ARIZONA DEPARTMENT OF TRANSPORTATION

REPORT NUMBER: FHWA-AZ97-454

INTEGRATION OF ISTEA AND DATABASES

Final Report

Prepared by:
William Roetzheim
Marotz, Inc.
13518 Jamul Drive
Jamul, CA 91935

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Phoenix, Arizona 85007
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Federal Highway Administration

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16. Abstract

ADOT's ISTEA and related systems contain a wealth of valuable information. However, lack of integration amongst these systems prevents ADOT from realizing the full value this data may provide if accessible to a wider audience.

As a part of determining an appropriate integration strategy, it is important to consider the findings that resulted from executive surveys and interviews. A summary of key findings includes the following:

Integration is expected to offer new opportunities and efficiencies although substantial cost savings do not appear likely primarily due to resource limitations.

There is a need for better performance metrics. Availability and use of measurement information must be carefully considered.

Integration should be small in scope, focused, and gradually implemented. Integration must be affordable using existing resources. Systems must be accessible in user friendly formats. Technical skill levels of potential users are limited.

Based upon our research and understanding of ADOT resources and needs, it is our recommendation that ADOT pursue development and implementation of the INFACCS system (database link) to achieve the goal of data integration. This system has been demonstrated to the satisfaction of Marotz and ADOT TAC members and has earned the support of both groups.

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METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	2.54	centimeters	cm
ft	feet	0.3048	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	6.452	centimeters squared	cm^2
ft^2	square feet	0.0929	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
mi^2	square miles	2.59	kilometers squared	km^2
ac	acres	0.395	hectares	ha
		MASS (weight)		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		VOLUME		
fl oz	fluid ounces	29.57	millimeters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.0328	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3

Note: Volumes greater than 1000 L shall be shown in m^3.

Symbol	When You Know	Multiply By	To Find	Symbol
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

These factors conform to the requirement of FHWA Order 5190.1A

*SI is the symbol for the International System of Measurements

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
yd	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
yd^2	kilometers squared	0.39	square miles	mi^2
ha	hectares (10,000 m^2)	2.53	acres	ac
		MASS (weight)		
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1000 kg)	1.103	short tons	T
		VOLUME		
mL	millimeters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

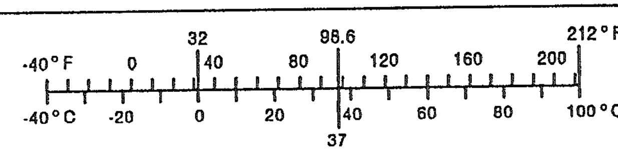


Table of Contents

Overview

In July of 1996, Marotz, Inc. began a study of ISTEA database integration for the Arizona Department of Transportation (ADOT). Business, database, and architectural analyses were performed, and candidate tools were considered to determine the feasibility, goals and recommended direction of the integration.

Initial Kick-Off and Interviews

The project began with an introductory kick-off meeting at ADOT. Technical Advisory Committee (TAC) members and Marotz reviewed and agreed on the project plan. ADOT systems within project scope were identified as well as points of contact for each system.

A series of interviews were arranged with ADOT managers for the purpose of gathering information regarding each department's technical requirements, capabilities and needs. Comprehensive documentation outlining ADOT strategies, architecture, data and operations was provided to assist in defining current infrastructure.

Data Flow Diagrams and Joint Application Development Session

Based upon the initial interviews and applicable documents, specific ISTEA data flows were diagrammed using the System Architect CASE tool. These diagrams were reviewed and further refined during a joint application development session (JAD) at ADOT that involved representatives from ISTEA and related departments. ADOT participation in this type of forum ensured that all aspects of each system's flow were accounted for including all internal and external interfaces.

Appendix I includes a management system summary, data flow tables and diagrams.

Executive Interviews

Executive input and support was recognized as an important factor in the success of any integration solution at ADOT. Interviews with key executives, along with their responses to published questionnaires, provided Marotz with valuable information to assist in formulating an appropriate plan for integration. ADOT executives were very forthcoming and helpful in identifying critical success factors, trends impacting goals, and potential barriers likely to affect the integration effort. Also discussed were unexpected benefits resulting from integration, how an integrated system might be used, type and form of information desired, and potential use and outcomes of this study.

Results of the executive interviews include the following key points:

Integration is expected to offer new opportunities and efficiencies although substantial cost savings do not appear likely primarily due to resource limitations.

There is a need for better performance metrics. Availability and use of measurement information must be carefully considered.

Integration should be small in scope, focused, and gradually implemented. Integration must be affordable using existing resources. Systems must be accessible in user friendly formats. Technical skill levels of potential users are limited.

A user accessible data dictionary would be of substantial benefit and would identify common data elements to avoid duplicates of systems/entries and would identify gaps in data.

A common desire amongst this group of ADOT representatives, was for development of a user accessible data dictionary which would identify common data elements to facilitate research efforts and maintenance (e.g. avoid duplicate systems/entries, identify gaps in data). Additionally, any initiatives to address this need were recommended to be low cost and low profile.

Commercial Data Warehouse Tools

Candidate data warehouse tools were identified, including two commercial products plus one which was developed internally by ADOT. Marotz sponsored half-day demonstrations of each of the two commercial tools selected at ADOT offices in October. Representatives from both Oracle Corporation and SHL Systemhouse provided presentations and written material describing their integrated transportation management systems for consideration by ADOT. Appendix III provides details regarding each of these systems.

A third demonstration was presented to the ADOT TAC members and Marotz representatives in January. ADOT's Transportation Planning Group, developers of the system, provided this presentation of the INFACCS system

The table that follows provides evaluation results for the Oracle, SHL and ADOT proposed solutions. Although the Oracle and SHL systems were impressive, INFACCS is clearly the superior solution for ADOT's needs. Criteria used to evaluate each system is detailed following the table.

Values: High – 3; Medium – 2; Low – 1 Evaluation Criteria

INFACCS	Oracle	SHL	
3	1	2	Incremental Procurement
3	1	2	Affordability
3	2	2	Tailored to ADOT Needs
3	2	2	Easy Data Access
3	1	2	Compatible with ADOT System Architecture (DBMS, hardware, etc.)
3	3	3	ISTEA Integration
1	3	1	Present Historical Data Logically
2	3	1	GIS Tie-In
2	3	3	Depth of Functionality
3	2	1	Development / Purchase Risk
2.6	2.1	1.9	Total Score

Evaluation criteria descriptions:

Incremental Procurement –

Can the software be purchased incrementally, allowing ADOT to migrate toward an ever more powerful system as funding is available and needs are more clearly defined? Incremental procurement allows ADOT to purchase the system gradually as funds are available.

Affordability –

Is the software affordable, including both the cost to procure and install the software itself and the cost for required upgrades to the ADOT infrastructure? Affordable systems are more clearly justified for the ADOT environment than extremely expensive systems.

Tailored to ADOT Needs –

Is the software easily tailored to specific ADOT needs? The software will better meet ADOT needs if it can be easily tailored.

Easy Data Access –

Can the data be easily viewed and manipulated by engineers and managers within ADOT? Ease of data access is one of the primary values of an integrated ISTEA system.

Compatible with ADOT System Architecture (DBMS, hardware, etc.) –

To what extent is the application compatible with existing ADOT architectural elements? Compatibility simplifies on-going system maintenance and training.

ISTEA Integration –

To what extent does the software fully integrate the various ISTEA management functions? The greater the degree of integration, the more powerful the decision support capabilities can be.

Present Historical Data Logically –

Can historical data be viewed intuitively? Viewing historical data can be useful in performing various types of analysis about historical trends.

GIS Tie-In –

What is the extent to which the software can be integrated with a Geographical Information System? Much of the ADOT desired functionality is best represented using a GIS.

Depth of Functionality –

What is the depth of analysis tools and other functionality included with the software? More functionality results in more powerful software.

Development / Purchase Risk –

What are the risks of project failure or other development/purchase problems. Lower risk projects are safer in terms of delivering on their promise.

INFACCS

INFACCS is being developed by ADOT's Transportation Planning Groupin response to requirements for a common ISTEA management reference system. Objectives of the project include: identification of data redundancy between management systems;

identification of duplicative data collection and storage effort; enhanced transportation planning through a technical architecture that will support query and reporting and seamlessly span multiple management systems. Planned completion of INFACCS is April of 1998. Following are some of the benefits that will be provided by this system:

- Literal end-user access to data and reports

- Integration non-standardized databases

- Existing systems shall remain the same

- Network load and server processing management

- Easy to maintain and administrate

- Does not affect the production environment

- Low risk investment and implementation

Additional details regarding INFACCS can be obtained from Micon, Inc.

DataFinder

The DataFinder program was developed by Marotz as a means of immediately addressing one of the deficiencies that has resulted from ISTEA non-integration: the need for a data dictionary. ADOT executives identified this same deficiency as an issue warranting attention during their interviews with Marotz. Data Finder is a data dictionary that finds and defines data elements existing within any one of the ADOT databases. Using DataFinder, an ADOT associate can search and determine the source or existence of specific system elements and/or descriptions as well as other element information.

Summary of Findings and Recommendations

ADOT's ISTEA and related systems contain a wealth of valuable information. However, lack of integration amongst these systems prevents ADOT from realizing the full value this data may provide if accessible to a wider audience. Integration is indeed a worthwhile goal and will undoubtedly enhance the effectiveness of the databases maintained by ADOT.

As a part of determining an appropriate integration strategy, it is important to consider the findings that resulted from executive surveys and interviews. A summary of key findings includes the following:

> Integration is expected to offer new opportunities and efficiencies although substantial cost savings do not appear likely primarily due to resource limitations.
>
> There is a need for better performance metrics. Availability and use of measurement information must be carefully considered.
>
> Integration should be small in scope, focused, and gradually implemented. Integration must be affordable using existing resources. Systems must be accessible in user friendly formats. Technical skill levels of potential users are limited.
>
> A user accessible data dictionary would be of substantial benefit and would identify common data elements to avoid duplicates of systems/entries and would identify gaps in data.

Based upon our research and understanding of ADOT resources and needs, it is our recommendation that ADOT pursue development and implementation of the INFACCS system (database link) to achieve the goal of data integration. Although in its early stages it was uncertain as to whether this system would meet ADOT's integration needs, INFACCS has made great advances in the directions necessary to resolve integration issues. This system has been demonstrated to the satisfaction of Marotz and ADOT TAC members and has earned the support of both groups.

Resources

ADOT Documents

ADOT Technical Information Resources Three Year Plan 1996-1998
Micon Inc. Executive Presentation 8/1/96
Strategic Plan for ITS Communications
Arizona State Transportation Plan 12/94
Lima and Associates diagrams (2 pg.)
HPMS ESAL report samples (4 pg.)
HPMS Field Manual 8/30/93 and 4/22/94
State Bridge Inventory System (SBIS) Guide 10/91
Safety Management System Work Plan 7/1/94
CLOSE with ALISS 2/88
ATIS News 7/30/96
ISTEA/Data Coordination Project, Final Report 7/95
Draft YMPO 1995 Congestion Management Report
Maintenance Management Table of Contents for Rating Criteria Sheets (3 pgs)
PTMS Transportation Management System, 2/95
Public Transportation Management System (PTMS), Phase Two Strategic Options 3/96
PTMS Report and Database User's Manual, 9/95
PAG 1992, Mobility Management Plan, Summary Plan
Draft Final Report, Congestion Management System
Congestion Management System, Fiscal Year 1995
Intermodal Transportation Division, Data Elements
Intermodal, Traffic Engineering Group, Data Elements
Lee Engineering, CMS Link File Description (2 pgs)
Pavement Structure for Table
Pecos Data Elements
National Bridge Inventory Record Format

ADOT Associates

The following ADOT associates played a valuable role in contributing to this study. Their genuine interest, forthright manner, consideration and support in providing assistance was greatly appreciated.

Name	Title or Department	Role in Study
Dell Beesley	Five Year Plan	Technical Advisory Committee
Larry Bonine	Director	Executive interviewee
Wes Bowling	Five Year Plan	Participated in initial interview and information gathering

Name	Title or Department	Role in Study
		process
Dale Buskirk	Intermodal Management	Participated in initial interview and information gathering process
Ron Chubb	Maintenance Management	JAD attendee
Murray Collon	Maintenance Planning Services, EDP Supervisor	JAD attendee
Wayne Collins	Intermodal Transportation Division, Deputy State Engineer	Executive interviewee
Dan Davis	Bridge	JAD attendee
Jim Delton	Pavement Management	Project Manager; participated in initial interview and information gathering process; JAD attendee; participated in evaluation of DataFinder
Jim Dorre	Maintenance Management	Participated in initial interview and information gathering process; evaluated DataFinder
David Duffy	Traffic Engineering	JAD attendee
Tony Gonzales	GIS	Participated in initial interview and information gathering process
August Hardt	Assistant State Engineer	Executive interviewee
Ken Howell	Congestion Management (Lee Engineering)	Participated in initial interview and information gathering process
Glenn Jonas	FMS	JAD attendee
Charles Jones	PPMS	JAD attendee
Hari Khana	Project Scheduling	Participated in initial interview and information gathering process
Greg Kiely	Public Transit Management	Participated in initial interview and information gathering process; JAD attendee
Jay Klagge	Transportation Planning	Executive interviewee
Cheryl Egland	Engineering	DataFinder evaluation
John Louis		Technical Advisory Committee, DataFinder evaluation
Mike Manthey	Safety Management & ALISS	Participated in initial interview and information gathering process; JAD attendee; participated in evaluation of DataFinder
Joe O'Neill	Equipment Services	Executive interviewee
Mary Peters	Deputy Director	Executive interviewee

Name	Title or Department	Role in Study
Bob Pike	Traffic Monitoring & HPMS	Participated in initial interview and information gathering process; JAD attendee
Thalia Pratt	Public Transit Management	JAD attendee
Wayne Rich	GIS Mapping	JAD attendee
Suzanne Sale	Administrative Services	Executive interviewee
Bill Sapper	Public Transit Management	JAD attendee
Tom Schmitt	State Engineer	Executive interviewee, DataFinder evaluation
John Semmens	Intermodal Transportation Division, Senior Planner	Project Manager DataFinder installation
Jim Shea	Freeway Management	Participated in initial interview and information gathering process
Katie Underwood-Murphey	Chief Information Officer, Technical Information Resources	Executive interviewee
Tim Wolfe	Intelligent Highway	Participated in initial interview and information gathering process
Pe-Shen Yang	Bridge Management	Participated in initial interview and information gathering process; JAD attendee

Commercial Resources

Technical presentations of commercial data warehouse tools for transportation management systems were provided at ADOT by:

Oracle Corporation
SHL Systemhouse Inc.

Other Resources

A presentation of ADOT's PMIS integration plan was provided during the January TAC meeting by Dell Beesley and Wes Bowling.

Appendices

Appendix I	Glossary
Appendix II	Management System Summary Table and Data Flow Tables and Diagrams
Appendix III	Oracle Transportation
Appendix IV	SHL Infrastructure Management System
Appendix V	DataFinder User's Manual

Appendix I

Glossary

Glossary

	Definition
ADOT	Arizona Department of Transportation
ALISS	Accident Location Identification and Surveillance System, safety management system
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
CLOSE	Locates candidate locations for operational evaluations
COG	Council of Government
CMS	Congestion Management System consists of information based on the identification of congested facilities and mobility conditions
EMS	Equipment Management System
FHWA	Federal Highway Authority
FMS	Freeway Management System maintains records of district road conditions and traffic volumes
HPMS	Highway Performance Management System consists of historical information that represents travel estimates for the National Highway System
IMS	Intermodal Management System consists of information based upon the convenient intermodal movement of people and goods through the integration of transportation facilities and systems
ISTEA	Intermodal Surface Transportation Efficiency Act
MAG	Metropolitan Association of Governments
MPO	Metropolitan Planning Organization
NBI	National Bridge Inventory
PECOS	Maintenance management system tracks maintenance of pavement, ditches, fences, (not buildings), interstate, rest areas, landscaping, paint stripes, ramps, lots.
PMIS	Project Management Information System tracks information resource data, geographical locations, project tracking data, comments, cost estimates and actuals, additional planning data (projections for completion dates)
PMS	Pavement Management System is a historical information repository of pavement conditions and characteristics
PONTIS	Performs economic forecasting, planning and project maintenance scheduling
Project Scheduling	Maintains an overview of projects ad their scheduling status and cost
PTMS	Public Transit Management System
RPTA	Regional Public Transit Authority
SBIS	State Bridge Inventory System tracks information about state bridges as dictated by the NBI
SMS	Safety Management System (ALISS)
SIA	Structural Inventory and Appraisal Sheets
TAC	Technical Advisory Committee
TMS	Traffic Management System

	Definition
TPG	Transportation Planning Group

Appendix II

Management System Summary Table

Data Flow Tables and Diagrams

Management System Summary

ISTEA MANAGMENT	SYSTEM	DESCRIPTION	AUTOMATION
Bridge	SBIS State Bridge Inv PONTIS	SBIS (State Bridge Inventory System) tracks information about state bridges dictated by the NBI (National Bridge Inventory). PONTIS will perform economic forecasting, planning and project maintenance scheduling.	PC based Borland Dbase IV PC based mult serv
Pavement	PMS Pavement Mgmt Sys	PMS is a historical information repository of pavement conditions and characteristics.	Four Microsoft Foxpro databases
Safety	ALISS Accident Location Identification & Surveillance	ALISS is a historical repository of information pertaining to accidents. CLOSE program locates candidate locations for operational evaluations.	Sun/PC environment using Sybase database software. Core of ALISS is UNIX-based Geographical Information System, GIS, developed with ESRI's ARC/INFO and ARCVIEW software components.
Public Transit	PTMS Public Transp. Facilities & Equip.	PTMS is used to manage conditional and descriptive information of both vehicle and facility type assets which fall under the Public Transportation classification.	Microsoft Foxpro
Intermodel	IMS	Intermodal system consists of information based upon the convenient intermodal movement of people and goods through the integration of transportation facilities and systems.	Microsoft Access integrated w/Mapinfo GIS software
Congestion	CMS	Congestion consists of information based on the identification of congested facilities and mobility conditions.	Quatro spreadsheet
	HPMS Highway Performance Monitoring	HPMS consists of historical information which represents travel estimates for the National Highway System.	Microsoft Foxpro
	PMIS 5 Year Plan Project Mgmt. Info. Sys.	PMIS tracks information resource data, geographical locations, project tracking data, comments, cost estimates and actuals, additional planning data (projections for completion dates).	
	FMS Freeway	FMS maintains records of district road conditions and traffic volumes.	Sybase Sun Unix

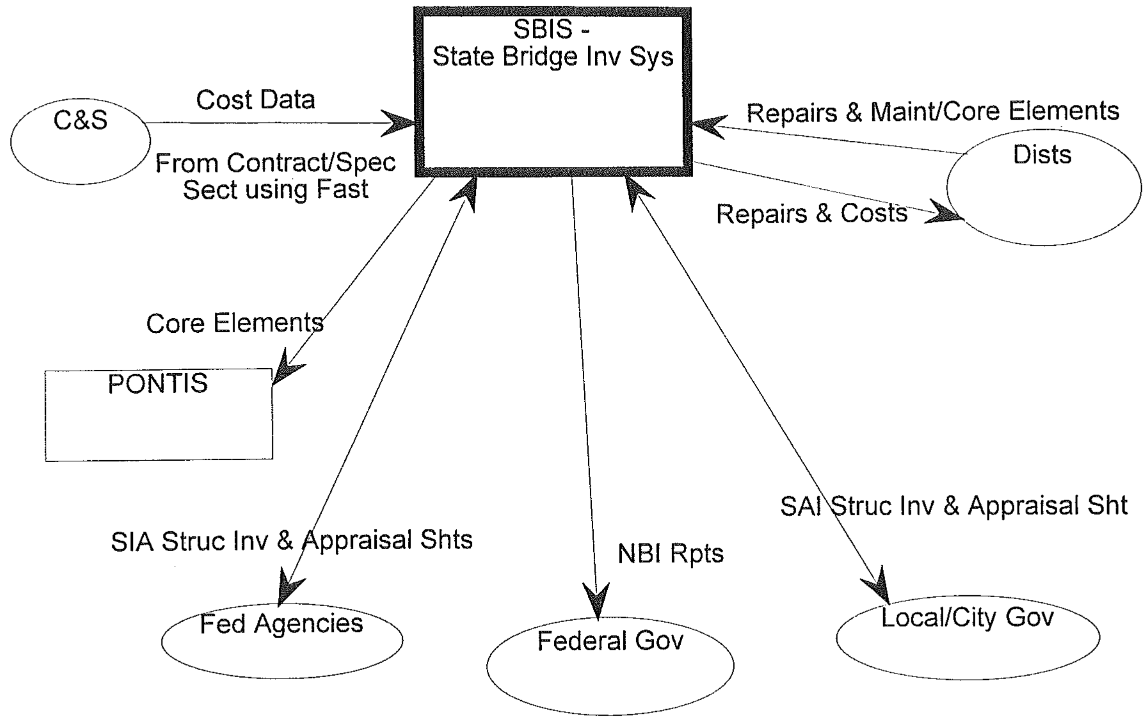
ISTEA MANAGMENT	SYSTEM	DESCRIPTION	AUTOMATION
	PECOS Maintenance Mgmt. Sys.	Tracks maintenance of pavement, ditches, fences, (no buildings), interstate, rest areas, landscaping, paint stripes, ramps, lots.	Pecos II dbase & mainframe (IMS)
	Project Scheduling	Maintains overview of projects and their scheduling status and cost.	Primavera/Artemis

SBIS

State Bridge Inventory System

The State Bridge Inventory System, SBIS, tracks information about state bridges as dictated by the National Bridge Inventory, NBI. Data flow is summarized in the following table and diagram.

Incoming Data Flow	Outgoing Data Flow
Cost Data from contract specialists using FAST	
	Core elements to PONTIS
SIA structure inventory and appraisal sheets from federal agencies	SIA structure inventory and appraisal sheets to federal agencies
	NBI reports to federal government
SAI structure inventory and appraisal sheets from local and city government	SAI structure inventory and appraisal sheets to local and city government
	Repairs and costs to districts
Repairs and maintenance/core elements from districts	

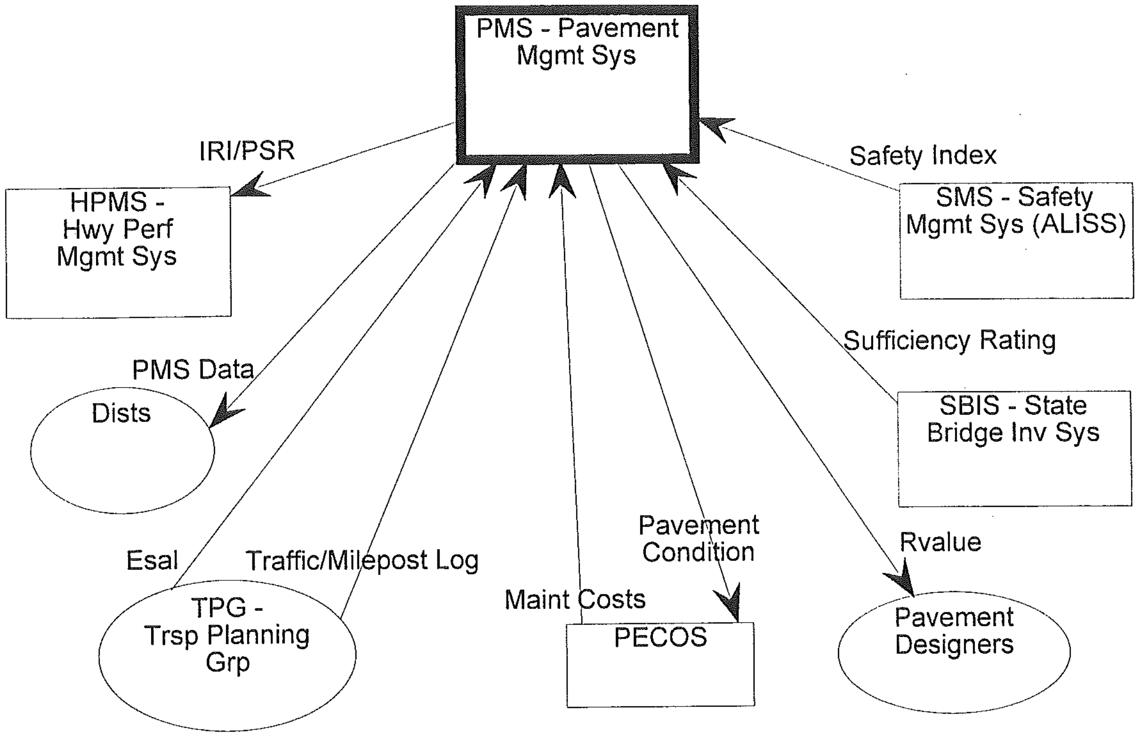

SBIS -
State Bridge Inv Sys
C&S
Cost Data
From Contract/Spec
Sect using Fast
Repairs & Maint/Core Elements
Dists
Repairs & Costs
Core Elements
PONTIS
SIA Struc Inv & Appraisal Shts
NBI Rpts
SAI Struc Inv & Appraisal Sht
Fed Agencies
Federal Gov
Local/City Gov

PMS

Pavement Management System

The Pavement Management System, PMS, is a historical information repository of pavement conditions and characteristics. Data flow is summarized in the following table and diagram.

Incoming Data Flow	Outgoing Data Flow
	IRI/PSR to HPMS
	PMS data to districts
Esal data from TPG	
Traffic/milepost log from TPG	
Maintenance costs from PECOS	
	Pavement condition to PECOS
	R value to pavement designers
Sufficiency rating from SBIS	
Safety index from SMS	

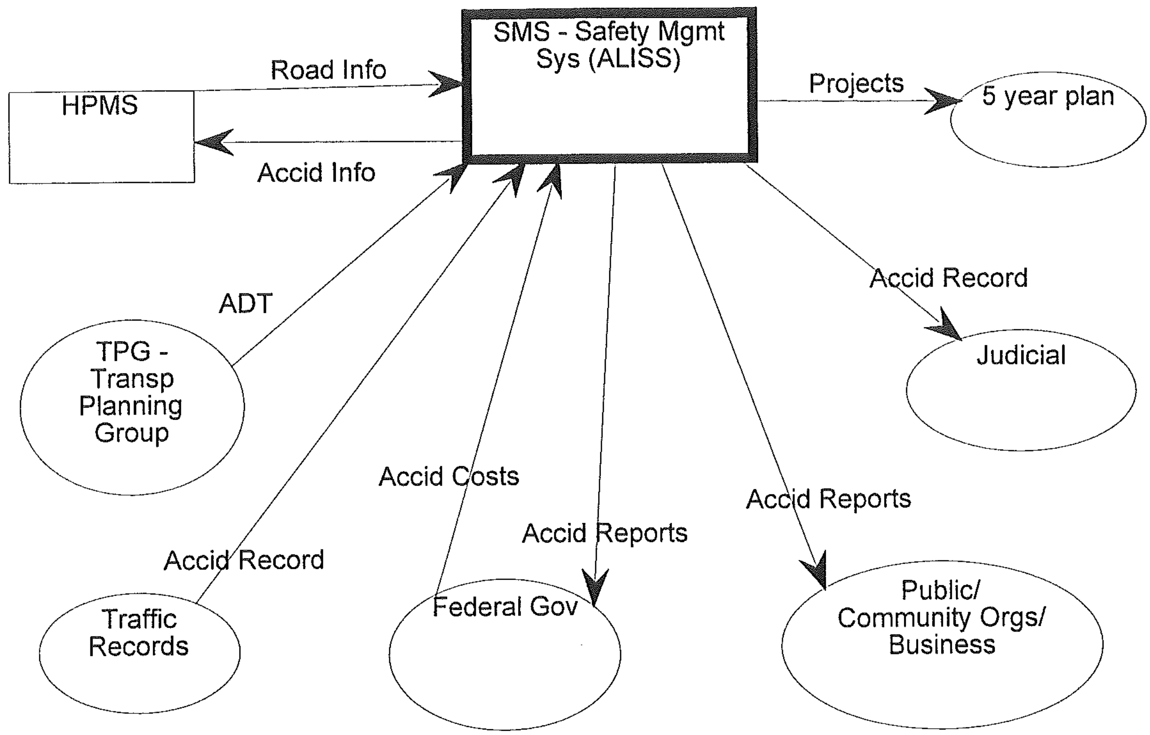

PMS - Pavement Mgmt Sys
IRI/PSR
HPMS - Hwy Perf Mgmt Sys
Safety Index
SMS - Safety Mgmt Sys (ALISS)
Sufficiency Rating
SBIS - State Bridge Inv Sys
PMS Data
Dists
Esal
Traffic/Milepost Log
TPG - Trsp Planning Grp
Maint Costs
Pavement Condition
PECOS
Rvalue
Pavement Designers

ALISS

Accident Location Identification and Surveillance System

The Accident Location Identification and Surveillance System, ALISS, is a historical repository of information pertaining to accidents. The CLOSE program locates candidate locations for operational evaluation. Data flow is summarized in the following table and diagram.

Incoming Data Flow	Outgoing Data Flow
Road information from HPMS	
	Accident information to HPMS
ADT from TPG	
Accident records from traffic records	
Accident costs from federal government	
	Accident reports to federal government
	Accident reports to public, community organizations, businesses
	Accident records to judicial
	Projects to five year plan

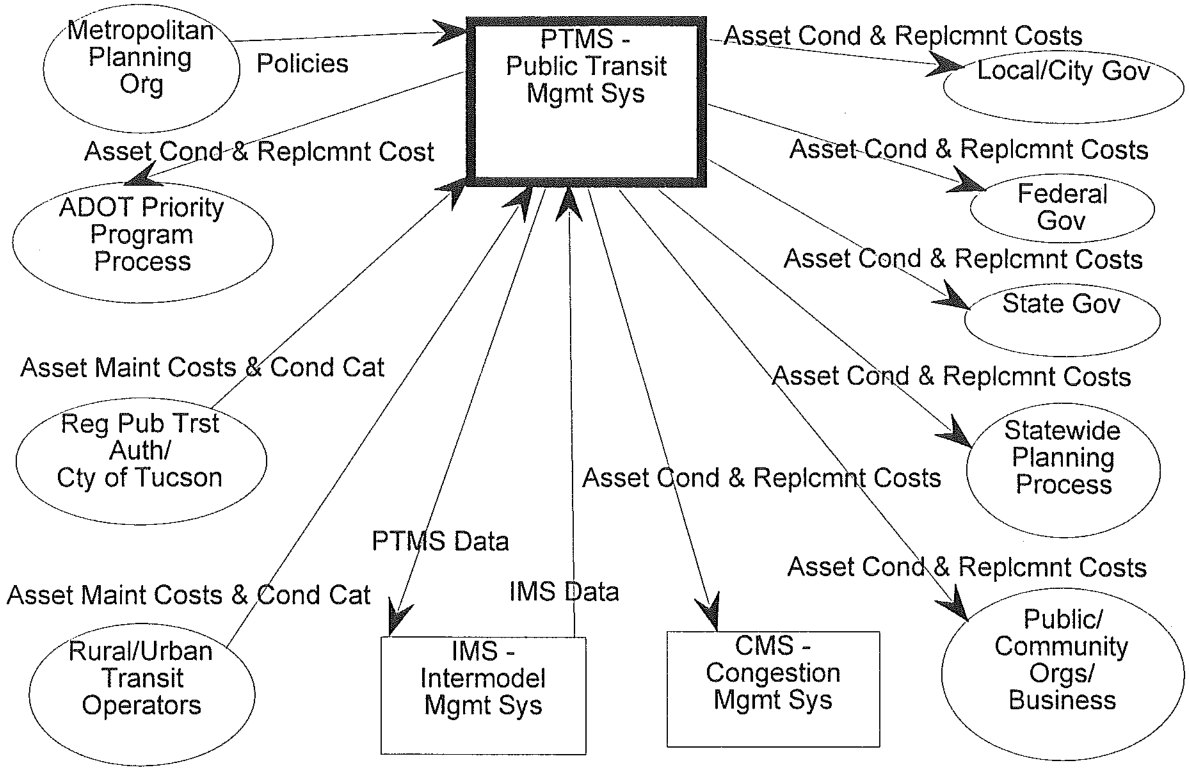

SMS - Safety Mgmt Sys (ALISS)
HPMS
Road Info
Accid Info
Projects
5 year plan
ADT
TPG - Transp Planning Group
Accid Record
Judicial
Accid Costs
Accid Reports
Accid Reports
Accid Record
Traffic Records
Federal Gov
Public/ Community Orgs/ Business

PTMS

Public Transit Management System

The Public Transit Management System is used to manage conditional and descriptive information of both vehicle and facility type assets which fall under the Public Transportation classification. Data flow is summarized in the following table and diagram.

Incoming Data Flow	Outgoing Data Flow
Policies from MPO	
	Asset conditions and replacement costs to priority program process
Asset maintenance costs and conditions categories from regional public transit authority and rural/urban transit operators	
	PTMS data to IMS
IMS data from IMS	
	Asset condition and replacement costs to CMS, public, community organizations, businesses, statewide planning process, state/federal/local/city government

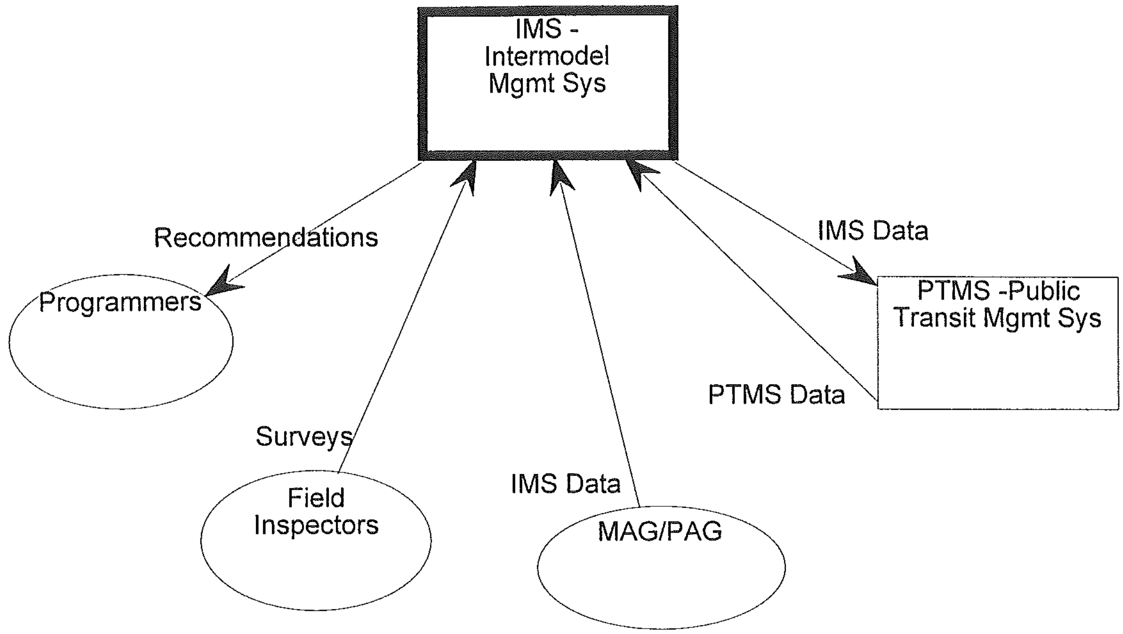

PTMS -
Public Transit
Mgmt Sys
Metropolitan
Planning
Org
Policies
Asset Cond & Replcmnt Cost
ADOT Priority
Program
Process
Asset Maint Costs & Cond Cat
Reg Pub Trst
Auth/
Cty of Tucson
Asset Maint Costs & Cond Cat
Rural/Urban
Transit
Operators
PTMS Data
IMS Data
IMS -
Intermodel
Mgmt Sys
CMS -
Congestion
Mgmt Sys
Asset Cond & Replcmnt Costs
Local/City Gov
Asset Cond & Replcmnt Costs
Federal
Gov
Asset Cond & Replcmnt Costs
State Gov
Asset Cond & Replcmnt Costs
Statewide
Planning
Process
Asset Cond & Replcmnt Costs
Asset Cond & Replcmnt Costs
Public/
Community
Orgs/
Business

IMS

Intermodal Management System

The Intermodal Management System, IMS, consists of information based upon the convenient intermodal movement of people and goods through the integration of transportation facilities and systems. Data flow is summarized in the following table and diagram.

Incoming Data Flow	Outgoing Data Flow
	Recommendations to programmers
Surveys from field inspectors	
IMS data from MAG/PAG	
PTMS data from PTMS	
	IMS data to PTMS

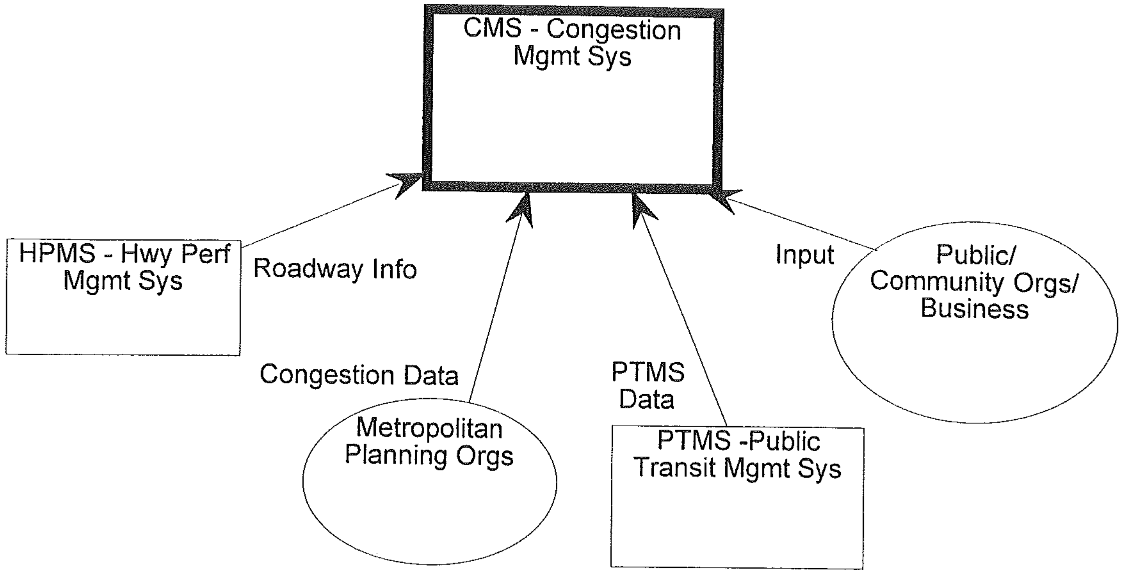

IMS -
Intermodel
Mgmt Sys
Recommendations
IMS Data
Programmers
PTMS -Public
Transit Mgmt Sys
PTMS Data
Surveys
Field
Inspectors
IMS Data
MAG/PAG

CMS

Congestion Management System

The Congestion Management System, CMS, consists of information based on the identification of congested facilities and mobility conditions. Data flow is summarized in the following table and diagram.

Incoming Data Flow	Outgoing Data Flow
Roadway information from HPMS	
Congestion data from MPO	
PTMS data from PTMS	
Input from public, community organizations, businesses	



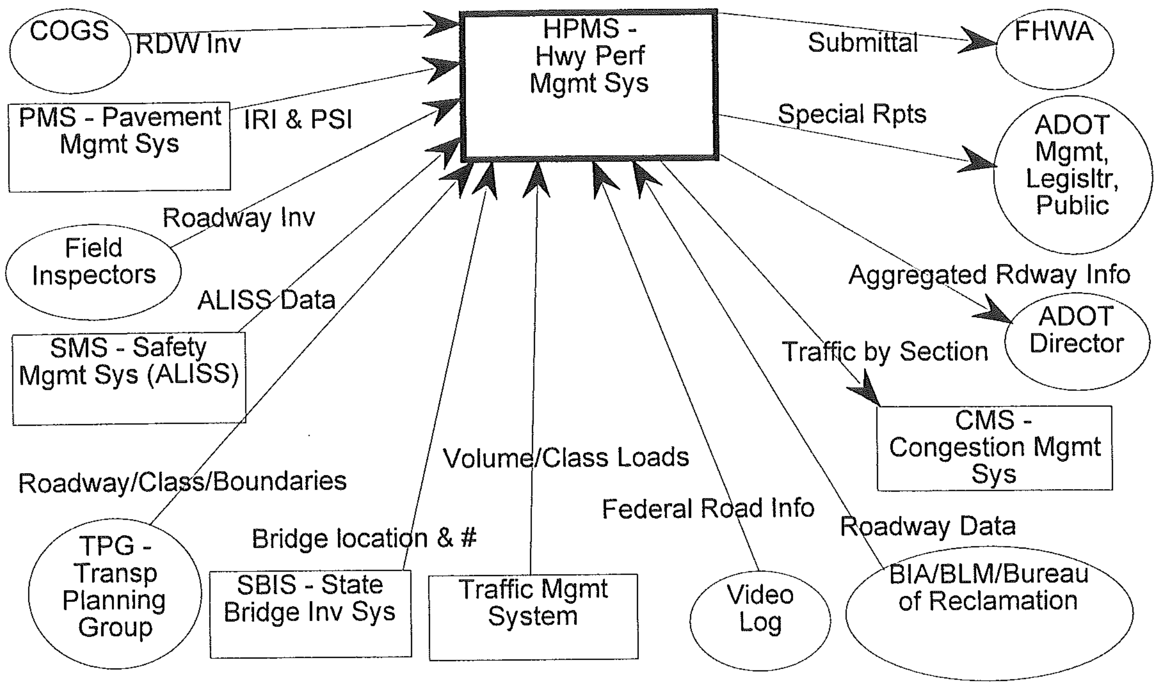
Future plans include rating information from BMS, SMS, IMS, PMS and from non-urban COGs such as Ctrl AZ Assoc of Gov (CAAG), N AZ Council of Gov (NACOG), SE AZ Gov Org (SEAGO), W AZ COG (WACOG).

HPMS

Highway Management System

The Highway Management System, HPMS, consists of historical information that represents travel estimates for the National Highway System. Data flow is summarized in the following table and diagram.

Incoming Data Flow	Outgoing Data Flow
RDW from COGS	
IRI and PSI from PMS	
Roadway Inventory from field inspectors	
ALISS data from ALISS	
Roadway, class, boundaries from TPG	
Bridge location and number from SBIS	
Volume/class loads from TMS	
Federal road information from video log	
Roadway data from BIA/BLM/Bureau of Reclamation	
	Traffic by section to CMS
	Aggregated roadway information to ADOT director
	Special reports to ADOT management, legislators, public
	Submittal to FHWA

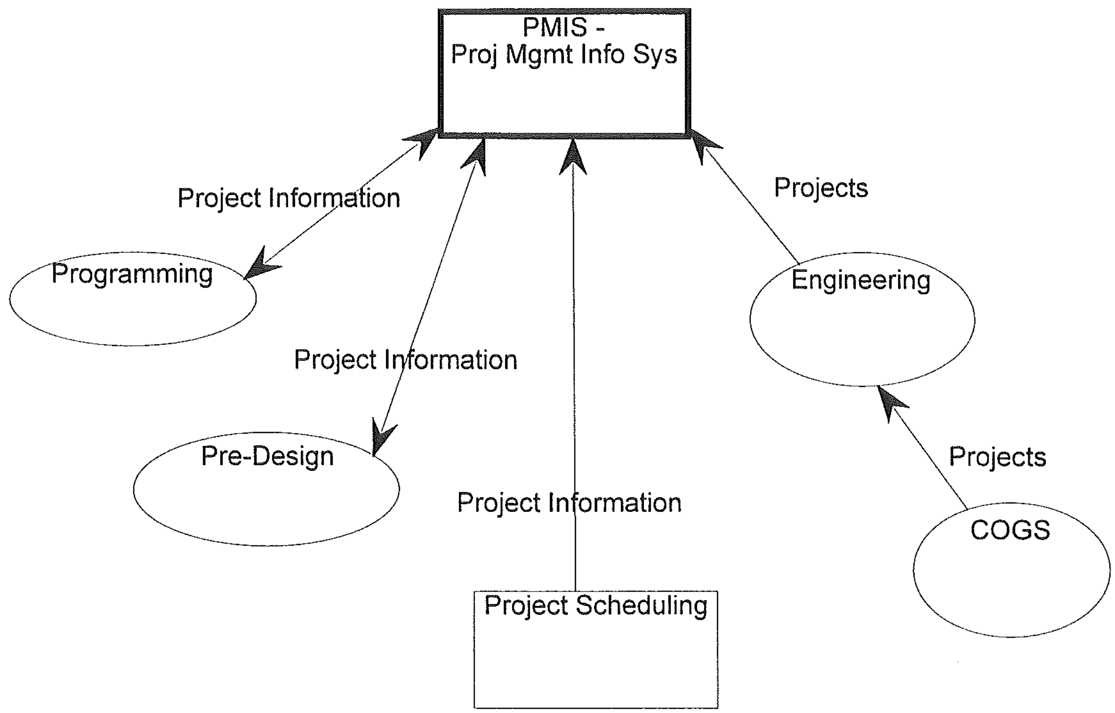

COGS
RDW Inv
HPMS - Hwy Perf Mgmt Sys
Submittal
FHWA
PMS - Pavement Mgmt Sys
IRI & PSI
Special Rpts
ADOT Mgmt, Legisltr, Public
Roadway Inv
Field Inspectors
ALISS Data
Aggregated Rdway Info
ADOT Director
SMS - Safety Mgmt Sys (ALISS)
Traffic by Section
CMS - Congestion Mgmt Sys
Volume/Class Loads
Roadway/Class/Boundaries
Federal Road Info
Roadway Data
Bridge location & #
TPG - Transp Planning Group
SBIS - State Bridge Inv Sys
Traffic Mgmt System
Video Log
BIA/BLM/Bureau of Reclamation

PMIS

Project Management Information System

The Project Management Information System, PMIS, tracks information resource data, geographical locations, project tracking data, comments, cost estimates and actuals, additional planning data (projections for completion dates). Data flow is summarized in the following table and diagram.

Incoming Data Flow	Outgoing Data Flow
Project information from programming and pre-design	Project information to programming and pre-design
Project information from project scheduling	
Projects from engineering (originating from COGS)	

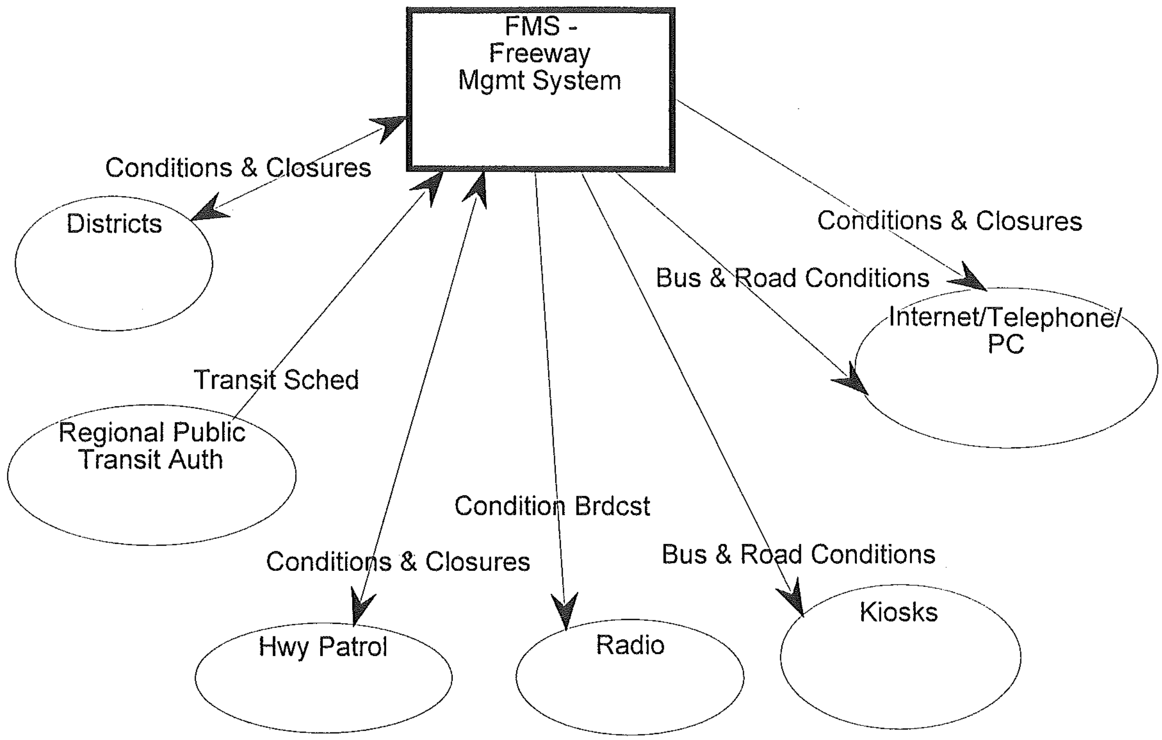

PMIS -
Proj Mgmt Info Sys
Project Information
Projects
Programming
Engineering
Project Information
Pre-Design
Projects
Project Information
COGS
Project Scheduling

FMS

Freeway Management System

The Freeway Management System, FMS, maintains records of district road conditions and traffic volumes. Data flow is summarized in the following table and diagram.

Incoming Data Flow	Outgoing Data Flow
Conditions and closures from districts and highway patrol	Conditions and closures to districts and highway patrol
Transit schedule from regional public transit authority	
	Condition broadcast to radio
	Bus and road conditions to kiosks, internet, telephone, PC
	Conditions and closures to internet, telephone, PC

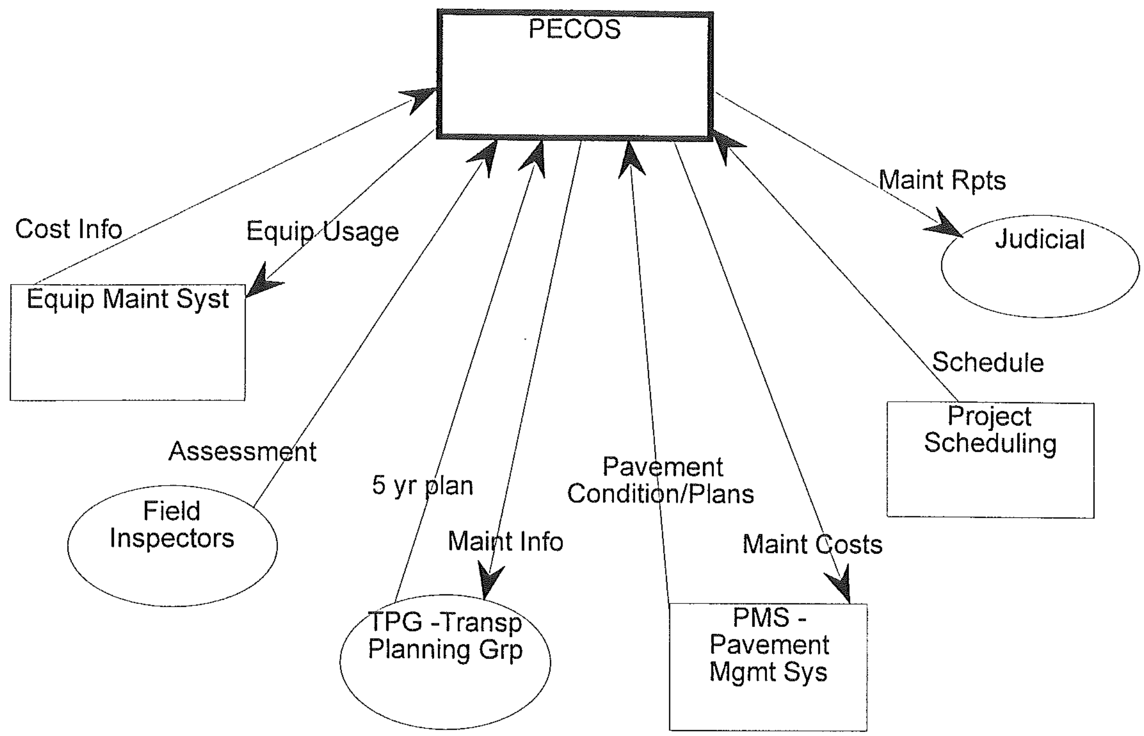

FMS -
Freeway
Mgmt System
Conditions & Closures
Districts
Transit Sched
Regional Public
Transit Auth
Conditions & Closures
Hwy Patrol
Condition Brdcst
Radio
Bus & Road Conditions
Kiosks
Conditions & Closures
Bus & Road Conditions
Internet/Telephone/
PC

PECOS

PECOS Maintenance Management System

The PECOS Maintenance Management System tracks maintenance of pavement, ditches, fences, (not buildings), interstate, rest areas, landscaping, paint stripes, ramps, lots. Data flow is summarized in the following table and diagram.

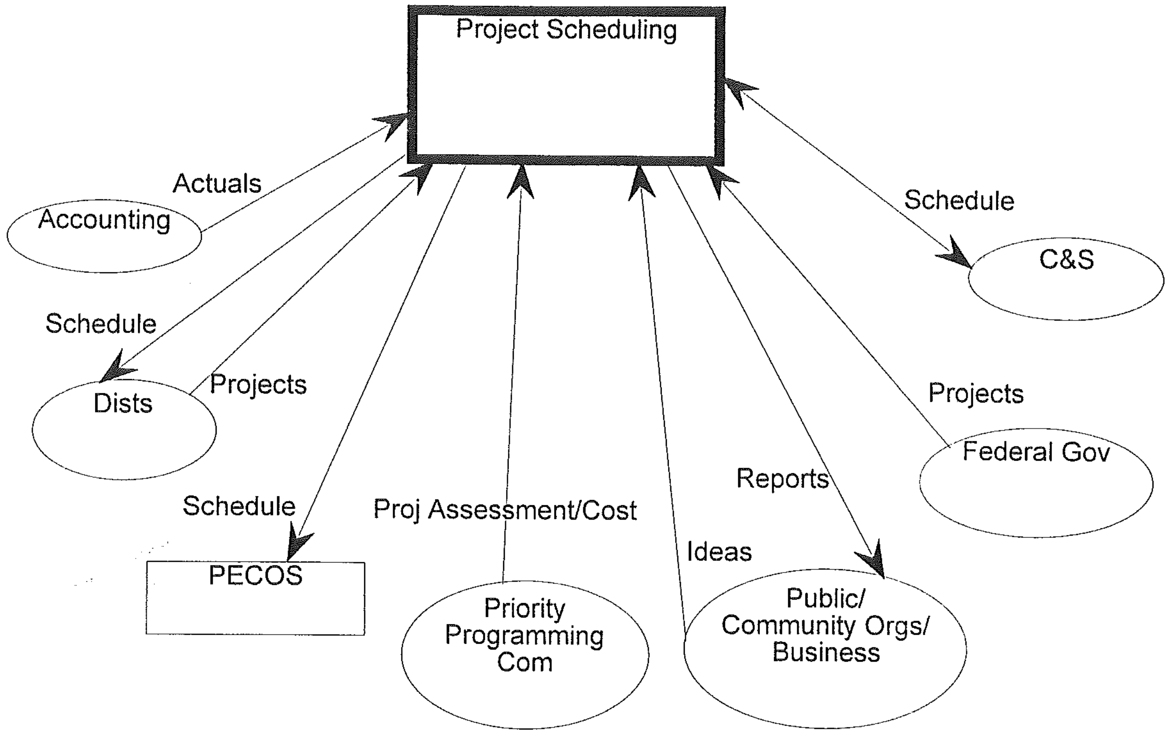
Incoming Data Flow	Outgoing Data Flow
Cost information from EMS	
	Equipment usage to EMS
Assessment information from field inspectors	
5 year plan from TPG	
	Maintenance information to TPG
Pavement condition and plans from PMS	
	Maintenance costs to PMS
Schedule from project scheduling	
	Maintenance reports to judicial


PECOS
Cost Info
Equip Usage
Maint Rpts
Judicial
Equip Maint Syst
Schedule
Project Scheduling
Assessment
5 yr plan
Pavement Condition/Plans
Field Inspectors
Maint Info
Maint Costs
TPG -Transp Planning Grp
PMS - Pavement Mgmt Sys

Project Scheduling System

The Project Scheduling System maintains an overview of projects and their scheduling status and cost. Data flow is summarized in the following table and diagram.

Incoming Data Flow	Outgoing Data Flow
Actuals from accounting	
	Schedule to districts
Projects from districts	
	Schedule to PECOS
Project Assessment and cost from priority programming committee	
Ideas from public, community organizations, businesses	
	Reports to public, community organizations, businesses
Projects from federal government	
Schedule from C & S	Schedule to C & S

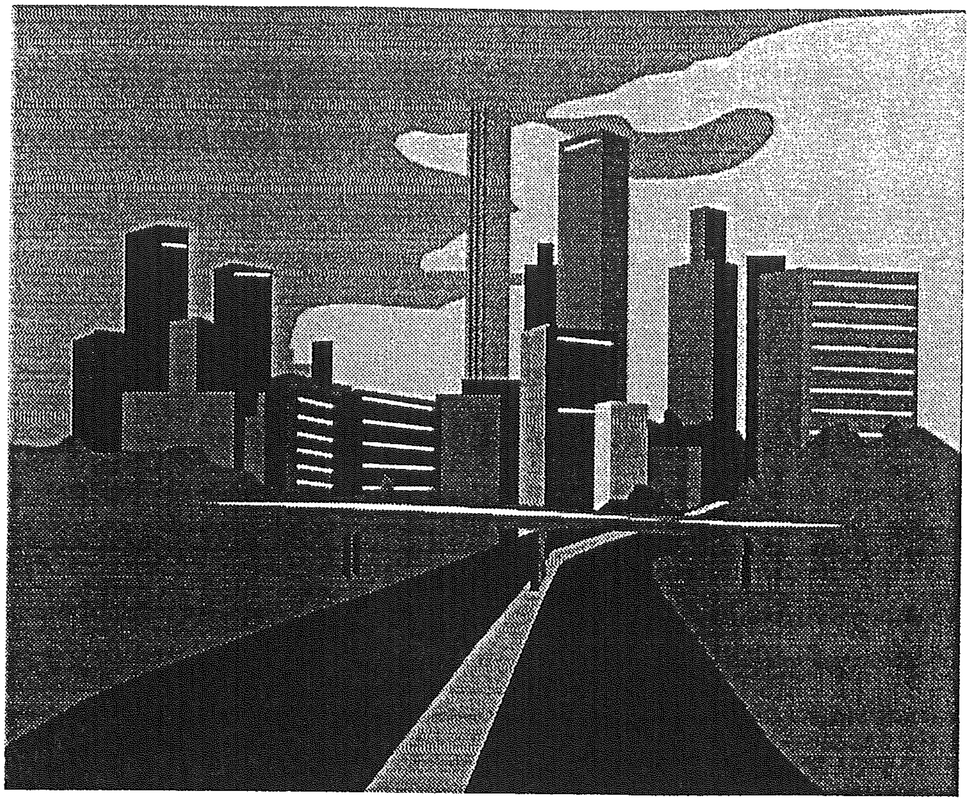

Project Scheduling
Actuals
Accounting
Schedule
C&S
Schedule
Dists
Projects
Projects
Federal Gov
Reports
Schedule
Proj Assessment/Cost
Ideas
PECOS
Priority
Programming
Com
Public/
Community Orgs/
Business

Appendix III

Oracle Transportation Manager

ORACLE

Oracle Corporation
8800 Cal Center Drive
Suite 300
Sacramento
California 95826
phone 916.366.0792
fax 916.366.3051



Oracle Transportation Manager

The Solution of Choice

Oracle Transportation Manager

Oracle Transportation Manager (OTM), is an *Enterprise Solution Enabler* developed by Oracle Corporation specifically to meet the needs of public and private transportation agencies. This application maintains the core information on the various types of transportation networks and provides for the integrated storage of data on the related infrastructure. OTM provides the flexibility to manage not only a highway network, but also rail, bus, waterway, pipeline, and utility line networks. OTM meets the needs of Transportation Agencies and takes advantage of the latest hardware and software technologies.

OTM combines the latest computer technology, a base of transportation clients, and a team of Oracle's Transportation Specialists, resulting in the application solution for diverse Transportation Agencies worldwide

The OTM Solution

OTM was developed to address the particular needs of the transportation industry. OTM, as preconfigured and setup, manages a core set of data items relating to the transportation network. It has been designed so that it can be configured to address the specific inventory data needs of individual clients. This configuration effort is accomplished through the use of OTM's existing tables and Oracle's CASE products.

The inherent features of the system allow the product to be used successfully worldwide, by a variety of agencies with differing needs, without modifying the base source code. Therefore, agencies do not need to employ large programming staffs to maintain the application system. In addition, Oracle Services has dedicated development and maintenance consulting groups that can assist with the implementation of OTM.

Industries Served by Oracle Transportation Manager

The transportation industry can be defined as any agency or corporation that needs to manage a network that transports people or goods. The OTM product has been developed to satisfy the diverse yet common needs of the transportation industry. The following are a few examples where OTM can be used:

- Highway Systems
- Street Systems
- Railway Systems
- Waterway Systems
- Utilities

The product allows management of one or more modes of transportation supporting multi-modal systems. OTM allows the establishment of multiple transportation networks within the data base. For each network, it maintains the individual routes, their history, and their connectivity to one another. It then provides the means by which the various types of infrastructure inventory used on the different types of networks are recorded and retrieved.

The OTM Vision

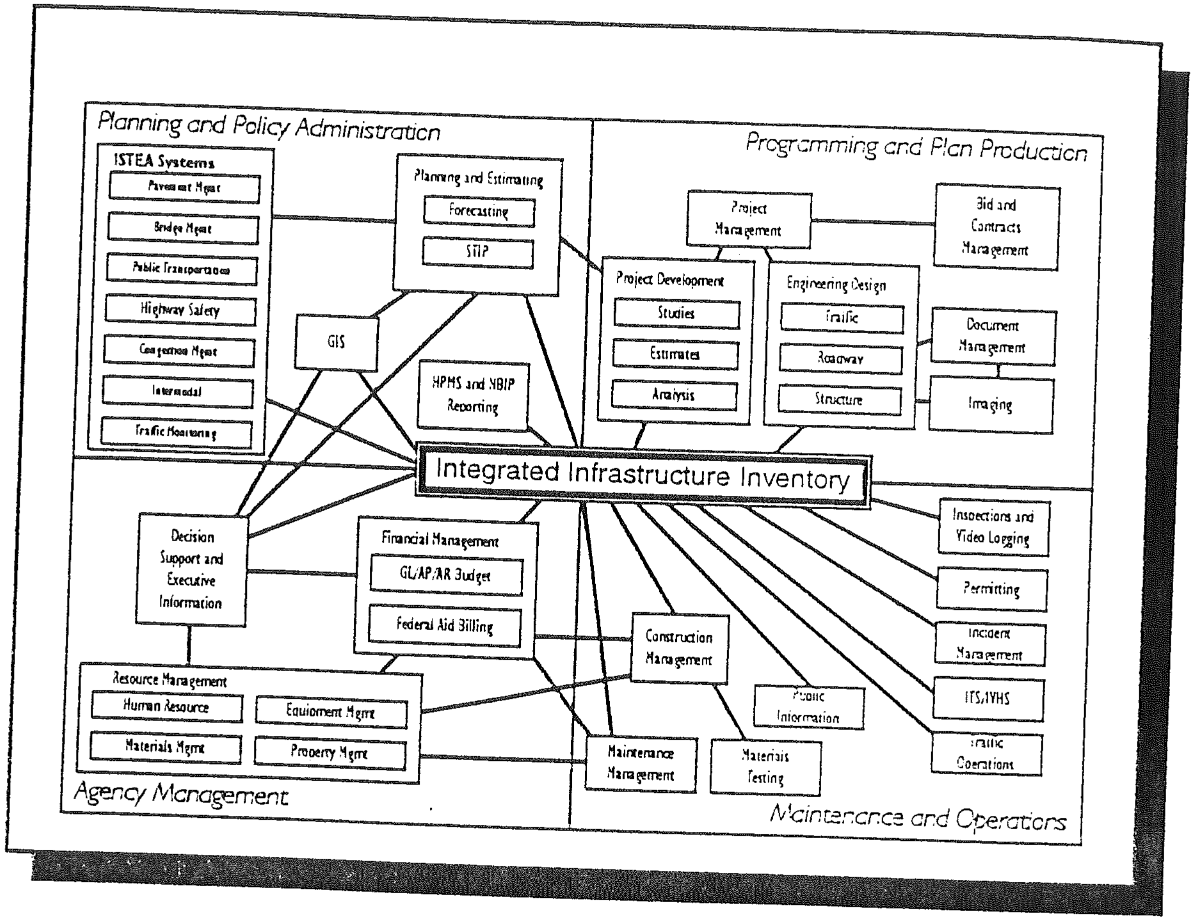
Transportation agencies are large and complex entities made up of numerous discrete units. All to often, the business processes of these units extend only to the limits of their own responsibilities. As a result, they have tended to act independently of each other. In particular, the development of automated systems has typically been constrained to only the information that the unit itself required.

However, transportation agencies as a whole are now beginning to take a longer and wider view of their business processes. They recognize that the independence of the individual units has led to the creation of equally independent computer systems forming "information islands" within the agency. Unfortunately, since these systems were developed with a narrow focus, it is often difficult, and in some cases impossible, to assemble information concerning the same physical facility from the disparate sources.

Our approach in developing Oracle Transportation Manager was to look at the transportation agency as a single business entity with many separate but related needs. We began by recognizing that the "information islands" all contained a single common element; the transportation network. No matter what information was being gathered or created, it all, in one way or another, had to be equated to one or more locations on the network. Therefore, we undertook to design OTM using the concept of the transportation network as the core element of an enterprise-wide solution enabler for transportation agencies. Around this core could then be built the various applications needed by the individual units within the agencies.

In our vision, the Information Structure of a typical transportation agency can be viewed as an interconnected set of applications with the integrated infrastructure inventory at the center. This vision is illustrated by the following diagram which shows the typical types of information systems found in a state department of transportation.

Transportation Department Information Structure



With this image in mind, we then decided on the key objectives of the system design. These can be summarized as follows:

1) The scope of the system would be *transportation*, not just highways. As the successor to the Oracle*Highways product, we recognized the reality that transportation agencies are no longer solely in the business of building roads. Rather, they are now responsible for entire transportation systems that can include multiple modes. Thus, OTM would have the ability to concurrently accommodate multiple modal networks as well as the intermodal relationships between networks.

2) The system must be capable of utilizing multiple linear referencing methods simultaneously. Although virtually all transportation agencies use linear referencing to locate items on the networks, they do not all use the same methods. In fact, it is not uncommon to find multiple referencing methods being used within the same agency. For this reason, OTM would be designed to permit the creation and use of multiple alternate referencing systems.

3) The product should allow the use of both the English and metric systems of measurement. The drive toward metrication of the transportation industry was fully underway at the time OTM was being conceived. For this reason, OTM would be designed to accommodate either or both systems. In OTM, attribute and location data can be entered or viewed in either system based on the user's preference. It is stored in the system units established by the client at the time OTM is configured.

4) OTM must maintain temporal (date) information about both the network and the inventory. We recognized that transportation networks are not static. They grow and change frequently. Because of this, agencies must be able to determine not only the current network and inventory status, but also what it was at a given point in time, past or future. OTM, therefore, would be designed to date stamp the data records.

5) The system should incorporate the principals of dynamic segmentation. The storage of information about the network should reflect the actual physical conditions without the need for artificial break points. For example, if a road is paved with concrete across multiple counties, the system must allow a single pavement data record to be created that includes the beginning and ending points of the concrete pavement. The user should not be required to create multiple records simply because the road crosses a county line.

6) The product must utilize the full power of the latest Oracle technology. This includes:
   a) The use of Oracle's CASE products (Designer/2000™ and Developer/2000™) for the creation of both OTM Core and user application modules
   b) Creation of a Graphical User Interface with Oracle Forms 4.5™
   c) Allowing a true relational data structure in Oracle 7™ which can be defined by the client.

Having established the vision and objectives for Oracle Transportation Manager, we proceeded to design and create a system that would realize these high goals.

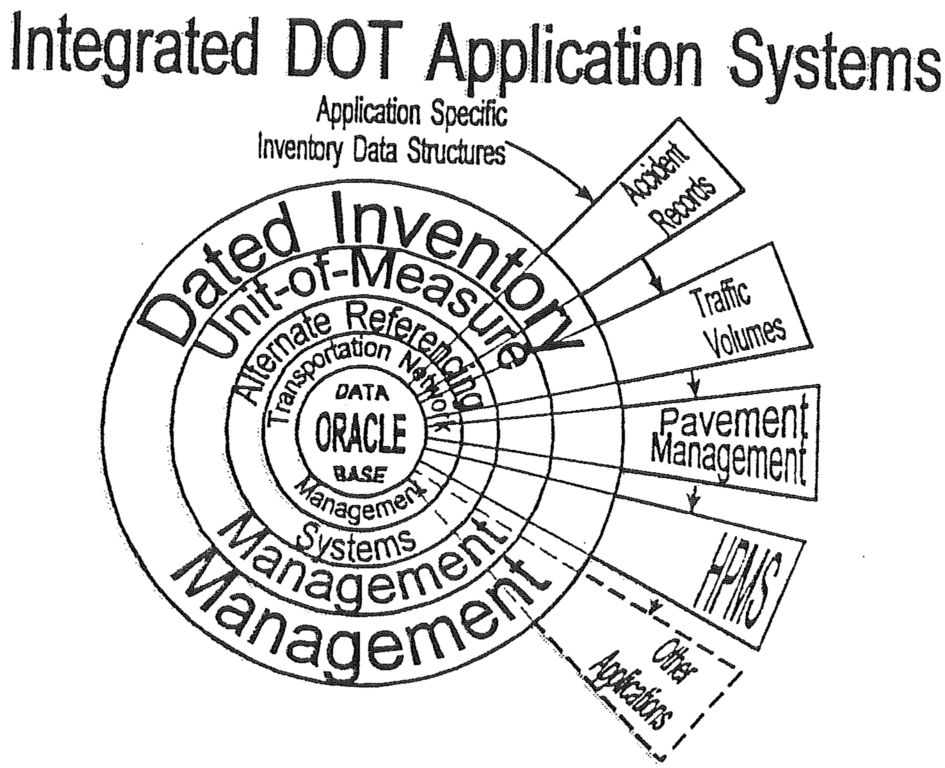
OTM Product Architecture

OTM has been developed to overcome the problems that result from most legacy systems in transportation agencies. These systems have been developed over time and were usually created for a specific purpose. Consequently, many functions are duplicated across the systems consuming valuable resources. Compounding the situation are instances when the data is referenced in different manners resulting in a situation where the information can not be compared between functional areas.

In examining legacy systems, such as pavement management, accident records, and traffic volumes, it is apparent that each maintains different information. Their common thread, however, is that each of them has some representation of the underlying transportation network. The difficulty is that frequently these representations are not compatible or synchronized with each other. This makes the cross-retrieval of information labor-intensive and time-consuming at best and impossible at worst.

OTM takes an alternate approach, as shown in the following diagram, of building the transportation network representation at the core of the system and allowing the functional applications to be "plugged into" this core. In this manner, all of the functional applications share the same representation of the transportation network simplifying the cross-correlation of the data.

The diagram below illustrates the concept and components of OTM. The core elements are shown in the circles while the "arms" show examples of the types of applications that can be built onto OTM. Following the diagram are paragraphs explaining each of the components.



Oracle Data Base

OTM is built on the industry-standard Oracle Relational Database. Oracle's core product is the Oracle7™ database, a powerful data storage system capable of supporting nearly every major computer language as well as text, images, audio and video. In addition to the Oracle7 database, Oracle offers tools, applications, education and consulting services. Oracle's tools provide forms generation, sophisticated reporting and graphics, comprehensive data communications, and intelligent text management.

Oracle software runs on personal digital assistants, set-top devices, PCs, workstations, minicomputers, mainframes and massively parallel computers. Oracle is the leader in client/server computing, mainframe downsizing, and corporate reengineering. And it is the leading software for the emerging Information Highway.

Transportation Network Management

The Network Management function is used to create the overall transportation network. Once the network is established, inventory items can then be associated with the network using the preferred referencing system.

OTM can handle multiple types of transportation system network. It has been created with the specific intent of managing the total inter-modal transportation system. Individual networks can be created and maintained separately by mode of transportation (e.g. the roadway network, the rail network, etc.)

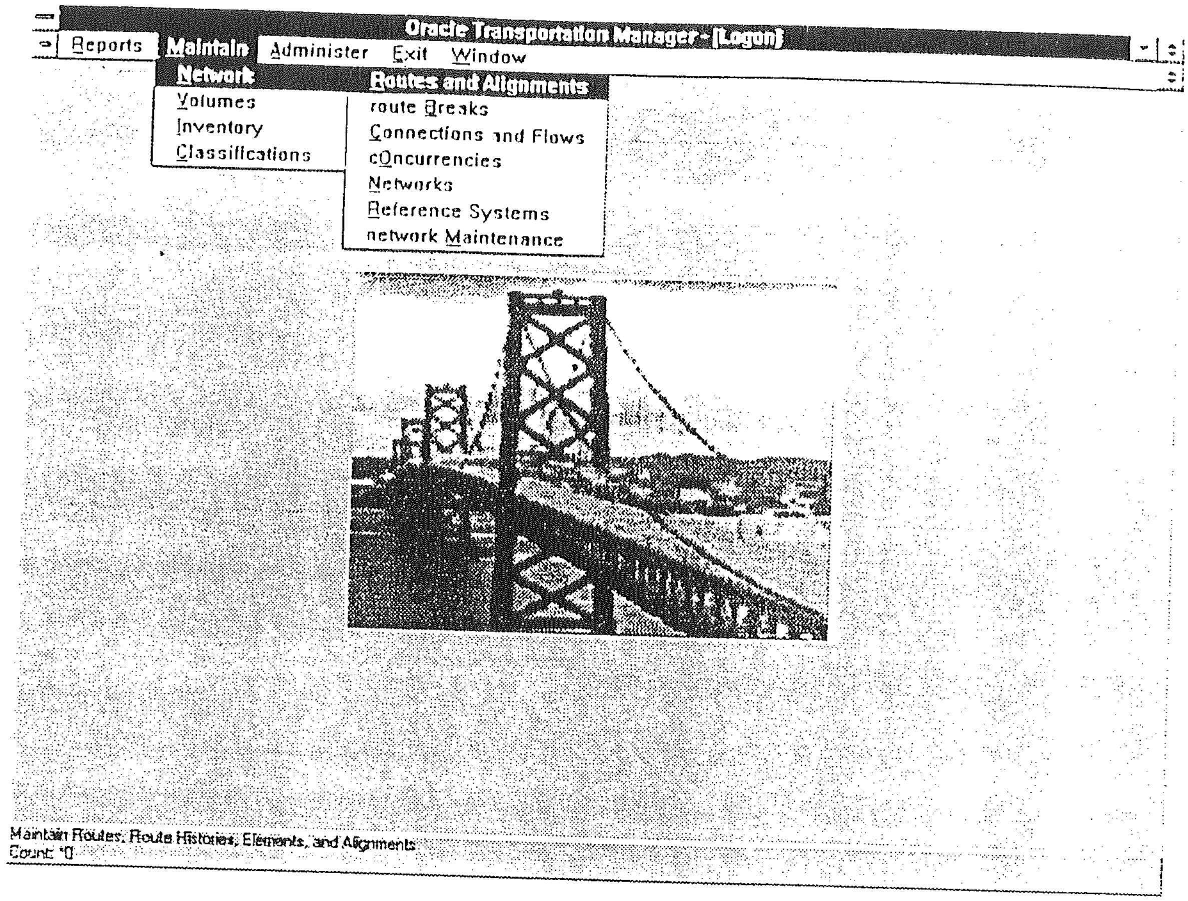
Special conditions along routes are also accommodated by the Network Management function. These conditions include alternate alignments between two sides of the same route, connections between routes, such as interchanges, intersections, and route crossings, concurrencies of two or more routes on the same physical infrastructure and breaks in routes.

OTM can also maintain information on the driving sequence or traffic flow of the route. This can range from simply recording that two routes intersect to defining what the valid traffic directional changes at the intersection are. OTM also can record traffic restrictions.

Below are the functions available within OTM to establish the transportation network:

- Maintain Networks
- Maintain Routes and Elements
- Maintain Route Breaks
- Maintain Route Concurrencies
- Maintain Route Independent Alignments
- Maintain Element Connections
- Maintain Route Intersections, Interchanges, and Crossovers
- Maintain Traffic Flow and Traffic Flow Details
- Maintain Alternate Reference methods
- Maintain Route Group Types
- Maintain Groups and Group Members

The basic Network Management menu items are shown on the following screen image.

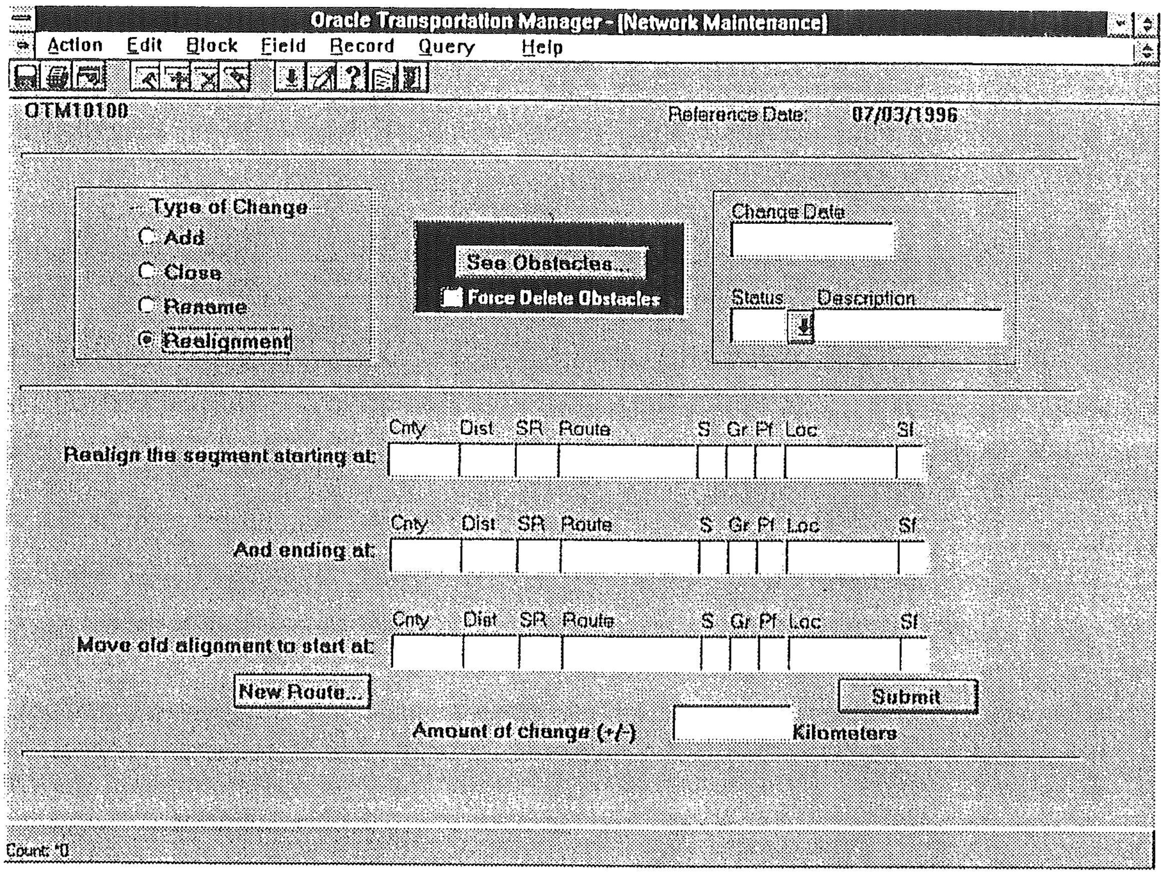


In addition to defining a network, Network Management includes special Network Maintenance functions. These are the types of processes that are normally very difficult to accommodate in legacy systems typically because the systems were developed to work within the transportation network as it existed when the system was created without regard to possible future changes. The design of OTM specifically includes the tools needed to keep the network up to date. The following OTM Network Maintenance functions are available within OTM:

- Add a Route Segment
- Close a Route Segment
- Rename a Route Segment
- Route Segment Realignment

When these processes are invoked, the affected segments are either closed by setting the END DATE or opened by adding the segment with a new BEGIN DATE (see the section below on DATED INVENTORY MANAGEMENT for a discussion on how OTM maintains data temporally). No segments are deleted from the system. All inventory on closed sections is likewise expired by setting the END DATE. If a Network Maintenance function results in a change in the overall route length, the locations of all of the inventory "downstream" of the change are automatically recalibrated to the correct position. Thus the user is not required to individually adjust the locations of existing inventory items.

Because both the network and the inventory records are maintained temporally, it is possible for the user to see the data as it existed at a given point in time. The following is an image of the Network Maintenance screen using a County/District/Route/Postmile type of referencing system.



Alternate Referencing Systems

It has been Oracle's experience that not all Departments of Transportation use the same referencing system. Although the easy answer would be to force all users of OTM to utilize a common system, practically speaking, this is not possible. Many agencies have significant investments in their data and would find it overwhelming to do a major conversion effort to an unfamiliar referencing system. Instead, OTM has the ability to use multiple reference methods. This allows inventory infrastructure information to be stored and accessed by any reference measurement scheme.

OTM maintains the location of the network and infrastructure inventory items using a base referencing system employing a linear offset reference method. This is the most efficient way to locate information within a transportation network. However, due to legacy systems, business rules, or user preference, most agencies do not reference their inventory data in this way. In fact, in many agencies, there are multiple ways of referencing locations within the same agency. Examples are:

- County Route and Milepost
- Landmark plus Offset
- Linear Referencing Systems
- Route and Offset
- Rail Route Number and Offset

Recognizing the uniqueness of each agencies methodology of referencing data, OTM's flexibility allows clients to set up their own particular referencing systems. The OTM System Administrator can set up a single or multiple referencing systems without additional programming or module customization. OTM creates cross-reference links between the base and alternate referencing systems.

Users can choose the preferred reference method at any time when or while logged on. All OTM data is available through these alternate reference methods to any user. Thus two users sitting side by side can be simultaneously viewing the same data using different referencing systems. Through data base views, the referencing systems can be extended to other software tools that connect to the Oracle database. This includes GIS systems, Oracle Data Browser, Excel, and other Microsoft Windows-based products.

When an alternate reference method is selected, the screens in OTM are dynamically changed to include the fields used for that system. For example, the above screen image shows a user-defined referencing system composed of County, District, SR, Route, route Suffix, GR, location Prefix, Location (milepost), location Suffix. With the exception of Route and Location, all other fields including the displayed prompts, are user-definable. So, for example, if a second reference method were defined with Route, Location, and County, those are the three fields that would appear on the screen.

Unit of Measure Management

OTM allows data to be stored in either Metric or English units. The System Administrator determines the unit in which the value is stored in the database as the Inventory Model within OTM is defined. However, as with referencing, the way the data is stored may not be the way all users want to see it. So OTM provides a User Preference that allows the user to select the type of units that the system is to display.

Within the OTM database structure, an available function converts data from Metric units to English units or vice versa. This flexible functionality is another Oracle solution added value. The application (both screens and reports), has the ability to display and input data items in three ways:

1. Display/update data in its native database structure
2. Display/update data in Metric units only
3. Display/update data in English units only

Dated Inventory Management

OTM utilizes the concept of date stamping changes to both the Network and the Inventory data. As a result, when the Network Maintenance functions (Add, Close, Rename, Realign) are invoked, the actual changes are implemented through the use of BEGIN DATE and END DATE fields. Old information is expired by setting the END DATE and new information is added with a BEGIN DATE. Likewise, the inventory template forms require both BEGIN DATE and END DATE as fields. The BEGIN DATE identifies the date on which the data became effective. The END DATE indicates the last day that this information was valid.

Through the use of this approach, expired data is not deleted from the system. Rather it is kept so that the user can make inquires into the state of the transportation network and inventory as of a specific date. In fact, OTM provides a REFERENCE DATE for each user as a User Preference which controls all of the information that the user sees. When a user logs onto OTM, the REFERENCE DATE defaults to the current date. However, the user can easily change the REFERENCE DATE to any date desired. From that point on (until the user either changes the date again or exits the system) the user will see the information from the data base as it existed on that date. As an example, assume that a user wants to determine what traffic signs were in place at a specific location prior to a roadway closure that occurred on June 17, 1993. By setting the REFERENCE DATE to June 16, 1993, he would see the network and the signs as they existed on that date.

Client-Definable Applications and Data Model

Once the OTM core has been installed and configured, the client-specific inventory data models and applications can be constructed around it. The Oracle CASE Tools allow clients to configure the OTM system to meet their specific needs. The model relationships are defined through CASE products including integrity constraints. The OTM application, with minimal programming, recognizes this custom Inventory and Data Model supporting the model throughout the application.

OTM takes full advantage of all Oracle7 database features such as:

- Distributed database tables
- Database triggers
- Database roles
- Database Integrity constraints
- Database primary and foreign key relationships
- Oracle CASE technology.

Other OTM Features

Data Storage/Dynamic Segmentation

OTM utilizes the principles of Dynamic Segmentation to store the inventory data. That is, for a given attribute, the value information is stored as a single entry from the point where the value begins to where it ends. There is no artificial static segmentation of the data as there has been in many legacy systems. For example, frequently the legacy systems have used the referencing system as the key to the data records. As a result, when one element of the referencing system changed, such as the County, a new record had to be created even if the data value stayed the same. So if a concrete road was built that crossed fifteen counties, there would be fifteen pavement records created. OTM, on the other hand, tracks the referencing system separately from the inventory and melds the two for the user. Thus, in this example, OTM would only create one entry for the concrete road that included its beginning and ending points.

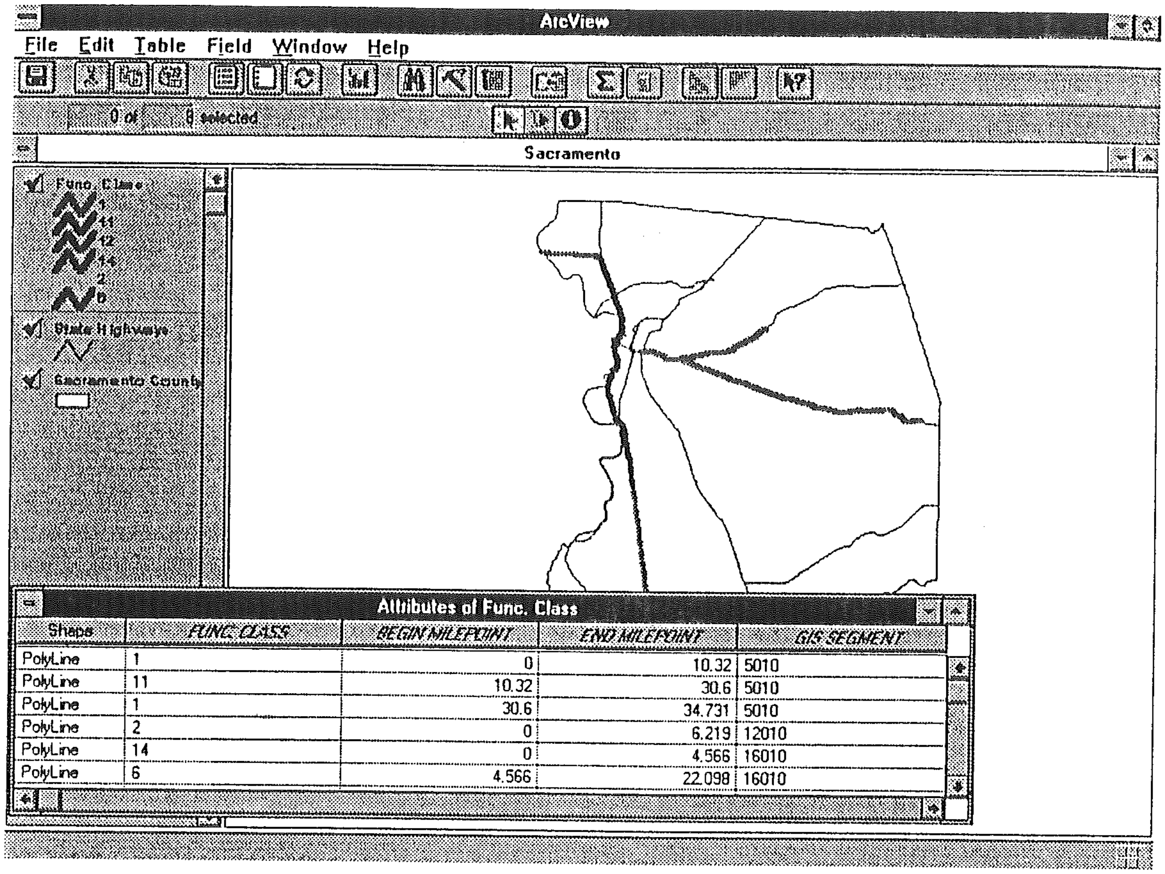
Since all of the inventory tables are constructed in this manner, OTM can relate information from the different inventory tables to each other based on their location on the network. Thus, the data can be viewed and updated in a simple, straightforward manner without concern for static segmentation.

Easy to Use Graphical User Interface

The OTM system uses Oracle Forms Version 4.5. The application runs under Windows in a client/server configuration. Because this is a Graphical User Interface (GUI) with on-line help, its is easy to use for even non-computer users. Data is accessed quickly and easily

GIS Integration

The application allows for easy integration with most Geographic Information Systems. OTM can be used with GIS products from ESRI, Intergraph, GDS, and most other GIS vendors. The following screen shows OTM data being accessed from ESRI's Arc/View product



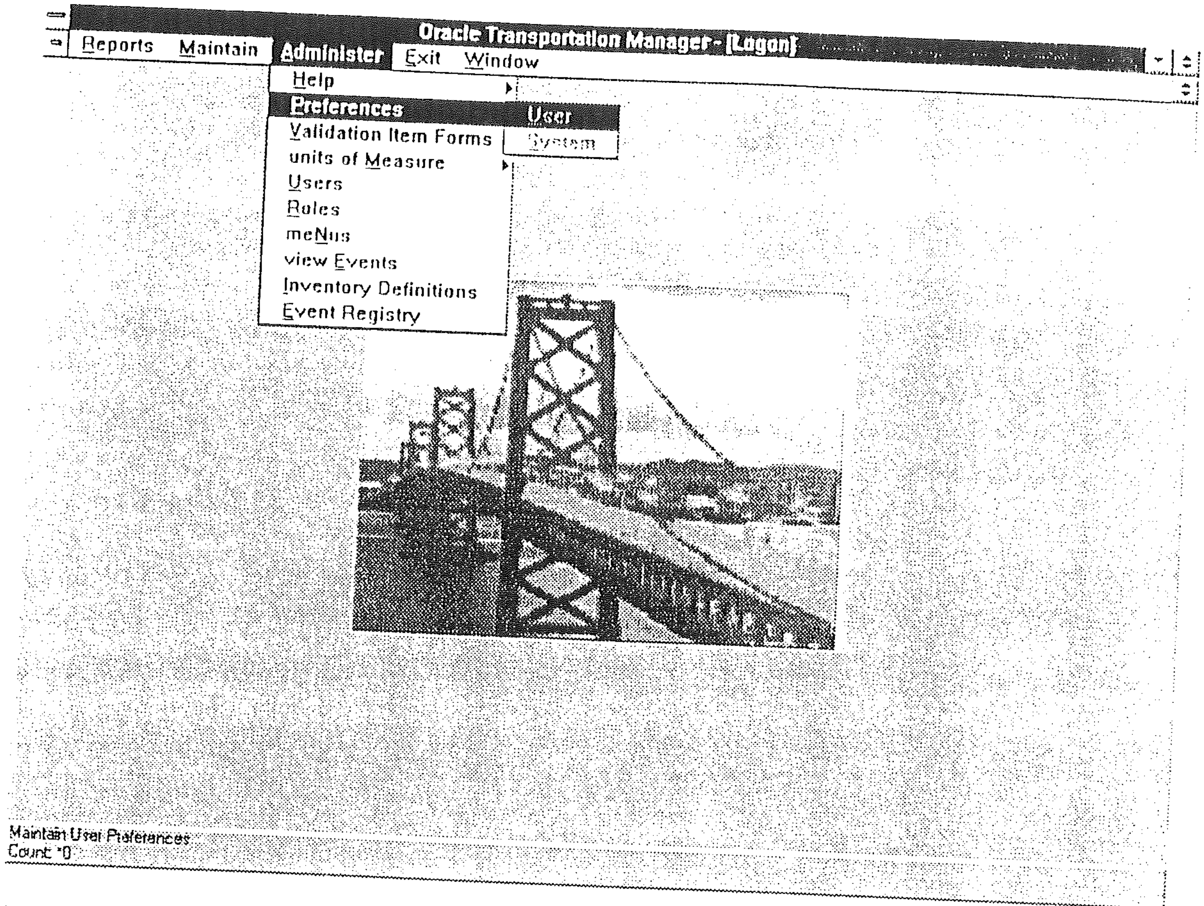
System Administration

The OTM application includes System Administration functions that easily allow the client Application Administrator to manage the system.

OTM's System Administration functions include:

- Maintain System Preferences
- Maintain Validation Tables
- Maintain Unit Conversion Factors
- Maintain User Information
- Maintain Role Information
- Maintain Menus
- Define Inventory

The following screen shows the items on the Administer menu.



The OTM product also integrates with other standard Oracle database administration modules, such as the Windows-based Oracle7 DBA Administration functions. These functions include:

- User Manager
- Object Manager
- Database Manager
- Role Manager

Query Builder

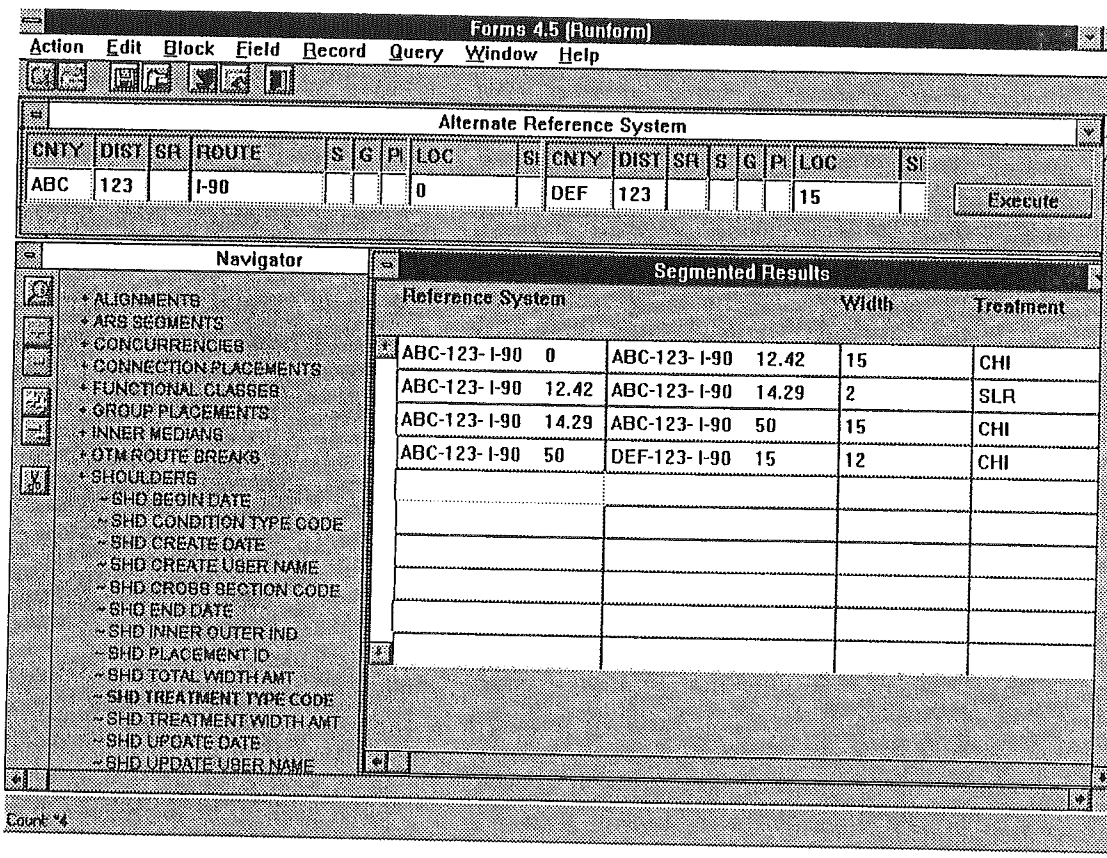
Because the inventory data is stored in multiple tables, OTM includes a dynamic Query Builder. This function allows the user to graphically select tables and attributes and construct a query that will simultaneously retrieve information from the various tables. This is the mechanism for answering questions such as "List all the pavement types, pavement conditions, accidents, traffic volumes, and signs on Route 50 in Adams county from milepost 10 through milepost 15." This is the kind of cross-system information that has been difficult to retrieve in the past. The Query Builder also allows users to select inventory data based on value changes in individual or multiple attributes. The resulting information would include all attribute data selected for reporting purposes. Users have the ability to define on-line what data attributes are to be extracted.

For each attribute selected, the user can choose various ways to create the results.

- Break on the data attribute value
- Summarize on the data attribute value
- Minimum value on segment
- Maximum value on segment
- Dominant value on segment
- Weighted average of value on segment
- First value found on segment
- Count number of values found on segment

The module can be used to create data files to be imported into other systems or for fixed reporting such as for Highway Performance Monitoring System (HPMS).

The following screen illustrates the use of the Query Builder.



In Summary, Oracle Transportation Manager:

+ Is a flexible *Enterprise Solution Enabler*
+ Was designed specifically to meet the needs of public and private transportation agencies
+ Maintains the core information on transportation networks
+ Provides for the integrated storage of data on the related infrastructure
+ Allows the simultaneous use of multiple referencing systems
+ Stores the network and inventory data temporally
+ Allows the simultaneous use of English and metric measurement systems
+ Can eliminate the "islands of information" common in DOT legacy systems
+ Performs complex network maintenance functions automatically
+ Allows the user to define the inventory data model
+ Provides the attribute data storage for information display through GIS systems
+ Is CASE-based and uses a fully relational database structure
+ Utilizes the most current ORACLE technology.

It is these capabilities that make Oracle Transportation Manager the *Solution of Choice* for transportation agencies.

Appendix IV

SHL Infrastructure Management System

SHL
An MCI Company

Transportation Management Information System (TMIS)

Mississippi Department of Transportation

Definition of Project Scope

MDOT

May 16, 1996

Prepared By:
Connie Flannigan
SHL Systemhouse TMIS Project Manager

Definition of Project Scope

Introduction to TMIS Project

Mississippi Department of Transportation has contracted with SHL Systemhouse to deliver a Transportation Management Information System (TMIS). The contract began April 1, 1996. A pilot installation is scheduled to be complete by April 30, 1997 with full system implementation completed by June 30, 1997.

The TMIS project was initiated to comply with the Intermodal Surface Transportation Efficiency Act (ISTEA) which mandated that each state Department of Transportation implement six management systems including pavement, bridge, safety, congestion, public transportation, and intermodal. The main goal of the management systems was to facilitate the states in making funding decisions. Because the nation's infrastructure is deteriorating at a faster rate than it is being rehabilitated, each state needs to use federal funding more efficiently. Even though the legislature retracted the ISTEA requirements, MDOT has made the decision to implement the three systems that were most important to the traveling public in Mississippi - pavement, bridge, and safety.

The scope of the TMIS project includes creating the three integrated management systems for pavement, bridge, and safety. The application will provide easy access to data which now resides in many locations throughout the DOT. At the core of the application will be an enterprise database which stores the pavement, bridge, and safety data, as well as project and financial data. The system will allow users to combine data in new ways using a user-friendly graphical user interface. By utilizing the TMIS application in conjunction with the integrated GIS and analysis tools, users will be able to plan projects taking into consideration current and forecasted conditions, location, and funding alternatives. Users will also have the capability to view associated documents and multi-media files such as CAD design files, word processing documents, spreadsheets, photogaphs, and videologs, all on-line. From TMIS, users will be able to produce a wide array of output including standard textual reports, as well as presentation graphics such as pie charts, bar charts, and intelligent maps and plots.

The scope of work presented in this document is intended to define the boundaries of the TMIS project. It is not intended to define the detailed requirements which will be included in the Requirements Definition deliverable to be completed next month. The SHL project team will be responsible for completing the requirements as defined in the Functional requirements matrix in MDOT's RFP.

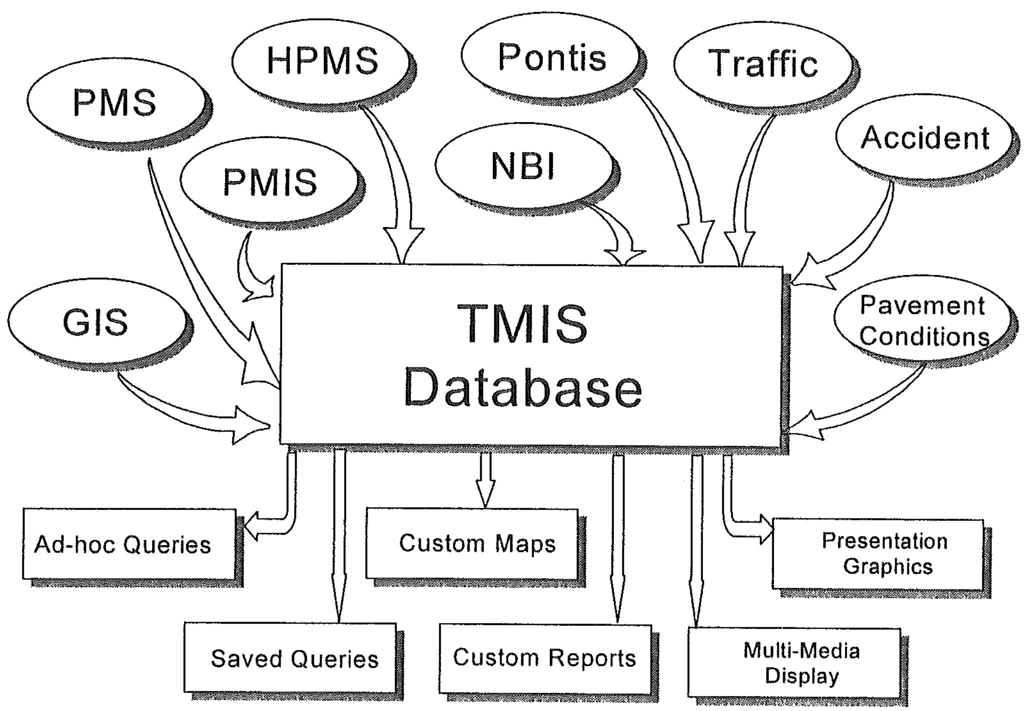
Scope of Work to be Provided

TMIS incorporates several integrated building blocks or modules. Those modules include the TMIS database, Intergraph GIS products, analysis tools, document management, office automation tools, and a graphical user interface. The SHL project team will be responsible for designing, developing, and implementing the enterprise database, the document management system, and the graphical user interface. The team will be responsible for integrating the GIS products, the analysis tools, and the office automation tools. The team will also produce the necessary documentation for the TMIS application and will train MDOT staff on developed aspects of the system.

TMIS Data Base

At the core of the management systems will be the TMIS database built with Sybase System 11 database technology. The SHL project team will use MDOT's Enterprise Data Model as a starting point, but will update the logical data model as needed to reflect the data stored in each of the data sources listed in the RFP. The SHL project team will be responsible for working with the proper MDOT contacts to determine the formats and locations for each of the data sources and for designing and developing the routines necessary to move the data from these sources into the enterprise database.

The diagram below shows the major data sources for TMIS including Geographic Information System (GIS), Pavement Management System (PMS), Project Management Information System (PMIS), Highway Performance Monitoring System (HPMS), National Bridge Inventory (NBI), Pontis, traffic data, accident data, and pavement condition data collected by the Pavetech van.



The data sources are divided into two types - one-time conversions and automated conversions. The one-time data conversions will involve moving data from the legacy data source, whether it is now stored in an ASCII or another database format, to the enterprise database with no further updates to take place to the legacy data. In these cases, the legacy system will be abandoned. The automated data conversions will involve moving the data to the enterprise database from the legacy system and also setting up parameters for periodic updates of the enterprise database as changes are made to the legacy sources. In these cases, the legacy data source will still be maintained for other purposes within MDOT. The enterprise database will therefore be "bridged" to these legacy sources.

GIS

Intergraph's GIS tools will be incorporated for geo-referencing and mapping output. The GIS products to be used include the full suite of MGE products including MGE Administrator, MGE Basic Nucleus, MGE Analyst, and MGE Finisher; as well as Intergraph's latest viewing tools, if at all possible. The TMIS team will be working with Intergraph to determine if the release dates for the new product line will allow use on this project.

The SHL project team will be responsible for working with MDOT to complete the GIS base map. Completing the GIS base map will include either digitizing or checking existing map features for completeness and accuracy, attributing or evaluating current attribution of map features, ensuring that the maps are in the proper projection, building the network files necessary for developing the linear referencing scheme to be used for dynamic segmentation, building the necessary topology files for spatial analysis based on the query requirements of MDOT, and for creating standard plotting formats. Error corrections for data will be limited by the completeness of data and information supplied by MDOT.

The SHL project team will also be responsible for designing, developing, and implementing the integration of the GIS with the TMIS application. The GIS will be used for intelligent mapping, dynamic segmentation, spatial analysis, and feature-based plotting.

Analysis Tools

The analysis tools to be integrated include Pontis for the bridge management system and a pavement analysis package yet to be determined for the pavement management system. The TMIS team will be working with the Research Division to determine the best approach for the pavement analysis tool. The integration of the analysis tools with TMIS will allow users to view the results of the analysis through the TMIS interface. Part of the data required by and created by the analysis systems will be stored within the enterprise database.

The SHL project team will be responsible for designing, developing, and implementing the interface to Pontis as well as the pavement analysis tools when selected by MDOT. The analysis required for the safety management system will be designed, developed, and implemented by the TMIS team as part of the application.

Analysis will also be performed when executing ad-hoc or saved queries. When users are running these queries, various data elements from across the management systems can be combined to analyze the information in the database. Algorithms will be established to calculate additional information such as the accident density. Some of the algorithms will determine performance measures indicating whether or not the DOT is improving the transportation network. The saved query and custom query forms will limit the user's access to the data in the TMIS database, but will also decrease the complexity of setting up the query parameters.

Document Management

The document management requirements of TMIS will include developing an interface for viewing scanned raster documents such as bridge and roadway design plans or accident reports, Microstation design files, Microsoft Office files, photographs,videologs, and audio files. The TMIS project team will be responsible for scanning sufficient documents to test the functionality of the system. The interface will also allow users to link the proper record in the enterprise database with the associated document. One view of the videolog will be converted from the 400 Super VHS tapes to a digital format to be accessible by TMIS.

Office Automation Tools

Microsoft Office automation tools (Word, Excel, and PowerPoint) will be integrated to allow users to start-up one of these applications from within TMIS. If an associated document is in a Microsoft Office file format, the user will be able to click on the document and start the appropriate application. The SHL project team will be responsible for creating the interface to these applications.

Graphical User Interface

The graphical user interface will be built using PowerBuilder. The interface will allow users to navigate through TMIS using a point and click mechanism accessing the data in the enterprise database and using the functionality provided by the additional modules described above. In addition, PowerBuilder will provide the development environment and programming language for creating the TMIS application. The SHL project team will be responsible for designing, developing, and implementing this graphical user interface and the programming modules.

SHL
An MCI Company

Infrastructure Management System (IMS) Overview

Prepared for:
Marotz, Inc. and Arizona DOT

August 27, 1996

Table of Contents

1. Executive Summary

SHL Systemhouse Corporation is pleased to have the opportunity to provide information to Marotz, Inc. We understand that your firm is currently working with Arizona DOT in making recommendations for implementing systems similar to the custom application that SHL is developing for Mississippi DOT.

SHL Systemhouse, a wholly-owned subsidiary of MCI Telecommunications Corporation, is a recognized industry leader in the systems integration and technology deployment marketplace. Since 1974, SHL has expanded its global presence to include more than 90 business centers employing 6,500 professionals worldwide with an annual revenue of nearly $1.4 billion dollars.

SHL is the pioneer in providing TRANSFORMATIONAL™ Services which enable customers to re-engineer their business processes through fundamental changes in their underlying information technology architecture. Customers look to SHL to provide the unique range of services, expertise, and management necessary to take care of their current needs while assisting them to move their mission-critical systems away from costly, traditional platforms to less costly, more powerful and more flexible client/server, open systems computing environments.

SHL is currently providing this type of TRANSFORMATIONAL™ Services to a number of organizations in both the public and private sector. Government clients for whom SHL has or is currently performing these types of projects include the American Association of State Highway and Transportation Officials (AASHTO), the Mississippi Department of Transportation (MDOT), the Province of Alberta Transportation and Utilities (AT&U) Department, the Province of Alberta Registries Bureau (including Vehicle Registration and Drivers License), the Ohio Department of Transportation, Ohio Department of Public Safety, the Canadian Ministry of Transport, the Canadian Department of Public Works, and the California Franchise Tax Board. Private sector clients include Browning-Ferris Industries (BFI), Delta Airlines, Tupperware, Dow Jones and The Washington Post.

In addition to our focus on TRANSFORMATIONAL™ Services, SHL has also established itself as a leading provider of consulting and systems integration services to Transportation and related agencies. SHL has developed business relationships with many of the transportation departments throughout the United States and Canada, and SHL staff are professionally active with AASHTO, the American Association of Motor Vehicle Administrators (AAMVA), and the Highway Engineering Exchange Program (HEEP). SHL has recently performed or is currently conducting a number of mission critical projects for Transportation and related agencies. These projects include:

- **Design and development of the American Association of State Highway Transportation Officials (AASHTO) Construction Management System (CMS)**
  The scope of this project, in which over twenty state DOT's and the Federal Highway Administration (FHWA) participate, has been conceptualized with a "best practices" orientation and involves significant business process re-engineering. The resulting CMS software is being designed in an open systems architecture to support portability and

scaleability across various DOT technical environments. It is being developed utilizing PowerBuilder as the primary development toolset in an open database environment. It has also been architected to facilitate integration with a number of third party software packages and enabling technologies including office automation software, document imaging, text management, bar-coding, geographic information systems (GIS), global positioning systems (GPS), and CADD technology.

- **Design and development of the Mississippi DOT (MDOT) Transportation Management Information System (TMIS)**
  SHL is currently under contract with Mississippi to implement the DOT's ISTEA Management Systems, including Pavement Management, Bridge Management, and Safety Management. The project, called TMIS, (Transportation Management Information System), began on-site in Mississippi the first of April. This effort includes implementing an Enterprise Database, built on Mississippi's enterprise data model and using Sybase as the relational database engine. The database is being populated with information currently housed in MDOT's many legacy systems. A PowerBuilder interface is being developed for creating ad-hoc and saved, or frequently executed queries. Integrated into the application will be Intergraph's GIS suite of products as well as analysis tools including Pontis for bridge analysis and a pavement optimization package. The ad-hoc and saved query tools will allow users to view textual information from the relational database, but will also display the query results in the GIS base map, and provide viewing of associated files such as CAD design files, word processing documents, spreadsheets, photographs and videos.

- **Providing outsourcing services to Alberta Transportation & Utilities (AT&U) for Information Services**
  AT&U is undergoing significant changes due to outsourcing and restructuring of the entire department. The size of the organization is going from over 4,000 a few years ago to a target of around 750 by the end of this year. In order to accomplish this, many functions performed by the government employees are being outsourced to private partners. This outsourcing includes the design and maintenance functions as well as the information technology (I.T.) services.

  SHL will be AT&U's partner for the information technology outsourcing for two tiers of services. The first tier includes AT&U's current IT services and maintaining stability during the transition period while responsibilities are moved from the current AT&U staff to the new SHL team. The second tier of services encompasses the application enhancements. The vision for AT&U I.T. services includes establishing a series of technology building blocks which will form the foundation for future applications. These building blocks will include developing a data repository to store database attributes as well as additional files such as word processing documents, spreadsheets, Microstation design files, scanned documents, photographs, and videos. A geographic information system (GIS) will be implemented and integrated to give AT&U users as well as outside contractors, consultants, and the general public geographic access to data through a common base map. Additional building blocks will include document, file, and workflow management, as well as integrated office automation tools and the use of Internet, GPS, and other modern and emerging technologies. A common user interface will be implemented to give a standard look-and-feel to how users access the data in the data repository as well as the GIS.

- **Assisting the Ohio Department of Transportation in creating an enterprise data model** in support of the Federal ISTEA mandates and a Department initiated decentralization effort — SHL's role, along with Intergraph Corporation, was to plan, organize, conduct, and document a series of JAD sessions involving users representing major business and engineering disciplines throughout the department. This project was approached from a re-engineering focus and part of the scope of all JAD sessions includes identification/selection of business process for re-engineering as a precursor to any planned automation.

- **Development of a Traffic Records Strategic Plan for the State of Ohio through a joint project between the Ohio Department of Transportation and the Ohio Department of Public Safety** — The scope of this project includes identifying strategic business objectives, analyzing and documenting current business processes, developing a conceptual design of a Traffic Records system and identifying/selecting business processes for re-engineering through follow-up projects. Other tasks included conducting an Organizational Impact assessment and development of a comprehensive Transformation Plan to guide the implementation of the Strategic Plan from a business, organizational and technical perspective.

- **Implementation of a Financial and Materials Management System for Transport Canada** — The scope of the project involves migrating from an outdated mainframe and dispersed PC environments to an integrated system. This integrated system will be implemented using client/server technology with processing distributed across Canada. The technology is based on Oracle's distributed Financial and Materials Management packages executing on PC's running Microsoft Windows connected to DEC/SCO UNIX-based servers and a VAX/VMS Enterprise Server through local and wide area networks.

- **Design and development of a state-of-the-art Construction Management System (CMS) for the Ohio Department of Transportation** which is aimed at improving the Department's overall operations — The objective of this system is to realize paper, time, and cost savings, while increasing quality and capacity. Part of the scope of this project involved developing and implementing a comprehensive Change Management Plan to assist ODOT with the smooth implementation of the new system across Ohio. In addition, as part of SHL's maintenance contract, project members have now initiated re-engineering of several remaining manual processes in the Materials Testing area.

We trust as you review this document you will recognize the breadth and depth of SHL's approach as well as the level of transportation experience. SHL uses the full depth of its resources and brings complete corporate commitment to bear on creating successful Infrastructure Management Systems for Departments of Transportation.

2. SHL's Approach to Infrastructure Management Systems

The vision for SHL's approach to building an Infrastructure Management System (IMS) consists of several integrated building blocks or modules. Where possible, commercially available software is used, and SHL makes every effort to work with the products and tools currently being used at each of the DOTs.

All of the modules may not be necessary for every application, so SHL will work with each client to determine their unique requirements and will tailor the solution to the specific situation.

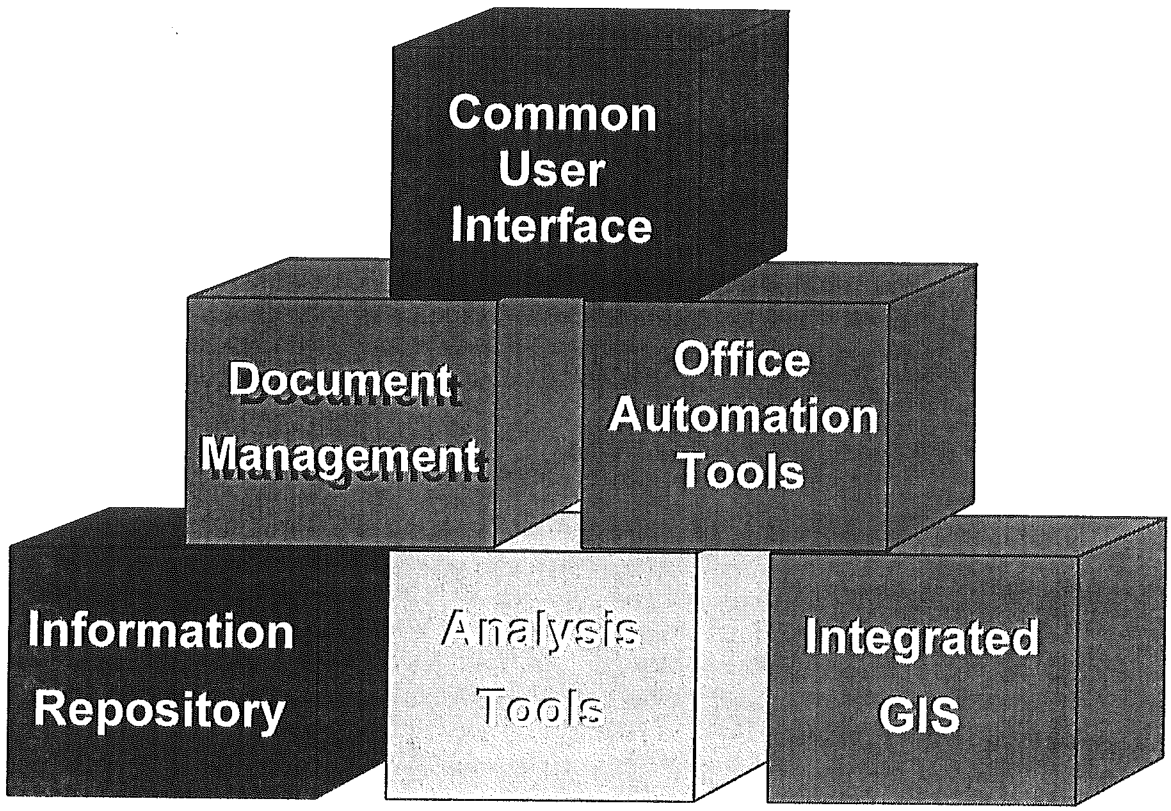
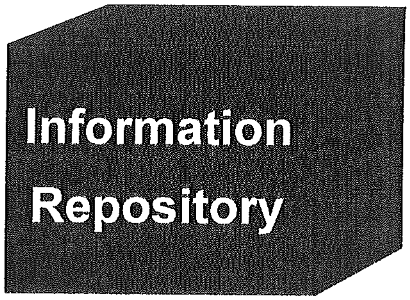


Figure 2-1 Infrastructure Management System Building Blocks

2.1. Information Repository



At the core of the IMS architecture is the information repository containing information about a DOT's maintainable assets, their current conditions, and other related transportation data. The repository will include database information but will also contain maps, CAD design files, photographs, videos, graphs, scanned documents, images, word processing files, spreadsheets, and spatial data. This data may currently be stored in several different locations throughout a DOT.

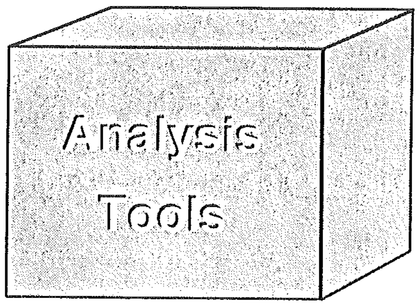
The tabular data stored in the information repository will be built using a relational database and will be structured to obtain the maximum practical efficiency using optimization routines. It will be accessible to all necessary DOT users based on database privileges assigned by the administrators of the system.

Enterprise data modeling and other data administration activities will be performed using case tools. Case tools couple unmatched ease-of-use and a sensible bi-level design process to allow users to quickly organize logical concepts and then translate them into high quality database designs.

This bi-level structure plays a key role in every aspect of database design. With it, users avoid confusion in design, saving countless hours of rework. The conceptual level is extremely useful for business presentation because it allows intuitive, non-technical descriptions of application's logic. Here a user only needs to consider the logical make-up of the application, such as the cardinality of one relationship between entities. The case tool can take care of the physical translation. Throughout both design levels, the case tool monitors your models to check their validity. Keeping things organized from the start with separate levels helps not only on the original design, but when maintenance becomes necessary as well.

A near-term objective for SHL and each DOT is to catalog all data which will be a part of the repository. For each type of data, the branch responsible for Creating, Reporting, Updating, and Deleting will be identified. This helps the DOT and SHL determine where data redundancies exist, and where overlapping data entry and storage costs exist. Using this catalog, the owners of the data will be established, and therefore the data source for conversion or bridging into the repository will be determined. By storing data elements only once, the repository will reduce data redundancy, increase the efficiency of the database by reducing access times, and will minimize the effort required for data collection and maintenance.

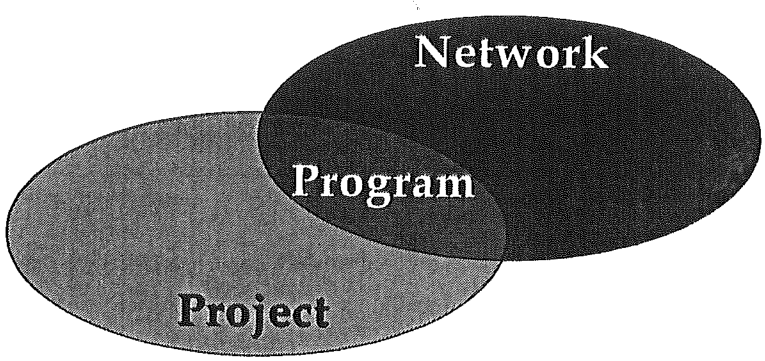
2.2. Analysis Tools



The integration of analysis tools is another building block in the IMS architecture. Analysis tools are used to determine the short- and long-term rehabilitation and reconstruction needs for roads and bridges. The life-cycle analysis portion of the analysis tools will help the DOT determine trends for different materials and what construction methods are the most effective.

SHL is aware that most DOTs are currently implementing Pontis for their bridge analysis tool, and is therefore working to closely integrate this package in their IMS applications. For pavement analysis, there is much more variety so SHL will work with each DOT to integrate their choice of tools. The results from the analysis using these tools becomes a part of the information repository so that all DOT users can query and report on this data. It is therefore important that mechanisms be established to allow data sharing and transfer between the IMS application and these analysis packages

Analysis packages perform two levels of analysis — network and project. Network level analysis considers the needs for the entire state and project level analysis evaluates a particular project to determine the best strategy for that highway segment or individual bridge.



Network Level Analysis is used to:

- Find least-cost long-term preservation strategies
- Promote development of consistent standards for functional improvements
- Facilitate "what-if" analysis of alternative policies and budgets
- Support continuous improvement of predictive models

Project Level Analysis is used to:

- Identify needs on each structure
- Develop projects: specific actions and costs
- Review benefits vs. costs and set priorities
- Develop a budget-constrained program of projects

The intersection of the network and project level analysis produces the program. The program will therefore take both levels of analysis into consideration in determining which projects meet the most critical and cost effective needs of the DOT.

Performance Measures

Performance Measures should be integrated into the analysis tools and should therefore be a part of the IMS application. These performance measures will help to determine if the DOT is meeting the goals established by the analysis process.

Algorithms should be associated with each performance measure and then integrated with the analysis tools. In order to be effective and reasonable, performance measures require consensus and must be controllable by the agency which is being measured. By making sure that the performance measures are computable, they will be consistently calculated and interpreted.

Some example performance measures for pavement, bridge, and safety are listed below:

Example Pavement Performance Measures

- User cost of functional deficiencies
- Cost / Benefit ratio of actions that should be performed
- Backlog of rehabilitation and construction
- Vehicle-miles on adequate pavements
- Mean pavement condition rating
- Current average maintenance cost
- Average age of pavement
- Average Strength of pavement

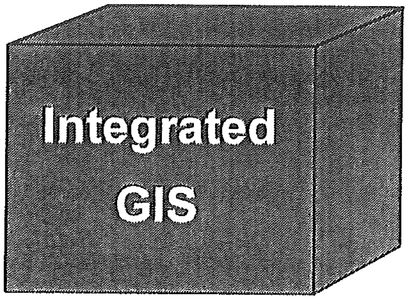
Example Bridge Performance Measures

- Weight restrictions - % of truck VMT (vehicle miles traveled) or tonnage affected
- Clearances - % of bridges able to accommodate legal loads; % of truck VMT or tonnage affected
- Bridge width
- Scour criticality
- Backlog of repairs by different priority categories
- Railings below standard
- Hours out of service
- Element condition state distributions

Example Safety Performance Measures

- Average accident density rate for state-maintained routes
- Number of "hazardous" locations
- Number of accidents
- Number of fatal accidents
- Total number of fatalities
- Total number of accidents by functional type

2.3. Integrated GIS Tools



SHL understands the importance of GIS technology in implementing a successful IMS architecture. GIS provide DOTs not only a mechanism for displaying and querying for information graphically, but also the core functionality needed to determine the results of queries to the information repository.

An integrated GIS will provide:

- A Common Linear Referencing Scheme
- A Common Display for Query Results
- Map Based Queries
- Dynamic Segmentation
- Dynamic Sectioning
- Spatial Analysis
- Feature Based Plotting

A Common Linear Referencing Scheme

In order to minimize the effort of storing many different attributes about the transportation network and response times for query results, a common linear referencing scheme should be established. The first part of the linear referencing scheme is the route name. This name should be consistent across all database tables which have location information and should also be linked to the graphical objects in the base map. The second portion of the linear referencing scheme determines how the highway distances are denoted. For instance, all data attributes could include columns which store the beginning and ending mileposts or the beginning and ending GPS coordinates. This second portion can vary across tables as long as the route name is consistent.

A Common Display for Query Results

The GIS base map is used to display various types of information based on the unique requirements of each user of the system. The GIS should be flexible so that different background features can be turned on and off based on the need for detailed data, but a common base map should be available for all applications. This base map will display the results of queries, using either basic GIS methods or using dynamic segmentation and sectioning. Either way, the user should be able to view the graphical objects which correspond to the results of queries.

Map Based Queries

Map based queries allow users to select map objects in order to view associated attributes. Four types of map based queries should be available - single select, multi-select, area select, and fence select. Single select allows users to click on a single map object such as a bridge and review the textual data about that bridge such as NBI number, location, capacity, etc. Multi-select allows users to choose more than one map object and then scroll-through the associated records. Area select allows users to select all the features within another area map feature. For example, a user can view all of the bridges that are within a particular county. Fence select allows the user to draw an area in the map for querying items that are within or not within that area.

Dynamic Segmentation

Dynamic segmentation is the process of combining multiple distributed attribute (linear-referenced) tables to determine the route segments which meet a database query. For transportation networks, many of the attributes change at different locations along the highway. For example, the width of the road might not change where the traffic count changes or where the pavement condition changes. It is therefore necessary to calculate beginning and ending points when the corresponding tables are overlaid for query purposes. The figure below shows an example of dynamic segmentation.

In this example, the user is querying for particular sections of Highway 43 which meet the query "Find the segments of Highway 43 between 0.00 and 10.00 mileposts that have 4 or more lanes, a condition rating less than or equal to 3 and an average daily traffic count greater than 7500". Only the sections that meet the query criteria would be output in this example but those output segments would be broken whenever any of the input attributes change.

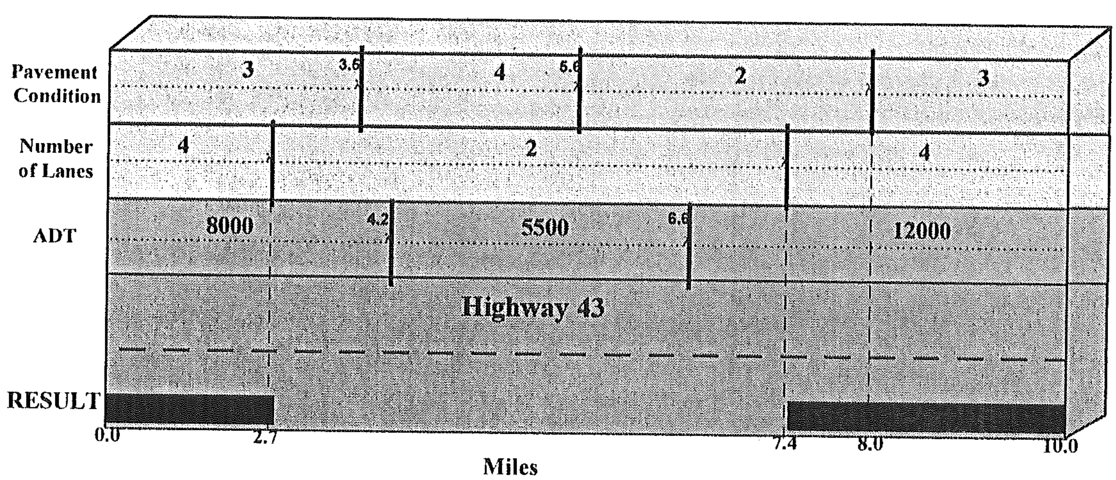


Figure 2-2 Dynamic Segmentation

Dynamic Sectioning

Dynamic sectioning includes performing dynamic segmentation and then aggregating additional values. In the example below, the user wants to find the number of lanes and the average daily traffic count on Highway 43 between mileposts 0.00 and 10.00. After the highway has been segmented, the user wants to then determine the average condition rating and the minimum condition rating. Dynamic segmentation would first be executed to determine the number of lanes and ADT. The resulting segments would be broken any time either of these two attributes change. Dynamic sectioning would then determine the condition rating values for each segment. If there is more than one value for a segment, the length of each separate piece would be determined and then an average condition rating would be calculated and the minimum value would also be stored in the results table. The symbology of the output can also be changed based on an attribute value. In this example, highways with an ADT between 0 and 10,000 are displayed in orange and those highways with an ADT greater than 10,000 are displayed in purple.

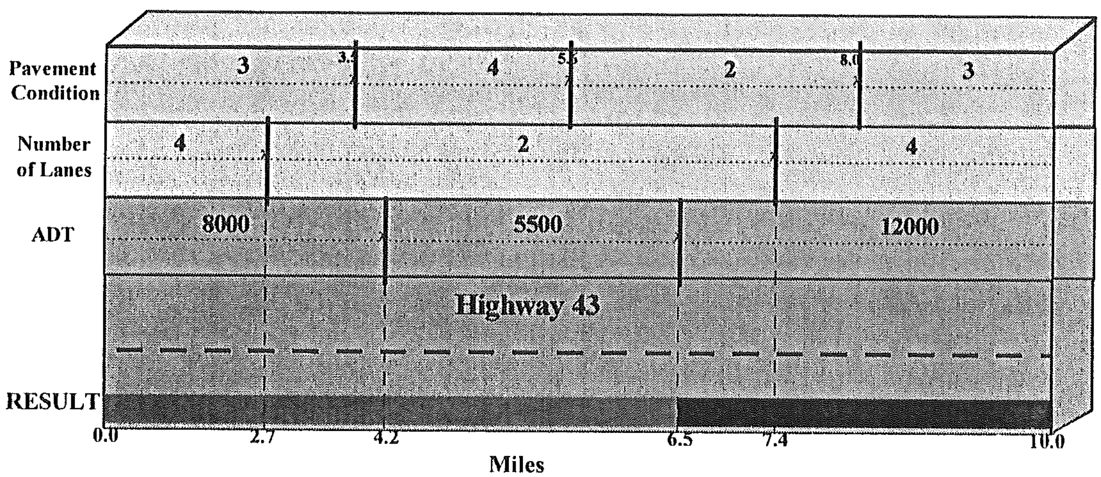


Figure 2-3 Dynamic Sectioning

Dynamic sectioning is also important when comparing historical values. For example, when looking at HPMS sample sections, the beginning and ending milepoints for those sections would need to remain consistent from year to year in order to determine trends for condition ratings, etc. This means that even though part of the sample has a lower condition rating or a different ADT, the aggregate values for the segments need to be determined and compared to historical values.

Spatial Analysis

Spatial analysis includes building "topology" for the graphic elements in the base map. Building topology is the process of setting up the spatial relationships between the objects in the base map so that objects know where they are in relation to other objects. This allows users to execute spatial queries. Examples of spatial queries include:

- Queries which search for elements inside other elements, such as bridges within a forest boundary or highways within a municipal district.

- Queries which search for elements that are within a given distance of each other, such as railroad stations that are within 50 miles of an airport or accidents that are within 500 feet of an intersection.

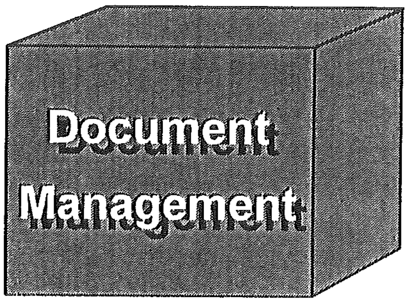
- Queries which search for intersecting elements, such as intersecting highways or construction areas that overlap two municipal districts.

The converse of each of the above queries can also be found, such as areas outside of other elements, elements that are not within a given distance of another element, and elements that do not intersect.

Feature Based Plotting

GIS tools also provide the capabilities necessary to produce feature-based plots. This means that when producing maps for plotting purposes, the symbology of the features can be changed based on database or physical attributes. For example, yellow might be a good color for displaying highways on a monitor, but when plotted, the highway symbology should be changed so that there is significant contrast to the white paper background. Symbology can also be changed based on database attributes. For example all counties could be color-filled differently based on their population. Patterns can also be applied at plot time. For example, a forest area might just be a collection of line strings in the base map, but when plotted, an area pattern could be applied to show forest symbols on the plot. This enables users to use significantly less disk space when storing files and also decreases display times.

2.4. Document Management



The Document Management building block will establish how files, such as scanned documents or spreadsheets, are manipulated and moved throughout the department. As an information repository is built a DOT, the integrity of the data will be harder to manage as more and more users have access to this information. Implementing document, file, and workflow management capabilities will help manage the large volume of files and make them available to all users on the network. Electronic forms help alleviate the problems of processing and routing paper forms. Implementing an electronic forms-based solution can also increase productivity by speeding up and standardizing the routing process, reducing errors, and ensuring that a form is not destroyed or misfiled.

File Management allows users to check files in and out. Files are either checked out for update or for viewing purposes, and only one user at a time can have update privileges. That means if one user is updating a file, such as a Microstation design file, subsequent users must check out the file as view only. Although these subsequent users may be able to change the file, they will not be able to check the file back into the information repository as the master copy. Any changes will be for the individual's purposes only so that data integrity is maintained.

The files managed by the application can be many types including word processing documents, text files, spreadsheets, design files, scanned documents, photographs, videos, etc. This concept is also applied in relational database technologies which allow only one user at a time to update either a table or a row depending on the database parameters and the levels of security.

Document management is a specialized type of file management in that it allows users to view many different types of file formats. Document management tools are generally geared toward scanned documents. A DOT's document management tool should handle large size documents such as design plans, and should also be able to read many industry standard scanned file formats without it being necessary to perform conversions.

Workflow Management works in conjunction with file and document management and is the component of the architecture that provides the ability to electronically route work from one person to another based on pre-defined rules, conditions, and/or events. This includes automatically routing data and documents over the network to the users next responsible for working with them. A workflow automation system keeps track of the processes a document goes through and alerts users when operations are overdue.

Workflow management systems can be implemented through the purchase of packaged software, custom developed applications, or a combination of the two. The approach is determined through an analysis of the business work process environment where the levels of workflow complexity, volumes of transactions, processing costs and functional requirements are assessed.

3. Example Screens

The following pages contain example screens to show functionality which could be available using the architecture building blocks discussed in the previous section. The screen layouts were developed for the Mississippi DOT (MDOT) proposal. SHL is currently developing the DOT's ISTEA Management Systems, including Pavement Management, Bridge Management, and Safety Management. The project, called TMIS, (Transportation Management Information System), is began April 1, 1996, and is now nearing completion of the functional design.

Many of the screens shown in this section have been modified during this functional design phase to reflect the unique requirements of MDOT and the decisions that were made during the Joint Application Design (JAD) sessions that have been conducted over the last several months.

Based on the phone conversation with Morotz Consulting, SHL believes that the Mississippi project has many similarities to the types of applications that Arizona DOT is interested in implementing. The screen layouts are therefore provided to demonstrate SHL's understanding of the requirements of an IMS and to give Morotz Consulting and Arizona DOT ideas on how other DOTs may be proceeding. The screens do not show all the necessary functionality and the functionality demonstrated is just beginning to be developed. They are provided to illustrate the vision of capabilities only. Those capabilities shown in the examples include:

- Ad-hoc Queries and Reporting
- Saved Queries and Reporting
- Custom Queries (Analysis) and Reporting
- Document Display

Ad-hoc Queries and Reporting

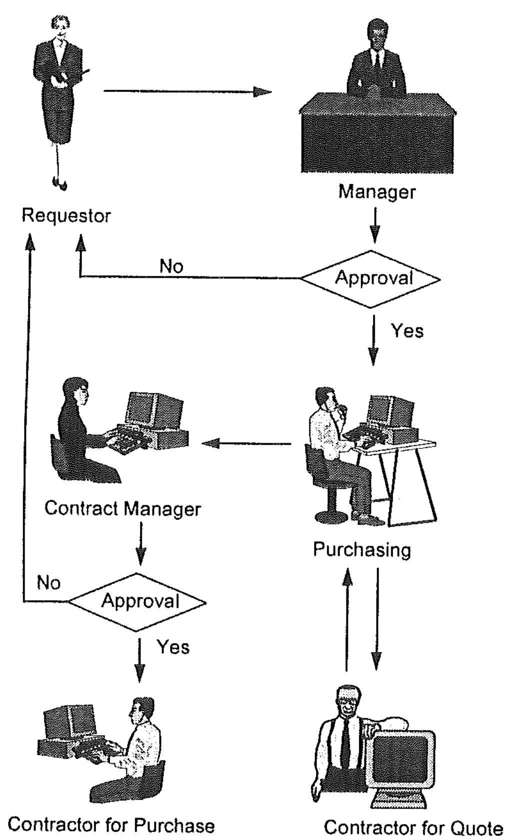
The application architecture described will allow users to combine data from within the information repository across the different applications to execute ad-hoc queries. The figure on the next page shows an example ad-hoc query screen that allows users to select data from several different applications to create a customized report and map.

In the example, a user can choose pavement, bridge, safety, project, and / or financial attributes for query purposes. Each of the attributes that is chosen will be a heading for the associated report. By clicking on one of the attributes, a user can choose to add conditionals to that attribute. In the example, a user has chosen to query for the pavement sections which have an average daily traffic (ADT) greater than 5000 and a prestressed concrete bridge. Attributes chosen from each of the functional areas will be included in the customized report.

Workflow software can augment the E-mail processes. The logging in of a document can be done automatically by software that provides this functionality. Each piece of mail becomes an on-line document tracked automatically as it makes its way through the department via a workflow product, workgroup software, or E-mail. A status event field can be generated by workflow software which can be used for various purposes such as document tracking and performance monitoring. Workflow functionality can also include queuing mechanisms where units of work can be automatically passed to the area that addresses the next logical work function (or person that performs a task on this unit of work).

Other general benefits of workflow technology include the following:

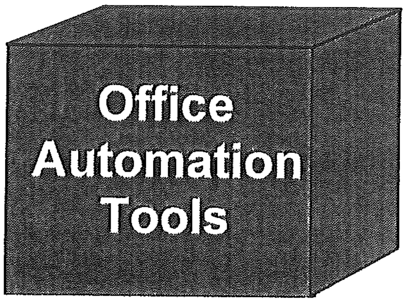
- It ensures that all transactions (i.e., action requests, incoming forms, incoming correspondence, financial transactions, and incoming telephone inquires and requests) are processed to completion;
- It can distribute workloads evenly to the staff available;
- It can track and report on staff productivity levels;
- It can track and report on client service performance levels and provides throughput statistics;
- It provides flexibility in transaction handling to support continuous improvement of business processes; and
- It can significantly improve service quality.



Automating a process flow like the one shown on the left means that no paper documents have to be printed. All approvals, reviews, and requests are made electronically.

One of the principles of the DOT architecture will be the effective use of technology relating to the automation of workflow processes. To facilitate the incorporation of automated file, document, and workflow management tools into the architecture, the DOT will need to define the optimal work processing environment. This can be accomplished through prototyping during detailed process re-engineering. The results of this effort will form the basis for determining the actual uses of supporting technologies such as file, document, and workflow software.

2.5. Office Automation Tools



The office automation tools building block will incorporate integrating office information functions including word processing, spreadsheets, presentation graphics, personal databases, e-mail, and the use of the Internet. The backbone of the office automation is the network, which allows users to transmit data, mail, and even voice.

Users should also be able to use the Internet as a tool for gathering information about technology and what is happening in the transportation industry. The Internet can provide a valuable exchange mechanism for sending files to users that are not connected to the LAN. Many transportation agencies are establishing Web sites to inform the general public on how their tax dollars are being utilized. The Web sites can also be used to inform potential contractors and consultants of future business opportunities and as a mechanism for receiving documents such as RFP's or design standards. In the example screen below, Arizona DOT provides information about their Intergraph CADD system and then provides descriptions of the hardware and software being used as well as a mechanism for downloading CADD design files and cell libraries.

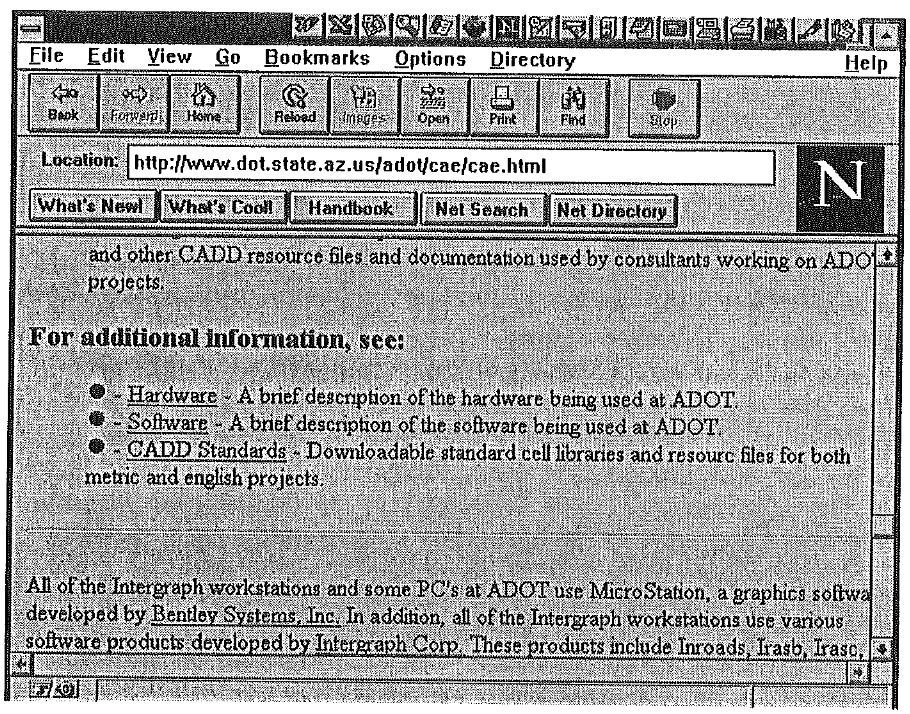
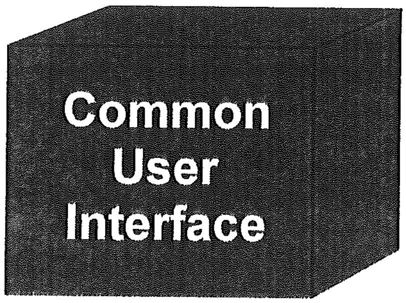


Figure 2-4 Web Site Screen

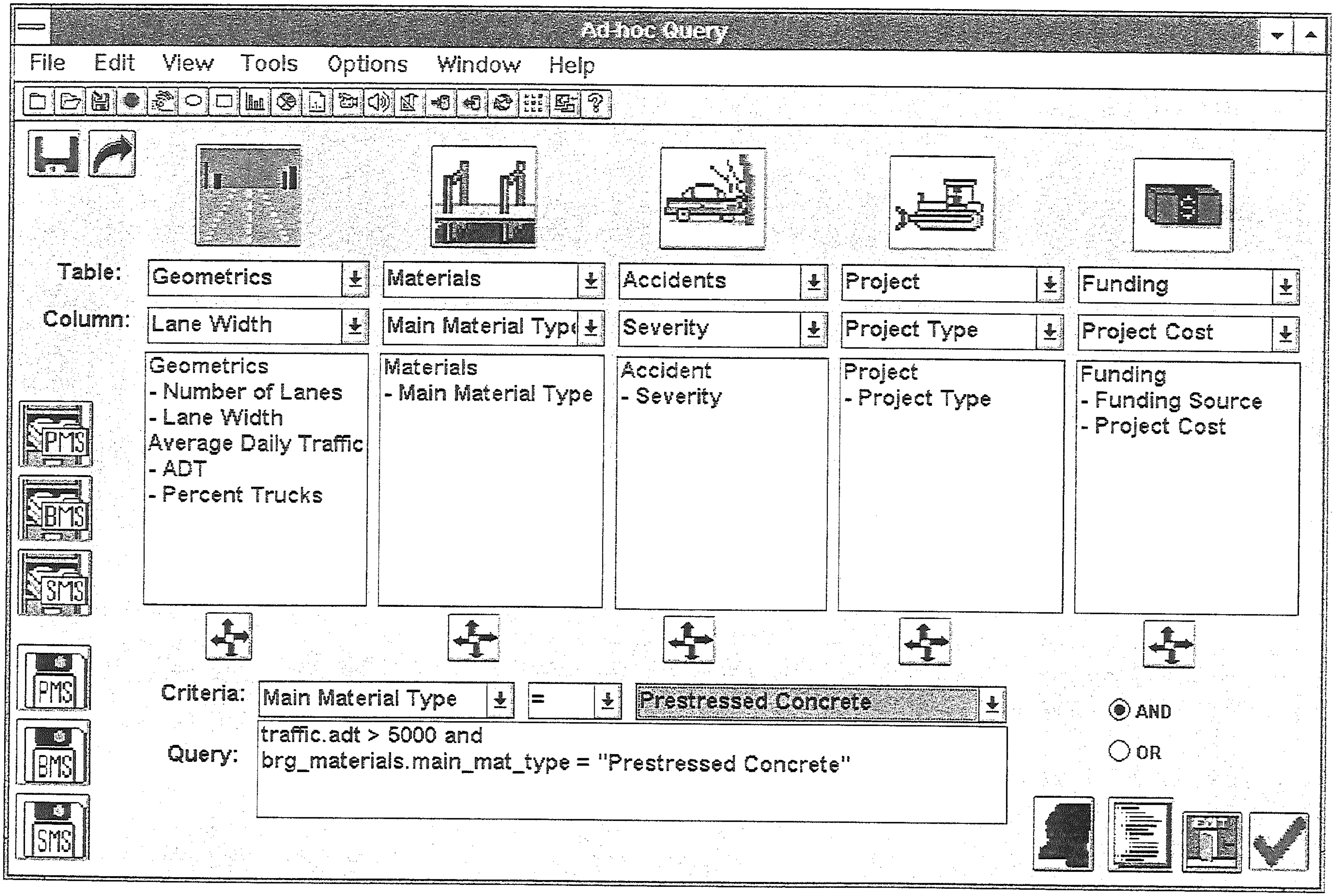
2.6. Common User Interface



The final building block in the architecture is the common user interface. This interface will be built with an industry standard graphical user interface (GUI) development tool which will provide the same Windows look and feel to all windows in the application. The interface will also accommodate different levels of users giving greater details and additional functionality only to the users that need it. The Windows look and feel will allow users to more quickly familiarize themselves with the application because icons and commands are consistent and easily recognized.

The common user interface will be point and click driven providing intuitive navigation and transparent access to data and communication services. It should not be necessary for the end user to know where on the network the data resides. The interface will also allow users to view data from several different applications simultaneously. One of the largest problems that many DOT's currently face is data accessibility because much of the data needed resides in legacy systems that are on incompatible platforms. This makes it very difficult to combine data in order to create the custom reports and maps needed to make efficient decisions. Using the common interface, a user will be able to view any data in the information repository limited only by viewing privileges. This will allow users to create ad-hoc queries, reports, and maps combining data in any manner. The common user interface is the glue that bonds together all the other building blocks.

Ad-hoc Queries Screen



A report from the executed ad-hoc query screen is shown on the next page. For this report, additional parameters were also set up to tell the system how to combine and calculate additional columns. For example, the number of accidents on each highway section was counted, the "mode" or most common bridge material was determined, and the accident density was calculated using a user-defined algorithm. Clicking at the top of a column would cause the report to be sorted on that column. A user could then choose to print this report to any configured printer on the network.

After a report is generated, the user might then wish to view the details about the resulting records. By choosing the  icon, a user could bring up "tabs" giving all the details about the pavement sections found from the executed query. The tabs are an effective way of displaying a large number of attributes. The tab on top lists the geometrics for the pavements. Additional tabs for highway crossings, construction, conditions, conditions opposite direction, lane information. traffic, rehabilitation, friction, analysis, and history can be viewed which give the user additional information for that category. When viewing the master tabs for one functional area, additional tabs from other areas may also be displayed. The information populated in the additional tabs will be based on the current record in the master tabs. For example, if a user is viewing a pavement record that extends from milepost 0.00 to 2.54 on Highway 43, and then selects to view the safety tabs, the accidents that occurred on that section of Highway 43 will be displayed in the accident tab. Example "tabs" are shown on the page after the example report. These screens can also be used for data input.

After viewing the records in the data repository, the user can then choose to create a map display to view the results of the query in the GIS base map. Symbology for the map can be set up as "single" or "attribute-based". The page after the "tabs" shows a screen for setting up Attribute -based symbology. Here the user has chosen to change the symbology based on the ADT. For highway segments with an ADT between 0 and 4999, the segment will be color 1, level 10, style 0, and weight 5. The user can either key in the values for symbology or select the corresponding button to bring up a selection panel. For example, choosing the color palette would bring up a user-defined color table.

After creating the map, the report list will then be linked to the output map objects so that a user can choose a row in the report to highlight the corresponding graphics. A user could also click on the map object to highlight the corresponding row in the report.

Query Results Report Screen

Query Results Report

File Edit View Tools Options Window Help

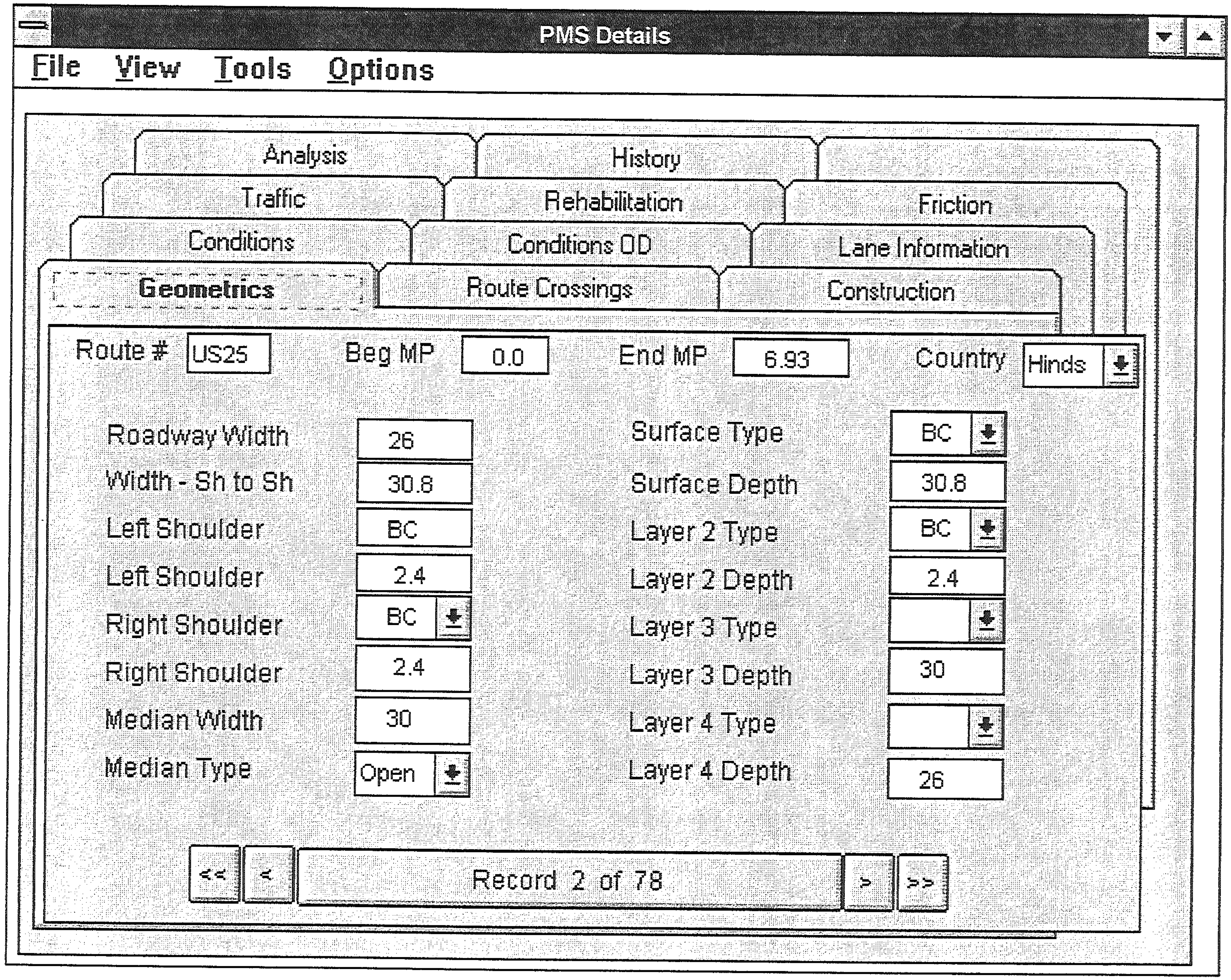
Project Report

11/06/95

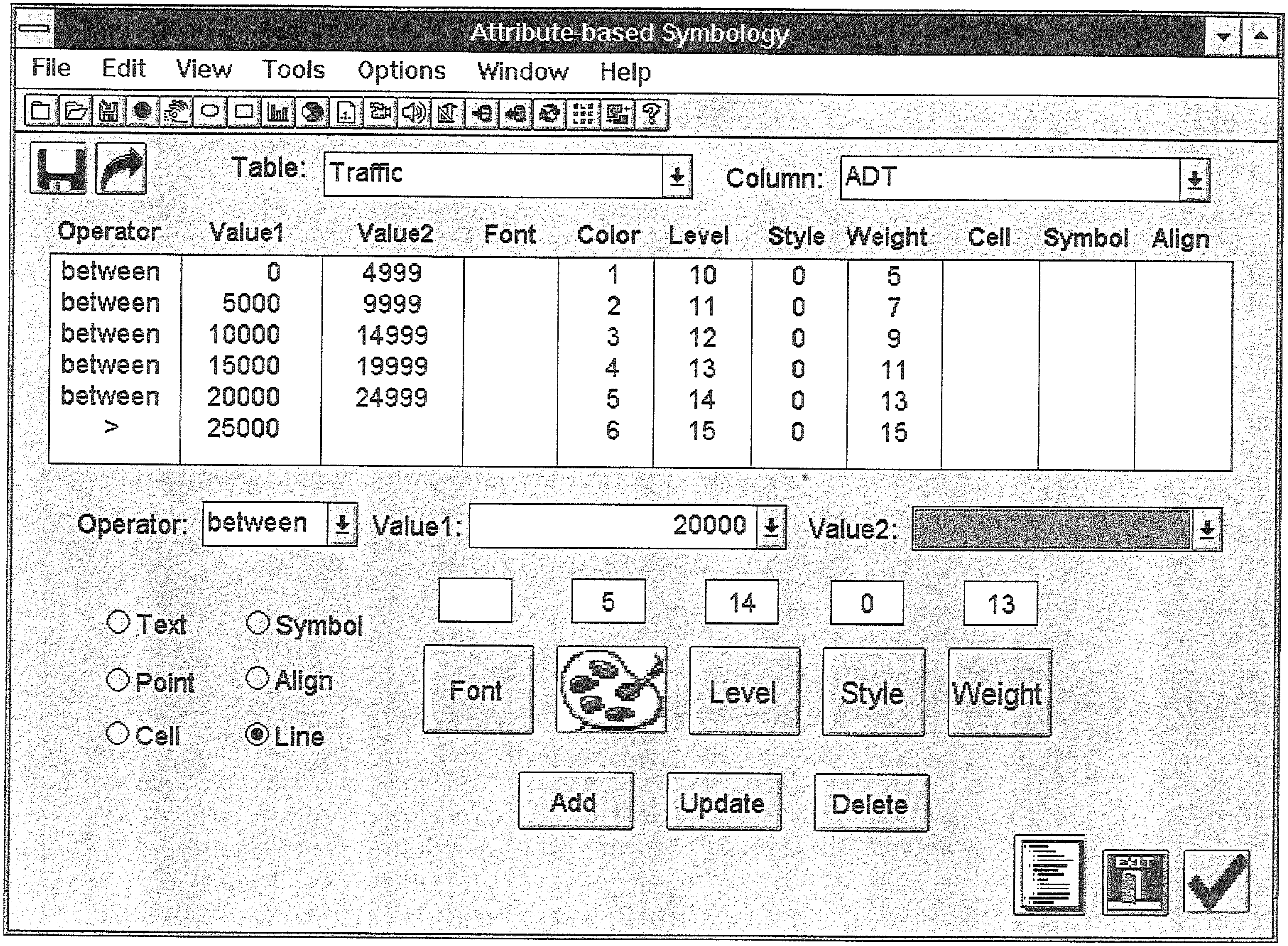
Route #	BMP	EMP	# Lanes	Lane Wd.	ADT	% Trucks	Project Type	Project Cost	Bridge Type	# Acc.	Acc. Sev.	Acc. Dens.
I-55	22.43	23.49	6	14	56900	10	Recon.	1,310,000	Steel Girder	22	F	4.33
I-55	53.92	55.38	8	13	75300	9	Recon.	3,420,000	Steel Girder	19	F	10.29
I-55	56.22	59.60	8	13	64500	9	Overlay	1,080,000	PS Concrete	14	F	8.55
I-55	78.30	84.20	6	14	68300	10	Overlay	1,600,000	PS Concrete	31	I	11.82
I-55	134.81	136.11	4	14	45200	11	Recon	3,290,000	Steel Girder	18	F	25.37
US19	22.33	22.98	2	12	16300	5	Widen	552,000	None	6	PDO	3.22
US19	25.68	26.58	4	12	13200	5	Widen	665,000	None	3	PDO	1.28
US19	36.77	39.55	4	12	11900	4	Resurf.	292,000	Timber	10	I	6.44
US72	0.00	2.37	3	11	3500	2	Overlay	764,000	PS Concrete	10	I	13.12
US72	3.56	3.94	2	11	4100	2	Resurf.	129,000	Concrete	9	F	10.96
Rte41	0.00	1.22	2	12	6300	2	None	0	None	3	PDO	2.92
Rte41	5.66	6.46	2	11	7800	3	None	0	None	0	-	-
Rte41	7.90	8.39	2	12	5100	4	None	0	PS Concrete	8	I	1.28
Rte41	10.11	10.21	2	11	4200	3	None	0	Concrete	5	PDO	4.39
US25	2.36	3.67	6	13	22300	9	Overlay	134,000	Truss	12	PDO	3.48
US25	4.53	4.81	7	13	25300	10	Recon.	591,000	None	18	F	15.39
US25	8.33	8.87	6	12	21900	10	Recon.	320,000	None	10	F	12.96
US25	8.95	9.24	4	12	19200	11	Overlay	172,000	PS Concrete	22	I	10.41
US25	9.46	11.25	4	13	22300	10	Overlay	388,000	Steel	9	F	20.97

EXIT

PMS Details Screen



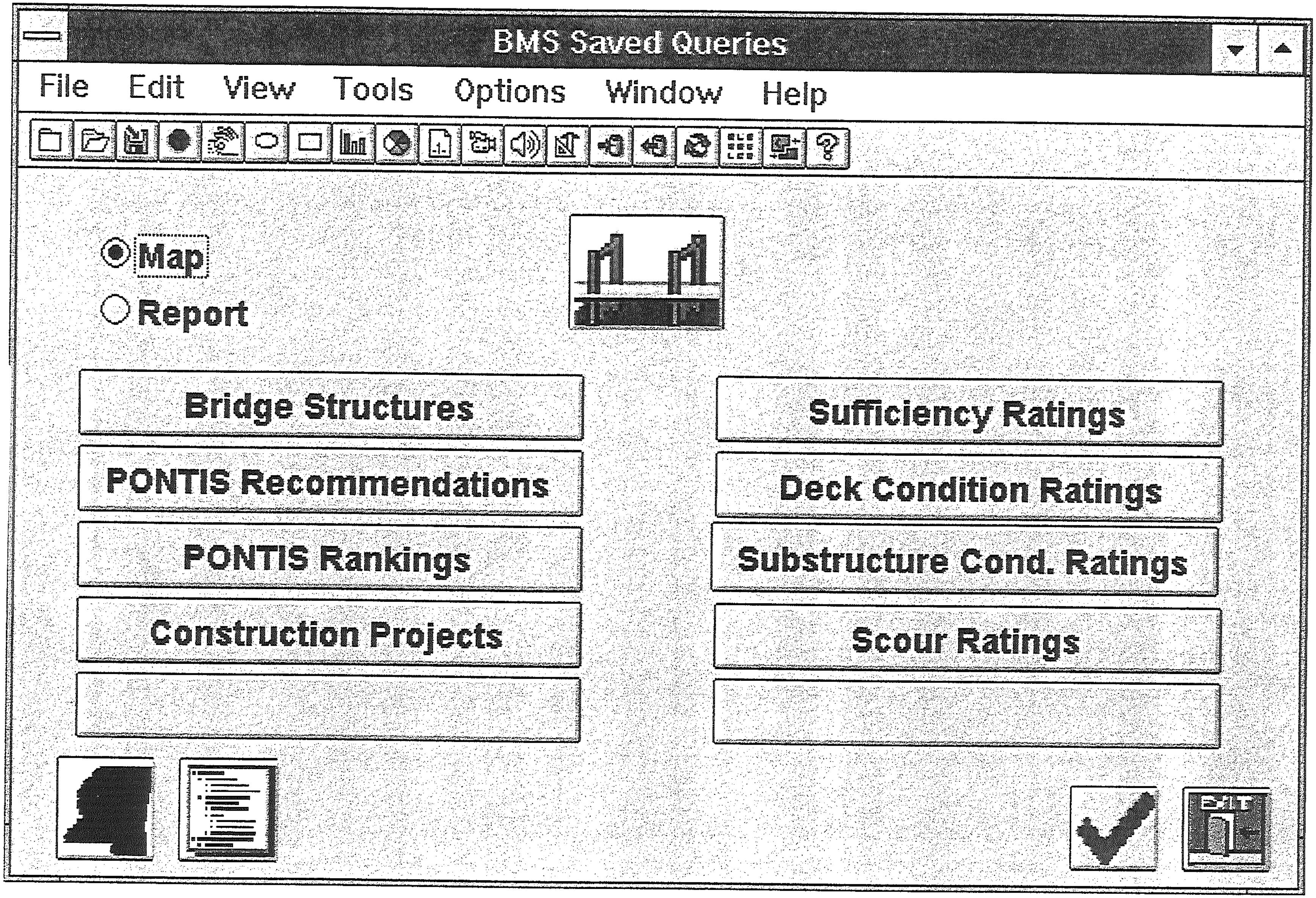
Attribute-Based Symbology Screen



Saved Queries and Reports

For users that do not want the complexity of setting up ad-hoc queries, saved queries and reports will be provided. These screens will list the reports and maps that a user needs to produce on a regular basis. A standard report or map will be created when one of the buttons is selected using the current data in the data repository. The next page shows an example of saved queries that might be executed by an executive manager in charge of the bridge projects.

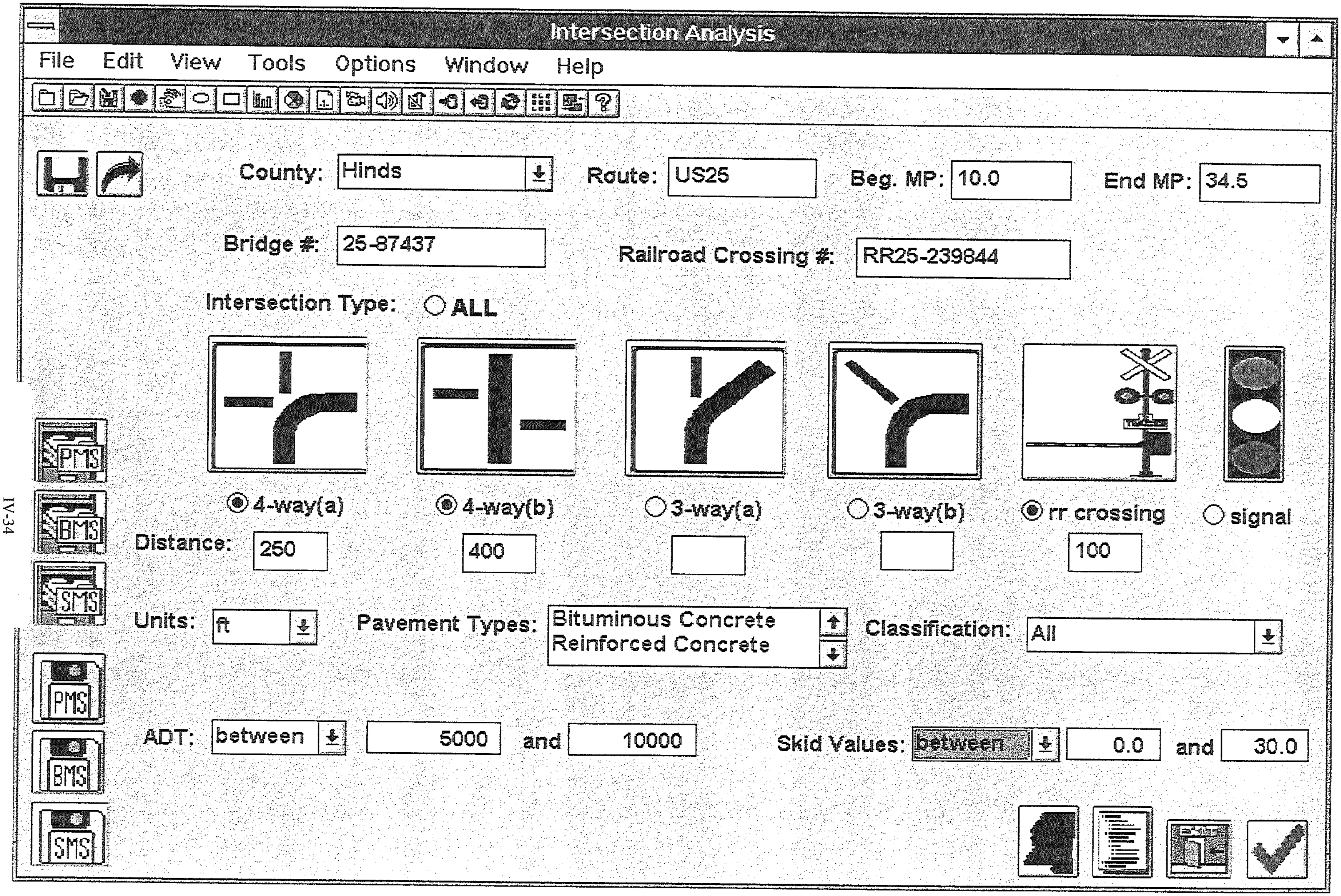
BMS Saved Queries Screen



Custom Queries and Reports

There will be times when the saved queries screen does not allow enough input, but the user still does not want the complication of the ad-hoc query screens. For these situations, screens such as the one shown on the following page would be created. This screen illustrates the ability for users to choose an intersection type and then use spatial analysis to determine the numbers and types of accidents that are attributed to that intersection. The distance from the intersections that the GIS is to search will be user-definable and can be modified based on the intersection type.

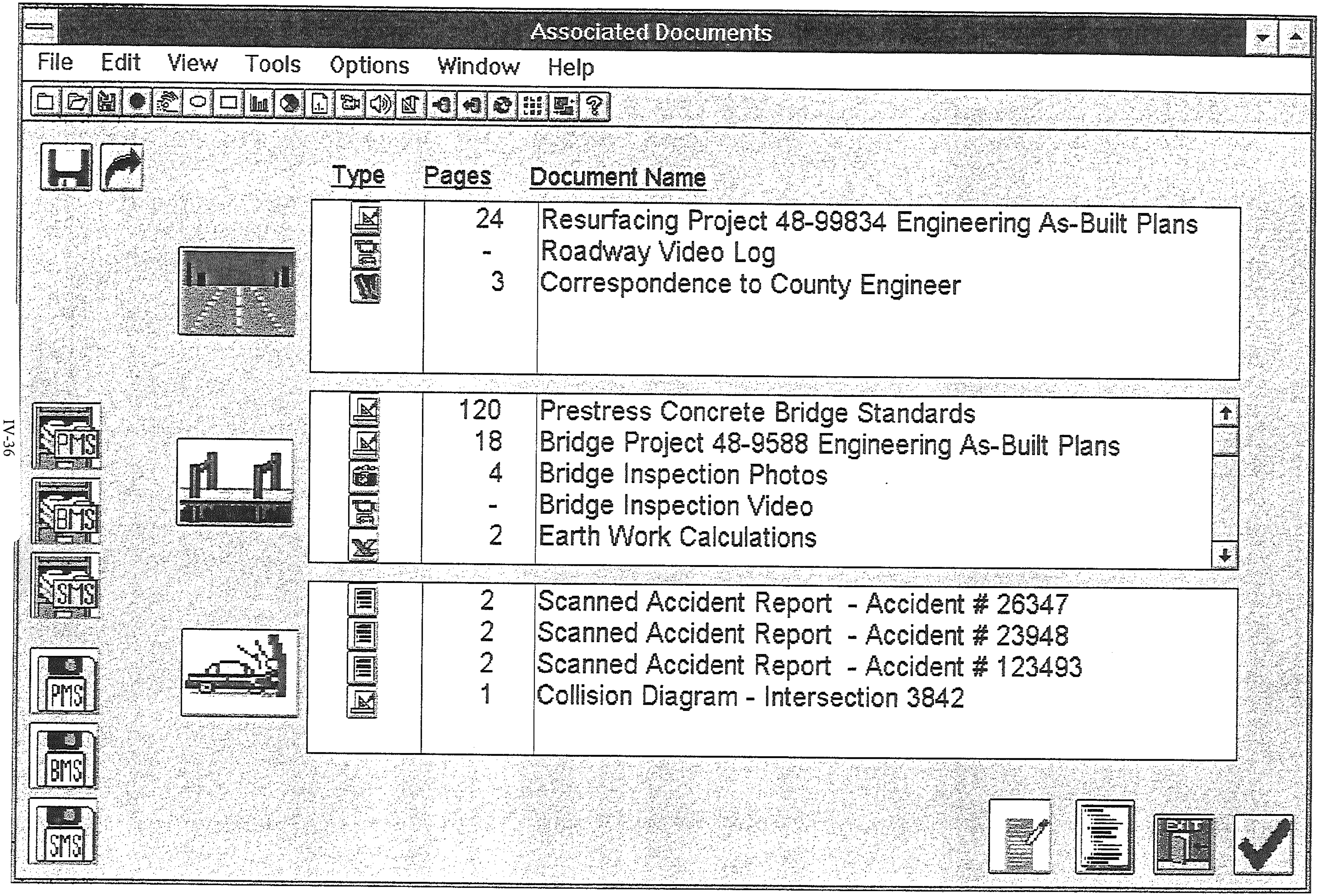
Intersection Analysis Saved Query Screen



Document Display

A user may also wish to view associated documents such as word processing documents, design files, or videos and photographs. In the example screen on the next page, a list of the pavement, bridge, and safety documents is shown. The document name, the number of pages and the document type is given for each document found. The document type is depicted by the icon in the left column.

Associated Documents Screen



4. Structured Methodology

SHL utilizes a structured methodology for the successful completion of the IMS projects. Since its origin in 1974, SHL has been accumulating and updating its methodology knowledge base gained from years of successful projects for a wide variety of clients, applications, and technical environments. The current generation of that knowledge base is SHL TRANSFORM™.

SHL TRANSFORM is a comprehensive, client/server, object-oriented, multi-media project development performance environment. It provides a corporate knowledge base, illustrated in the figure below, and a set of project support tools.

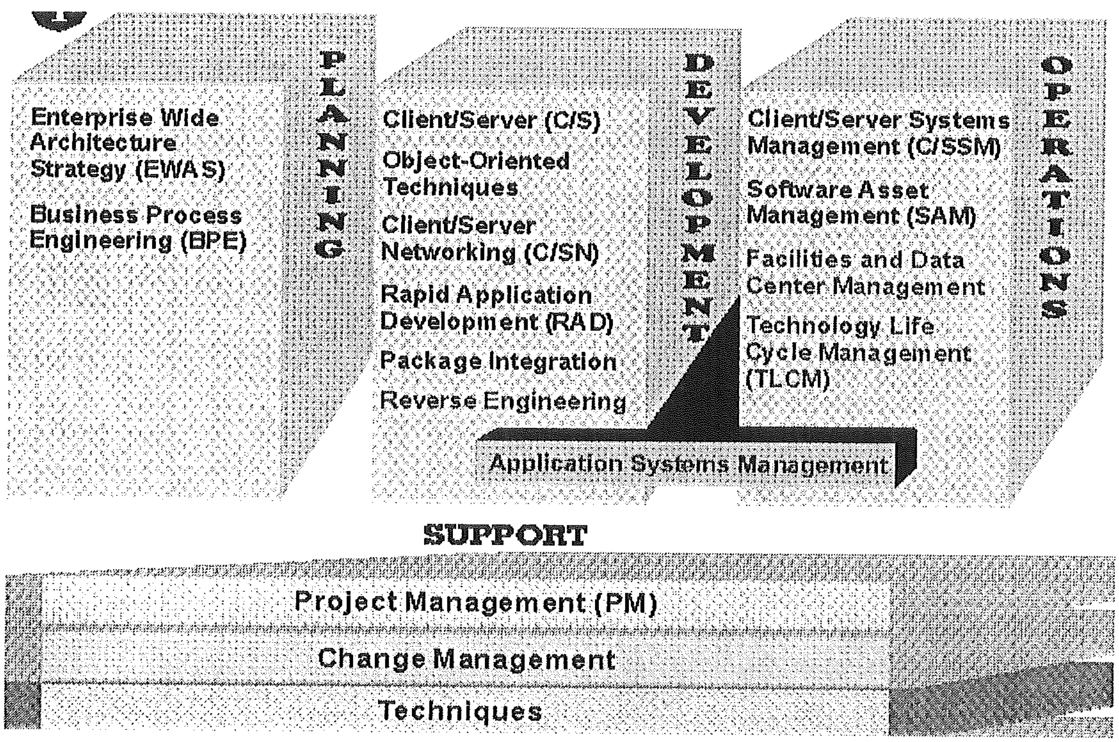


Figure 4-1 SHL TRANSFORM Knowledge Base

The corporate knowledge-base includes the following components:

Methodologies (stages, tasks, roles, deliverable descriptions)

- Planning
  - Enterprise-Wide Architecture Strategy
  - Business Process Engineering
- Development
  - Client/Server
  - Object-Oriented Techniques

- ◊ Client/Server Networking
- ◊ Rapid Application Development
- ◊ Package Integration
- ♦ Operations
  - ◊ Client/Server Systems Management
  - ◊ Software Asset Management
  - ◊ Project Management
    - ◊ Change Management

- Procedures (e.g., information engineering)

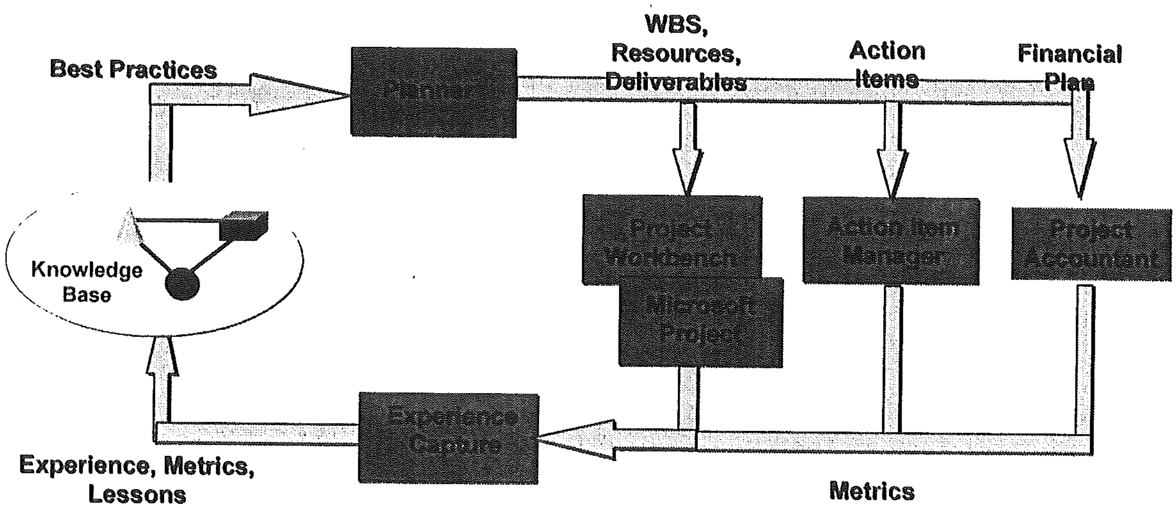
- External Industry Standards (e.g., ISO 9000)

- Prior Project Experience (e.g., metrics, approach, technology, solutions)

- Techniques, Rules of Thumb, Checklists, Templates

As shown in the next figure, the project support tools are intended to automate the flow of knowledge within the project, drawing on the best practices, experience, metrics, and lessons garnered throughout SHL. They are integrated into the desktop workstation environment.

Figure 4-2 Project Support Tools



- **The Viewer**

The Viewer is a multi-media tool used to navigate and search the Knowledge Base, displaying the multi-media, hypertext modules. The following sample shows the input and output objects, the techniques, and the role assignment for a task. The middle panel on the screen shows the objects describing the task.

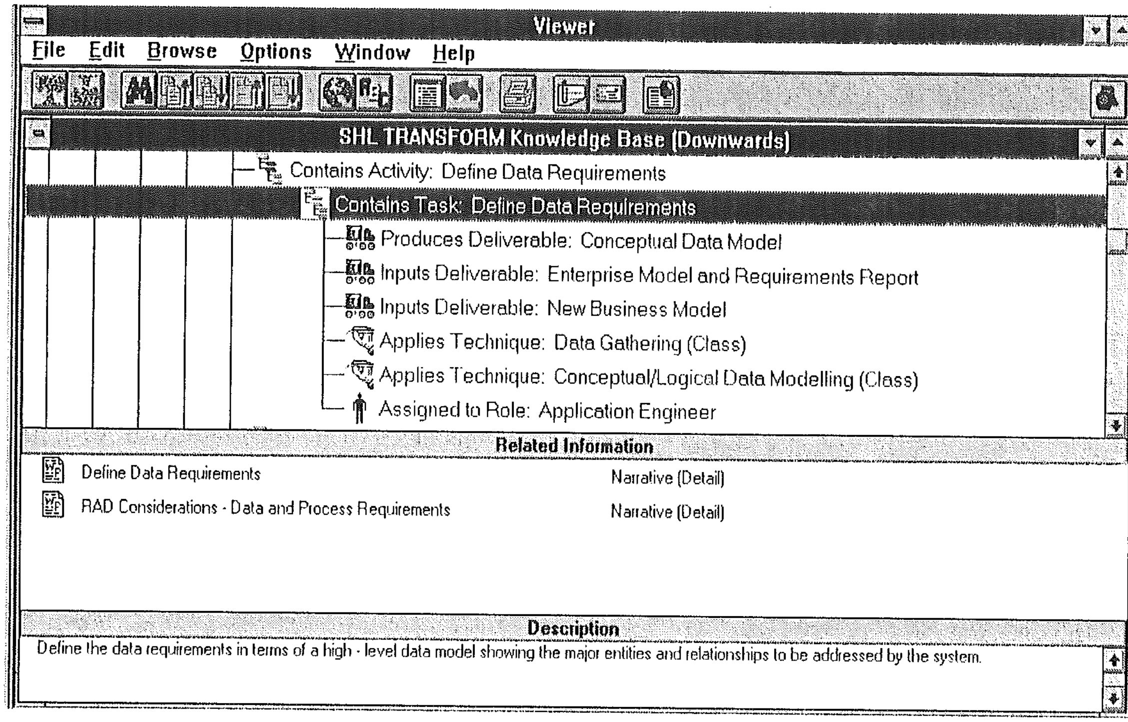


Figure 4-3 Viewer Screen

- **The Planner**

This tool enables project managers to assemble and customize a project plan by extracting tasks from one or more of the Knowledge Base methodologies as required for the project at hand. The tool is intelligent enough to actually critique the final plan for the project manager.

- **Project Workbench for Windows**

The initial project plan developed using the Planner tool is downloaded into Project Workbench for Windows to support the ongoing management of the project.

- **Action Item Manager**

This is a workflow management tool that tracks the processing of routine project transactions: Decision Requests, Change Requests, Problem Reports, Service Requests.

- **Checkpoint**

This e-mail-enabled workflow management tool enables each project team member to electronically prepare and submit their weekly project status report. Team leaders and the project manager also use the tool to aggregate the status reports they receive into a single status report for the team.

- **Pro*Suite**

This set of tools is used to support the analysis, documenting and design functions within Business Process Engineering.

- **Air Mosaic**

This tool is used to enable project staff to access the Internet (e.g., vendor information).

For IMS projects, SHL TRANSFORM will:

Assist the project team in applying software engineering principles to the development of an IMS

Assist project management in deploying and administering strong project management principles

Provide state-of-the-art development methodology guidance

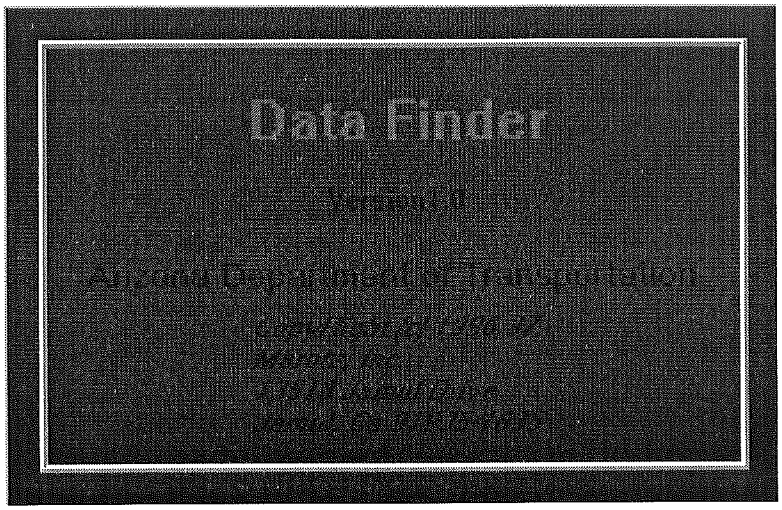
Give the DOT the advantage of methodology expertise developed and refined by leading development professionals across SHL

Give the DOT the advantage of a state-of-the-art automated methodology tool. For example, AT&T has purchased an SHL TRANSFORM license to use across its consulting and system integration operations worldwide

Provide an integrated workbench of project management and delivery tools

Appendix V

DataFinder User's Manual



User's Manual

Marotz, Inc.
13518 Jamul Drive
Jamul, CA 91935-1635
info@marotz.com

Data Finder User's Manual

Produced for

Arizona Department of Transportation
1130 N. 22nd Ave. 075R
Phoenix, Arizona 85009

by

Marotz, Inc.
13518 Jamul Drive
Jamul, CA 91935-1635
info@marotz.com

Data Finder
User's Manual

Limited Warranty

Marotz, Inc. warrants the physical program disks and physical documentation to be free of defects in materials and workmanship for a period of sixty (60) days from the date of purchase.

Our liabilities shall be limited solely to replacement disks and documentation and shall not include any other damages. We will not be liable for consequential, indirect, special, or other similar damages or claims, including loss of profits or any other commercial damage. In no event will Marotz, Inc.'s liability for damages to you or any other person ever exceed the price paid for the license to use the program.

License Agreement

Data Finder is not copy protected, but it is protected by copyright law and international treaty provisions.

Marotz grants to the Arizona Department of Transportation an unlimited right to use, duplicate, and modify the delivered software application, source code, and accompanying documentation.

Table of Contents

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Overview and Benefits

This chapter presents an overview of Data Finder as used by The Arizona Department of Transportation (ADOT).

Within ADOT, there are many computer systems which contain hundreds of data elements. Within these systems, there is a wealth of information available to ADOT associates. However, it can be difficult to determine what information exists and where it can be found.

Data Finder is a data dictionary which serves as a reference for ADOT associates who wish to determine the source or existence of specific system elements as well as other important element information. For each element identified, Data Finder will provide:

- Element name
- Element description
- Element type
- Element length
- Element table (if applicable)
- System name (to which the element belongs) and description
- Name, department, phone and e-mail address of an ADOT representative who can provide additional information regarding the system or element.

Data Finder will search multiple fields including element name and element description. This benefits the user in a number of important ways:

- It is an efficient method of identifying data sources
- Related elements which may be of interest to the user can be revealed through the search mechanism
- Element descriptions provide an opportunity for the user to become educated about elements previously unfamiliar to them
- Using the search and sort capabilities of Data Finder, this program can be used as a maintenance tool for system managers. Review of specific elements across multiple systems will reveal duplicate elements as well as those which may be missing from a particular system.

System Requirements

Data Finder requires an IBM PC compatible computer, 4 MBytes or more of RAM, and Microsoft Windows version 3.1 or later. Data Finder has been tested with and works properly under Windows 95.

Using This Manual

This User's Manual is divided into the following chapters for your convenience:

Installing Data Finder provides specific instructions for installing Data Finder on your system and a complete description of the Data Finder directories and files.

Quick Start Guide provides a fast introduction to the Data Finder user interface and describes how to use key Data Finder features.

Menu Choices and Buttons is a complete reference to all Data Finder menu choices and buttons.

Data Finder Tutorial presents screen reference and guidance on how to use Data Finder for specific tasks and provides information on how to use the various reports available in Data Finder.

User's Manual On-Line provides instructions on how to use Data Finder's on-line Help files.

Glossary provides terminology names and descriptions referenced throughout this manual.

Getting Help

This section outlines what to do if you require assistance setting up or using Data Finder on your computer. Data Finder has been thoroughly tested, and should run smoothly with your computer.

Marotz has supplied a comprehensive set of documentation, including a User's Manual and full on-line help. These sources of information, along with internal support from your organization, can usually help you solve any problems you may experience while using Data Finder.

Guarantee

Marotz, Inc. warrants the physical program disks and physical documentation to be free of defects in materials and workmanship for a period of sixty (60) days from the data of purchase. Our liabilities shall be limited solely to replacement disks and documentation and shall not include any other damages. We will not be liable for consequential, indirect, special, or other similar damages or claims, including loss of profits or any other commercial damage. In no event will Marotz, Inc.'s liability for damages to you or any other person ever exceed the price paid for the license to use the program.

Installing Data Finder

This chapter steps you through the process of installing Data Finder. We cover the process of inventorying your Data Finder materials, preparing for the installation, installing Data Finder, and conclude with a summary of the Data Finder directories and files.

Checking Your Data Finder Package

Data Finder is shipped on 3 1/2 inch high-density (1.44 MByte) IBM formatted disks. Your Data Finder product package should include one hard copy User's Manual and a set of labeled disks. The disks are each individually labeled (e.g., disk 1 of 2) to allow you to quickly ensure that all disks are present.

Preparing for Installation

In this section we help you prepare to install Data Finder. This preparation process includes ensuring that your system configuration is compatible with Data Finder, closing existing applications prior to installing Data Finder, checking the README.TXT file, backing up your Data Finder disks, and a brief introduction to the Data Finder installation program.

Minimum and Recommended System Configurations

Table 1 shows the minimum and recommended system configuration for Data Finder. Please ensure that your system configuration meets these requirements prior to attempting to install Data Finder.

Minimum Configuration	Recommended Configuration
80386 CPU	80486 CPU or better
4 MBytes of RAM	16 MBytes of RAM or better
VGA compatible monitor	VGA compatible monitor
Windows 3.1 or later	Windows 95 or Windows NT
3.5 inch high density floppy drive	3.5 inch high density floppy drive

Table 1: Data Finder Minimum and Recommended System Configuration

Closing Applications Before Installing

Data Finder opens several files while running. Prior to installing Data Finder, it is best if you close other running applications. This will free up as much memory as possible for use by the installation program, thus minimizing the possibility of an "out of memory" condition. If the installation program still does not run properly, you may wish to exit Windows fully, then restart Windows. This will free any resources, including memory, that other applications may have left allocated.

Checking the Readme File

The first installation disk contains a text file called README.TXT. This file contains information and answers to questions that were too new for inclusion in the hard copy documentation. This file will automatically be displayed at the conclusion of your software installation. If you are having problems getting Data Finder to install on your system, you should use a text editor (e.g., Notepad) to view this file to see if your particular problem is covered.

Backing Up Data Finder Disks

It is always a good idea to keep a backup copy of floppy disks. You can backup the Data Finder disks using the file manager or the DOS program DISKCOPY. Marotz will only replace lost or destroyed Data Finder disks. There is a replacement fee charged for replacing lost or destroyed software disks.

What the Installation Program Does

Later in this section we describe the exact directories that the installation program creates, and the files that the installation program places in those directories. No other changes are made to your system during installation. Deleting Data Finder from your system is as simple as deleting the indicated directories.

Installing Data Finder

This section steps you through the specific steps of installing the Data Finder software onto your hard drive.

Running the Installation Program

Insert the first Data Finder distribution disk into your computer's 3 1/2 inch floppy drive slot. Select the file called SETUP.EXE and double click on it. You may also select the file and from the File menu select Open.

Customizing the Installation

You may want to configure your system to chose between installing only the Data Finder Application or the Application plus the empty data files. You will want to particularly keep this in mind when you are doing a reinstallation of the application and you do not want to overwrite your existing data files. To do this, chose the Custom Setup from the install disk and check the box that contains Application only (check box for Empty Data Files needs to be blank otherwise new data files will be installed and overwrite existing data files).

Completing the Installation

After you have selected your configuration, SETUP will complete the installation. In addition to copying files from the disk to your hard drive, SETUP will create a Data Finder program group and install the Data Finder application icon in this program group. At the conclusion of the installation process, the Data Finder README.TXT file will be displayed. Read this file carefully for any new information about the Data Finder application.

Installing Data Finder on a Network

To install Data Finder on a network, specify the network drive as the destination during the installation process. You should install both the Data Finder application and the Data Finder data files on the network drive for a network installation. Data Finder expects the data files to reside in the default directory when the application is run. This is normally the same directory where the Data Finder application itself resides. You must then manually create the Data Finder program group and application icon on each network workstation that will be configured to access Data Finder.

If you are installing Data Finder on a network, you may need to configure the Borland Database Engine (BDE) to your particular network environment.

If your computers are already running the Borland Database Engine, check with your network administrator. The configuration is probably already done for you. This will be the case, for example, if you are using Paradox for Windows or DBase for Windows.

If this is your first Borland Database Engine application, or your network administrator has not already configured the Borland Database Engine for multi-user use, then you will need to edit the BDE configuration file.

Editing the BDE Configuration File

The configuration is accomplished by editing the BDE configuration file. This is normally accomplished using a program called BDECFG.EXE (found in the BDE directory). Run this program and select the Drivers tab (this is the default tab). In the "Driver Name" list box, select Paradox. For the Net Dir parameter, specify the file server that will be used by each of the Data Finder users. For example, if the server was mapped to a local drive "M": you would specify the Net Dir location as "M:\". It is critical that each client computer accessing the shared data files point to the exact same physical location on the network for the Net Dir file location.

If the application was previously run without this parameter set, you may have residual lock files remaining behind. To remove these, ensure that no user is accessing any of the Paradox data files (either in Data Finder or any other application using Paradox), then search the server and each local drive for lock files (*.LCK). Delete each of those files to complete the process.

Data Finder Directories and Files

Data Finder creates the following directories during the installation process:

- Dfinder - This directory contains the Data Finder application and all files required by the Data Finder application and the Data Finder data files. If you do not already have the Borland Database Engine installed on your computer, then Data Finder will install the engine in the IDAPI directory.

The SETUP.EXE program sets a default path on the local drive for storage of the application and data folders. The installer may browse and select a new path to store these folders. The Borland Database Engine will be stored under C:\Program Files\Borland\Common Files\BDE.

The Data Finder application itself consists of the files shown in Table 2. All of these files with the exception of the help files (ending with .HLP) must be present for Data Finder to run. The help files must be present for Data Finder on-line help to work.

File	Description
Dfinder.exe	The Data Finder application itself.
Dfinder.hlp	The on-line version of this User's Manual.
Dfinder.ini	The Data Finder initialization file.
REDME.txt	The Data Finder Readme file that is displayed at the end of the installation procedure.
Elements.db Employee.db Lu_area.db Lu_freq.db Lu_table.db Lu_type.db System.db	The Data Finder database files.

Table 2: Data Finder Application Files

Quick Start Guide

This chapter provides a fast introduction to the Data Finder user interface and describes how to use key Data Finder components.

Starting Data Finder

The easiest way to start Data Finder is by double clicking on the Data Finder icon which is illustrated below in Figure 1. If you are using Windows 95, you may wish to create a shortcut to Data Finder on your desktop. See your Windows 95 documentation for the procedure to accomplish this.

Figure 1: Data Finder Icon

If you have not already done so, start Data Finder at this time. Data Finder begins running in full-screen mode.

Screen Components and Features

This section presents an overview of components and application features.

Title Bar

Figure 2 displays the Data Finder title bar which appears at the top of all Data Finder screens. The System Menu is accessed by clicking on the System Menu Request button (Data Finder icon located on the left side of the title bar). You can quickly close the Data Finder application by selecting CLOSE from the System Menu, or by double clicking on the System Menu Request button (icon).

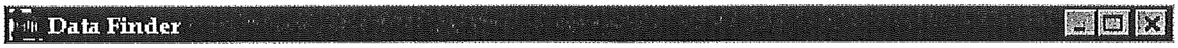


Figure 2: Title Bar

The Maximize button is on the right corner of the title bar. When the Data Finder window is full screen, this button is used to make the Data Finder window smaller. When it is not full screen, you can resize the Data Finder window by using the mouse to drag a window edge or corner. To maximize the window again, click on the Maximize button.

The Minimize button is to the left of the Maximize button. This button shrinks the Data Finder window to an icon at the bottom of your screen. To restore the window back to its original size, double click on the Data Finder icon.

The title area of the title bar is used to move the Data Finder window around the screen if it is not full screen. The title area can also be used to maximize the Data Finder window to cover the full screen. Simply double click on the title bar.

Table 3: Menu Bar

Menu Bar

Table 3: The Data Finder menu bar appears at the top of the application screen just below the title bar. The menu bar displays the File, Maintain, Report and Help drop down menus. The Data Finder menu hierarchy is defined in Table 4 below. Each of these menu choices is covered in depth in the chapter titled, *Menu Choices and Buttons*.

Menu Choice	Used For
File | Exit	Allows exit from Data Finder.
Maintain | Area	Update available Area selections.
Maintain | Element Type	Update available Element Type selections.
Maintain | Update Frequency	Update available Update Frequency selections.
Maintain | Table	Update available Table selections.
Reports	Prompts display of the Reports dialog box from which reports and printing can be selected.
Help | Instructions	Displays the on-line version of this User's Manual.
Help | About	Displays information about Data Finder.

Table 4: Data Finder Menu Hierarchy

Hot Keys

Hot keys are a quick way of selecting a menu, tab or button. The underlined letter of a menu, tab or button is the hot key. Hold down the "Alt" key on the keyboard along with the hot key (simultaneously) to quickly move to the desired menu, tab or button. For example, in Figure 3 which follows, hot keys include "A" for the Maintain menu, "O" for the Employees tab, and "I" for the Employees grid Insert button.

There are some keyboard hot keys that come standard to the Windows environment. These hot keys can be used within the Data Finder application when working in the Description fields for systems or elements. The mapping for Windows hot key functions is shown in Table 5.

Non-Menu Item	Function Key
Cut	Ctrl + X
Copy	Ctrl + C
Paste	Ctrl + V
Undo	Ctrl + Z

Table 5 : Windows Function Key Equivalents

Tab Key

In addition to using the cursor (via mouse or keyboard arrows) and hot keys, you may also use the Tab key to move throughout the Data Finder selections that are available on each screen.

Scroll Bar

Data Finder makes use of many grids to display various types of data. Movement throughout each grid can be accomplished by using the cursor and keyboard arrows or mouse. Movement can also be accomplished by clicking the scroll bar or the scroll arrow, or by dragging the scroll box (Figure 3).

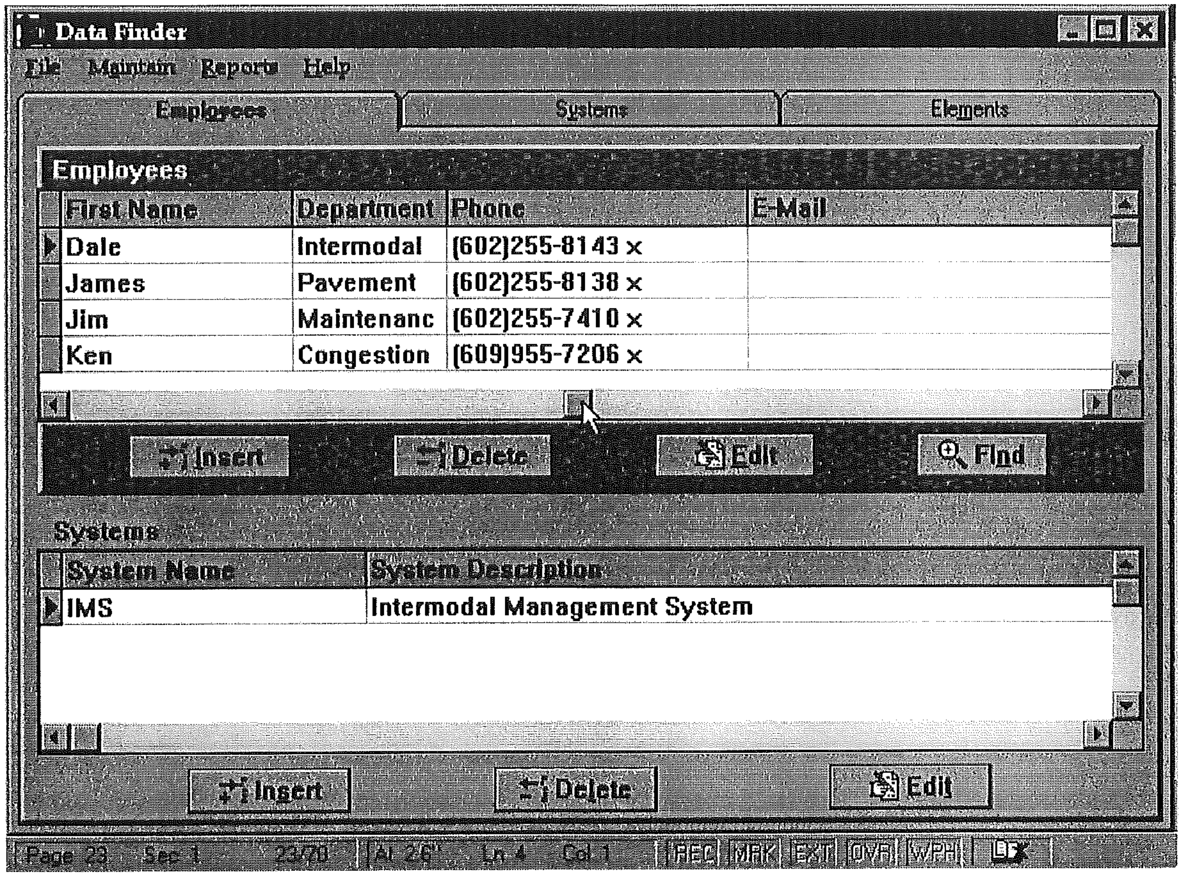


Figure 3: Scroll Bar

Grids

The Data Finder program makes use of many grids for display of data. Use the cursor (mouse or arrow keys), tab key and scroll bars to move through each grid.

Figure 4: Grid displays can be altered and searched using the Grid Settings pop-up dialogue box. Right click the mouse anywhere within a grid to prompt display of this dialogue box.

Use the "Fields Displayed in a Grid" tabs on the left side of the dialogue box to view current displayed fields and available displayed fields. From the second tab, "2Available," you may select the fields you wish to display by highlighting the desired fields and choosing the "Add to Grid" or "Delete From Grid" buttons beneath the tabs. To return to the original grid format (fields), select the "Reset to Defaults" button.

The "Display Label" text box can be used to change grid label names. On the grid, highlight the grid label you want to change, right click the mouse on the grid to display the Grid Settings pop-up dialogue box, then type the new label in the "Display Label" text box. Select the OK button to initiate the change.

Display length and field width can be changed on a grid by highlighting the field, right clicking the mouse button within the grid to display the Grid Settings pop-up dialogue box, then use the up and down arrows for "Display Length" and "Grid Width" to alter dimensions. Size can also be key entered into each text box rather than to use the up and down arrows. Select the OK button to initiate the change.

To search for text within a field, select the magnifying glass at the bottom of the Grid Settings pop-up dialogue box as pictured in Figure 4. The Find Field pop-up dialogue box will appear. Enter the text, or sub-string text, for which you are searching in the text box. Select the magnifying glass to the right of the text box to initiate the search. Search results will appear at the bottom of the Find Field dialogue box for "Field Name" and "Field Value." Use the "Count Records" button to display the total number of records found. Use the "Prior" and "Next" buttons to view each record in succession.

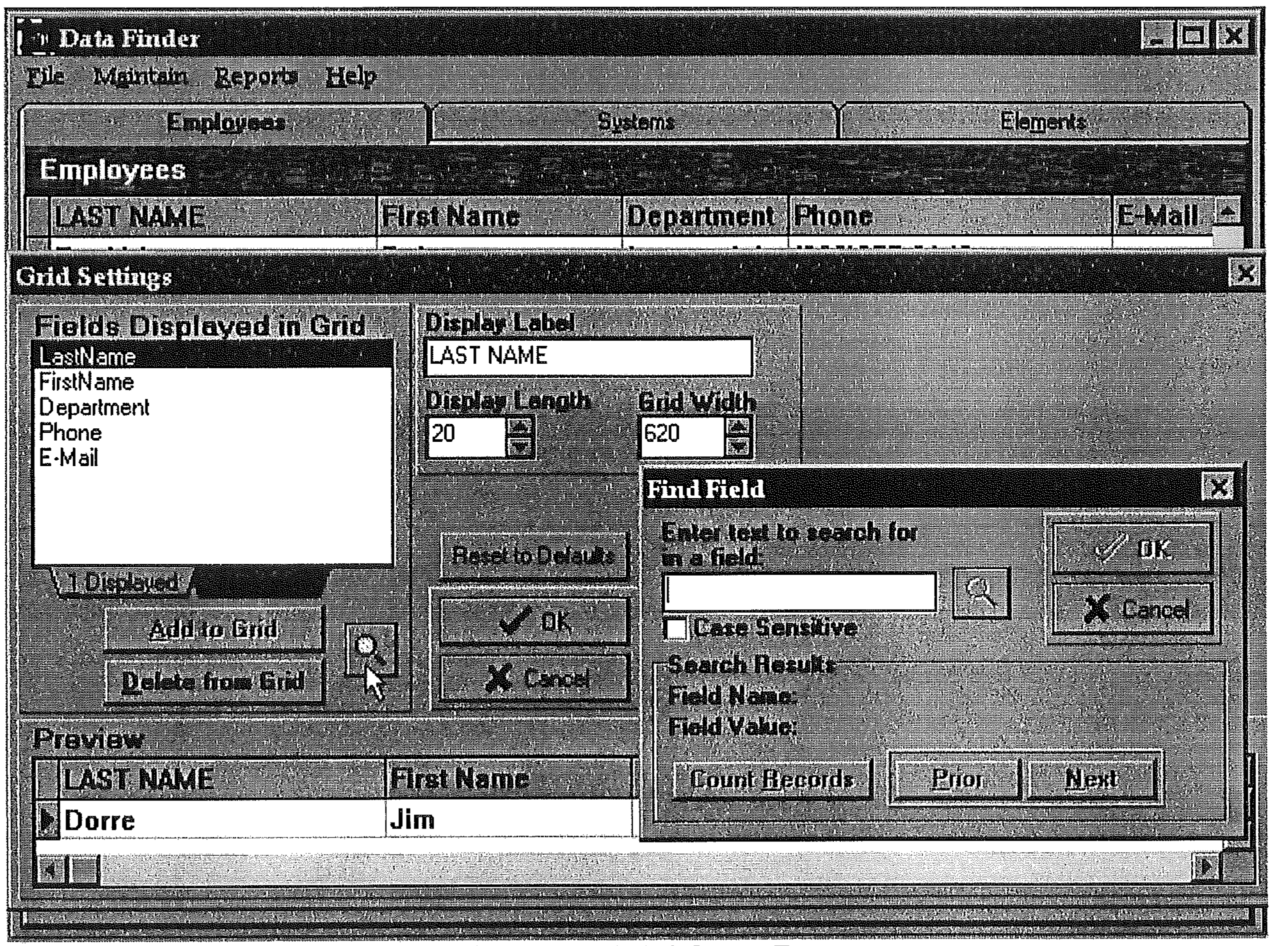


Figure 4: Grid Settings & Find Field Pop-Up Dialogue Box

For grid fields which cannot display the large amount of data they contain (such as the Element tab, Element Description field), double click on the field to display a pop-up box containing all data in the field (see Figure 5).

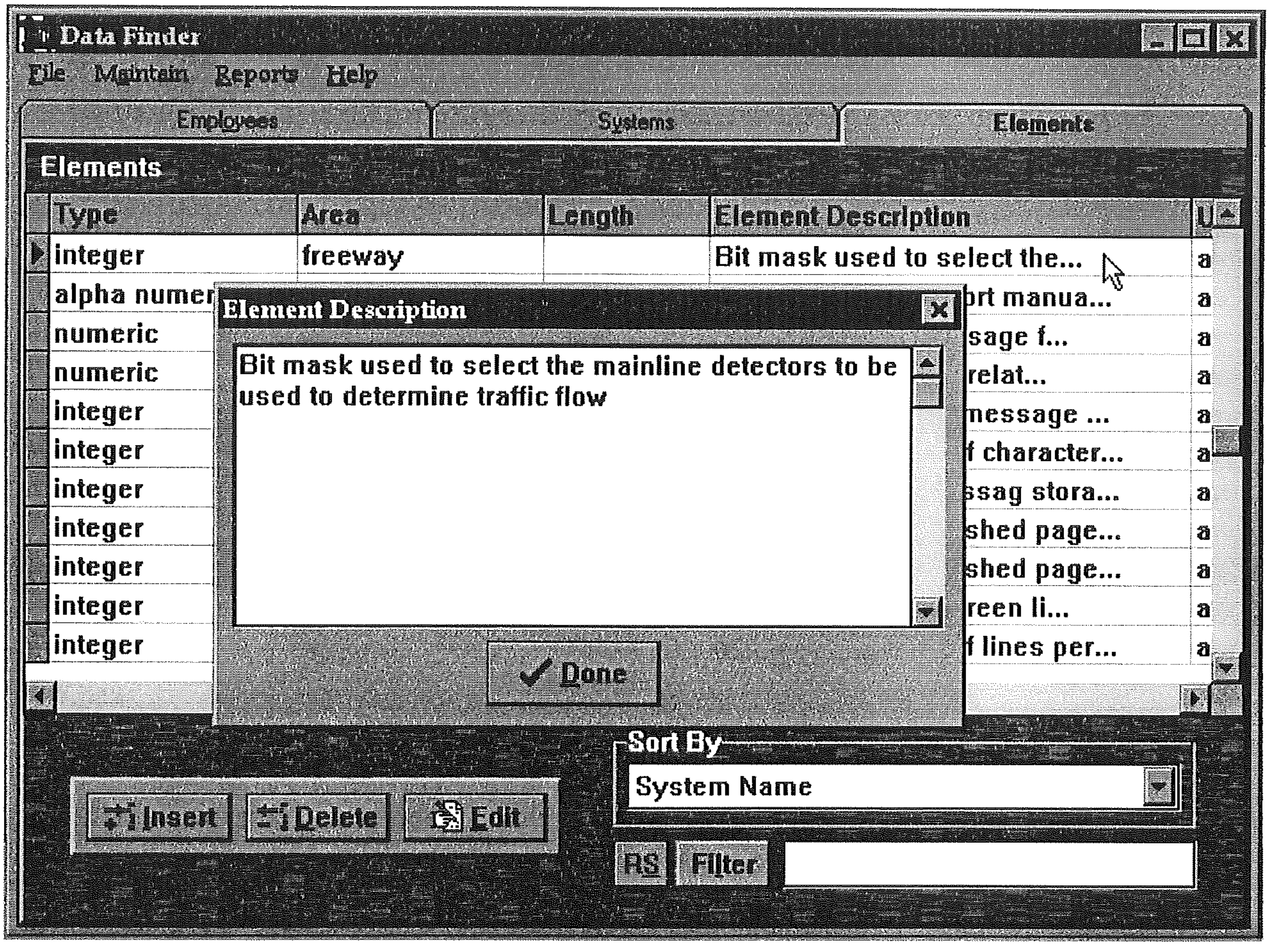


Figure 5: Element Description Pop-Up Box

Data Finder Tab Screens

Data Finder is composed of three tabbed screens. There is one tab screen for each of the three primary types of data in Data Finder: Employees, Systems and Elements. Before using these screens, it is important that the user understand the relationship between the three primary types of data: Each system is assigned to an employee; systems are composed of elements. Using the tab screens, employees, systems and elements can be inserted, deleted, edited and searched by selecting the buttons for each of these functions.

Employees Tab Screen

Figure 6: The Employees tab screen is used primarily for viewing and update of employee data. . When an employee is selected from the Employees grid, the system(s) assigned to the employee appears in the lower, Systems grid The buttons beneath each of the grids can be selected to insert, delete and edit the data for each grid. The Employee grid at the top of the screen can be searched using the Find button.

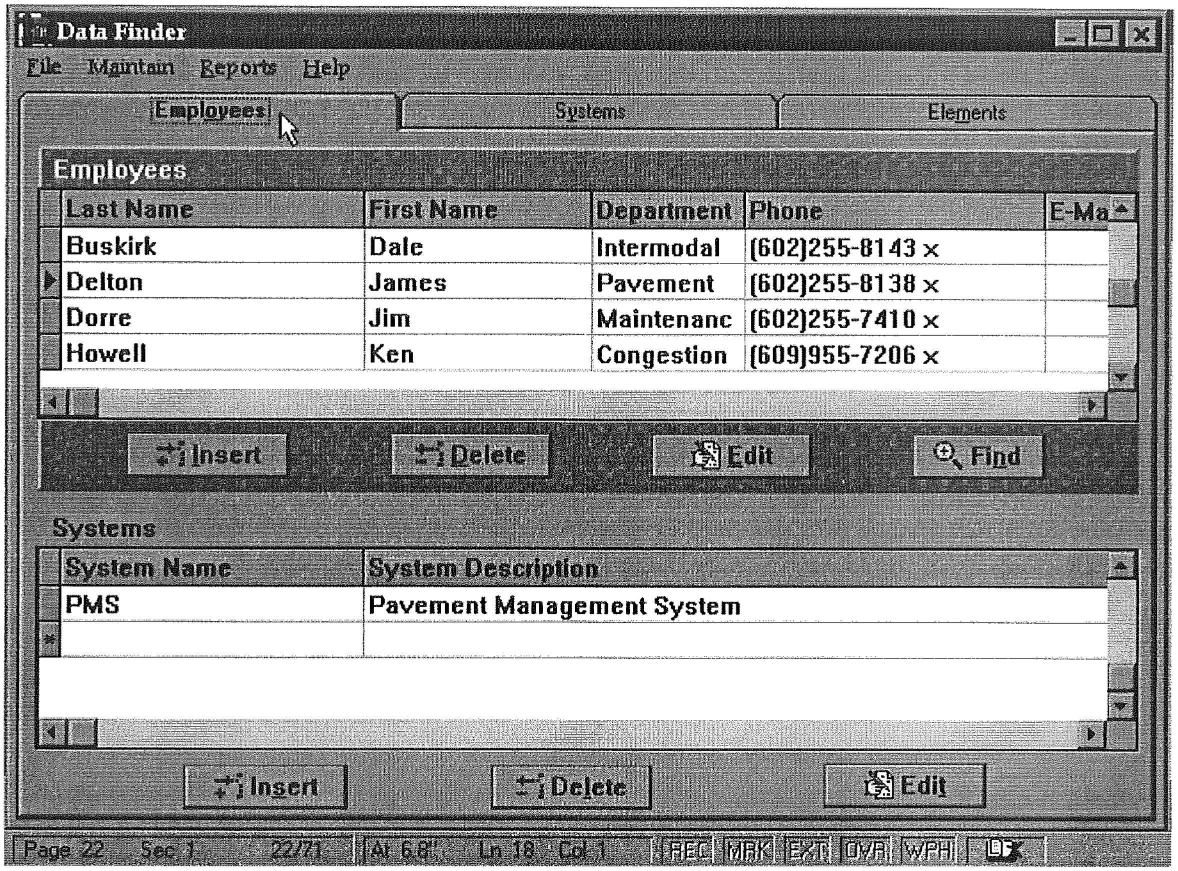


Figure 6: Employees Tab Screen

Systems Tab Screen

Figure 7: The Systems tab screen is used primarily to view and update system data. When a system is selected from the Systems grid, the elements assigned to the system appear in the lower, Elements grid. The buttons beneath each grid can be selected to insert, delete and edit the data for each grid. The Systems grid at the top of screen can be searched using the Find button. The user can print from the Systems Grid using the Print button.

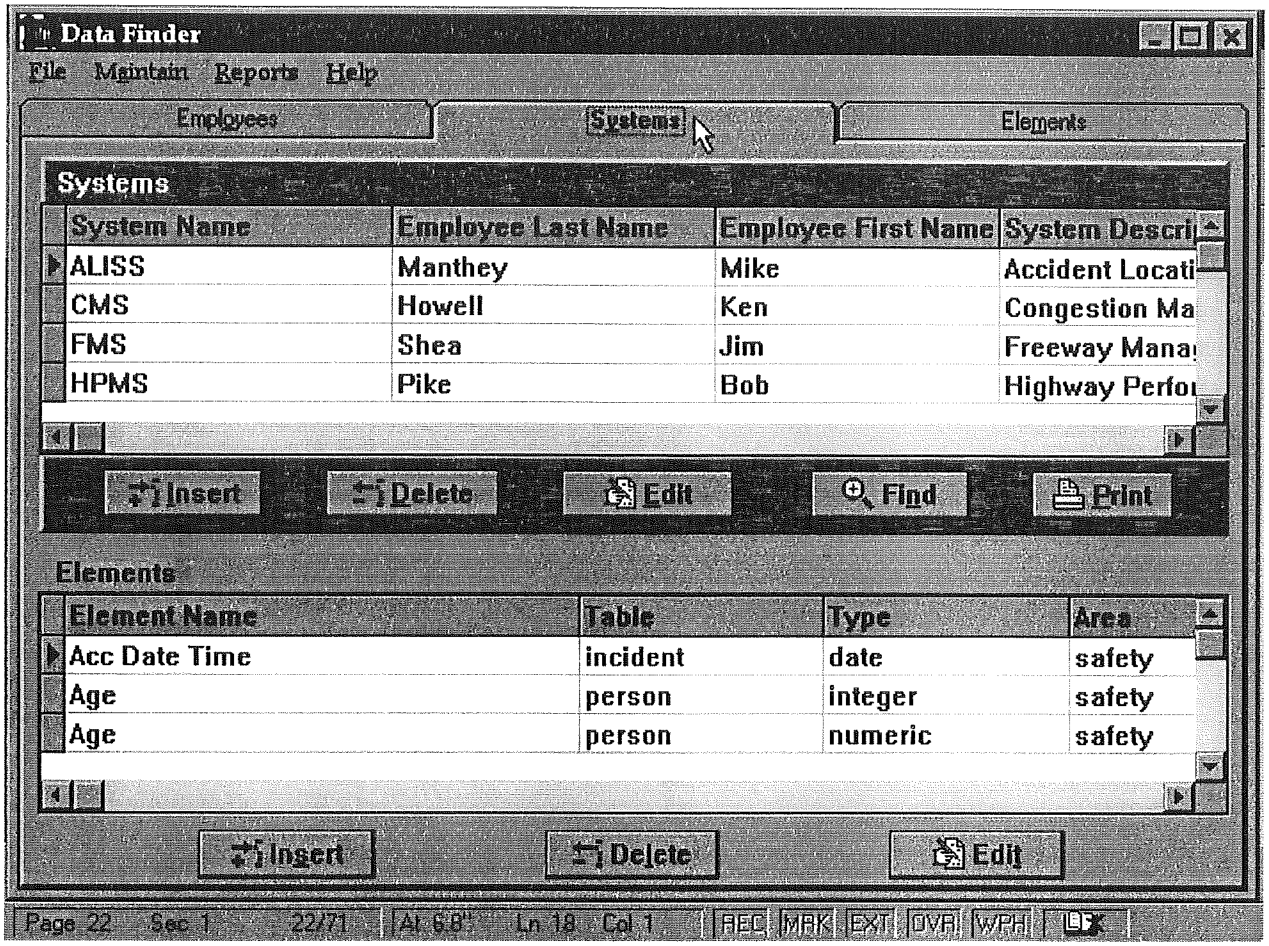


Figure 7: Systems Tab Screen

Elements Tab Screen

The Elements tab consists of one grid for update and search of elements as pictured in Figure 8. The Elements grid data can be updated using the insert, delete and edit buttons beneath the grid. The data fields can be sorted by selecting the sort options below the grid. The data can also be searched by entering the search criteria in the Filter box at the bottom of the screen and selecting the Filter button. This filter performs a search of both the Element Name and Element Description fields of the grid. The filter is not case sensitive and will perform sub-string searches (e.g.: enter pave to find all element names and descriptions that include "pave," "pavement," "Pavement," etc.). Select the RS (reset) button to the left of the Filter box to reset the Elements grid (for display of all elements in Data Finder).

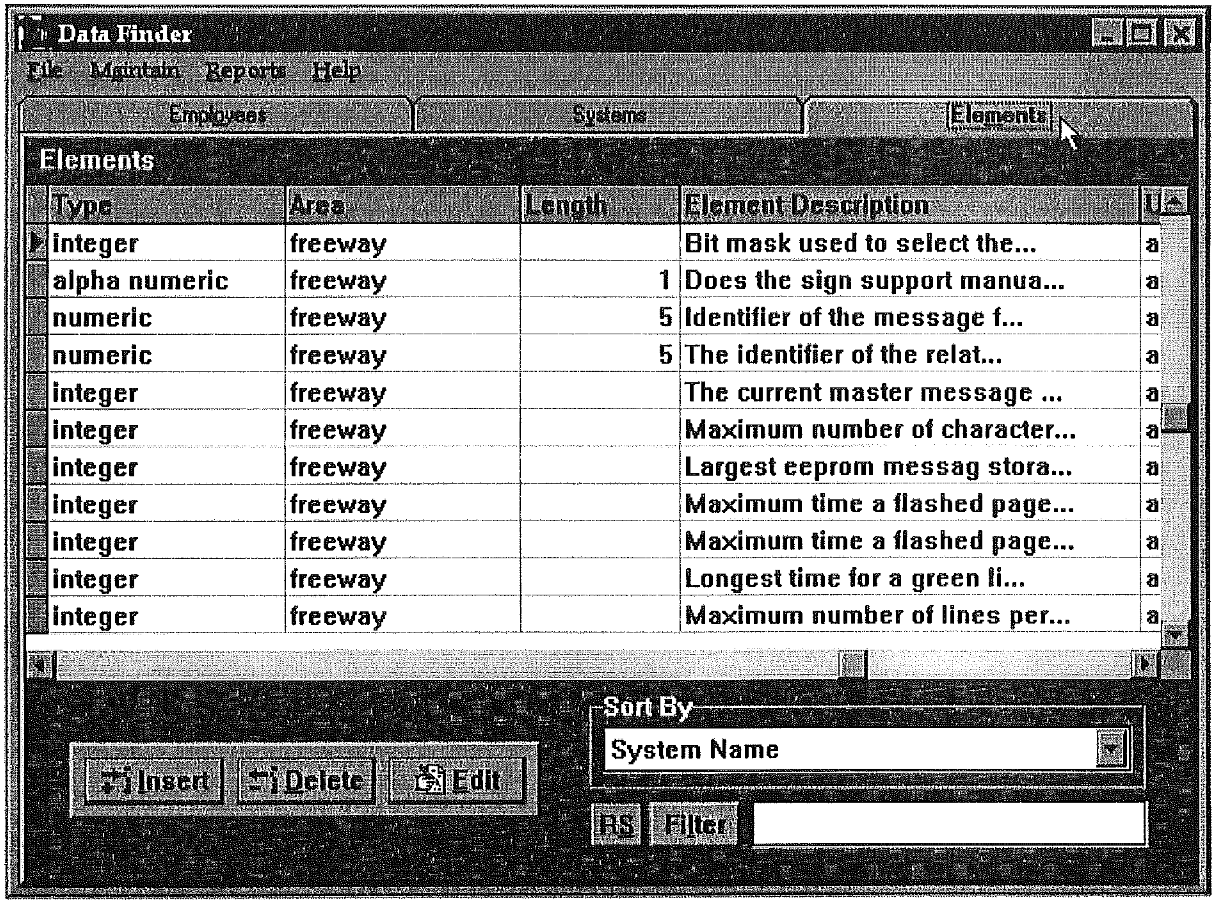


Figure 8: Elements Tab Screen

Menu Choices and Buttons

This chapter provides a complete reference to all Data Finder menu choices and buttons.

Keyboard Access to Menu Choices

Looking at the Data Finder menu choices, you will notice that most or all have a single letter underlined. You can select a menu choice without using the mouse by holding down the "Alt" key on your keyboard and pressing the underlined letter. For example, to access the File menu using the keyboard, you can hold down the "Alt" key and the "F" key simultaneously. The file menu drop-down box will appear.

Menu Choices

Following are detailed descriptions of Data Finder Menu choices.

File / Exit

This menu choice exits Data Finder.

Maintain / Area

Displays the lookup table for Area. Area selections can be added, deleted and edited from this screen.

Maintain / Element Type

Displays the lookup table for Element Type. Element Type selections can be added, deleted and edited from this screen.

Maintain / Update Frequency

Displays the lookup table for Update Frequency. Update Frequency selections can be added, deleted and edited from this screen.

Maintain / Table

Displays the lookup table for element Table. Element Table selections can be added, deleted and edited from this screen.

Reports

This menu choice prompts the Reports dialog box from which reports can be selected and report printing can be initiated.

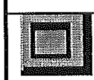
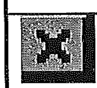
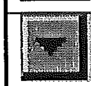
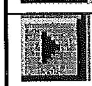
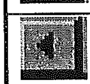
Help / Instructions

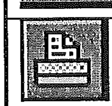
Displays the electronic version of this User's Manual.

Help / About

Displays the Data Finder copyright notice, software version and software build date.

Buttons

Buttons	Tab Screen	Function
	All Screens, Title Bar	System Menu Request button
	All Screens, Title Bar	Minimize button
	All Screens, Title Bar	Maximize button
	All Screens, Title Bar	Close button
	All Screens, Grids & List Boxes	Scroll up
	All Screens, Grids & List Boxes	Scroll down
	All Screens, Grids & List Boxes	Scroll right
	All Screens, Grids & List Boxes	Scroll left
	Employees, Systems, Elements Tabs	Insert employee, system or element
	Employees, Systems, Elements Tabs	Delete employee, system or element
	Employees, Systems, Elements Tabs	Edit employee, system or element
	Employees & Systems, Tabs	Find employee or system

Buttons	Tab Screen	Function
Print	Systems Tab	Print system
Cancel	Pop-Up Screens & Dialogue Boxes	Cancel
No	Delete Dialogue Boxes	No
OK	Pop-Up Screens & Dialogue Boxes	OK
Yes	Delete Dialogue Boxes	Yes
Add	Maintain Menu, Dialogue Boxes	Add
Post	Maintain Menu, Dialogue Boxes	Post
Close	Maintain Menu, Dialogue Boxes	Cloe
Done	Element Description Box	Done
Filter	Elements Tab	Filter for element name and element description fields
RS	Elements Tab Reset Button	Reset the filter; reset to view all Data Finder elements
Delete from Grid	Grid Settings Dialogue Box	Delete field from grid
Add to Grid	Grid Settings Dialogue Box	Add field to grid
Reset to Defaults	Grid Settings Dialogue Box	Reset grid to default settings
	Grid Settings Dialogue Box	Magnifying glass; initiate search
Count Records	Grid Settings Dialogue Box	Count records; total number of records
Prior	Grid Settings Dialogue Box	View prior record
Next	Grid Settings Dialogue Box	View next record
	Report Dialogue Box	Print

Data Finder Tutorial

This chapter presents specific guidance on how to insert, delete, and edit data as well as how to search within Data Finder.

Maintain Menu Selections

Prior to inserting or editing any data in Data Finder, it is necessary to update the Maintain menu selection with data Areas, Element Types, Update Frequencies, and element Tables. Once entered, this information will be available to the user when inserting or editing data.

Select Maintain from the menu as pictured in Figure 9.

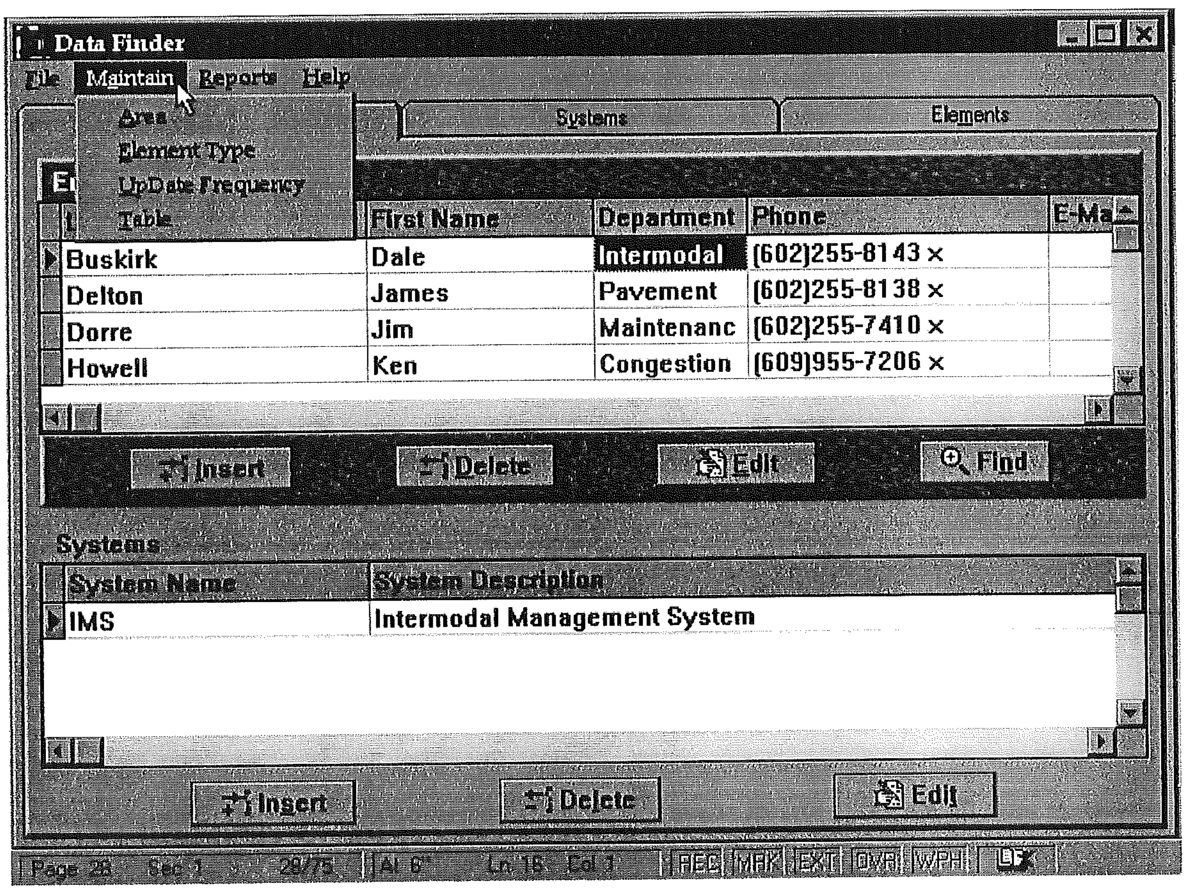


Figure 9: Maintain Menu Drop-Down List

From the Maintain menu drop-down list, select the option you would like to update. Selection of any of the four options will result in display of a Lookup Table. We will select the Area option and view the Lookup Table for area as shown in Figure 10.

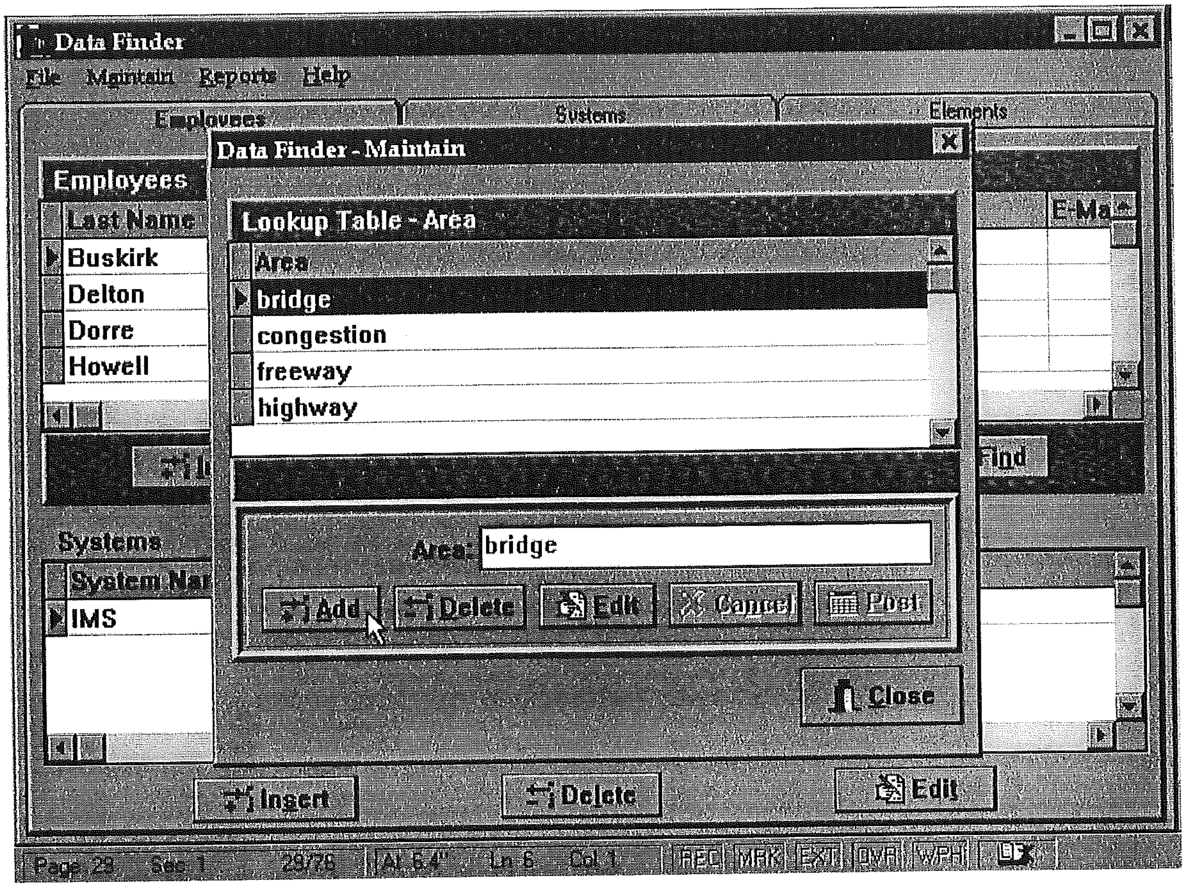


Figure 10: Maintain Menu, Lookup Table-Area

To add to any lookup table, select the Add button and enter the new entry in the text box (e.g.: Area text box above). If you are satisfied with your entry, select the Post button and the new entry will be added to the lookup table grid.

To edit an entry that already appears in the lookup table, highlight your selection in the table grid, then choose the Edit button. Your selection will appear in the text box where you can then alter the content (using your cursor to highlight information requiring change). Once satisfied with your changes, choose the Post button and the edited information will appear in the lookup table grid.

To delete an entry, highlight your selection in the table grid and select the Delete button from within the Maintain dialog box.

Insert/Delete/Edit Data

There are three primary types of data which can be inserted, deleted, or edited in Data Finder: employees, systems, and elements. Each type of data can be accessed and updated through individual tab screens identified as the Employees, Systems and Elements tabs. In addition, system data can also be accessed and updated on the Employee tab; element data can also be accessed and updated on the System tab.

The three primary types of data are related as follows: each system is assigned to an employee; systems are composed of elements.

Insert an Employee, System, or Element

This section describes how to insert employees, systems and elements. When inserting data, the sequence of actions should include: insert the employee assigned to the system; insert the system; then, insert the elements belonging to the system . If any of this information already exists in Data Finder, there is no need to insert it again. (e.g.: If the employee and system already exist in Data Finder, you may insert new elements without re-entering system and employee.)

Figure 11: First, we will insert an employee. Select the Employees tab and choose the Insert button beneath the Employees grid.

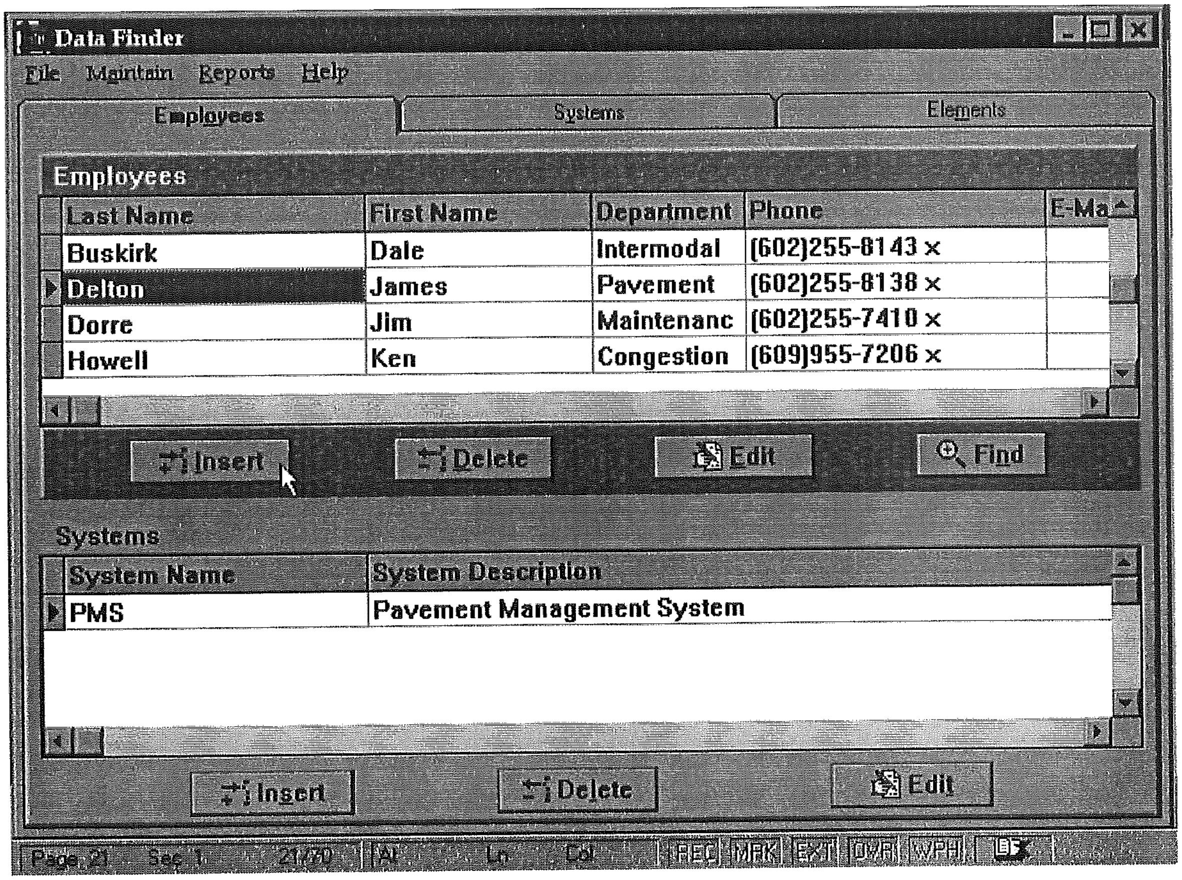


Figure 11: Employee Tab, Insert Button

The Insert Employee dialog box will appear as pictured in Figure 12. Complete the information required and select the OK button from within the dialog box. The new employee will then appear on the Employees grid at the top of the Employees tab screen.

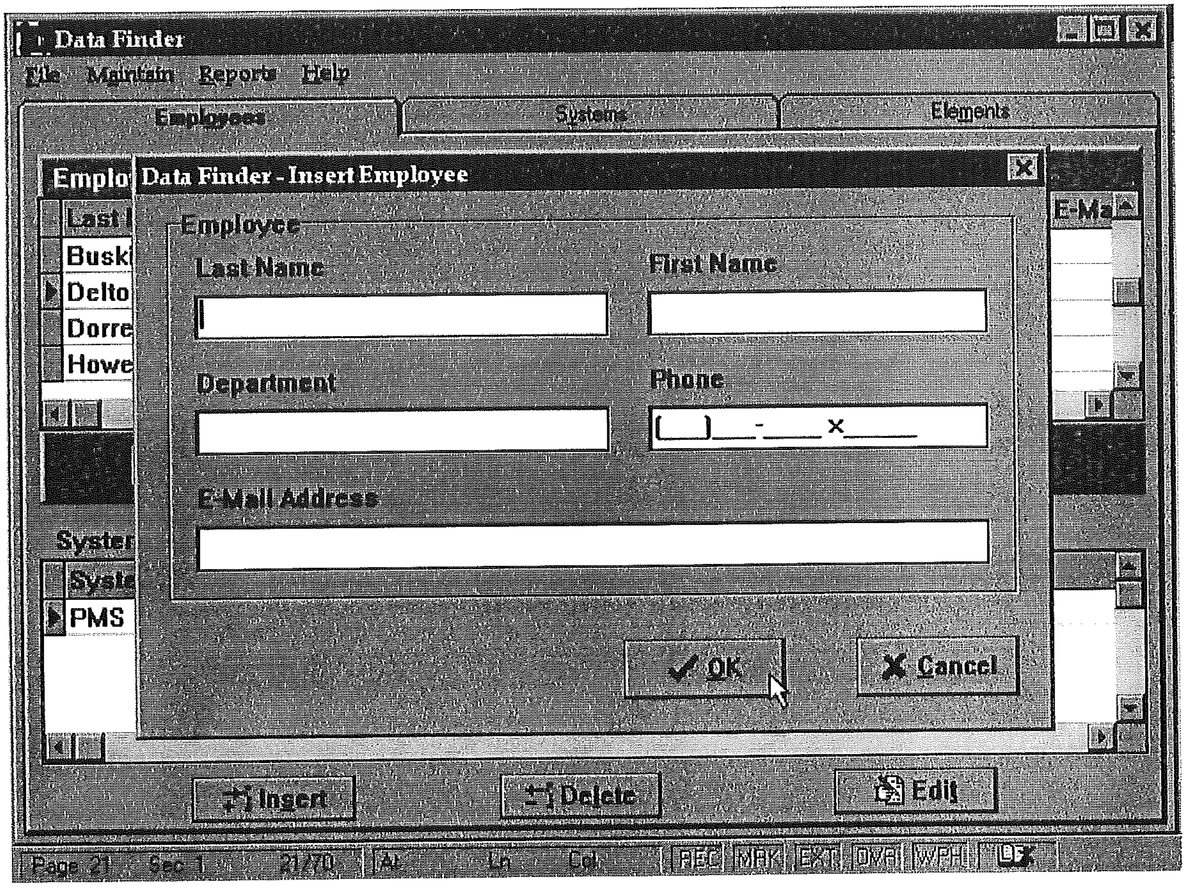


Figure 12: Employee Tab, Insert Employee Dialog Box

Now that we have inserted an employee, we will insert the system associated with that employee by going to the Systems tab. From the Systems tab, select the Insert button beneath the Systems grid to prompt display of the Insert System dialog box.

Enter the system information required in the Insert System dialog box as shown in

Figure 13. Area, Update Frequency and Select Employee are combo boxes requiring that you choose your entry from the drop-down list (by selecting the combo box arrow, then selecting your entry from the list which appears). Once all system information has been entered in the Insert System dialog box, select the OK button from within the dialog box to add the system to Data Finder. The new system will appear on the Systems tab, Systems grid, at the top of the screen.

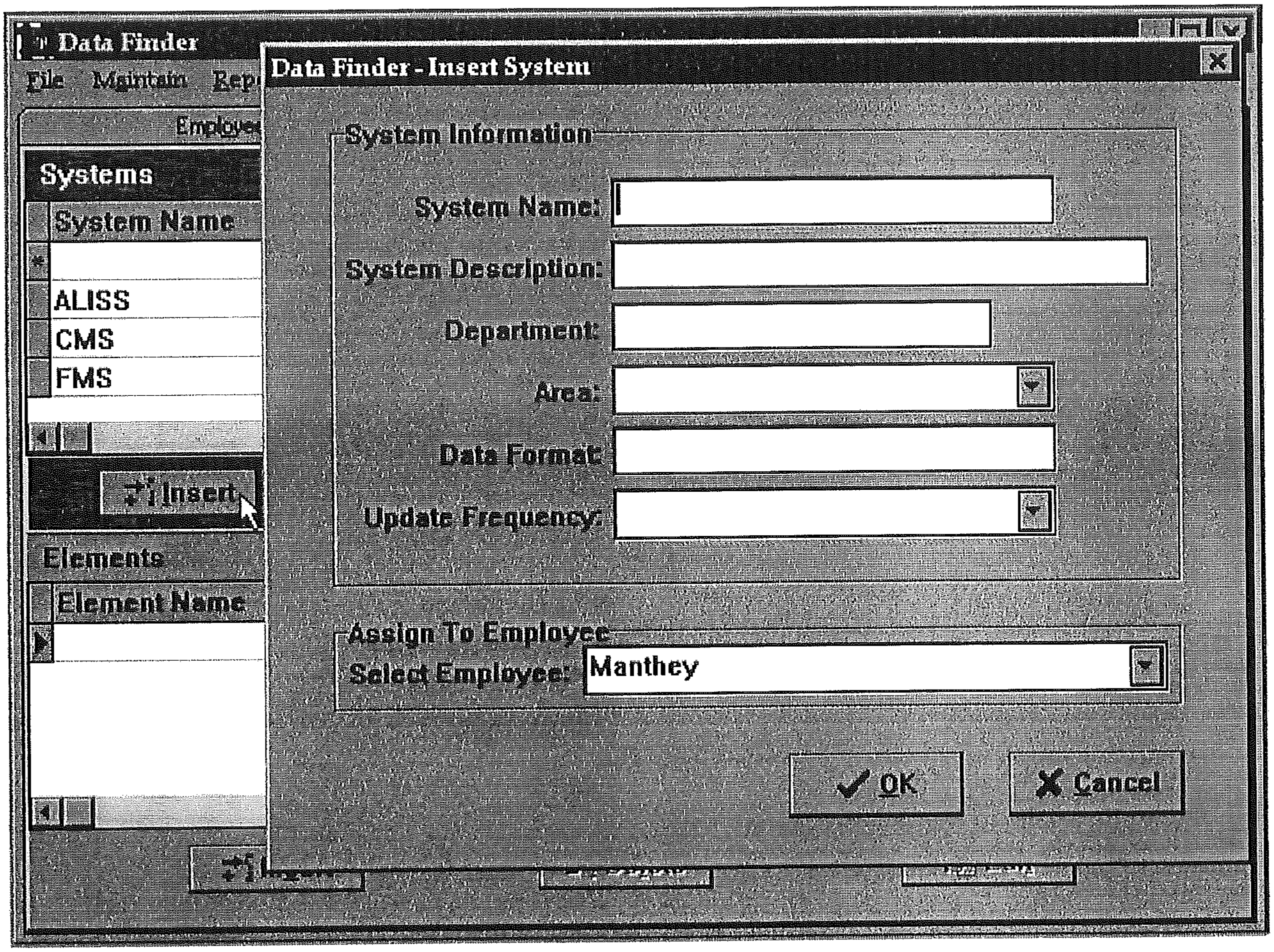


Figure 13: System Tab, Insert System Dialog Box

Note that systems can also be inserted on the Employee tab using the Systems grid Insert button on the bottom half of the screen as identified in Figure 14. This will prompt the Insert System dialog box to appear (as was pictured in Figure 13). However, if inserting a system from the Employee tab, the employee highlighted on the Employees grid (in this case, Manthey) will automatically appear as the assigned employee for the system at the bottom of the Insert System dialog box (in the Select Employee combo box).

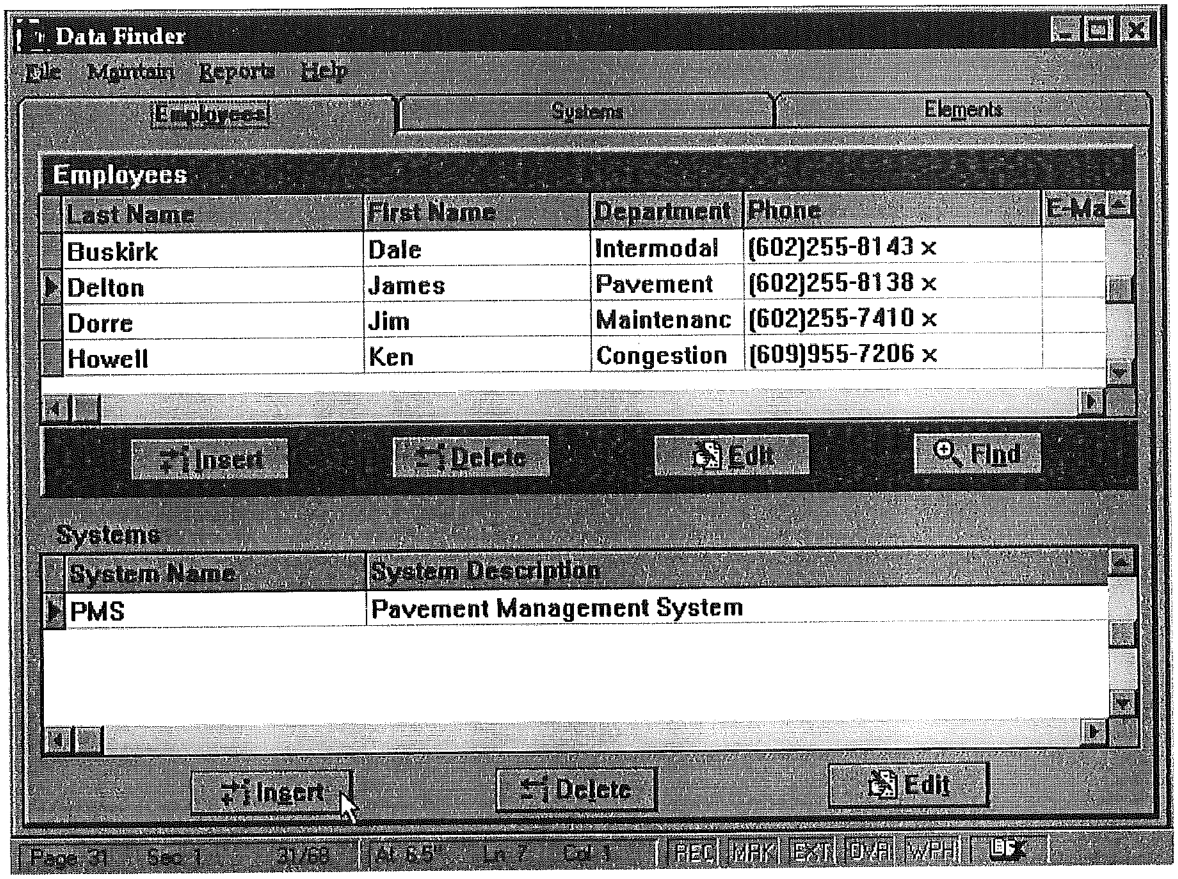


Figure 14: Employees Tab, Systems Grid Insert Button

We have inserted an employee along with a system. We must now insert the elements belonging to the system. Select the Elements tab and choose the Insert button, as shown in Figure 15, to display the Insert Element dialog box.

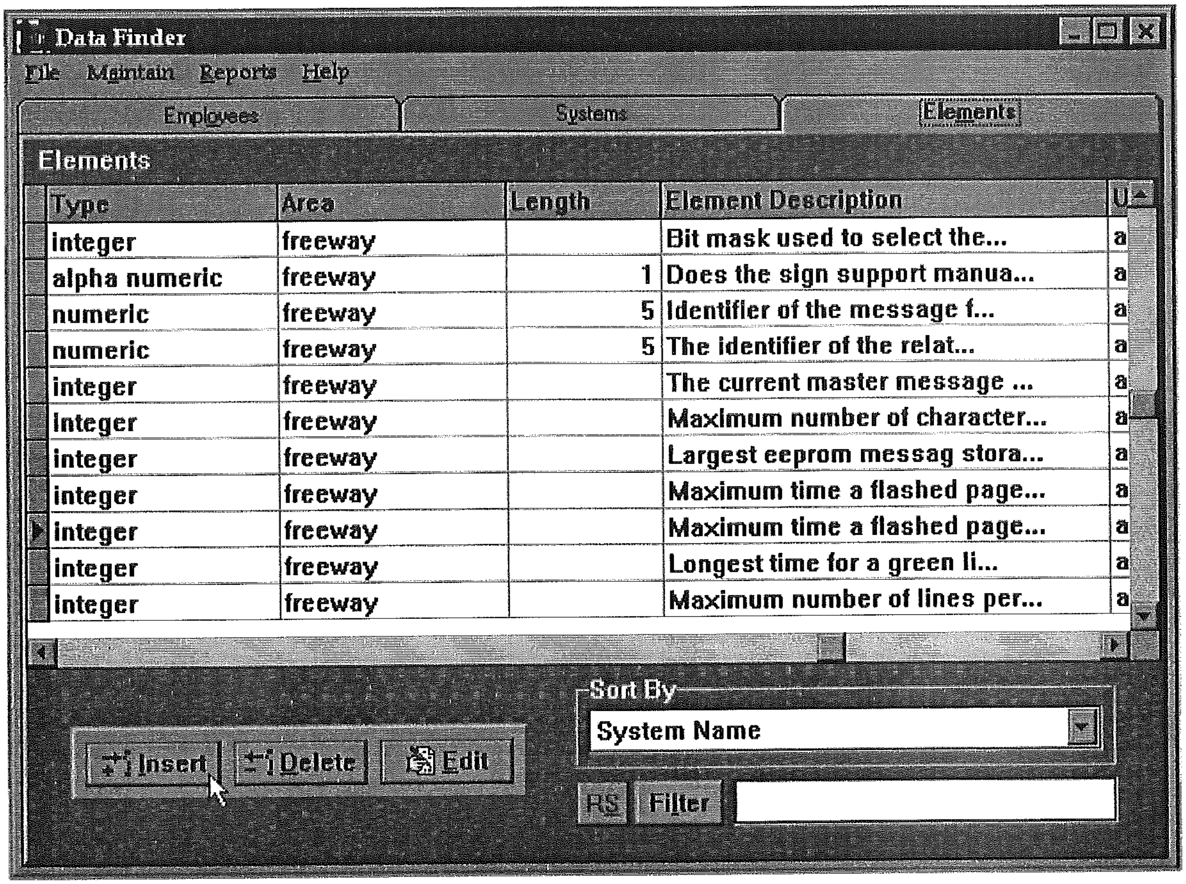


Figure 15: Elements Tab, Insert Button

Enter the element information required in the Insert Element dialog box as shown in Figure 16. Type, Area, Table, Update Frequency and Select System are combo boxes requiring that you choose your entry from the drop-down list (by selecting the box arrow, then selecting your entry from the list which appears). Once all element information has been entered in the Insert Element dialog box, select the OK button from within the dialog box to add the element to Data Finder. The new element will appear on the Elements tab, Elements grid at the top of the screen.

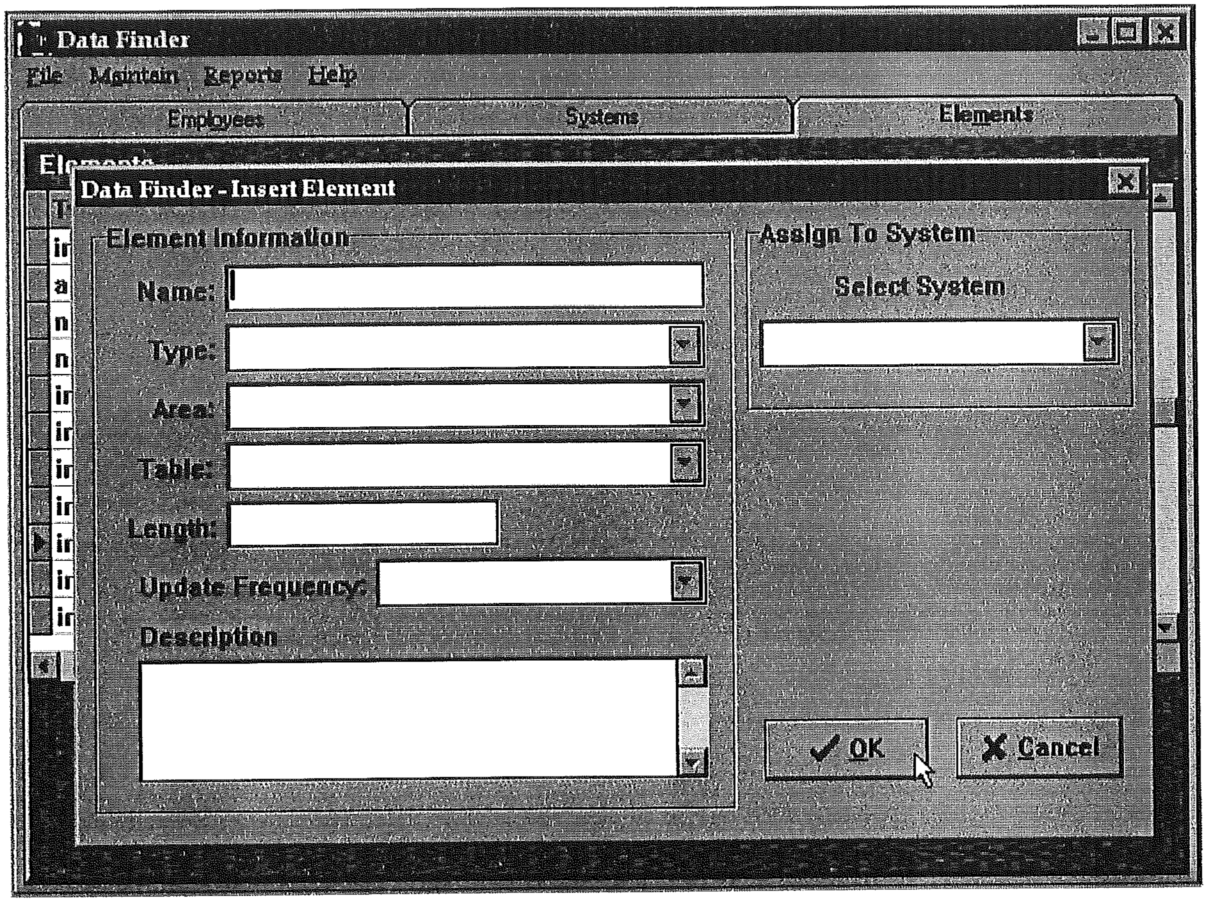


Figure 16: Elements Tab, Insert Element Dialog Box

Note that elements can also be inserted on the Systems tab using the Elements grid, Insert button on the bottom half of the screen as identified in Figure 17. This will prompt the Insert Element dialog box to appear (as was pictured in Figure 16). However, if inserting an element from the Systems tab, the system highlighted on the Systems grid (in this case, ALISS) will automatically appear as the assigned system for the element at the top of the Insert Element dialog box (combo box).

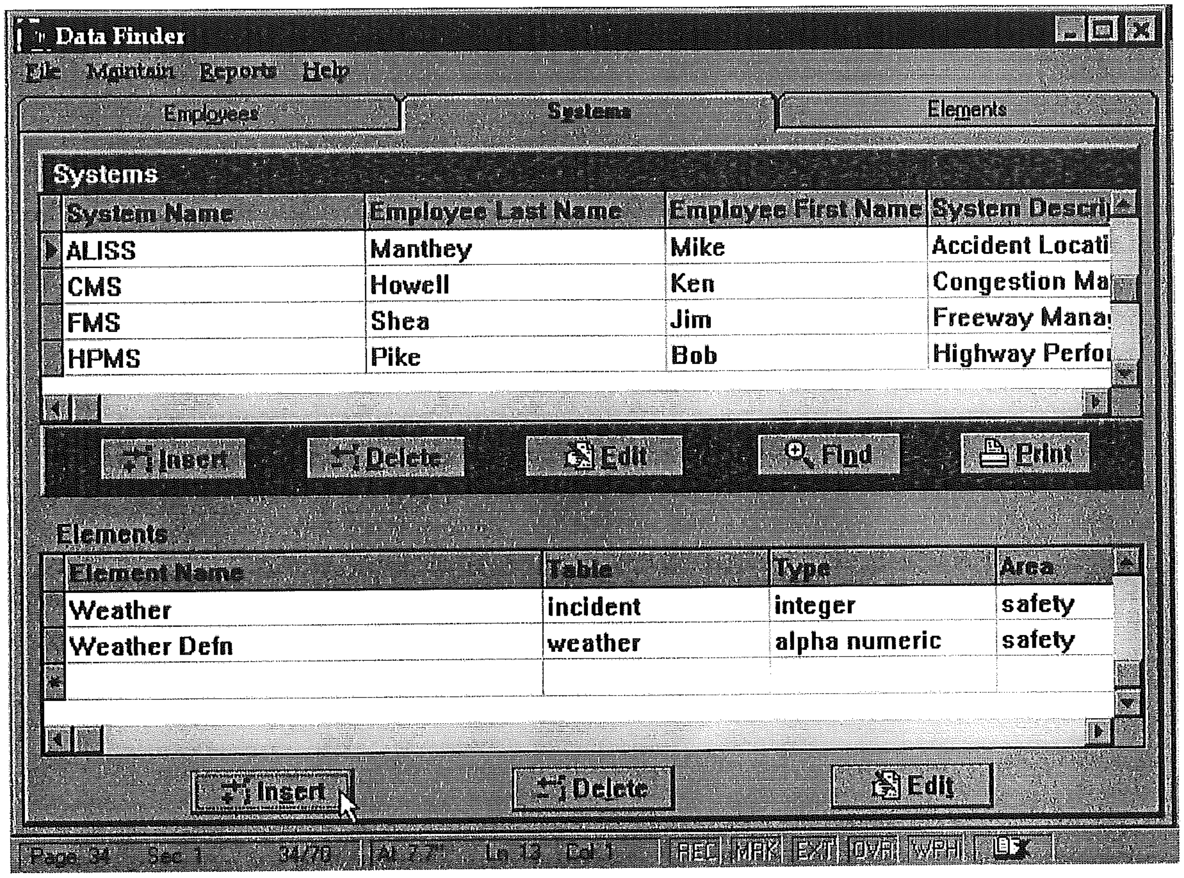


Figure 17: Systems Tab, Elements Grid Insert Button

We have now inserted an employee, system and element. We have explored two locations (tabs) from which to insert systems and elements. Now we will examine the process of deleting or editing data from Data Finder.

Delete or Edit an Employee, System or Element

To delete or edit employee, system or element data, select the appropriate tab or grid (Employee, System or Element), highlight the record you wish to delete or edit, and select the Delete or Edit button beneath the grid.

Figure 18: Employee data can be deleted or edited from the Employees tab, Employees grid (in the top portion of the screen). Highlight the record on the Employees grid (in this case, Delton), and select the Delete or Edit button beneath the grid. If the Delete button is selected, a warning box will appear prior to the record being deleted. Respond Yes in the warning box to delete the employee.

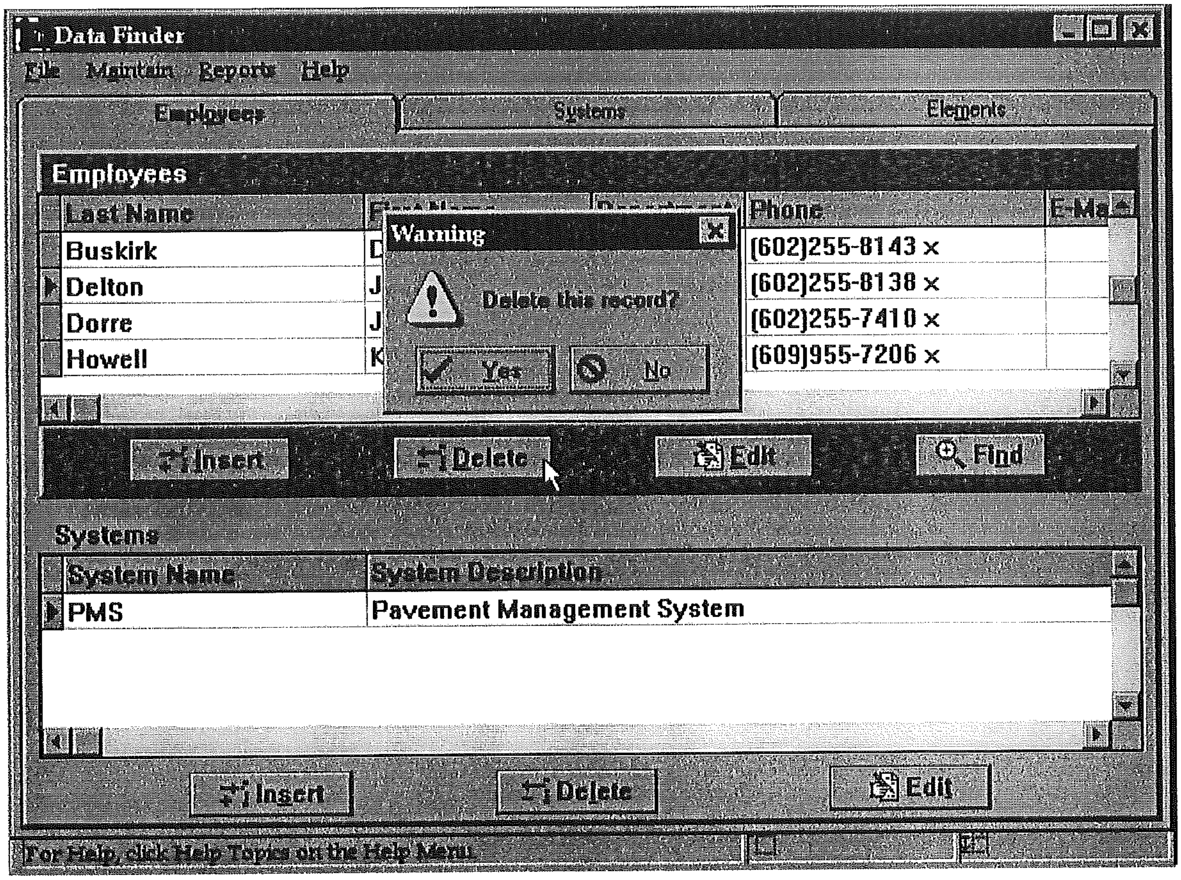


Figure 18: Employees Tab, Employees Grid Delete Button and Warning Box

Figure 19: If the Employees grid, Edit button is selected, the Edit Employee dialog box will appear. Change only the information you wish to alter by moving the cursor to the appropriate text box. Select OK from within the dialog box to initiate the change. Updated employee data will then appear on the Employees grid.

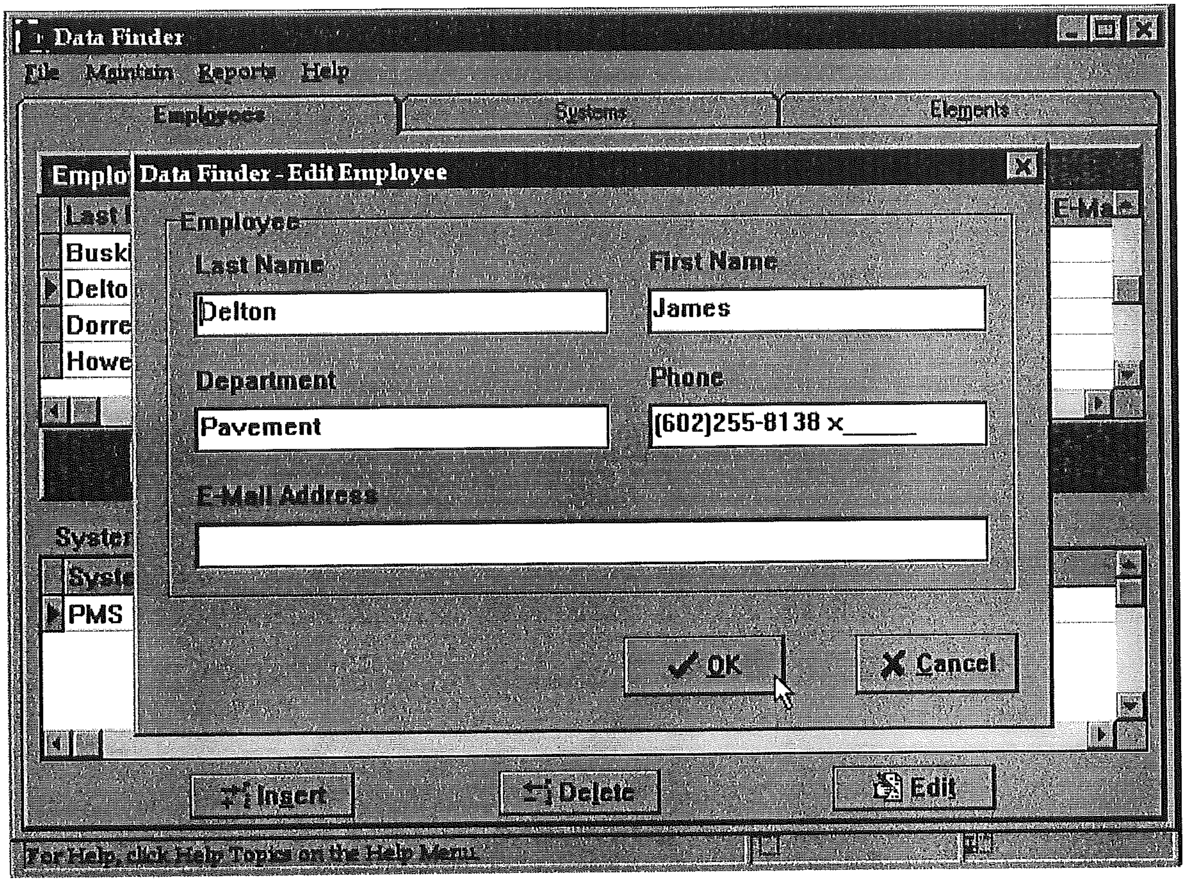


Figure 19: Employees Tab, Employees Grid Edit Dialog Box

We have learned how to delete and edit an employee record from the Employees tab. We will now review how to delete and edit a system record which can be accomplished from either the Systems tab or the Employees tab.

A system can be deleted or edited from the Systems tab or from the Employees tab. To delete or edit a system from either tab, highlight the system on the Systems grid (in this case, ALISS), and select the delete or edit button beneath the grid. If working from the Systems tab, the Systems grid can be found in the upper portion of the screen as shown in Figure 20. If working from the Employees tab, the Systems grid can be found in the bottom portion of the screen as pictured in Figure 21. Note that if using the Employees tab, to display the desired system in the Systems grid (ALISS), the system's assigned employee must be selected from the Employees grid (in this case, Manthey).

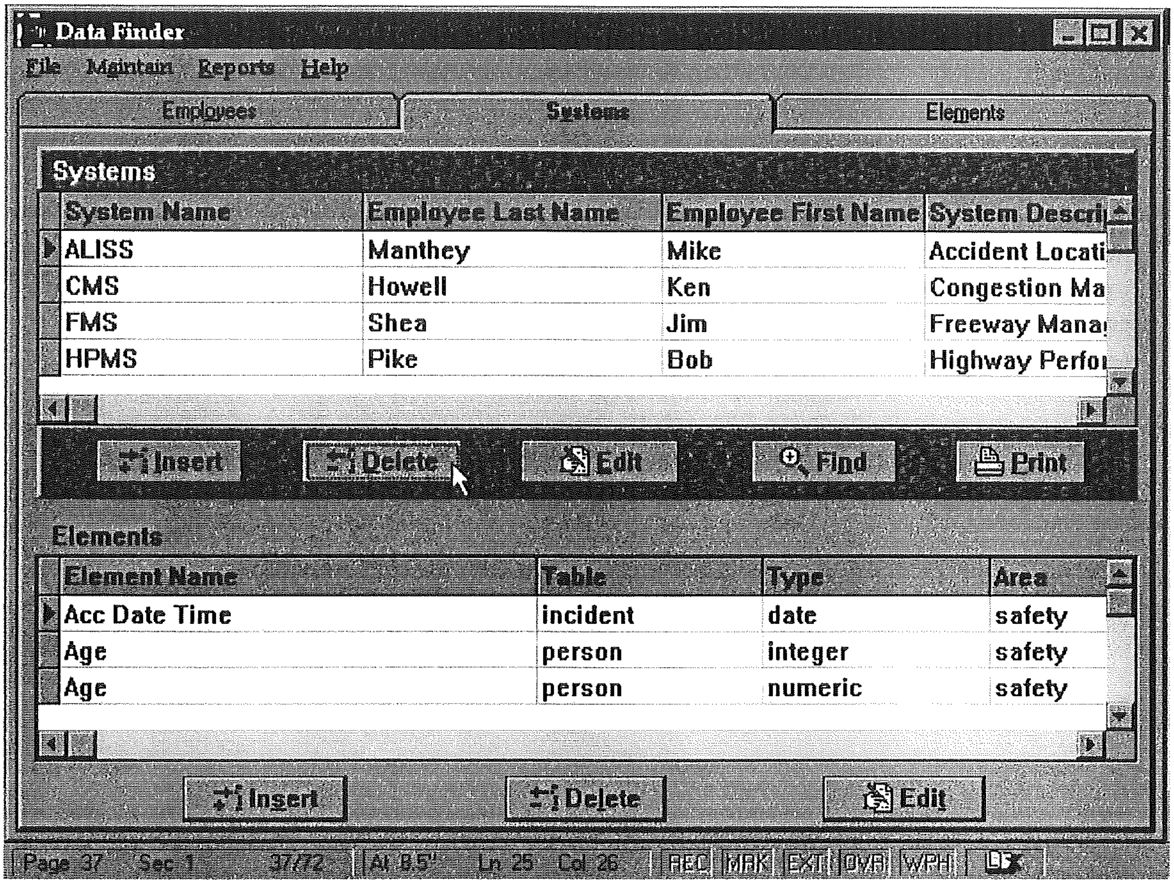


Figure 20: Systems Tab, Systems Grid Delete Button

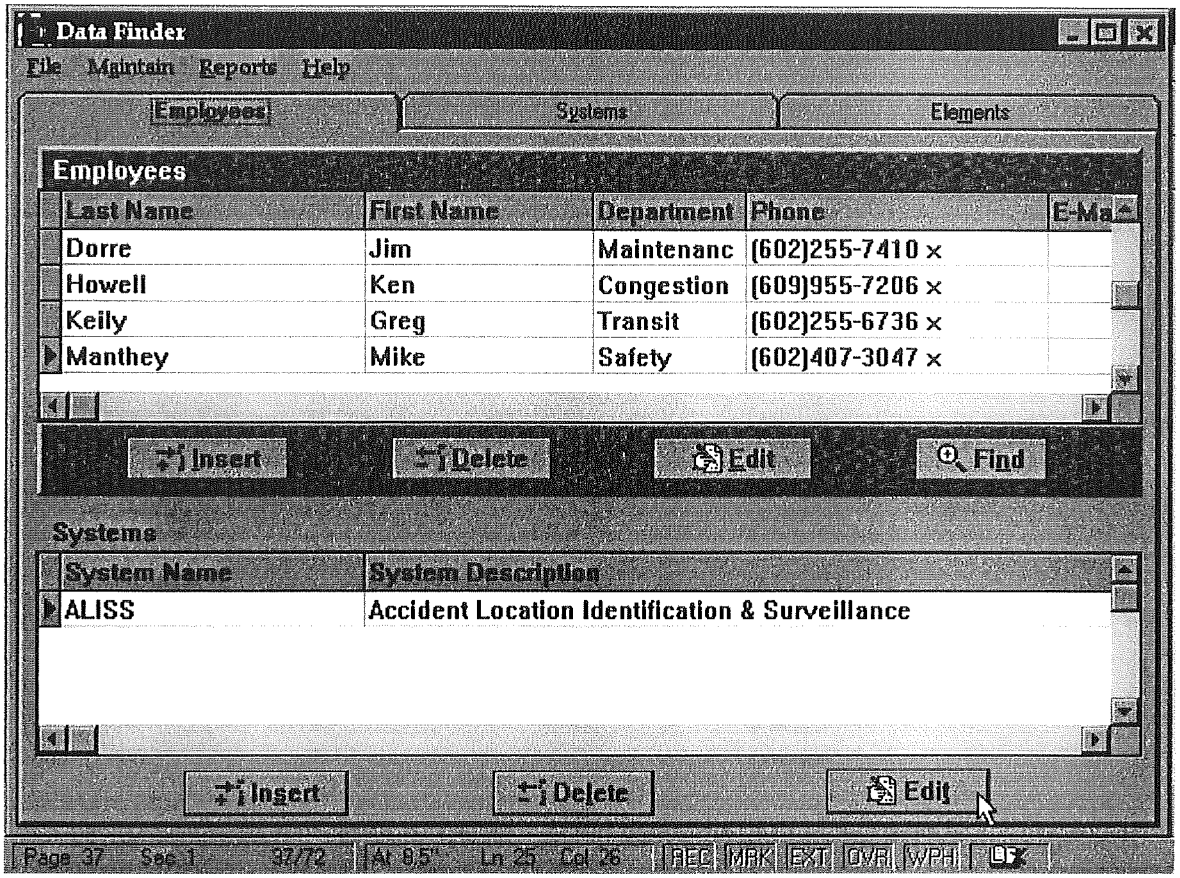


Figure 21: Employee Tab, System Grid Edit Button

If the Delete button is chosen, a Password dialog box will appear warning that all elements associated with the system will also be deleted. Once you are certain that it is correct to proceed, enter the password and select OK from the dialog box to delete the system record and all its elements. If the Edit button is chosen, the Edit System dialog box will appear. Change only the information you wish to alter by moving the cursor to the appropriate box. Select OK from within the dialog box to initiate the change. Figure 22 and Figure 23 depict these scenarios from both the Systems and Employees tabs.

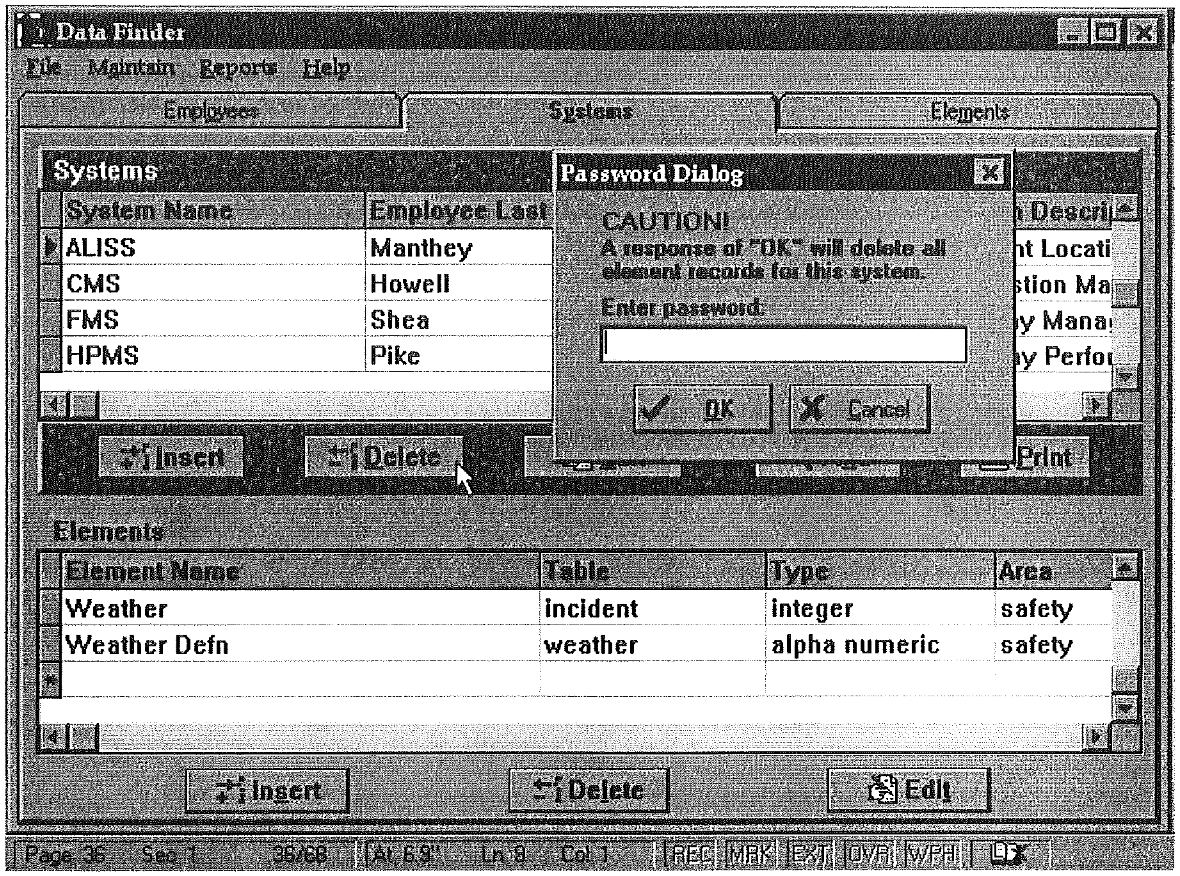


Figure 22: Systems Tab, Systems Grid Password Box

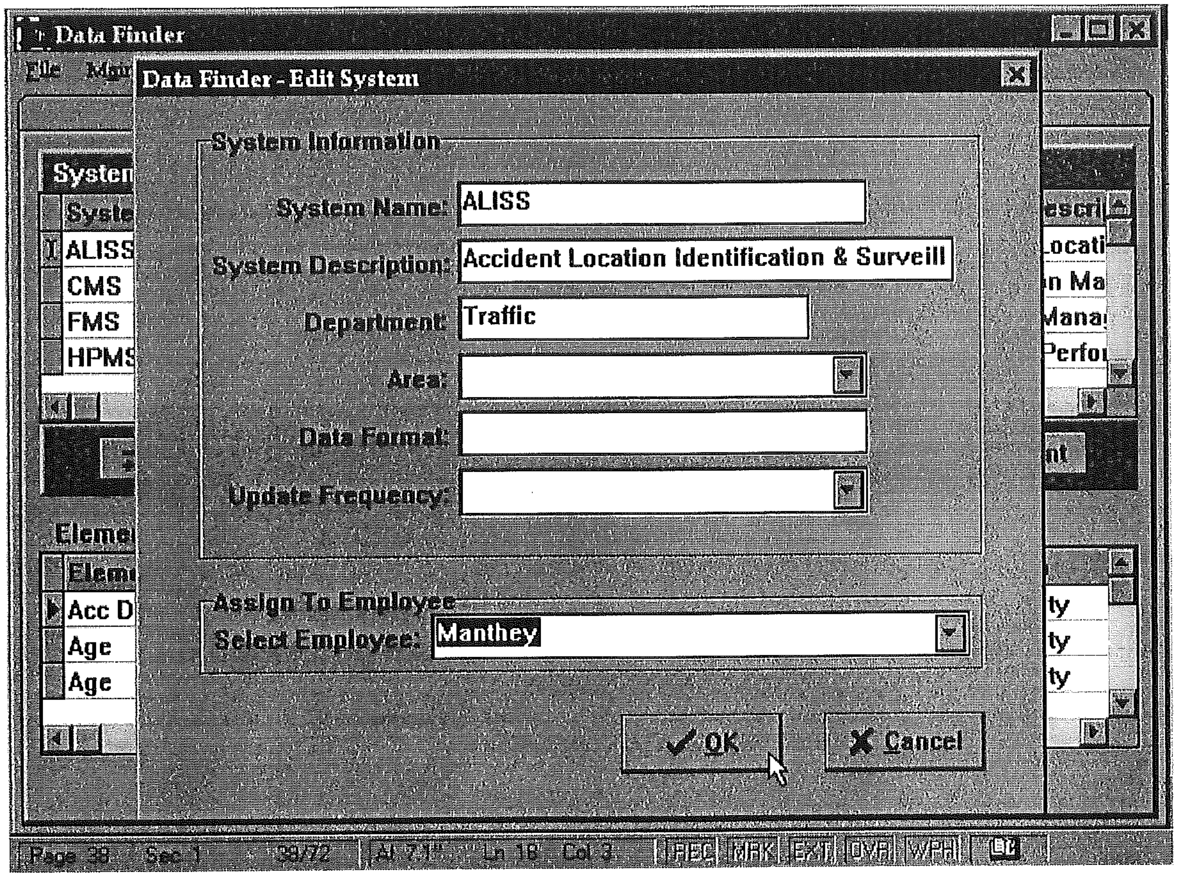


Figure 23: Employee Tab, System Grid Edit Dialog Box

In the above sections, we have deleted and edited both employee and system data. Employee data was deleted and edited from the Employee tab. System data was deleted and edited from both the System tab and the Employee tab. Now we will learn how to delete and edit element data.

An element can be deleted or edited from the Elements tab (Figure 24) or from the Systems tab (Figure 25). To delete or edit an element from either tab, highlight the element on the Elements grid (in this case, Land Area), and select the delete or edit button beneath the grid. If working from the Elements tab, the Elements grid can be found in the upper portion of the screen. If working from the Systems tab, the Elements grid can be found in the bottom portion of the screen. Note that if using the Systems tab, in order to display the desired elements in the Elements grid, the element's assigned system must be selected from the top, Systems grid (in this case, PTMS).

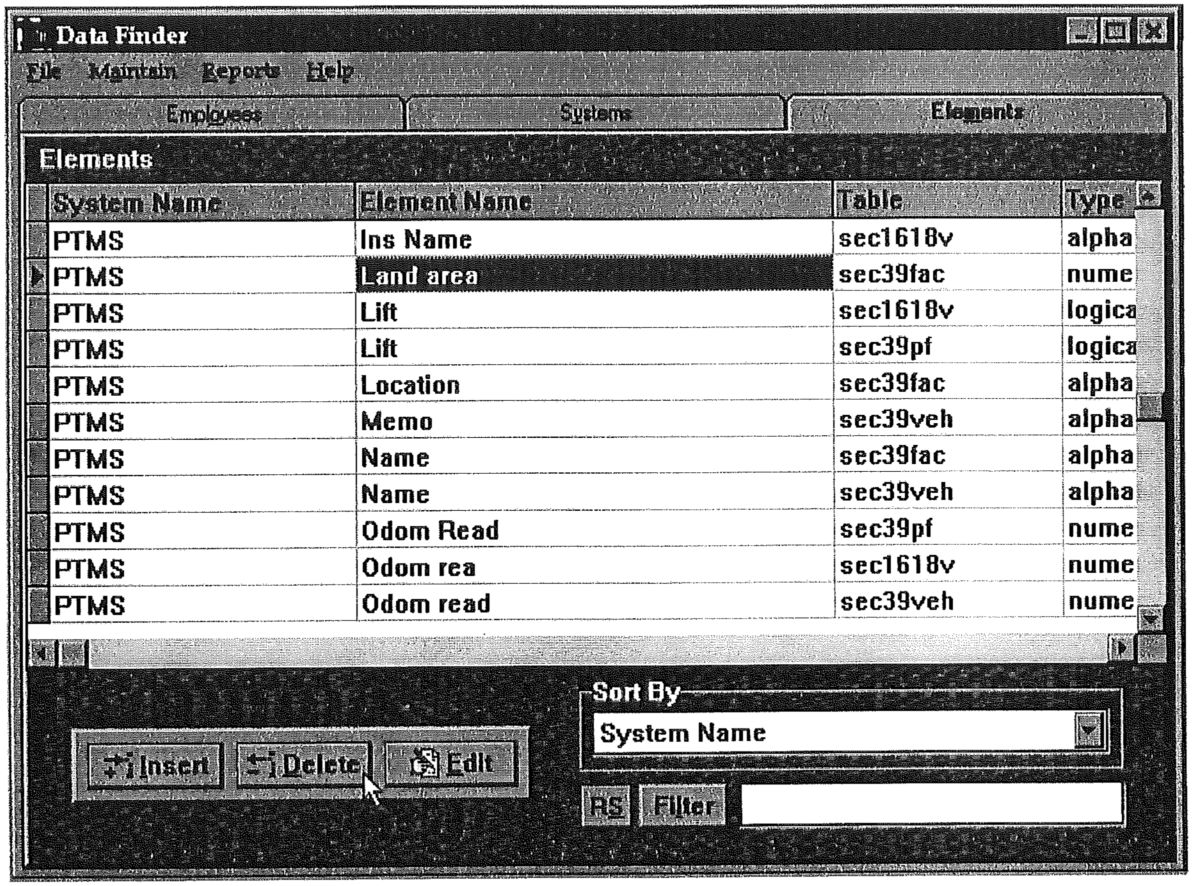


Figure 24: Elements Tab, Element Delete Button

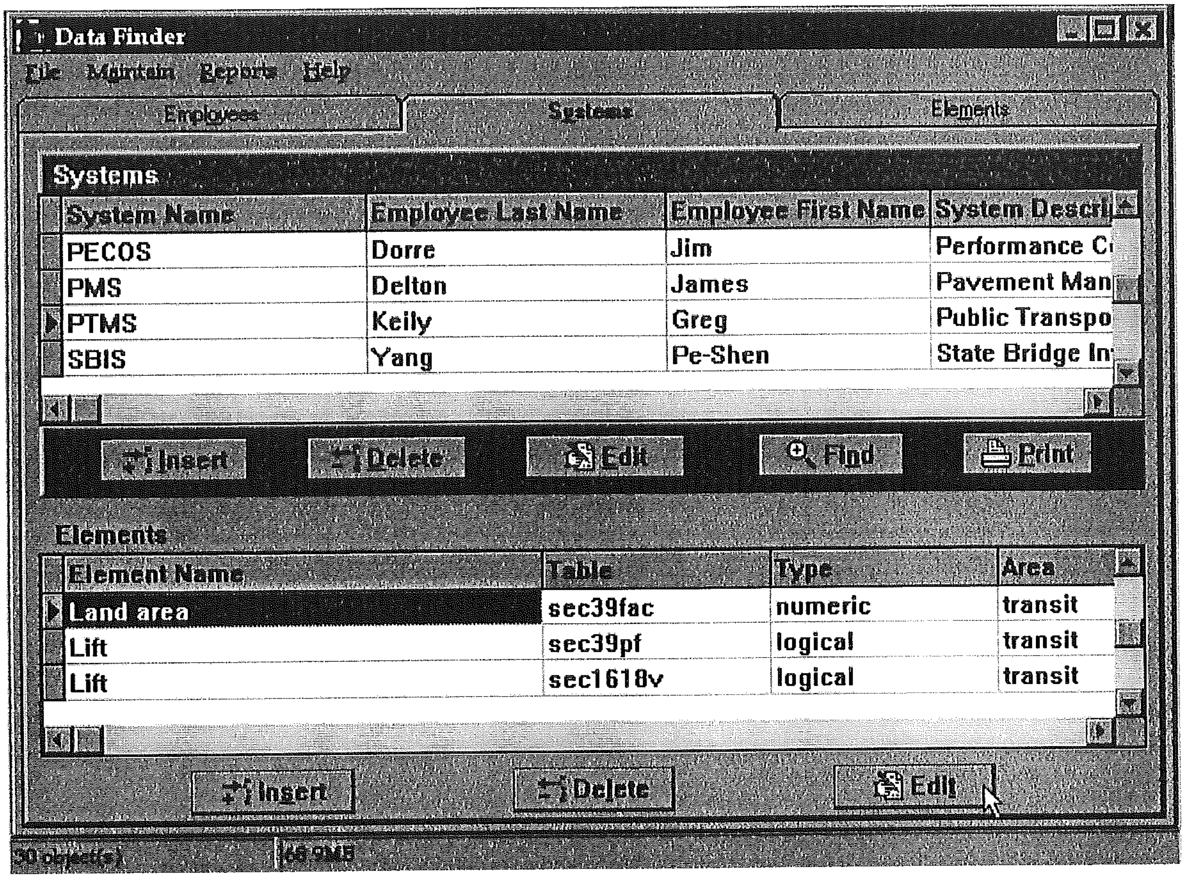


Figure 25: Systems Tab, Element Grid Edit Button

Figure 26: If the Delete button is chosen, a Warning box will appear. Select OK from the Warning box to delete the element. Figure 27: If the Edit button is chosen, the Edit System dialog box will appear. Change only the information you wish to alter by moving the cursor to the appropriate box. Select OK from within the dialog box to initiate the change. Updated element data will then appear on the Element grid.

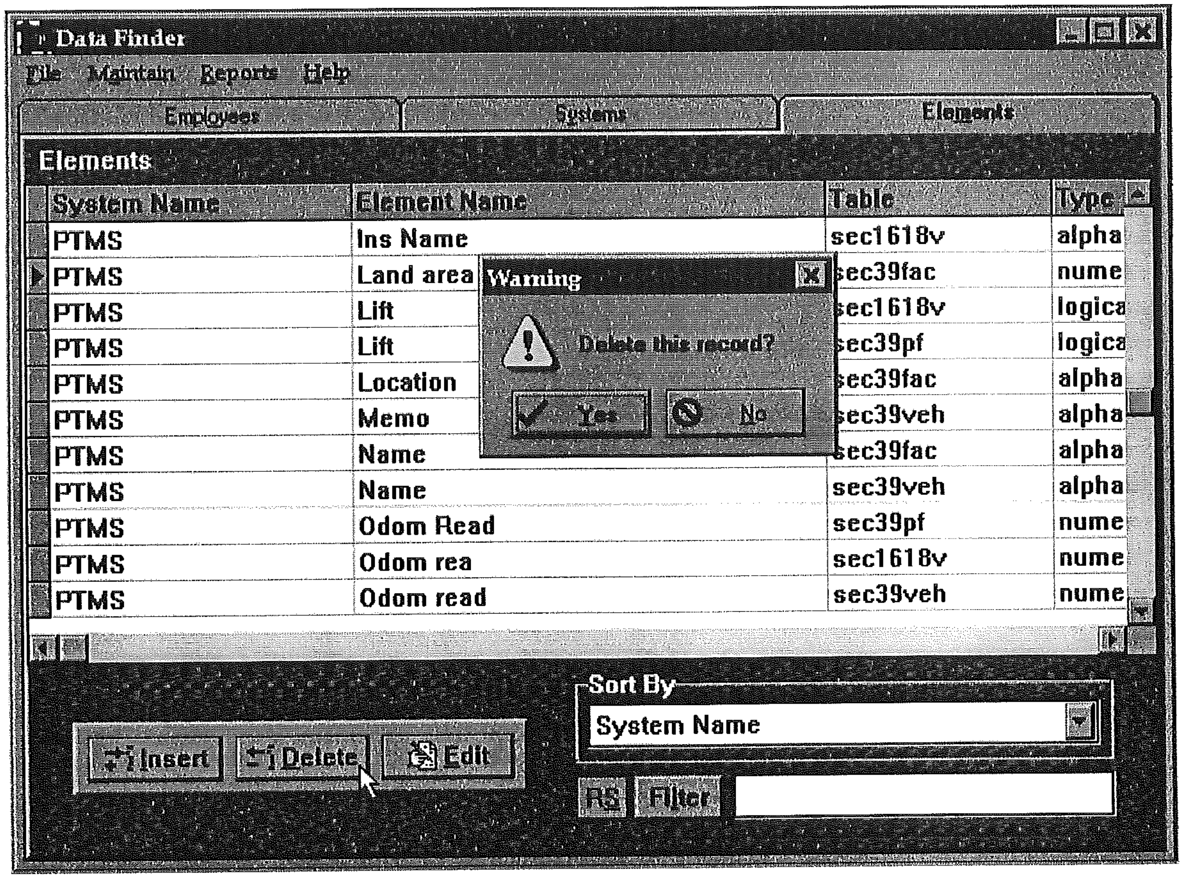


Figure 26: Elements Tab, Delete Dialog Box

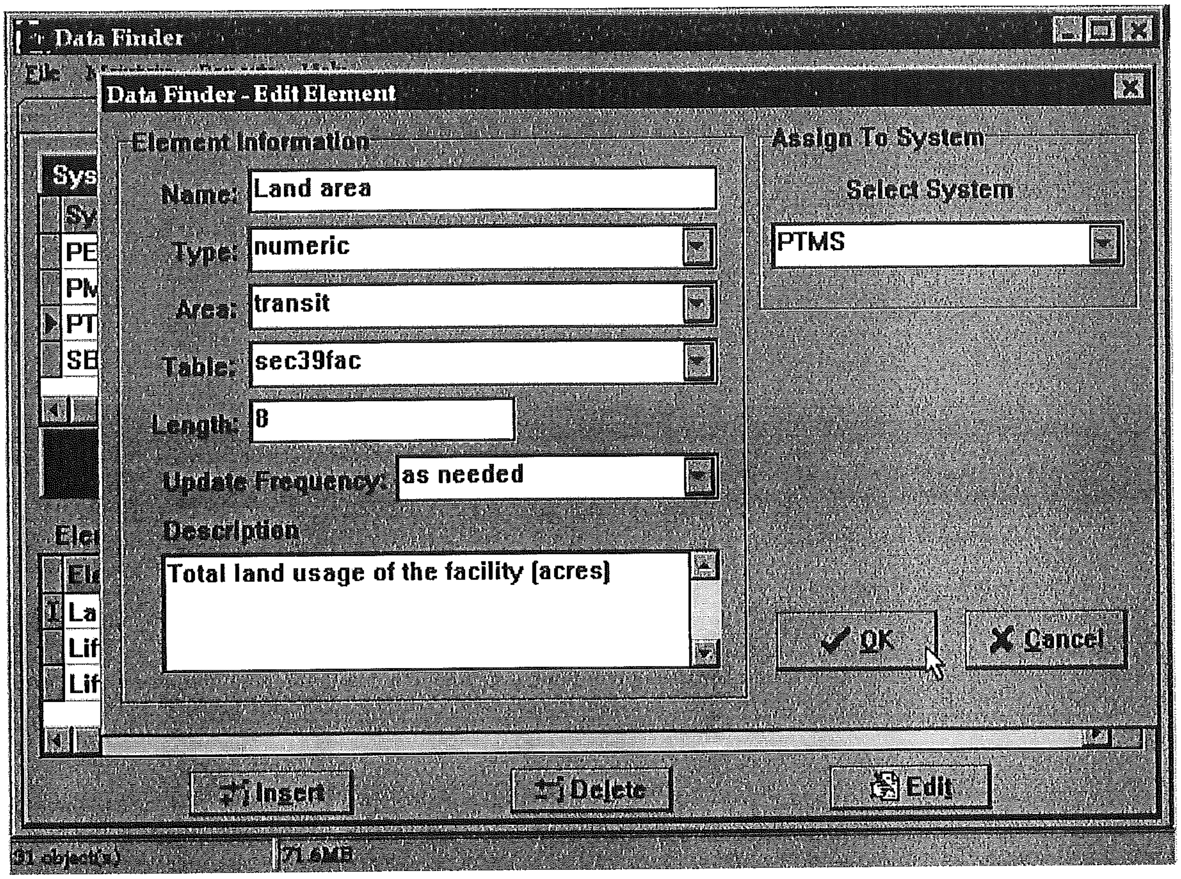


Figure 27: Systems Tab, Elements Grid Edit Dialog Box

We have deleted and edited employee, system and element data. Employee data was deleted and edited from the Employee tab. System data was deleted and edited from both the System tab and the Employee tab. Element data was deleted and edited from the Element tab and the System tab. Now we will learn how to search for data in Data Finder.

Finding Data

One of the most valuable aspects of using Data Finder is its search capability. This is of greatest value when searching the Element tab's Element grid. When filtering for searches in the Elements tab, benefits include: an efficient method for identifying element location; provides contact name for additional element information; can lead to the discovery of unknown or related elements; descriptions for unfamiliar elements can be explored providing an educational value; element type, size and table can be identified; similar element names and descriptions across all systems can be viewed and researched. Many of these same benefits apply to systems and employees when searching these tab grids.

We will now review how Data Finder's search capability can be used.

Both the Employees and Systems tabs have Find buttons which will initiate searches for specific employees or systems. Figure 28 illustrates how to find an employee. Go to the Employees tab and select the Find button from beneath the Employees grid. The Find Employees dialog box will prompt for entry of last and/or first name. The search is not case sensitive and you may enter part of only one name. Data Finder will perform a sub-string search (e.g.: enter "Joe" or "joe" to find "Joseph"). To initiate the search, select the Find button within the dialog box.

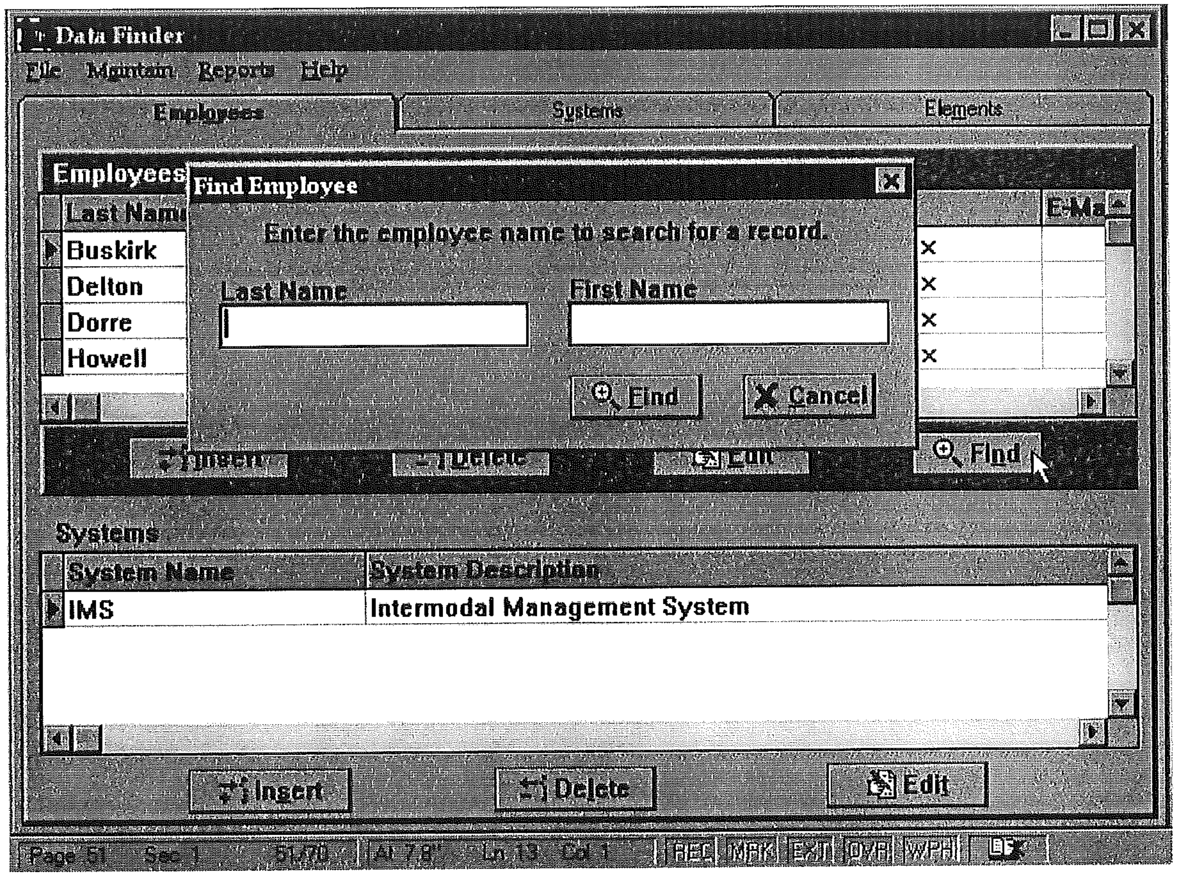


Figure 28: Employees Tab, Find Button and Dialog Box

Data which can be found on the Employees grid includes: last name, first name, department, phone and e-mail.

Figure 29: To find a system, go to the Systems tab and select the Find button beneath the Systems grid. The Find System dialog box will appear prompting you to enter the name of the system you'd like to find on the grid. Enter the system name in the text box and select the Find button from within the dialog box. The search is not case-sensitive (e.g.: enter "sbis" to find "SBIS").

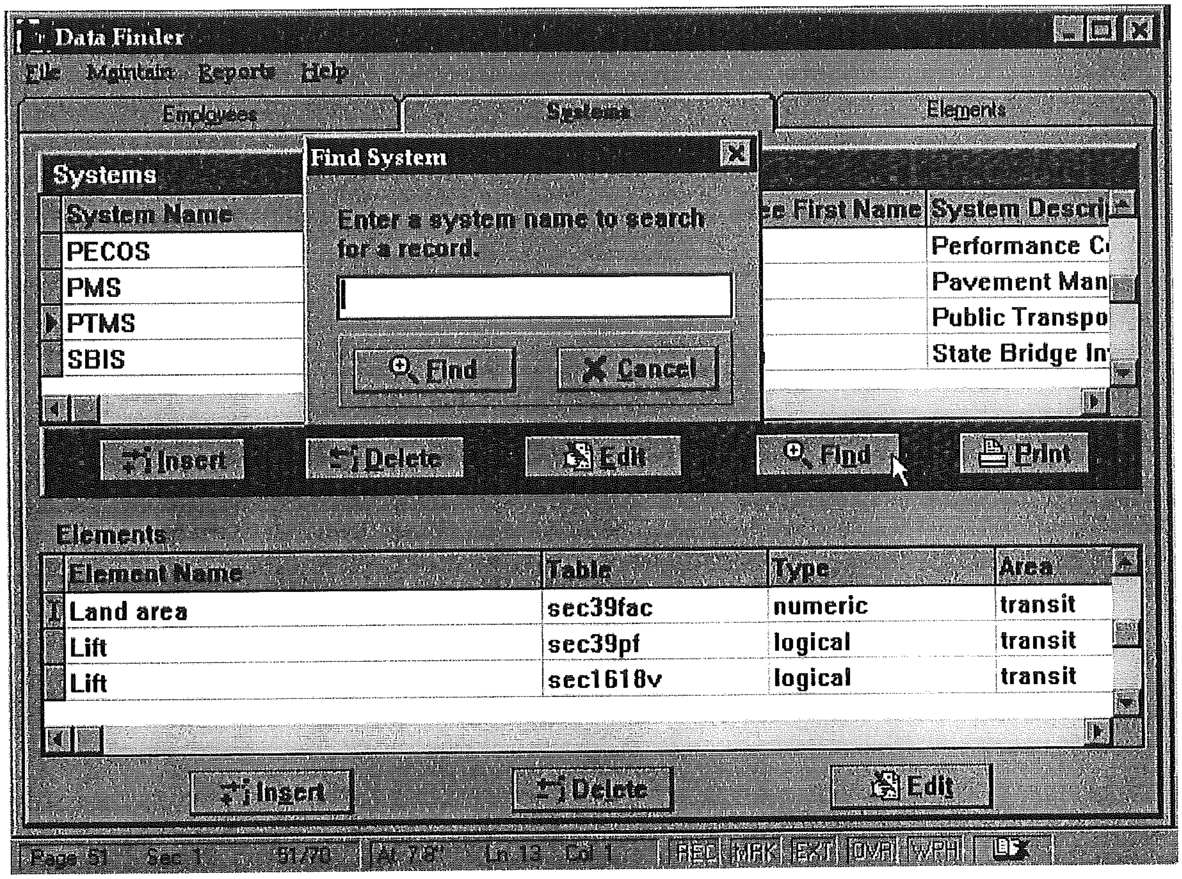


Figure 29: System Tab, Find Button and Dialog Box

Data which can be found on the Systems grid includes: system name, employee last name, employee first name, system description, department, area, data format and update frequency.

Figure 30: When searching for an element, select the Filter button at the bottom of the Elements tab. First, enter your filter criteria in the text box. The filter is not case sensitive and will perform sub-string searches of both the Element Name and Element Description fields of the Elements grid. (e.g.: Enter "terr" to identify all element names and descriptions containing "terr" or "Terr" such as "terrain.") The filter crosses all systems in Data Finder.

Select the reset button, "RS," to reset the Elements grid for display of all Data Finder elements.

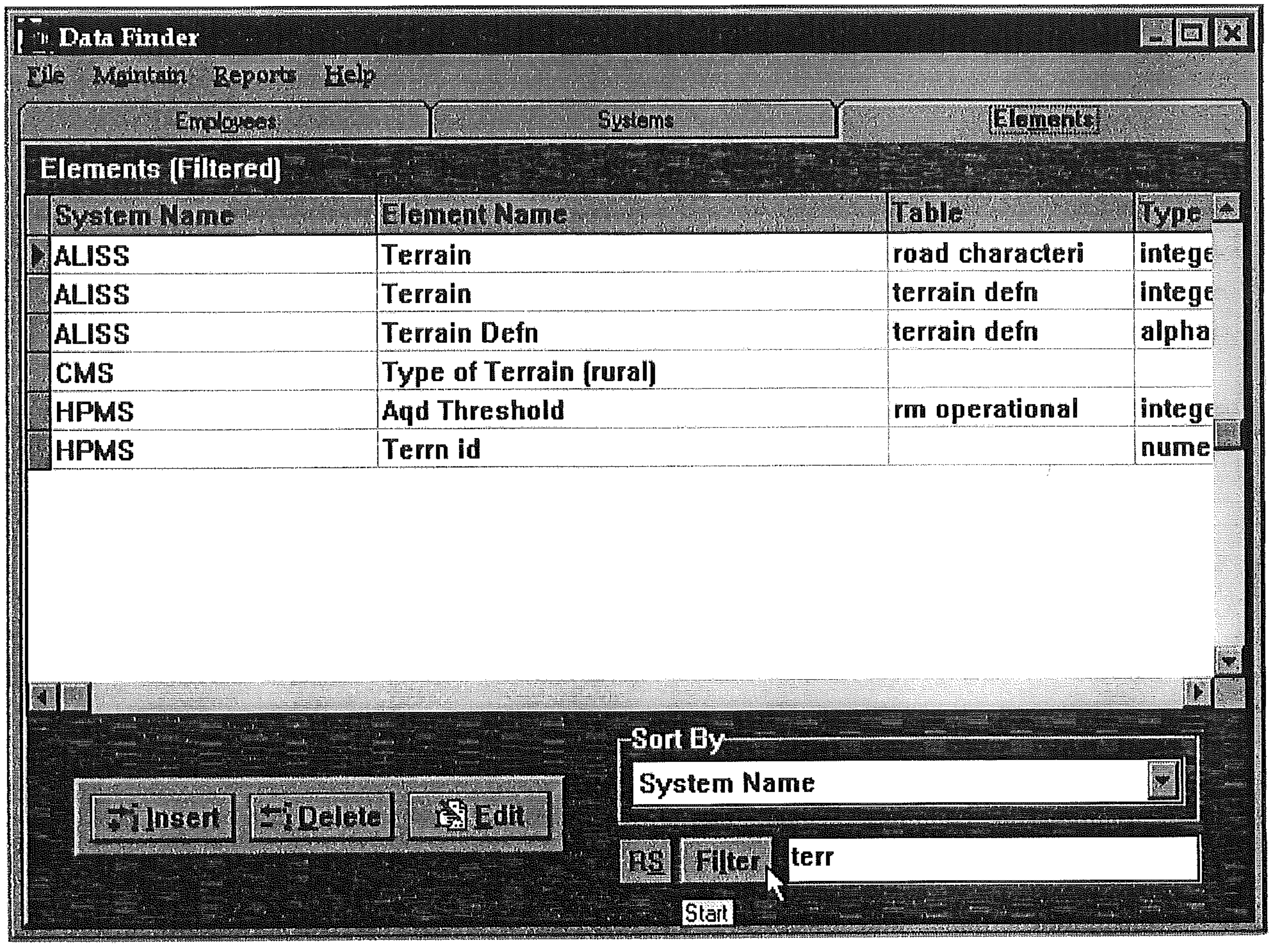


Figure 30: Elements Tab, Filter Button

The Elements grid provides the following element information: element name, system name, table, type, area, length, description, update frequency.

In this section, you have learned to search the Employees and Systems tab screens as well as to use the Filter for searches on the Elements tab. You have also learned some of the valuable benefits associated with these search tools so that you can put them to good use.

Reports

This section reviews the report capabilities of Data Finder.

Figure 31: You may print a system report listing all data elements including data detail. From the Systems tab screen, highlight the system you would like to print from the Systems grid at the top of the screen. Select the Print button to display the Report Destination dialog box. From this box, use the radio buttons to destination, range and number of copies for your report. You can view the report simply by designating the "screen" as the designation (sample in Figure 32).

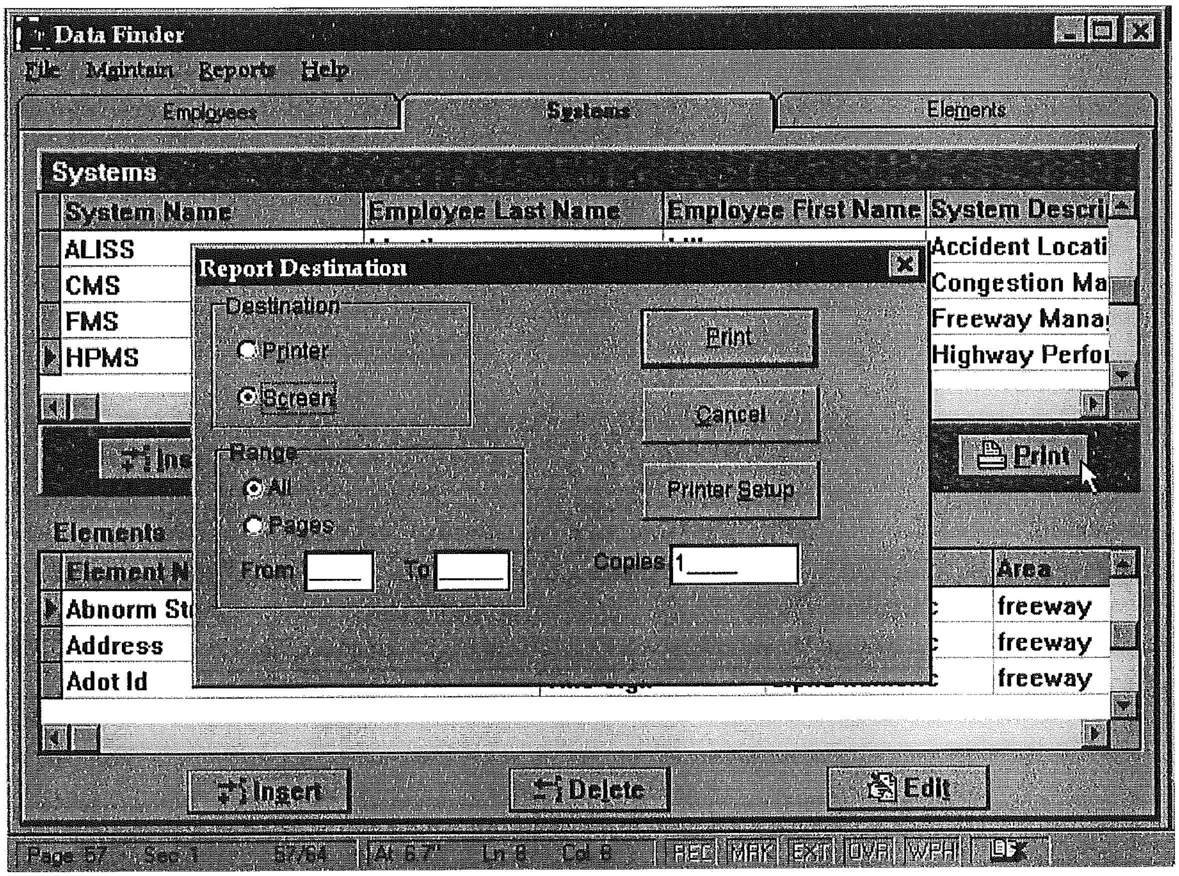


Figure 31: Systems Tab, Print Button and Report Destination Dialog Box

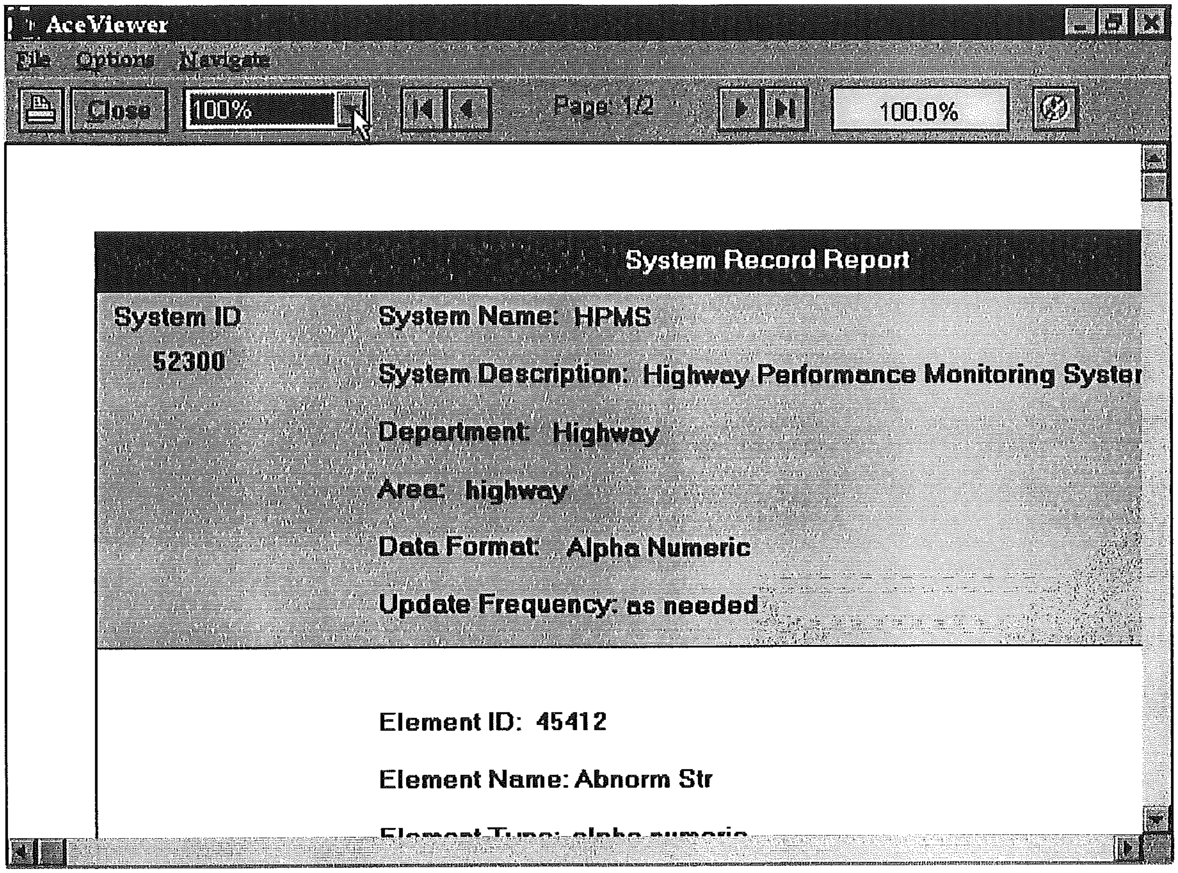


Figure 32: System Tab, Print Sample Report

Reports can also be selected from the menu bar by selecting Reports as shown in Figure 33. This will display the Reports dialogue box. All Systems can be selected for printing or the Filter box can be used for keyword searches within systems. The filter will identify and highlight the system(s) containing the keyword for printing. Select the Print button to display the Report Destination dialogue box as displayed in Figure 31.

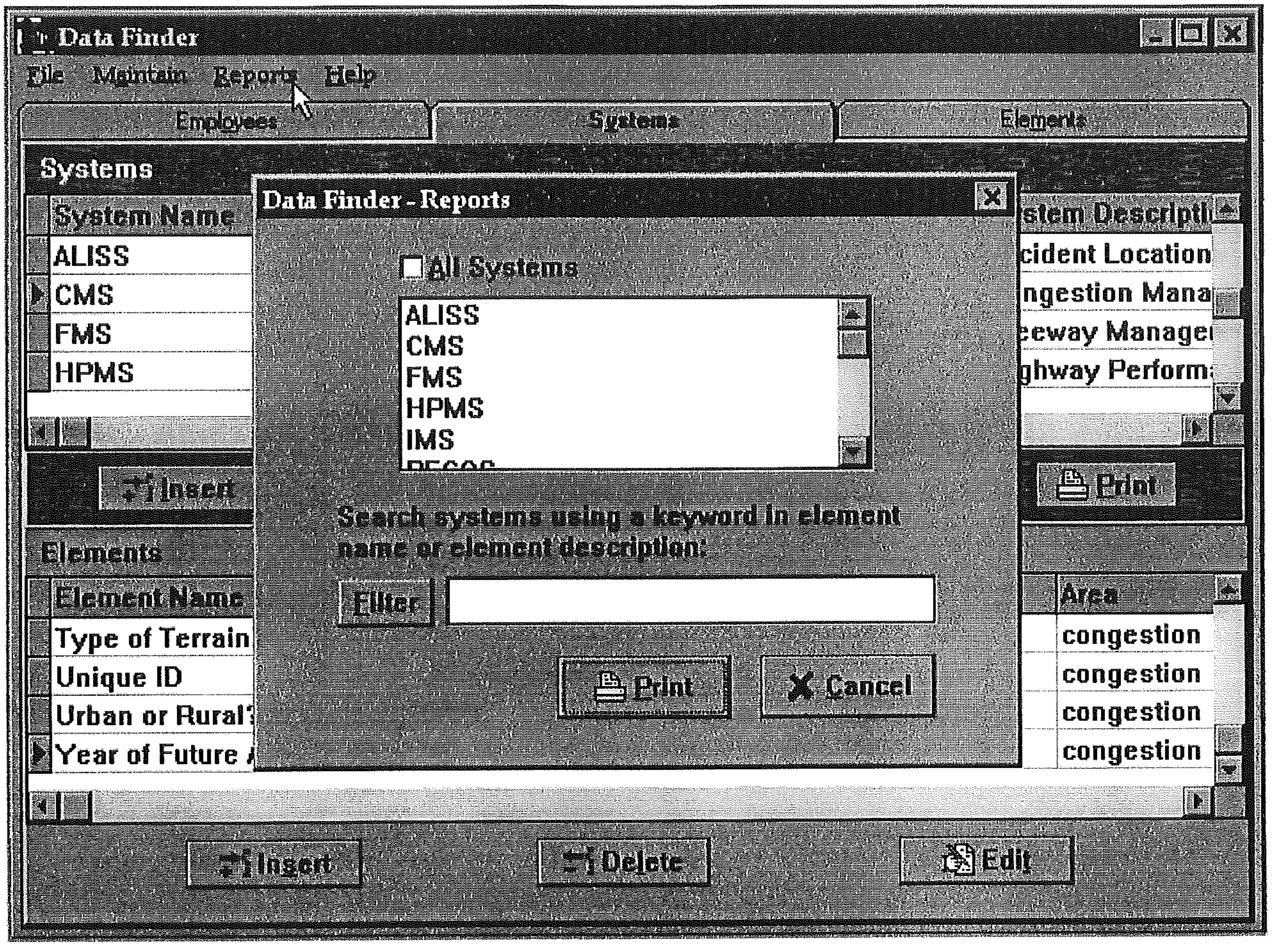


Figure 33: Reports Dialogue Box

On-Line Help

This chapter covers the on-line help available in Data Finder.

User's Manual On-Line

The entire User's Manual is available on-line for your convenience. Simply select Help | Instructions to view the on-line manual.

Search

The on-line Help allows a user to perform a search on keywords. The Index and Find Tabs are described below.

Index

Help | Instructions in Data Finder can perform a search on words marked in the Data Finder Index. To search for an item in the index, type the first few letters of the word you are seeking. Select the word from the bottom list box containing all entries in the index. Once the word is selected, you will be directed to the section in the Help File which deals with the indicated word or topic.

Find

Data Finder on-line help can also perform a search on all words contained in Help but not necessarily marked in the Data Finder Index. To perform a Find, select the Search | Find tab and type the first few letters of the word you are looking for. Select the word from the matching words list box in the middle of the screen, and click on the topic. Click Display from the bottom topic list box. You will be directed to the section in the Help file which contain the word you wanted to find.

About Quick Count

Selecting Help | About will display the Data Finder copyright, version, and technical support information. When requesting technical assistance, it is helpful if you provide us with the Data Finder version and build date.

Glossary

Word	Meaning
Area	Area of business such as pavement, bridges, etc.
Close Button	Button located at the top of the window on upper right corner of the title bar; closes the application window.
Element	Data element; multiple data elements comprise a system
Employee	Employee to which a system within Data Finder is assigned.
Filter	Search
Keyword search	Search set based on single set of key words
Maximize Button	Button on the right side of the Title Bar that allows a screen to be maximized (displayed full screen) or displayed in standard, overlapped mode.
Menu Bar	Bar located at the top of the window just below the title bar. This bar displays the various menu choices available within the application.
Menu Hot Key	Function keys that allow a user to access a menu choice using the keyboard. These menu choices can be accessed by either pressing the Alt or Ctrl key simultaneously with the underlined letter in the desired menu choice.
Minimize Button	Button to the left of the Maximize button on the Title Br that allows a screen to be minimized to an icon.
Readme File	Contains information and answers to questions that were too new for inclusion in the hard copy documentation. This file also contains a list of directories and files which loads on the computer.
SETUP.EXE	Installation program located on disk #1 of distribution diskettes. Installs the application.
System	ADOT computer systems; systems are assigned to an ADOT employee and are composed of elements.
System Menu Request Button	Button on the left side of the Title Bar that provides access to standard window functions.
Table	Table to which a data element belongs.
Title Bar	Bar at the top of a screen containing the screen's title and normally containing a System Menu Request, Maximize and Minimize button.
Type	Data type (e.g.: alpha-numeric, date, logical, etc.)
Update Frequency	Frequency at which data is updated.

W