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BUILDING A USER INTERFACE USING SQL*FORMS AND AN INTERMEDIATE TABLE

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Title

Building a User Interface Using SQL*Forms and an Intermediate Table

Teresa L. James
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Head 1

Abstract

There is usually a trade-off between flexibility and ease of use when a user interface is designed. This paper discusses a data retrieval interface that does not require end users to be ORACLE SQL*Plus programmers or to understand the structure of the database and offers them a very powerful and flexible access to the database. This interface is the front-end to a decision support system being designed and prototyped at Oak Ridge National Laboratory (ORNL).

The interface develops the "where" clause of a SQL select statement for the user based on selections the user makes and stores and then uses those choices to query a target table. Through SQL*Forms screens, reference data tables are used as a source of values from which users choose data or by which user entries are validated. The user's choices are stored in an intermediate table. Then the system builds a query for the target table(s) using an operating system script in which the values and column names in the intermediate table are used to form the "where" clause. The query is executed and data are retrieved.

Head 1

Background

The Worldwide Household Goods Information System for Transportation Modernization (WHIST-MOD) system being designed and prototyped by ORNL is a decision-support system for the Directorate of Personal Property of the Military Traffic Management Command (MTPP). MTPP is responsible for the worldwide shipment of U. S. Service members' personal property. The decision-support system will benefit the staff of the Personal Property Program in their tasks of program evaluation and policy setting. This system is designed to access a centralized database through a powerful set of information management tools.

The prototype system offers users, even those with minimal computer experience, easy access to a large selection of data elements and the ability to formulate complex queries. WHIST-MOD will be a dynamic system that evolves to meet the changing needs of MTPP staff.

User requirements for the WHIST-MOD system were identified during the analysis phase of the project. During this phase ORNL identified three modules that needed to be designed and prototyped to aid decision-support activities at MTPP. These modules include applications to provide a description of the database (system dictionary applications), applications to manage data (data acquisition and administration applications), and applications to retrieve and display data from the database (user applications).

There are two user interfaces in the user applications module, a front-end interface and a postprocessing back-end interface. The front-end interface allows the user to choose, retrieve, and store a subset of the larger database. The back-end interface allows the user to perform statistic analyses and generate graphical and tabular reports using the data subset. The front-end is being implemented using ORACLE, a relational database management system (RDBMS), and SQL*Forms; the back-end is being prototyped using SAS, a data management and statistical analysis toolset. This paper discusses the front-end user interface.

ORNL designed the front-end user interface to be flexible and generic enough to encompass the data access needs of all the users. During the analysis phase of the project, a group of twelve standard applications was identified as the reports the system needed to generate. The criteria for determining which reports to include were high frequency of use and/or high priority, as determined by MTPP managers.

There are three types of flexibility built into the front-end interface:

1. the ability to choose data parameters that are used to retrieve a subset of records from the database and to change these choices,
2. the capability of this single interface to produce any of the requested reports, and
3. the ability to support expansion and modification.

Head 1 The Interface

The user interface is designed to allow the users to choose the subset of data they want to appear on a report. Figure 1 illustrates the relationships between the various components of the user interface. Users move through the interface screens in the following order:

1. select an application category on the Application Category Screen,
2. select an application (report) on a User Application Screen,
3. select parameter categories on the Parameter Selection Menu Screen, and
4. select a subset of data from a reference table in any or all of the Lower-Level Parameter Selection Screens.

INSERT FIGURE 1 HERE.

As users make selections on the lower-level parameter selection screens, their choices are stored in a database table called the Conditions Table. An operating system script builds a query that retrieves data from the shipment tables based on the user choices stored in the Conditions Table. The data retrieved from this query are reformatted and written to an operating system data file. This file is used by SAS to generate reports and charts.

The following sections describe each screen of the front-end user application interface for WHIST-MOD. They also discuss how the selections made in these screens are saved in the Conditions Table and used to build the query for the selected report. Three types of screens are discussed:

1. the initial menu screens,
2. the main parameter screen, and
3. the lower-level parameter selection screens.

Head 2 The Initial Menu Screens

There are three initial menu screens. The first menu screen identifies the system. The second menu screen is the Application Category Screen. The purpose of this screen is to allow the user to specify a work division (i.e., Rate Acquisition, Quality Assurance, Operations, or Management Support) in order to retrieve a list of reports applicable to that division. The last menu screen is the User Applications Screen. It allows users to specify the report they want to produce.

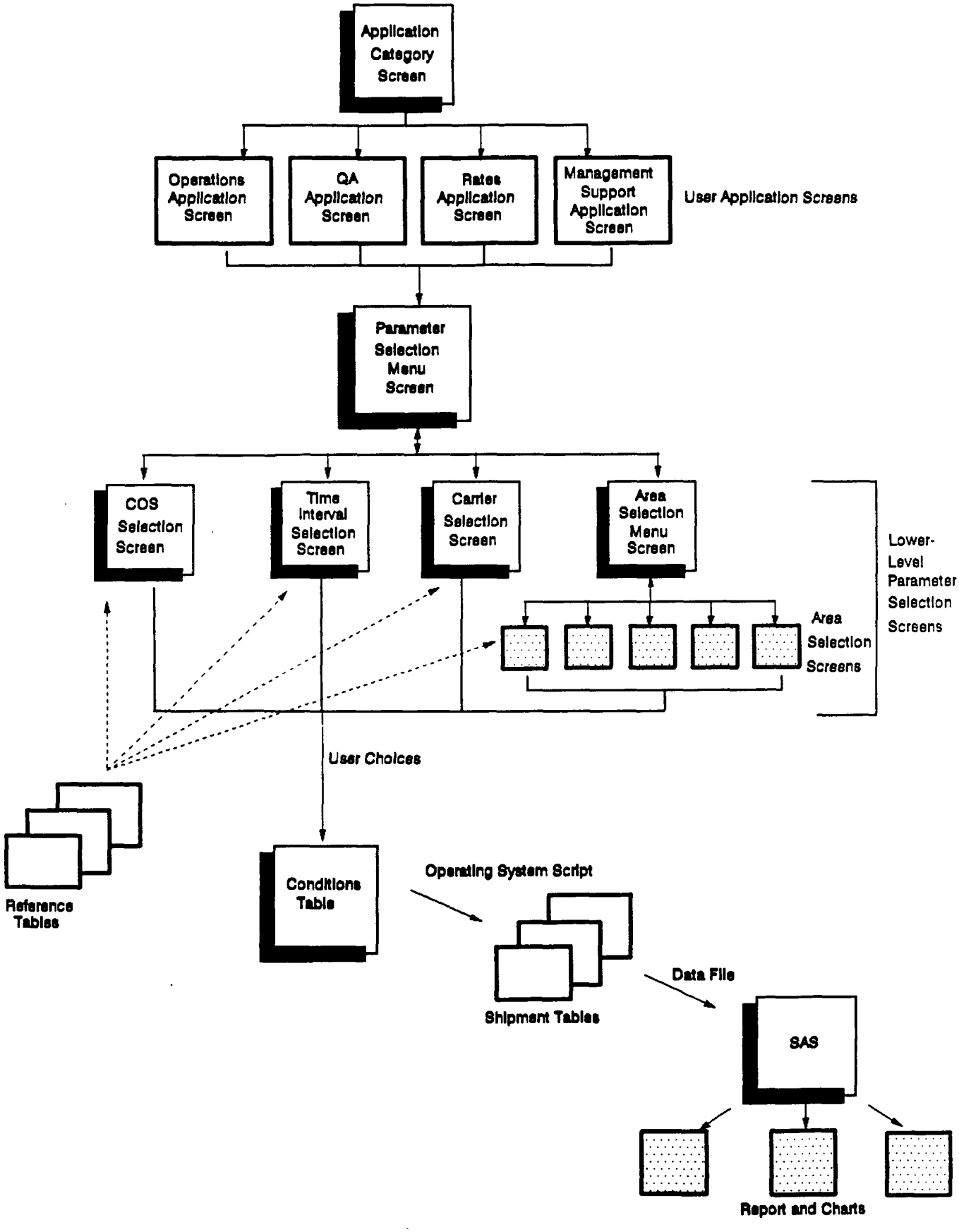


Fig. 1. Components and relationships of the user interface.

Head 2 The Parameter Selection Menu Screen

The Parameter Selection Menu Screen (Fig. 2) has a header line that identifies the user, the report application he/she chose in the previous menu screen, and the date. The screen is divided into two sections. The first section contains the service category selection field. The service category indicates the type of shipments, such as mobile home shipments or domestic shipments. This field allows the user to enter a service category or select a service category from a screen containing a list of valid values. The option chosen in this field may reduce the choices that are displayed in the lower-level Parameter Selection Screens and may reduce the data retrieved by the resulting query of the database. For example, if the user chooses domestic shipments as the service category, only domestic values will be available in the lower-level Parameter Selection Screens (i.e., only domestic carriers, domestic codes of service, domestic origins and destinations, and domestic rate and scoring cycles may be displayed/entered).

INSERT FIGURE 2 HERE.

The second section of the Parameter Selection Menu Screen contains four parameter categories:

1. code of service (COS),
2. carrier,
3. pickup date, and
4. origin and destination.

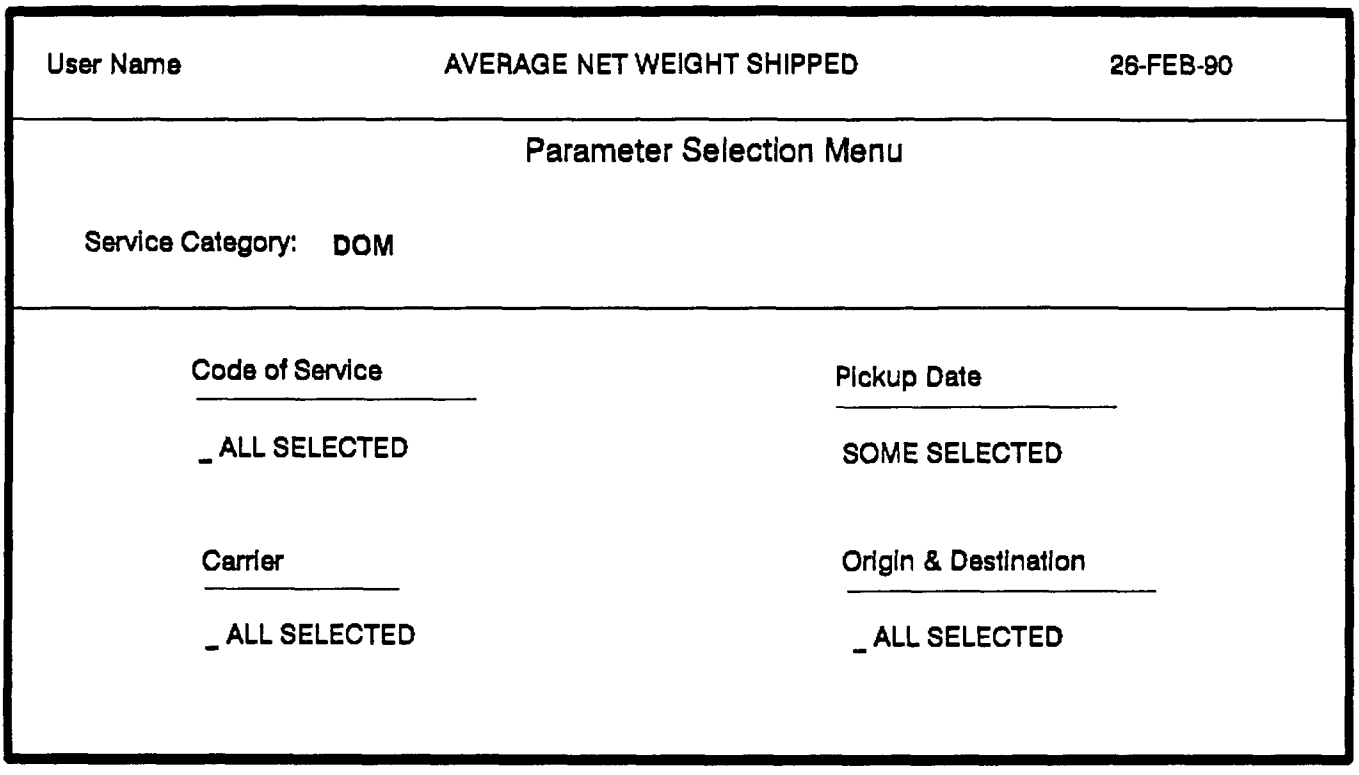
The user may select any or all of these parameters to limit/identify specific data for a report. For example, if the user does not want all codes of service to be retrieved for the report, he/she may choose the COS parameter category to move to a Lower-Level Parameter Selection Screen to specify a subset of codes of service. When users choose data in a Lower-Level Parameter Selection Screen, the message in the corresponding field on the Parameter Selection Menu Screen changes from "All Selected" to "Some Selected." By default, if the user does not choose to specify a particular parameter category (i.e., code of service, carrier, pickup date, or origin and destination), that parameter is not used to limit the query of the database and all the values for that parameter are retrieved. When the user selects a parameter category, a Lower-Level Parameter Selection Screen is displayed.

Head 2 The Lower-Level Parameter Selection Screens

Head 3 The Code of Service Selection Screen

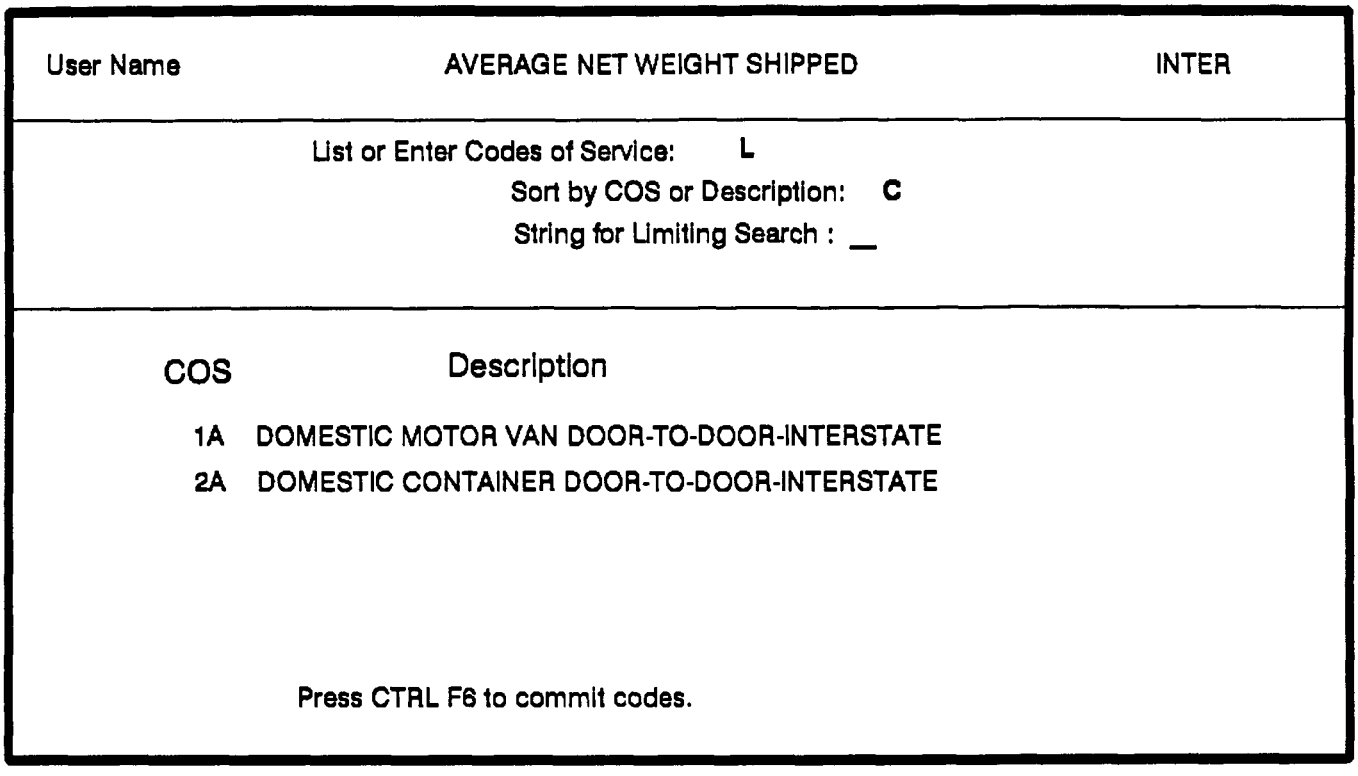
On the Code of Service Selection Screen the user chooses specific COSs to restrict the subset of data used in the report. The screen is divided into two sections (Fig. 3). The first section allows the user to control the data that will be displayed on the second section. The user may choose to display a list of applicable COSs or to enter them one at a time. If the user chooses to display a list of COSs, he/she must choose whether the list returned from the code reference table will be sorted alphanumerically by the COSs or by the description of the COSs. The user may also choose to enter up to two characters to limit the records retrieved into the second section (e.g., if the user enters "DO" for a sort on description, only those COSs that have a description beginning with "DO" will be retrieved).

INSERT FIGURE 3 HERE.



Char Mode: Replace Page 1 Count: *0

Fig. 2. Parameter Selection Menu Screen.



Use arrow keys to scroll up or down. Press END beside your choice(s).

Fig. 3. Code of Service Selection Screen.

In the second section of the screen, the user chooses specific COSs. If the user has chosen to list COSs, the list may be limited by the service category chosen. The user will select from a displayed list or enter a selection(s). These COS selections are saved to the Conditions Table and later used to build the query for this report.

Head 3 The Carrier Selection Screen

The Carrier Selection Screen allows the user to choose specific carriers to restrict the subset of data used in the report. Its functionality is like that in the Code of Service Selection Screen. The first section of the screen allows the user to control the data that will be displayed on the second section. The user may choose to display a list of applicable carriers or to enter them one at a time. If the user chooses to display a list of carriers, he/she must choose whether the list returned from the carrier reference table will be sorted by the carrier code or the carrier name. The user may also choose to enter up to two characters to limit the records retrieved into the second section (e.g., if the user enters "C" for a sort on carrier name, only those carriers whose name begin with a "C" are retrieved). In the second section of the screen, the user chooses specific carriers. If the user has chosen to list carriers, the list may be limited by the service category the user has chosen. He/she will select from a displayed list or enter a selection(s). The carrier codes are saved to the Conditions Table and later used to build the query for this report.

Head 3 The Area Selection Menu Screen and the Area Selection Screens

On the Area Selection Menu Screen users will specify an origin and/or a destination area category. There are five ways that users may define an area category:

1. geographic area,
2. Government Bill of Lading Office Code (GBLOC),
3. rate area,
4. country, or
5. state.

Once the user has made an origin or a destination area category selection, the user will move to the appropriate area selection screen.

There are five origin area selection screens, one for each category, and five destination area selection screens. These screens have the same design and functionality as the COS and carrier selection screens; however, the users are selecting area parameters to save and use to build the query.

Head 3 The Time Interval Selection Screen

The Time Interval Selection Screen allows the user to specify a range of shipment pickup dates. The user may choose one of three ways to enter a beginning and/or ending pickup date. The user may enter a rate cycle number, a scoring cycle number, or arbitrary dates. Entering a scoring and/or rate cycle number is appropriate only for two service category selections: international and domestic. If the user has chosen another service category (e.g. "ALL", "DPM", or "MOBILE HOME"), he/she cannot enter a rate or scoring cycle number. When he/she enters a rate or scoring cycle number, the associated beginning and ending pickup dates are retrieved and displayed on the screen. A user who is unfamiliar with the data may choose to display a list of applicable rate cycle or scoring cycle numbers. If the user wants to enter an arbitrary beginning and/or ending pickup date, he/she may move to the last section of the screen and enter the desired date(s).

The range of pickup dates chosen by the user are saved to the Conditions Table. These dates are used to build the query for the selected report.

Head 2 The Conditions Table

The Conditions Table contains all the choices the user has made from any of the Lower-Level Parameter Selection Screens data along with information about the user. Each user has a Conditions Table. Figure 4 shows the structure of the Conditions Table. An operating system script uses the data from this table to build the "where" clause of the actual query to the appropriate database table. For example, it builds a query that selects columns from a database table where

Carrier Code	=	any carrier code in the Conditions Table,
COS	=	any COS in the Conditions Table,
Origin Area	=	any origin state, origin country, origin rate area or origin GBLOC in the Conditions Table,
Destination Area	=	any destination state, destination country, destination rate area or destination GBLOC in the Conditions Table, and
Pickup Date	=	any date ≥ the beginning pickup date and/or any date ≤ the ending pickup date in the Conditions Table.

INSERT FIGURE 4 HERE.

If the user does not make a selection on a particular Lower-Level Parameter Selection Screen, then the shipment data retrieved from the database are not restricted by that parameter. For example, if the user does not specify carriers but does specify COSs, data will be retrieved about shipments that moved under those COSs. The data retrieved will not be restricted by carrier. Figure 5 shows a partial Conditions Table with sample data.

INSERT FIGURE 5 HERE.

In this example the user has specified two COSs, three carrier codes, a beginning and an ending pickup date, an origin state, and a destination GBLOC. The subset of data retrieved from the query of the shipment table will include only shipments that moved under these COSs, by these carriers, between these dates, from this origin to this destination.

Although this query could be built using SQL*Forms, the WHIST-MOD system needs to perform additional tasks that are not easily done in SQL*Forms. This system needs to open a data file that can be used by SAS, shut down ORACLE, and start the SAS back-end interface. An operating system script file was built to query the ORACLE database and perform these other tasks.

The use of an intermediate table to store user choices allows the user to select the data parameters needed to subset the data without knowing table names, column names, or SQL*Plus syntax. Using an operating system script file allows the user to query the shipment tables and retrieve data without using column names, table names, or SQL*Plus syntax.

Head 1 Conclusions

This paper discusses the components of an easy-to-use interface that can perform complex queries. The essential components are the interface screens which facilitate user choices; the Conditions Table, which stores user choices; and the script file which performs the query and puts the data in a file. This design may be adapted to a variety of situations and hardware/software platforms.

Name	Null?	Type
USER_ID	NOT NULL	CHAR(30)
TERMINAL_ID	NOT NULL	CHAR(8)
CODE_OF_SERVICE		CHAR(2)
CARRIER_CODE		CHAR(4)
BEGINNING_PICKUP_DATE		DATE
ENDING_PICKUP_DATE		DATE
ORIGIN_GBLOC		CHAR(4)
ORIGIN_RATE_AREA		CHAR(9)
ORIGIN_STATE		CHAR(2)
ORIGIN_COUNTRY		CHAR(20)
DESTINATION_GBLOC		CHAR(4)
DESTINATION_RATE_AREA		CHAR(9)
DESTINATION_STATE		CHAR(2)
DESTINATION_COUNTRY		CHAR(20)

Fig. 4. Conditions table structure screen.

COS	Carrier Code	Beginning Pickup Date	Ending Pickup Date	Origin State	Destination GBLOC
1A					
2A					
	CVLS				
	AAAA				
	CVLC				
				VA	
					LIFL
		01-NOV-89			
			30-APR-90		

Fig. 5. A partial Conditions Table with data.

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WHIST-MOD SYSTEM

- DoD project
- Decision Support System

WHIST-MOD MISSION

design a decision support system given the following definition:

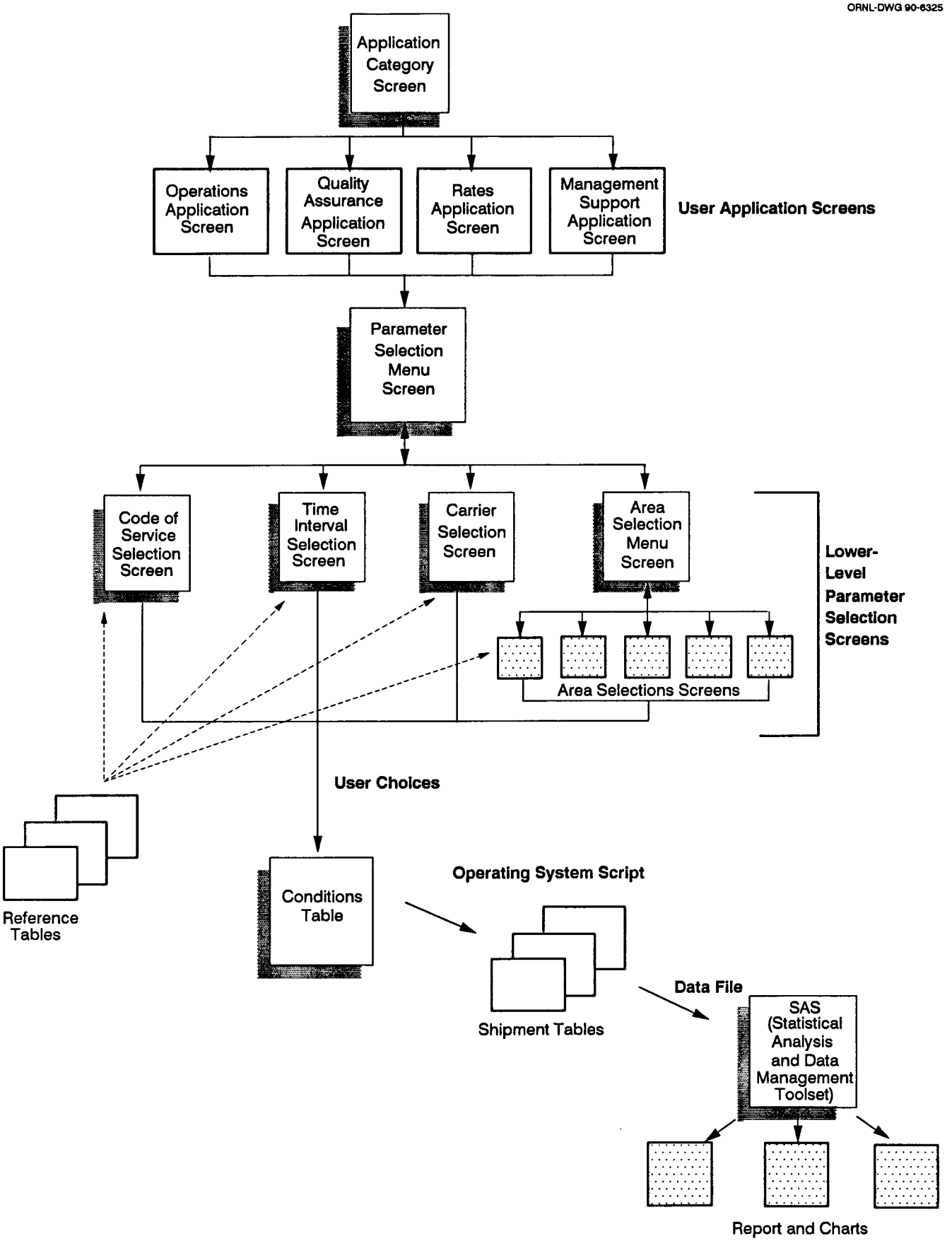
"... a decision support system should provide the staff at MTPP with access to the information required to help them make intelligent, informed decisions regarding operation and management of their organization. More specifically, a decision support system should ensure that the data provided is relevant and of the highest level of quality, be readily accessible to users of various skill levels, and have the flexibility to adapt to changing demands."
- Final Draft, WHIST-MOD Concept Paper, April 12, 1989, pp. 35.

COMPONENTS OF WHIST-MOD

- System dictionary
- Data acquisition and administration
- User interface

TWO USER INTERFACES

- Front-end ORACLE SQL*Forms interface
- Post-processing back-end SAS interface


Application Category Screen
Operations Application Screen
Quality Assurance Application Screen
Rates Application Screen
Management Support Application Screen
User Application Screens
Parameter Selection Menu Screen
Code of Service Selection Screen
Time Interval Selection Screen
Carrier Selection Screen
Area Selection Menu Screen
Area Selections Screens
Lower-Level Parameter Selection Screens
User Choices
Reference Tables
Conditions Table
Operating System Script
Shipment Tables
Data File
SAS (Statistical Analysis and Data Management Toolset)
Report and Charts

USER INTERFACE REQUIREMENTS

- Flexible and generic
- Modular
- Easy to use

A FLEXIBLE AND GENERIC INTERFACE

- Supports the production of 36 reports
- Supports the selection and manipulation of data for each report

A MODULAR INTERFACE

- Each function is a separate entity
- Easily accommodates changes to the system
- Easy to understand
- Easy to maintain

EASE OF USE OF THE INTERFACE

- Single keystrokes
- Extensive help messages
- Knowledge of database structure not required
- Knowledge of standard query language (SQL) not required

THE FRONT-END INTERFACE

- Select an application category on the Application Category Screen
- Select a report on a User Application Screen
- Select parameter categories on the Parameter Selection Menu Screen
- Select a subset of data from a reference table in any or all of the lower-level Parameter Selection Screens
- Store user choices in the Conditions Table

INITIAL MENU SCREENS

- System identification screen
- Application Category Screen
- User Applications Screen

WELCOME TO THE WHIST-MOD SYSTEM

PROTOTYPED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.

Press END to continue.

Application Category

Rates

QA

Operations

Management Support

Quit

Press END to choose option.

User Applications for Rates Division

- ☐ Average Net Weight Shipped
- ☐ Average Cost of Shipments
- ☐ Number of Shipments
- ☐ Number of Shipments that Went into SIT
- ☐ Change in Rate Levels
- ☐ Tonnage
- ☐ Number, Cost, and Tonnage for Volume Moves & OTOs
- ☐ Cost Avoidance

Press END to choose option.

THE PARAMETER SELECTION MENU SCREEN

- Header section
- Parameter categories section
  - Service category
  - Code of service
  - Pickup date
  - Carrier
  - Origin and destination

User Name	AVERAGE NET WEIGHT SHIPPED	26-FEB-90

Parameter Selection Menu

Service Category: **DOM - DOMESTIC SHIPMENTS**

Code of Service	Pickup Date
_ ALL SELECTED	SOME SELECTED
Carrier	**Origin & Destination**
_ ALL SELECTED	_ ALL SELECTED

THE LOWER-LEVEL PARAMETER SELECTION SCREENS

- The Code of Service Selection Screen
- The Date Selection Screen
- The Carrier Selection Screen
- The Origin and Destination Selection Screen

User Name	AVERAGE NET WEIGHT SHIPPED	INTER

List or Enter Codes of Service: **L**
Sort by COS or Description: **C**
String for Limiting Search : __

COS	Description
1A	DOMESTIC MOTOR VAN DOOR-TO-DOOR-INTERSTATE
2A	DOMESTIC CONTAINER DOOR-TO-DOOR-INTERSTATE

Press CTRL F6 to commit codes.

User Name | AVERAGE WEIGHT SHIPPED | DOM

Time Interval

Enter rate/scoring cycles below.

Rate Cycle	: DW89	Begin:	01-NOV-89	End:	30-APR-90
Scoring Cycle	:	Begin:		End:	

Enter requested dates below (DD-MON-YY).

Begin Date	:	End Date:	

_ Press CTRL F6 to enter your time interval choice.

User Name | AVERAGE WEIGHT SHIPPED | DOM

List or Enter Carrier Codes: L
Sort by Carrier Code or Description (Name) : C
String for Limiting Search : _

	SCAC	Carrier Name
*	AAAA	CLARK TRANSFER & STORAGE CO
	BBBB	CROWN MOVING & STORAGE INC OF ILLINO
*	CVLC	CARTWRIGHT VAN LINES INC
*	CVLS	CONTINENTAL VAN LINES
	CVLW	CLEARVIEW VAN LINES INC
	CVMO	CENTRAL VALLEY MOVING AND STORAGE
	CVMQ	COR-O-VAN MOVING & STORAGE CO
	CVNI	CENTRAL VAN LINES INC
	CVNS	CARDINAL VAN AND STORAGE
	CWMO	CROWN MOVING & STORAGE INC

Press CTRL F6 to commit SCACs.

THE AREA SELECTION MENU SCREEN

- Geographic area
- Government bill of lading office code
- Rate Area
- Country
- State

User Name	AVERAGE WEIGHT SHIPPED	INTER

Origin		Destination
_	Geographic Area	_
_	GBLOC	_
_	Rate Area	_
_	Country	_
_	State	_

Press PG Up/PG DN to move between origin and destination lists.
Press END to select or cancel an origin or destination.
Press CTRL F6 to accept your choice.

User Name	AVERAGE WEIGHT SHIPPED	DOM

List or Enter Origin States : **L**
Sort by State Code (C) or Description (D): **D**
String for Limiting Search : __

Code	Description
SC	SOUTH CAROLINA
SD	SOUTH DAKOTA
TN	TENNESSEE
TX	TEXAS
UT	UTAH
VT	VERMONT
VA	VIRGINIA
WA	WASHINGTON
WV	WEST VIRGINIA
WI	WISCONSIN

Press CTRL F6 to commit codes.

THE STRUCTURE OF THE CONDITIONS TABLE

Name	Null?	Type
USER_ID	NOT NULL	CHAR(30)
TERMINAL_ID	NOT NULL	CHAR(8)
CODE_OF_SERVICE		CHAR(2)
CARRIER_CODE		CHAR(4)
BEGINNING_PICKUP_DATE		DATE
ENDING_PICKUP_DATE		DATE
ORIGIN_GBLOC		CHAR(4)
ORIGIN_RATE_AREA		CHAR(9)
ORIGIN_STATE		CHAR(2)
ORIGIN_COUNTRY		CHAR(20)
DESTINATION_GBLOC		CHAR(4)
DESTINATION_RATE_AREA		CHAR(9)
DESTINATION_STATE		CHAR(2)
DESTINATION_COUNTRY		CHAR(20)

THE QUERY

Carrier Code	=	any carrier code in the Conditions Table
COS	=	any COS in the Conditions Table
Origin Area	=	any origin state, origin country, origin rate area or origin GBLOC in the Conditions Table
Destination Area	=	any destination state, destination country, destination rate area or destination GBLOC in the Conditions Table and
Pickup Date	=	any date ≥ the beginning pickup date and/or any date ≤ the ending pickup date in the Conditions Table

THE CONDITIONS TABLE WITH DATA

COS	Carrier Code	Beginning Pickup Date	Ending Pickup Date	Origin State	Destination GBLOC
1A					
2A					
	CVLS				
	AAAA				
	CVLC				
				VA	
					LIFL
		01-NOV-89			
			30-APR-90		

EXAMPLE OF DATA RETRIEVED FROM SHIPMENT TABLE

Code of Service	Carrier Code	Date Shipment Picked Up	Origin State	Destination GBLOC	Origin Net Weight
1A	CVLC	22-NOV-89	VA	LIFL	1180
1A	CVLC	30-NOV-89	VA	LIFL	5020
1A	CVLS	30-NOV-89	VA	LJFL	4440
1A	CVLS	15-APR-90	VA	LIFL	2860
2A	AAAA	27-NOV-89	VA	LIFL	19120
2A	CVLC	15-FEB-90	VA	LJFL	5410
2A	CVLC	15-MAR-90	VA	LJFL	5680
2A	CVLS	29-NOV-89	VA	LJFL	8120

SUMMARY

- Easy to use
- Flexible
- Modular