INTRODUCTION

The concept of a decision support system encompasses a wide range of tasks, including:
- statistical analysis
- forecasting
- market research
- data management
- quality improvement
- financial modeling

Effectively performing these tasks is essential in making the right business decisions in today's competitive global marketplace. In order to aid in making the right business decisions in a timely and accurate fashion, the decision support system (DSS) should provide data analysis and visualization tools for both traditional and innovative ways. But reality tells us, this is not always an easy goal to achieve and in fact, the goal is often quite difficult to accomplish due to information delivery barriers we must overcome.

This paper will briefly describe those barriers and how the SAS System can make them trivial. The remainder of the paper will focus on an example of an object-oriented approach to developing a graphical user interface (GUI) decision support application via the SAS System. Included will be an example of menuing paths a typical decision support application might include. A step-by-step guide in linking a menuing object to the existing application using SAS/EIS® and SAS/AF® software will also be included.

BARRIERS TO EFFECTIVE INFORMATION DELIVERY

The barriers to effective information delivery can be divided into four categories, all of which reflect the diversity we find in today's enterprise.

Diverse Data Sources

In most organizations, data files are distributed throughout the enterprise in different data bases and structures. Some data may be stored in DBMS tables on a platform different from the application's platform, others kept in flat files or perhaps in SAS data sets. Data often get reorganized and replicated by others in the same organization. This is costly both in terms of time and money. As a solution, the SAS System treats data as a generalized and available resource by providing transparent access. End users can easily generate queries and reports on data from any source.

Diverse User Requirements

Different people have different 'comfort levels' when using technology. The comfort level of an executive may be quite different from that of the business analyst or the programmer. Today's enterprise must be equipped to deliver information to all of these people in a form they can understand and use effectively. The SAS System, with its multiple interfaces, provides decision support tools to all levels of users, empowering them to make more informed business decisions.

Diverse Computing Environments

Today's organization has a diverse mix of computing resources, from PCs and workstations to minicomputer networks and large centralized mainframes. This diversity often causes difficulty in integrating the organization's computing resources for maximum effectiveness. The SAS System, with its MultiVendor Architecture (MVA), gives your organization greater flexibility in choosing where and how to develop applications for the most effective use of computing resources. With the SAS System, applications can be developed in one environment and ported to others without modification. For example, the demonstration accompanying this paper was developed on an IBM/PS2 running OS/2®. It was then ported to a Unix platform to create the screen shots included in this text. The demonstration will be shown using Microsoft's Windows environment. The interface and the code behind the interface did not need to be altered.

Diverse Application Needs

Most organizations have evolved into data-intensive companies. They have extremely broad applications needs. The CEO needs information to drive the success of the enterprise. The head of Human Resources needs a system to support employee quality improvement issues. The marketing staff may need graphical pricing models. No department is without its own special needs.

INTRODUCTION TO SAS/EIS AND SAS/AF SOFTWARE

SAS/EIS software and SAS/AF software are two of the components of the SAS System. They are application development tools that serve as a GUI-based, object-oriented gateway to the many decision support tools the SAS System provides.

SAS/EIS Software

SAS/EIS uses an object-oriented approach to provide quick access to integrated information. Pre-written objects provide ways to explore data in both traditional and innovative ways. Interactive drill-down and hotspotting methods are inherent in many of the objects provided by the software. Through the use of SAS/EIS's built-in objects, the functionality allows rapid prototyping of what otherwise could be a very time-consuming development process.

An object consists of both data and routines. The data provides information about the attributes of the object and the routines (or methods) define the behavior of the object. SAS/EIS software provides 27 of these objects, simplifying tasks ranging from performing host system commands to accessing key informational data to building sophisticated menuing GUI-based interfaces to other application components.

Each of the following sample SAS/EIS objects is available in EIS "Build Mode:" These objects represent ways to view data in making key business decisions:

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Creating Portable GUI-based Decision Support Systems with SAS® Software
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Charts and plots based upon data defined to the application. Includes drill down, dynamic selection of other variables in the data set, dynamic changing of the chart or plot type, and other sophisticated display features.

Graphical range dials displaying the value of a single variable in the data specified.

time-series forecasts produced by the FORECAST and AUTOREG procedure in SAS/ETS® software. It provides the ability to perform what-if analysis by interactively changing independent variables to determine their effect on the dependent variable.

Text based output results. The displayed report can have hotspots, value-driven ranges, and execution time notes.

Color-coded numerical ranges for the following objects: Critical Success Factor, Report, and Variance Report.

Signon application used to execute SAS/CONNECT® software. Enables access to remote data.

Spreadsheet application enabling execution of any SAS/CALC® spreadsheet application.

Varian report display values for two variables, showing the difference and percent difference between each pair of values. Includes ability to define drill-down hierarchy as defined to EIS, display graphs of the data, define hotspots and target applications on the reports. Ranges may also be defined to highlight data trends.

Of course, providing a mechanism to view and analyze data is very important in making sound business decisions. But, just as important is providing a gateway to that information. The following are SAS/EIS objects used to create GUI-based interfaces:

Menu application containing icons on a single window that are selected to execute other SAS/EIS applications.

Point-and-click menu desktop application. Graphical images with SAS/AF FRAME entry elements (i.e. standard widgets, user-defined classes of widgets, graphical text and SAS/GRAPH® output) can be used to construct the menu application.

List menu application. Items are selected to execute other SAS/EIS applications.

The applications developer can choose to simply use any of the above objects to create a complete GUI application or customize the built-in objects to meet diverse user needs. In response to users’ requirements, the developer can expand an existing object, or create completely new objects using SAS/AF software.

When SAS/EIS software is used in conjunction with SAS/AF software, a very powerful application for decision support (or any other type of application) can be created. SAS/AF software takes full advantage of the latest technology in applications development. With the advent of the FRAME entry, a new design component of SAS/AF software, applications can be designed and implemented using object-oriented concepts. The FRAME entry along with other types of entries are stored in a SAS catalog. As in SAS/EIS software, these applications commonly contain objects such as pushbuttons, scroll bars, list and radio boxes, graphical text and diverse graphics.

SAS/AF FRAME entries are typically driven by Screen Control Language (SCL), a programming language that includes variables, various data structures and an assortment of functions, methods, classes, CALL routines, and statements. Among many other advantages, the combination of SAS/AF and SCL provide the ability for the developer to

- design applications in an intuitive, graphical environment
- design quick prototypes
- develop reusable program modules
- write portable applications
- control design standards
- increase programmer productivity.

A DECISION SUPPORT APPLICATION

The decision support application presented here demonstrates the features of SAS/AF software, SAS/EIS software and the decision support tools of the SAS System.

The application includes the following:

- Financial Analysis
- Forecasting
- Market Research
- Project Management
- Quality Improvement
- Statistical Modelling

The components of the application are reflected in the main menu:

The applications developer can choose to simply use any of the above objects to create a complete GUI application or customize the built-in objects to meet diverse user needs. In response to users’ requirements, the developer can expand an existing object, or create completely new objects using SAS/AF software.
Display 1  Decision Support Application Main Menu

The demonstration will focus on the areas of forecasting, market research, and quality improvement. The data examined in each area represents different industries. This demonstrates how SAS software can manage diverse data sources, user requirements, computing environments and applications regardless of what the business area. The menu was built with the SAS/EIS "Graphics Menu Builder" object. Each button points to a defined "Target Application." The target application may point to another SAS/EIS object or to other modules supplied by the SAS System.

MARKETING RESEARCH

This component of the application focuses on a survey conducted by a local mass transit agency to obtain information on who rides the bus. Users can select "Project Plan" to display a menu listing two different formats for displaying the ordered tasks required to complete the rider survey.

Display 2  Bus Rider Survey Main Menu with Project Planning Selected

The Bus Rider Survey Menu is another example of the "Graphics Menu Builder" object. Note that the look and feel is similar to the main menu. However, it is very easy to alter its appearance to fit the diverse needs of its users.

If "Scheduled" is selected from the list menu, a SAS/AF object invokes an SCL program which displays a Gantt chart. The Gantt chart is a graph of the project schedule, from questionnaire design to data analysis to presentation of results.

Display 3  Bus Rider Data Entry Screen

The data entry operators can enter data into the data base through this screen. Built-in error checking is also available, using SCL as a means to programatically check for errors or automatically initialize dynamic or static values. This screen can also be used to review data after data entry. Or alternately, the data can be browsed in tabular format via the FSVIEW command or by clicking on the "Browse Data" option from the "Bus Rider Survey" main menu. Either way, subsetting processing may be used to analyze the data. For instance, you may want to subset the data according to the rider's reason for riding the bus to help determine bus schedules.

Some of the decision support features in this example include cross-tabulations to examine counts. This cross-tabulation shows the reasons for riding the bus versus the destination of the rider.
From the results here, one can determine the relationship between the two variables. That is, through a general association test, one can verify that depending upon the destination, there are different reasons the rider is riding the bus.

But what about other types of analysis? What about other relationships between the data? Correspondence analysis can be used to analyze the data from a matrix by creating a scatter plot of categorical variables.

In this scenario, two consumer groups were identified. The first group are students and low income part-time employees riding the bus to work. The second group are the middle or upper-income workers concerned with convenience or pollution. The graph is displayed in a SAS/AF FRAME entry with pushbuttons provided to zoom the graph for better visibility.

This information is further broken down by the location of the company's branches, revealing one reason for delays is the fact that Chicago and New York have big problems with backlogged claims.

Selecting Shewhart Analysis from the Quality Improvement menu displays a control chart that monitors the claims process over time.
Output 5  Insurance Company ABC: Shewhart Graph

The Drill-Down Analysis component takes advantage of the drill-down capabilities of the SAS/EIS Graphics Object. It enables the user to select summarized information on a window in order to see another window display more specific information. This is all possible through the use of the SAS/EIS metabase system. The metabase provides a mechanism used to register the application’s data and the data’s variables.

The example below displays a Business Graph Object that provides easy comparison of the processing times among branches, with the drill-down allowing comparisons among product lines within each branch.

Display 5  Insurance Company ABC: Drill Level One

Drill-down capabilities with the “Business Graph” object include the ability to either use the control arrows in the upper right corner of the screen to drill the data in its entirety or to subset it by clicking on a selected portion of a chart. The following example shows one drill level down after clicking on the bar labeled “New York.” Displayed are the New York branch’s yearly average processing times for each type of insurance offered.

Display 6  Insurance Company ABC: Drill Level Two

By using SAS/QC software in conjunction with SAS/EIS software, a solid quality control decision support application can be developed.

USING SAS/EIS OBJECTS TO LINK FORECASTING REPORTS TO THE DSS APPLICATION

Now attention will be focused on a step-by-step-guide on how to create SAS/EIS objects and link them to an existing application. In this scenario, assume pieces of an existing forecasting application are to be linked to the Decision Support application discussed above.

Forecasting Application Background

The forecasting application was written using both SAS/AF and SAS/EIS software.

Select Forecasting from the Decision Support main menu to display a list of forecasting choices. The “Custom Applications” component encompasses two companies, a popcorn company (Gourmet Popcorn, Inc.) and a carpet manufacturer. The popcorn company data may be accessed via the “Sales Analysis” button and this is where we will focus our attention. The Gourmet Popcorn, Inc. application forecasts sales data for distribution centers in five major cities. The company produces three different types of popcorn: White Cheddar, Banana Aloe, and Caramel Nut. When “Sales Analysis” is selected, two options are available to analyze the company’s data.

Forecast Sales

Defining the Task

In this example, we will
1. Create a menu for the popcorn company to review sales, plot sales and forecast sales.
2. Create an interface using the SAS/AF software FRAME entry
to plot the sales data.

3. Link the completed application to the Decision Support System

Implementing the Task

Once the SAS system is invoked, we may access SAS/EIS software several ways, one of which is through the use of the SAS System's pull-down menus (pmenus).

Mouse action:
1. Click on "Globals" to display a list of global actions.
2. Click on "SAS/EIS" in the "Globals" list to display the SAS/EIS main menu.

Display 7 SAS/EIS Main Menu
Access the application through the "Build EIS" button to modify or enhance it.

Mouse Action:
1. Click on "Build EIS" to access the SAS/EIS development environment.

Display 8 SAS/EIS Build-mode
In this example, the application database, "DSS93.ETSEIS," has been pre-defined. To create the menu used to invoke the "Sales Plot Data," use the "Graphics Menu Builder" object.

Mouse Action:
1. Click on "Add".
2. Click on "Graphics menu builder".

Display 9 SAS/EIS Graphics Menu Builder
Once selected, the "Graphics Menu Builder" attribute window appears, where a name and description must be supplied. To begin creating the menu, click on "Build." The "Methods" button is used to link user-defined methods to the object. The "Test" button is used to test the object during the development process. The "Notes" button allows the developer to specify a location of a notepad (a collection of text stored in a catalog entry of type SOURCE) used to enter or view notes about the current object. During execution of the application the user may click on the "Notes" pmenu button to view or edit the notepad.

Mouse Action:
1. Fill in the name of the menu and its Description.
2. Click on "Build".

Once in "build" mode, the developer can define widgets to the frame. A widget is a visual object in the user interface and is defined by one of the classes in the resource list. In this case, the visual object or widget to create first is "SAS/GRAPH Output." This widget displays graphics output from a SAS catalog entry type called GRSEG. By using the left-most mouse button and dragging across the frame, the developer can create a region. A region is a rectangular area that can contain a widget. To fill the region, press the right-most mouse button anywhere in the empty region. Select the "Fill" menu option and then select the "SAS/GRAPH Output" menu option.

Mouse Action:
1. Create a region by using the left-most mouse button and dragging the mouse until the desired size of the region is created.
2. Release the left-most mouse button.
3. With mouse pointer in the empty region, click on the right-most mouse button.
4. Select "Fill".
5. Select "SAS/GRAPH Output".
The "SAS/GRAPH Output Attribute" window is displayed. This is where the widget is named, the GRSEG entry is specified and additional attributes are defined. One of the additional attributes, "Target Application" can be a call to another SAS/EIS application or object, an invocation of a SAS command, a direct exit out of the menu, or a display of a help entry. This widget will point to an "EIS application."

**Mouse Action:**
1. Select GRSEG by either directly entering the name or by clicking on the control arrow.
2. Click on "Target application".
3. Click on "Edit value".
4. Enter the library, database, name and type either by directly entering them or by using the facility to traverse down allocated libraries.

A button should be created for each target application. To demonstrate another type of object, create another region on the frame by following the steps above. Instead of selecting SAS/GRAPH output, select "Graphic Text." This widget displays text as part of the interface using a variety of fonts, font sizes, and color schemes.

**Mouse Action:**
1. Create a region.
2. Select "Fill" by clicking on empty region with right-most mouse button.
3. Select "Graphic Text".
4. Fill in Text to be displayed, color, font and aspect.

The "Graphic text color" palette may be used to choose from a wide array of colors.
Two "listbox" objects are used to allow the user to select the "Product" and the "Region." The data displayed in these boxes can be pulled from a variety of sources. In this case, both the "Product" and the "Region" listboxes display items pre-defined during build-mode. A "Radio box" object is used to indicate the type of plot to display and a "Check box" object is used to determine whether or not the user wishes to display the generated plot in a template.

```
/* Obtain value from product listbox */
proddesc = getitemc(getniteml(product, 'TEXT'));

/* Obtain key value from SAS data set */
prodid = open('dss93.popprod', 'I');
rc = where(prodid, prodid='1');
proddesc = value(prodid);
rc = fetch(prodid);
if rc then
  prodkey = getvarn(prodid, varnum(prodid, 'PRODKEY'));
rc = close(prodid);
return;
```

A labeled section of code will be written for each widget that needs to perform a task when selected. It is also sometimes necessary and advantageous to perform a task when the user initially enters the frame, simply presses enter, or leaves the entry. This can be controlled by other labeled sections (INIT, MAIN and TERM).

Once the application is complete, edit the menu text for the listmenu object to associate the application name to the appropriate menu item ("Custom Application"). The following action should result:

1. Click on "Forecasting" from the "Strategic Decision Support" main menu to display a listmenu object.
2. Click on "Custom Application" from the resulting listmenu.
3. The "Gourmet Popcorn Inc." main menu displays.

This can be accomplished by entering the master application database in SAS/EIS build-mode and adding "Custom Application" to the listmenu object called by the "Forecasting" widget.

```
Mouse action:
1. Click on "Application Database".
2. Click on "Edit Database".
3. Click on "DSS93.DSSEIS".
4. Click on "DSSETS" with type of "LISTMENU".
5. Select "Edit".
6. Click on "Edit menu text" button.
7. Add an entry for "Custom Application" and fill in a description and indicate the catalog location of the "Custom Application" main menu.
8. Exit to "Build EIS" window.
```

Testing the Task

To test the application, click anywhere on the DSSEIS_DESKTOP index line and select the option to test. This will display the main menu. Click on "Forecasting" and the new "Custom Application" option will appear along with the other pre-defined options. Once "Custom Application" is selected, the "Gourmet Popcorn Inc." frame will be displayed.

```
Mouse action:
1. In the "Build EIS" window, click on DSSEIS.DESKTOP.
2. Click on "Test".
3. Click on "Forecasting".
```
4. Click on "Custom Application" in the list menu. Any further testing may be done by traversing through the popcorn company menu.

CONCLUSION

The SAS System for Information Delivery combines a powerful system of data access, management, analysis, and presentation capabilities with an interactive applications development environment. The applications development components of the SAS System are integrated, allowing developers to create flexible applications with greater speed and easier maintenance.

Object-oriented tools in SAS/EIS and SAS/AF software, along with a powerful applications programming language and exploitation of the latest advances in graphical user interfaces, enable developers to respond quickly and effectively to users' evolving needs. In addition, the SAS System's MultiVendor Architecture allows deployment of applications across multiple platforms, with no additional development time.

The SAS System provides the tools needed to create portable decision support systems that bring users and their data closer together. The ability to create graphical user interfaces enhances the presentation of information and facilitates its delivery to every level of the organization.

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REFERENCES


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