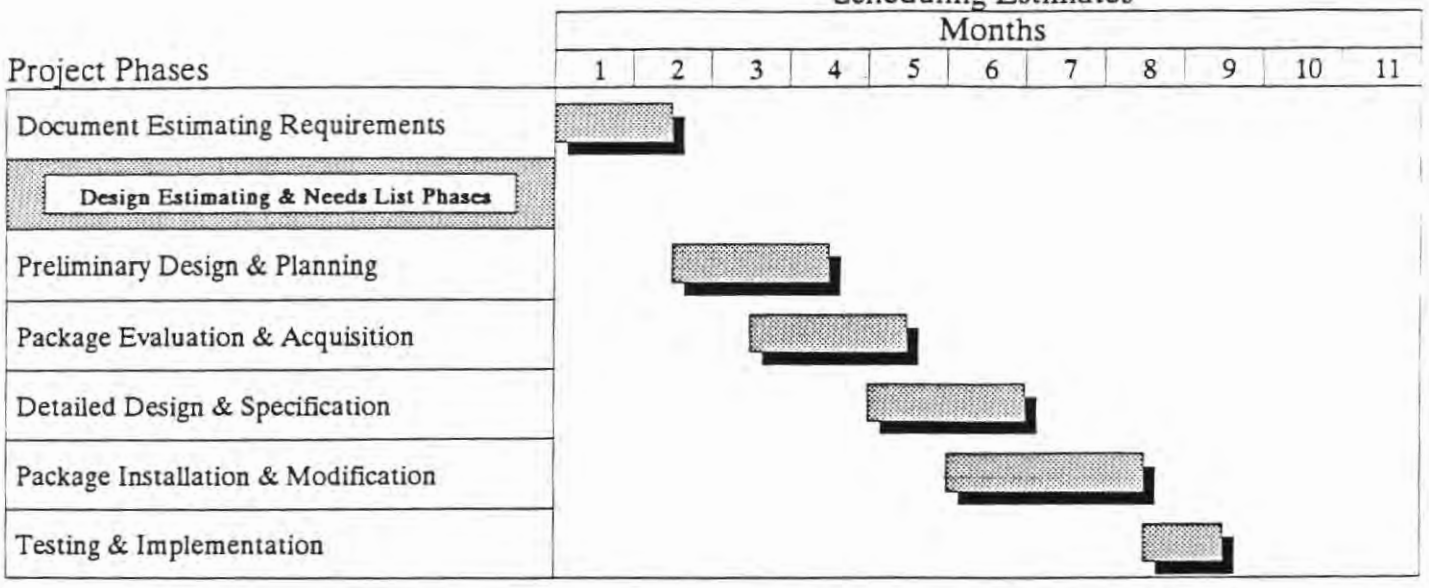


The overall risk estimated for this project is moderate. This can be attributed to the functional and technical complexity associated with integrating an estimating package with the existing design tools. Although caution should be taken to provide an integrated estimating environment, the complexity of the second sub–project is much lower.

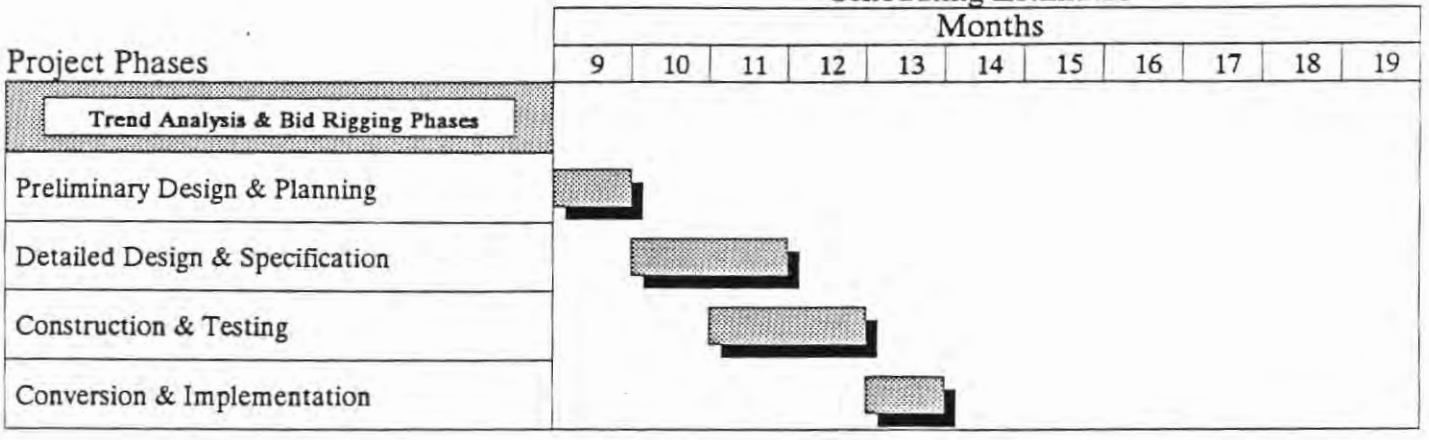
Project Estimates

	Staffing Estimates					
	Internal			External		
Project Phases	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
Document Estimating Requirements	1	1				
Design Estimating & Needs List Phases						
Preliminary Design & Planning	1/2	1				
Package Evaluation & Acquisition	1/2	1				
Detailed Design & Specification	1/2	1	1/2			
Package Installation & Modification	1/2	1	1			
Testing & Implementation	1/2	1				
Trend Analysis & Bid Rigging Phases						
Preliminary Design & Planning	1/2	1				
Detailed Design & Specification	1/2	1				
Construction & Testing	1/2	1	1			
Conversion & Implementation	1/2	1				

Scheduling Estimates



Scheduling Estimates



Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	11	13.5	16
DATA SERVICES FULL TIME PROJECT STAFF	1	1.5	2.5
USER INVOLVEMENT		☐	

Legend: ☐ Low ☐ Med. ■ High

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES		$0	
HARDWARE		$0	
PACKAGE SOFTWARE	$90,000	$140,000	$200,000
TOTAL ESTIMATED INCREMENTAL COSTS	$90,000	$140,000	$200,000

Assumptions:

- All estimates assume that a design estimating package meeting the Department's needs can be identified.
- "High" software cost estimates are based on the procurement of 25 copies of an $8,000 design estimating package.
- "Expected" software cost estimates are based on the procurement of 20 copies of a $7,000 design estimating package. A package cost discount is assumed by some site licensing or volume discount agreement.
- "Low" software cost estimates are based on the procurement of 15 copies of a $6,000 design estimating package.

Tangible Benefits

- This project should reduce the estimating efforts currently performed by several offices.
- Tying the Project Needs List to the actual design plans will ensure that no bid items are forgotten, holding contractors accountable for all items required on a project.

	Low	Expected	High
ANNUAL PRODUCTIVITY IMPROVEMENTS	$43,000	$57,500	$72,000

Assumptions:

- "Expected" productivity improvements assume a 20% gain in efficiency by all employees in the Bid Letting Office and two employees in the Materials & Surfacing Office (for preparation of Needs List and PS&E materials). "Low" and "High" estimates are based on productivity improvements of 15% and 25% respectively.

☐ Tangible Benefits

Intangible Benefits

- The implementation of design estimating software will facilitate the development of more cost–efficient designs by allowing costs associated with alternative designs to be instantly calculated.
- The ability to spot unreliable bid item estimates will increase the accuracy of project estimates.
- Bid rigging analysis capabilities would prevent the Department from dealing with parties participating in illegal price–fixing activities.

☐ Intangible Benefits

Legend: ☐ Low ☐ Med. ■ High

Project Summary

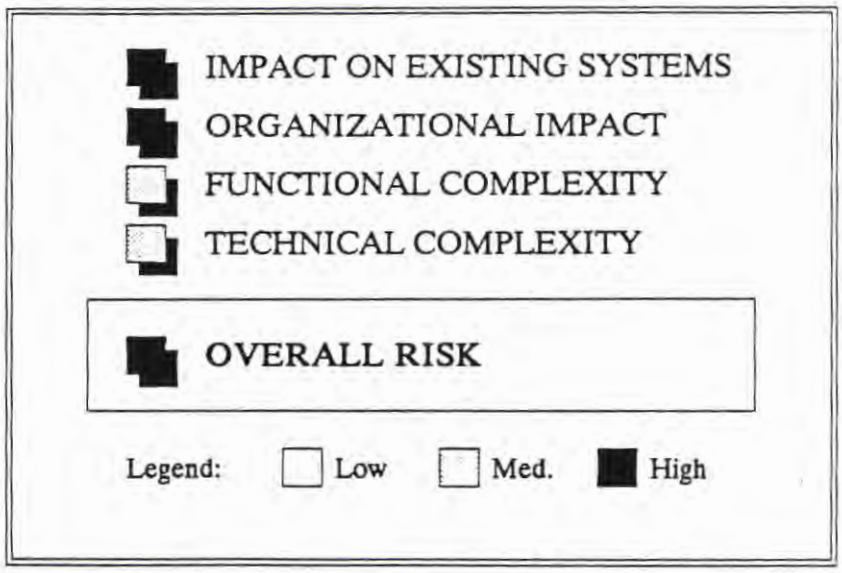
Section 1 of this plan identified the Department's accounting function as one of the most critical support functions within the Department. Yet, many of the Department's financial systems received low ratings. This is especially evident with the DOT Accounting System, which is over twenty years old and becoming increasingly difficult to maintain.

This project will provide for a phased replacement of all major components of the DOT's traditional accounting systems. The project should be initiated by preparing a detailed migration plan and outlining a phased implementation approach. This phased implementation should take into account the most efficient way to enhance all accounting functions. In order to provide an integrated application, these functions should include: employee time sheet, equipment cost distribution, financial management, accounts receivable, accounts payable and general ledger.

The replaced components should follow the standard systems development life cycle by defining functional requirements, developing a conceptual design, determining whether a package solution is available and providing for subsequent design and implementation steps based on the package versus custom development resolution. The project should also accommodate the development of interfaces to all affected applications including the State's MSA accounting system.

Although the project estimates provided below assume that a suitable accounting package can be identified to provide the system's core functionality, this package will most likely require extensive modification. Based on this project's extensive impact on existing systems, the project estimates below are very preliminary. They serve only to provide a relative magnitude of project scoping and cost.

Project Scoping & Complexity



There are many factors causing this project's overall estimated risk to be high. As discussed throughout this project, the Department's accounting applications affect a large number of other systems, causing a high "Impact on Existing Systems". A high "Organizational Impact" is also expected because of the Department's dependence on these systems for meeting Federal requirements and maintaining project cost information. Although a variety of accounting packages exist, the Department has a number of functional needs in this area. Therefore this project's "Technical Complexity" estimate and "Functional Complexity" estimate are moderate.

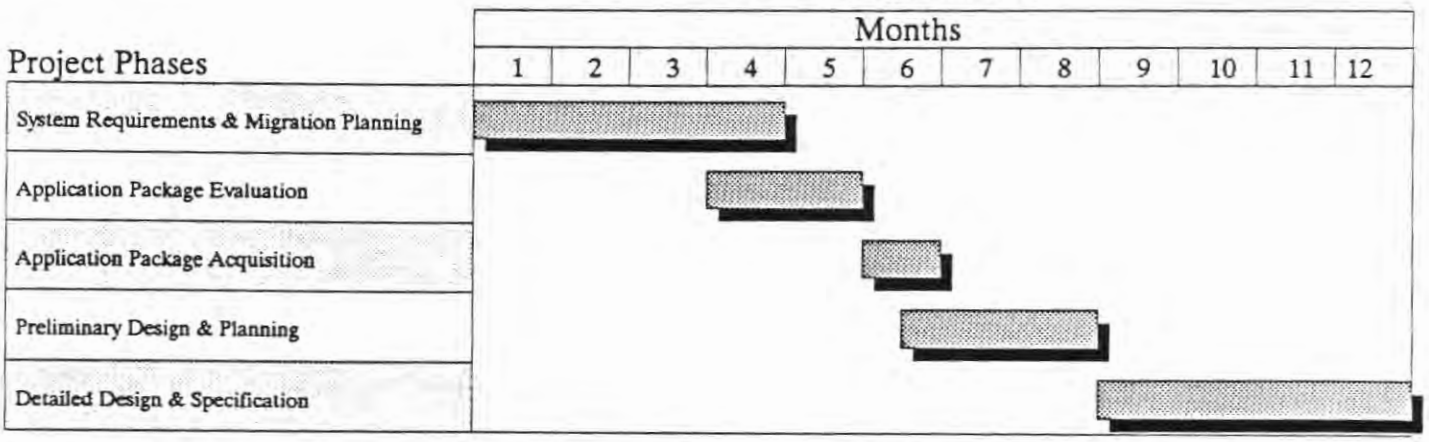
Project Estimates

Staffing Estimates

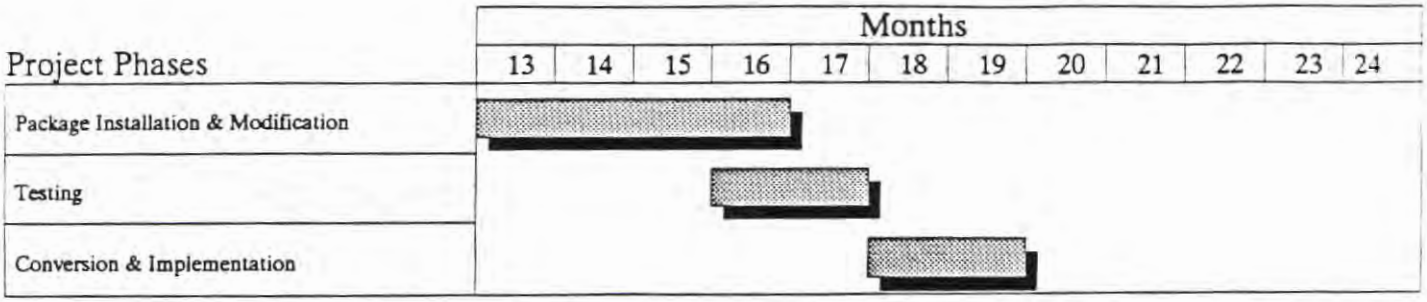
Project Phases	Internal			External		
	Proj Mgt	Analyst	Prgrmr	Proj Mgt	Analyst	Prgrmr
System Requirements & Migration Planning	1	2		1/2	2	
Application Package Evaluation	1	1		1/2	2	
Application Package Acquisition	1	1		1/2	2	
Preliminary Design & Planning	1	2		1/2	2	
Detailed Design & Specification	1	2		1/2	2	
Package Installation & Modification	1	1	2	1/2	2	
Testing	1	1	1	1/2	2	
Conversion & Implementation	1	1	1	1/2	2	

External Staffing Roles: The replacement of all major traditional components of the Department's accounting systems is a significant undertaking which will require substantial planning and structured project management. Due to the size of the undertaking and the importance of a successful implementation, external resources are recommended to participate in this strategic project. External resources may also bring valuable insight into similar implementations in other State Transportation agencies, and other packages which are available in the marketplace at the time.

Scheduling Estimates



Scheduling Estimates



Timing & Resource Estimates

	Low	Expected	High
PROJECT DURATION (MONTHS)	15	19	23
DATA SERVICES FULL TIME PROJECT STAFF	1.5	2	3
USER INVOLVEMENT		■	

Legend: ☐ Low ☐ Med. ■ High

Incremental Cost Estimates

	Low	Expected	High
CONTRACT SERVICES	$750,000	$950,000	$1,150,000
HARDWARE		$0	
PACKAGE SOFTWARE	$100,000	$150,000	$200,000
TOTAL ESTIMATED INCREMENTAL COSTS	$850,000	$1,100,000	$1,350,000

Assumptions:

- The above estimates assume that a core accounting package can be acquired. The estimates also assume extensive interface development and modification to the package.
- The "High" and "Low" project duration estimates are based on the "Expected", plus or minus 20%.
- All contract services cost estimates are based on estimated staffing levels multiplied over the respective "Low", "Expected" and "High" project duration estimates.

Tangible Benefits

- Replacement of the Department's financial accounting systems using newer technologies will improve program maintainability.
- Newer technologies will provide easier on-line input and retrieval of data.

	Low	Expected	High
ANNUAL PRODUCTIVITY IMPROVEMENTS	$85,200	$100,300	$115,300

Assumptions:

- The "Expected" productivity improvement assumes a 50% productivity gain in the system's maintainability (50% of 2 FTEs). In addition, it assumes a 15% productivity gain within Financial Operations, based on easier input and retrieval of data.

  The "High" and "Low" estimates are based on the "Expected" productivity gains, plus or minus 15%.

☐ Tangible Benefits

Intangible Benefits

- New financial systems will provide more timely access to management information.
- The new systems should provide decreased waiting time on month-end reports.
- Integration of currently interfaced applications will reduce data redundancies and data integrity problems.
- This project will provide one repository for financial data and develop one definition for each data element.

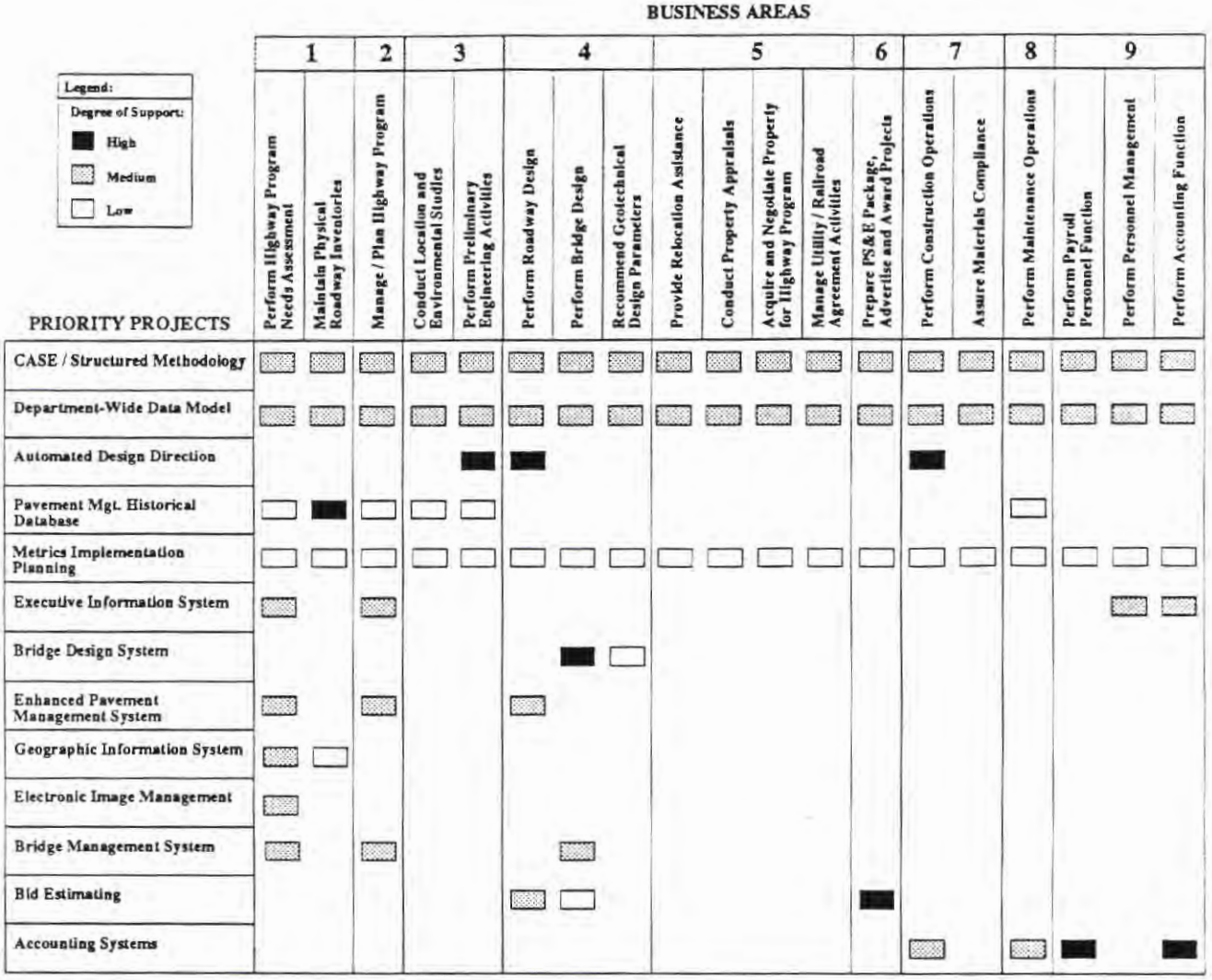
☐ Intangible Benefits

Legend: ☐ Low ☐ Med. ■ High

3. Impact of Priority Projects

The following matrix demonstrates the potential impact the implementation of these priority projects can have on the Department. The shaded bars identify the expected degree of automated support for specific critical business functions provided by the implementation of each project.

Exhibit 2.1



As explained above, "CASE/Structured Methodology" and "Department–Wide Data Model" involve the implementation of a structure supporting subsequent projects. In the long term, these projects can be expected to provide indirect support to all of the business areas. Two other projects, "Geographic Information System" and "Electronic Image Management", show limited support due to the scope of the initial project. In the short term, these projects support less critical functions. In the future, however, implementation of these projects will provide for additional application development, supporting many of the Department's critical functions.

The remainder of this section presents many projects that were identified as minor developments or enhancements. These projects may also improve the degree of support provided for the critical business areas.

4. Minor Application Development & Enhancements

The following minor application development and enhancement projects were also identified in the planning process. Although these projects are important, they do not represent the same level of strategic importance or require the resource investment necessary for the priority projects. Depending on the number of available data processing resources, these projects may be implemented in parallel with or between the implementation of priority projects. By providing these short term enhancements, Data Services may maintain a higher level of user satisfaction, while concentrating resources on priority projects.

Agreements Monitoring System

- Develop an Agreements Monitoring System:

  This project's goal would be to develop an Agreements Monitoring System capable of tracking the status of utility and railroad agreements.

Automated Testing

- Provide Automated Testing Equipment:

  Many of the tests performed in the central office and at field testing labs require manual calculations. The procurement of lab equipment that automatically records test results would reduce time and errors during testing procedures.

- Provide Computerized Scales for Weighing Materials:

  The procurement of automated scales for weighing project materials and calculating total tonnage would increase accuracy when determining pay quantities.

- Automate Collection of Test Cost Allocation Data:

  The Materials area is required to identify time spent on specific testing procedures by project. This project should begin by determining if this practice is necessary in the future. If so, standard tests and time values associated with the type of work could be established and used instead of actuals.

- Provide Data Collection Software for New Soil Strength Equipment:

  This project would provide the data collection software required for the newly acquired soil strength equipment.

Financial Reporting

- Provide Consolidated, Activity–Level Budgeting Reports:

  A consolidated financial report listing expenditures and contractual obligations would provide a valuable aid in monitoring an office's budget performance and projecting future expenditures. The reports should allow tracking of projects, programs and activities. Reporting may include: Available funds, object/subobject expenditures, travel, personal services, supplies, contractual services (including obligations and terms of contracts), assets and rents and utilities.

- Automate Financial Analysis for UMTA, HPR and PL Funding:

  This project would replace the current financial analysis for the UMTA, HPR and PL programs. It would provide an automated means of monitoring funding for each program.

Geotechnical Software

- Procure Geotechnical Software:

  This project would determine the Department's geotechnical functional requirements, and provide for the procurement of geotechnical package software.

Highway Safety Management System

- Develop a New Highway Safety Management System:

  The development of a new Safety Management System would provide users immediate access to timely accident information, automated analysis of hazardous locations and enhanced ad hoc reporting capabilities. The system would incorporate two emerging technologies (Image management and Geographic Information Systems) to allow efficient security and access to source documents, automated mapping of accident and traffic information and geographic analysis of accident trends using current maps. In order to maximize the timeliness of accident data, records could be entered online and/or scanned directly into the database. Historical data could also be maintained to provide more accurate historical analysis and reporting.

Maintenance Management System

- Improve Management of Maintenance Tasks using MMS:

  This project would provide for improved scheduling and monitoring of maintenance tasks using the Maintenance Management System. The six

week delay from when time is recorded against a task on the timesheet and when it is reflected in the Maintenance Management System has made it difficult to manage maintenance activities. This project would investigate the feasibility of increasing the frequency of accounting cycles or allowing MMS more direct access to timesheet data. It also may require changes to the time reporting and voucher subsystems.

- Automate the Maintenance Performance Budgeting Process:

  This project would automate the collection of maintenance needs data, allowing regions to prioritize and modify the number and scope of maintenance projects based on the funds available. This data should be easily transferred to the Maintenance Management System's Performance Budgeting application.

Non–State Trunk Roadways

- Replace Inventory & Needs Assessment for Non–State Trunk:

  In order to provide an approach to the assessment and prioritization of Non–State Trunk projects, the current inventory file may have to be replaced to provide detailed tracking of roadway conditions and features. If a common referencing approach can be used, the data may be added to the current RES files with slight modifications. Needs analysis capabilities may also be needed. This requirement may be addressed by the development of a comprehensive Pavement Management System. In the long–run, it may be feasible to integrate many of the local roads requirements with the information systems currently supporting the planning, designing, building and maintaining of State Trunk roadways.

Policies and Procedures

- Provide Online Access to Policies and Procedures:

  This project would provide the ability to view policies and procedures (e.g., guardrail policies) on computer displays throughout the Department. This should alleviate time spent searching through policies and procedures manuals and allow easy maintenance to a central file.

- Automate Performance Budgeting:

  This project would automate the collection and query of performance budgetin information. The following items could be included: WPRs, CCOs and Construction Status Reporting.

RES Inventories

- Provide Ability to Track Special Features:

  This project would enhance the RES files to allow the ability to track the location of special features. Possible features could include subdrains and flumes.

ROW Hardware Requirements

- Procure Additional Hardware for Right of Way:

  The procurement of additional personal computers and laptop computers would increase the efficiency of the Right of Way office. The PCs would be used to query and maintain the Relocation System and the Parcel Inventory and to communicate with other divisions via E–Mail. The laptops would be used to expedite the appraisal process by allowing the appraisers to complete forms electronically in the field. The laptops could also be used for viewing the status of relocations and acquisitions.

Traffic Control Sign Inventories

- Provide Online Access to Sign Inventories:

  Currently, many area offices maintain their own sign inventory on a PC–based system. Personnel in the central office are not able to make use of this data using the current system. This project would provide online access to the traffic control sign inventory for all offices.

Utility Permit System

- Add MRMs to Utility Permit System:

  This project would provide for the addition of Mileage Reference Markers to the current Utility Permit System. This would allow the capability to locate utility permits in relation to the highway system.