A Comparison of RS/I® and SAS® Software In Meeting Information Systems Development Needs

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Introduction

RS/1 and SAS software are two of the most widely distributed multi-functional packages in use today for developing information systems. It is not uncommon for software professionals to develop code primarily using one product or the other but not both. One of the reasons for this may simply be a lack of knowledge about the capabilities of both packages. Thus, our goal in this publication is to provide some information about RS/1 and SAS software in an attempt to show some of their similarities and differences. Of course, a detailed analysis of how RS/1 and SAS software can meet information systems needs would take many pages and would be beyond the scope of the present work. While this type of analysis and comparison would be beneficial, we have decided to focus our attention on an overall evaluation of both RS/1 and SAS software detailing some of the strengths and weaknesses of both packages. In addition, we present an application developed in an IBM VM/CMS environment using both RS/1 and SAS software. We hope that this will give the reader a greater understanding of the capabilities of both products and how those products might be best suited to meet information systems needs.

RS/1 Software - General

Readers of this paper probably need no introduction to the operation and capabilities of SAS Software in meeting information systems needs. However, to provide a point of comparison with RS/1 a number of features will be mentioned and described in some detail.

RS/1 software is a complete data management, statistical, decision support, and data analysis tool specifically devised for scientific, engineering, and manufacturing use. It streamlines complicated data investigation and statistical jobs so that the user can profit from detailed data analysis. RS/1 has a full range of integrated functions which include: data management, curve fitting, modelling, statistical analysis, graphics, and report generation. Also, it has a built-in programming language, RPL, that allows users to tailor the software to meet application needs.

RS/1 software is a robust tool for gathering and manipulating data. The basic structure for storing data in RS/1 is the two-dimensional table. RS/1 is primarily an interactive system; however, one can create procedures, using RPL, to perform repetitive operations so that the user does not have to type the same commands repeatedly. The execution modes of RS/1 can be interactive mode, non-interactive mode, and batch (or background) mode. RS/1 also runs on a variety of different platforms which include IBM PCs, VAX, IBM mainframes, as well as UNIX based systems.

One of the most useful features of RS/1 for pharmaceutical applications lies in its management of collected data, curve fitting, modelling, statistical analysis, graphics, and report generation procedures. The statistical procedures are fairly versatile, allowing the user to generate many different types of analyses by calling the desired procedure with the appropriate parameters. The output from all RS/1 procedures is stored in the same two dimensional tables as the data. This allows customization in reporting of the results. These procedures allow users to interactively access data to the table cell level. Also, with the use of Group Home file structure, the user can provide simultaneous update access to several concurrent users.

The functionality and operation of RS/1 can be customized using the RPL language. The programs can be run in many of the execution modes of RS/1. Alternatively, novices can use RS/Explore interactive software to analyze and display data even when they have no knowledge of the RPL language. In addition, programmers can develop full screen menu applications using RS/1 Watch Table Function to develop user-friendly interfaces.

RS/1 software allows the user to display a large variety of 2-D or 3-D graphics on a monitor or obtain plots on a number of plotters. Another very powerful feature of RS/1 is its graphics editing facilities. RS/1 also has the ability to edit graphs in real-time, i.e., the user makes a change, presses enter, and the graph is regenerated instantly on the graphics device.

The RS/Explore® software is an ingenuous system for graphical data investigation and statistical inquiry. It furnishes an extensive menu system that enables the scientific community to look and analyze data relationships to gain insight into the underlying process. It provides a proper level of advice, functionality, and ease of use so that the novice and the professional statistician can take advantage of the statistical analysis. It lets the user analyze a large number of characteristics and review them graphically to gain an understanding of complex data relationships.

The RS/Discover® software is a problem-solving tool that enables scientists, engineers, and manufacturers to optimize their process by taking advantage of designed experimentation techniques. It renders a complete, menu-based environment for setting up and analyzing experiments. The user is guided through the process with menus, prompts, and advice. It includes powerful graphics to display the relationships between factors and responses. Experts using this package can develop goals, plan experiments, and identify factors, constraints, and responses. These can be used to produce new and better products and processes.

The RS/QCA™ software affords ready to use statistical quality control practicality along with a complete set of application tools for developing custom solutions. It provides the basis for the user to monitor the processes, identify out-of-control conditions, investigate problem areas, and solve the user's process...
challenges.

RS/DECISION™ software is a realistic application building tool for generating expert system applications in domains such as maintenance, quality control, and troubleshooting. It is integrated with the RPL programming language so that the user has an environment to collect expert knowledge. The user can easily integrate RS/Decision into his/her current manufacturing applications without expensive interfaces.

BBN/Probe™ software is an interactive time-series analysis and graphics process that lets the scientific community monitor, reduce, and analyze very large and complex data sets from either simulation or testing applications. It saves time and resources by going directly to the test data without the typical data preparation process. Consequently, the user's staff can access and analyze test data themselves without understanding the recording system formats.

BBN/CLINTRIAL software offers pharmaceutical and biotechnology companies a unique environment for large scale clinical trials. It increases productivity at every step of the new drug registration process, from clinical trial planning through reporting, thus reducing time needed to submit a new drug application to the Food and Drug Agency.

Obviously, RS/1 provides many different features that can be of enormous value in meeting information systems needs.

Strengths of RS/1

In general, the greatest strength of RS/1 is its multitude of tools available in a single, integrated package. RS/1 contains a breadth of functionality that is rivaled by very few integrated packages. In fact, there are several notable features of RS/1 that can be considered its greatest strengths.

When people consider RS/1, they think primarily of statistical software. RS/1 does contain an excellent collection of multifunctional statistical software. The RS/Explore, RS/Discover, RS/Decision and RS/QC are probably the most notable and powerful statistical tools in the RS/1 toolkit.

Another strength of RS/1 lies in its ease of use, because interactive commands can be stored in a file as a procedure. Also, RS/1 can address data in a table at the cell level. Its graphics editor is very powerful in that it allows the user to change the graph interactively. RS/Explore gives the user expert advice as to the type of statistical test to be run while RS/Discover gives the user expert advice about how to design experiments. RS/Decision keeps all of the functionality of RS/1 while adding expert system rules to a knowledge base that assists laboratory personnel during experiment setup and analysis.

With the advent of version 4.3, RS/1 functionality is increased by moving to the x-windows environment. RS/1 has an identical and equally powerful product over a family of hardware/software platforms, such as UNIX, operating systems, VM/CMS, VMS, IBM mainframe computers, VAX computers, and PCs.

Weaknesses of RS/1

Its table editor is not a full screen editor. Data is addressed by moving the cursor cell by cell or with a jump command. RPL is not a standard programming language, which may lead to a reprogramming work if BBN Software Products decides to change RPL without significant input from its customers. While RS/1 can produce the standard graphics such as pie charts, histograms, x-y plots, and text charts, the default graphics are generally not of camera-ready quality. Another flaw is the lack of a procedure to analyze categorical data. Also RS/1 graphical procedures do not generate presentation quality output.

SAS Software - General

The basis of all SAS processing is a SAS data set which may actually exist or be a view defined under the multiple engine architecture of version 6. A SAS job consists of one or more sequences of data steps (creation of appropriate datasets) and PROC steps. The execution modes of SAS jobs can be display manager mode, interactive line mode, non-interactive mode, and batch (or background) mode. SAS also runs on a variety of different platforms which include IBM PCs, SUN workstations, VAX, IBM mainframes, as well as many others.

One of the most useful features of SAS software for pharmaceutical applications lies in its collection of statistical and "other" procedures. These procedures provide a wide variety of automatic calculations which (generally) produces an accurate report. However, the reports from the procedures are static. The statistical procedures are fairly versatile, allowing a person to generate many different types of analyses by manipulation of procedure options.

Another very powerful feature of SAS software is its full screen data editing facilities, particularly, FEDIT and FS/VIEW. These procedures allow users to interactively access their data. With the use of SAS/SHARE® software, one can provide simultaneous update access to several concurrent users.

Users can write programs using the SAS language. The programs can be submitted in any of the execution modes of SAS. Alternatively, novice users can utilize SAS/ASSIST® interactive software to analyze and display data with no knowledge of the SAS language. In addition, programmers can develop full screen menu applications using a variety of tools which include SAS/AF® or PMENU to develop user-friendly interfaces.

SAS/GRAPH® software allows the user to display a large variety of 2-D or 3-D graphics on a monitor or obtain plots on a great number of printers, slide cameras or plotters. SAS/GRAPH® has also the ability to store graphs in catalogs for later display.

In addition, to the above, there are many other products that provide many useful functions to users. Some of these are SAS/CONNECT®, SAS/FS®, SAS/DM®, SAS/ETS®, SAS/IML®, SAS/OR®, and SAS/QC®.

Obviously, SAS software provides many different features that can be of enormous value in meeting information systems needs.

Strengths of SAS Software
in the opinion of the authors, the greatest strength of SAS is its multitude of tools available in a single, integrated package. Very few software packages contain the breadth of functionality that SAS provides. In particular, there are several notable features of SAS that can be considered its greatest strengths.

When people reflect on SAS software, they think primarily of its non-linear modelling (NUN) procedure, linear regression (REG) procedure, and categorical data modelling (CATMOD) procedure, which are probably the most notable and powerful statistical tools in the SAS toolkit.

Another great strength of SAS software lies in its interactive products, namely, SAS/FSP® and SAS/AF. PROC FSEDIT is the feature product of SAS/FSP software and remains the best and easiest-to-use full screen data editor in existence today. SAS/AF is another very powerful product which allows the rapid development of structured menus which provide users with the power of SAS with little or no knowledge of SAS programming. Screen Control Language allows complete manipulations of screen displays in both FSEDIT and SAS/AF and provides great flexibility to application developers.

With the advent of version 6.06, SAS now provides a virtually identical and equally powerful product over the family of hardware/software platforms that SAS now supports. Also with the arrival of SAS/CONNECT users should be able to access data across these different platforms in a virtually transparent fashion. Another new feature of version 6 SAS software is the ASSIST facility that guides novice users through a series of menu interactions allowing for the construction of powerful programs. SAS/GRAPH can be used to produce camera-ready graphics output, although it is generally somewhat difficult to do.

Weaknesses of SAS Software

While the statistical procedures available in SAS software provide quite a powerful toolkit, effective and accurate usage of these procedures require some degree of statistical knowledge. There is virtually no "guidance" on the proper usage of any statistical procedure as it relates to a particular set of data. While this is generally not a problem for statisticians, it does create a problem for the casual user and may result in total erroneous analysis. Also, it is at best, difficult to access particular values generated as part of the statistical report if those values are not included in an OUTPUT dataset.

Graphics software is an essential component of any complete software package and SAS/GRAPH is certainly an important and powerful SAS product. However, compared to other graphics packages, for example TEL-A-GRAP, SAS/GRAPH does not rate very high. While SAS/GRAPH can produce all the standard graphics such as pie charts, histograms, x-y plots, and text charts, the default graphics are generally not of camera-ready quality. In addition, it takes more than a minimal amount of programming to bring the graphics up to a high level of quality. Also, since SAS/GRAPH is basically batch-oriented, it may take several time consuming interactions to get the titles, footnotes and legend lined up acceptably.

Application Section

Introduction

For purposes of comparison, a fairly typical information system project was selected from the pharmaceutical research arena, and is described as follows. It was desired to use compartmental modelling techniques to examine the kinetics of lipoproteins and the components of lipoproteins such as apoA-I. The initial values for the parameters to be estimated in an iterative algorithm should be calculated from the data using a numerical integration technique. Then non-linear estimation methods should compute the best fit to the data using the following equation.

\[ y = A + e^{a \times x} + B \times e^{b \times x} + C \times e^{c \times x} \]

Furthermore, this system should allow the graphical comparison of three models to the same set of data with a statistical test comparing their similarity.

The RS/1 Solution

The RPL programming language is flexible allowing the user to tailor RS/1 so that the user can automate processes to meet the needs as detailed above. This RS/1 solution was developed several years ago providing an excellent framework for generating adaptable and easy to use systems. Productivity was increased because systems were built quickly and efficiently. A newer version of RS/1 will aid the developer/user even more by providing a debugger, portability across different platforms, DBMS interfaces, access to all RS/1 functions, and an easy to use language.

Starting of the information system is by a REXX exec that invokes the RS/1 program with a group home of EXAMPLE (see Figure 1). The user is presented a ** prompt. He/she types CALL #FITTING to activate the application software. Figure 2 illustrates what the user would see in the first menu. The user must pick one of the types. The user then enters the dose, title of the graph, and the file name of where the data is to be stored (see Figure 3). If the user enters an existing table, he/she has the opportunity to edit previously entered data (see Figure 4) or enter new data.

```
/* REXX Exec */
"EXEC RS3TEST (GROUP=EXAMPLE VADDR=193

Figure 1

Figure 2

Choose one
1. Fit Multiple Compartment Open Model
2. Fit 2 Compartment Closed Model

1050
```
The data entry step allows the user to create a new table or modify an existing one. The user can select from the directory a list of previously created tables. Using RS/1's watch table function, the user can custom design a full screen entry window. One advantage of using the Watch Table Function is that error checking on the data can be performed via RPL program statements.

The data analysis step grants the option to accomplish a multi-compartmental nonlinear estimation model (see Figure 5). The user can provide initial estimates or let the RPL procedure use an iterative algorithm to calculate the initial parameters using the experimental data and a numerical integration technique. The initial values (see Figure 6) are passed on to the procedure Table Fit Function which provides analysis and printed and graphic output (see Figures 7 and 8). Since all the results are stored in 2x2 tables, it is a simple process to make graphs.

Enter a number to pick type of model (2): 3
Do you want to supply initial values? (No)
When this application was written, the number of graphics output devices were limited. Therefore, they could be directed to an IBM 3179G terminal, ZETA plotter, or a special TEL-A-GRAF file which gives the user flexibility (see Figure 9).

The SAS Solution

A person can very easily design an integrated information system (IS) to meet the systems needs as detailed above. Version 6 SAS/AF software provides an excellent framework which can be used to facilitate fast, friendly, and flexible interaction with the user while allowing full access to components of the system.

Initiation of the information system is by a REXX exec that invokes a SAS program via the AUTOEXEC option (see Figures 10 and 11). The SAS program starts a SAS/AF software application that provides full-screen, interactive menus to facilitate user interaction. Figure 12 illustrates what the user would see in the initial menu. The user must select the type of compartmental model desired, either OPEN or CLOSED. Using the SEL GROUP option in the ATTR screen of SAS/AF software allows one to “turn on” only one type. Should the user forget the acceptable doses, a “?” in the dose field obtains a static list of doses from the DOSES.LIST file (Figure 13). If one desired a dynamic list of doses (that is, a list of doses that changes depending on entered data) one can build a SAS dataset containing a list of unique doses and then use the DATAUSTC Sel function to open a SELECT window. This flexibility allows the user to minimize the amount of typing by “pointing and clicking” and this also tends to minimize entry errors.

/* REXX Exec */
SASLINK 6.06
"SAS (AUTOEXEC= 'EXAMPLE SAS'
EXIT

Figure 10

* EXAMPLE SAS AUTOEXEC PROGRAM;
LIBNAME RSI 'N';
DM 'AF C=RS1.SUGI.MAIN1.PROGRAM' AF;
DM 'BYR';

Figure 11

After defining the type of compartmental modelling to be done a BLOCK-style menu is displayed to the user which allows the selection of any item. This style menu is one of several styles of menus that version 6 SAS/AF software provides and is produced automatically by the SCL BLOCK function. One has a choice of 31 different color and shadowing combinations for the block menus. Help files are easily included in menus and are truly a blessing to users of any system. One can develop the IS so that help is available at many levels including the field entry level. Figure 14 indicates the functions accessible from this menu. The user has the opportunity to plot or analyze previously entered data or change/enter new data. This allows the user to bypass unneeded steps, thus saving time.

Figure 12

Please Select the Type of Compartmental Model Desired
CLOSED
OPEN

Please Select the Dose of Drug involved
(Enter a “?” to get a list of doses)

Figure 13

Select Data
Command =>
Make one selection.
1.0 mg/kg
10 mg/kg
90 mg/kg

The Data Entry step allows the user to create a new dataset or modify an existing one. The user can select from a list of previously created datasets in the manner that the dose was
selected (see above), thus minimizing keying errors. In this example, PROC FSVIEW is used in EDIT mode which allows the user to view, edit, and/or change data for multiple observations on the same screen. Alternatively, one could use the FSEDIT procedure to edit/change one observation/screen in a custom designed full screen entry window. One of the advantages of using FSEDIT is that one can perform interactive error checks on the data via FSEDIT options or SCL program statements.

The Analyze Data step provides the option to perform a 1, 2, or 3 compartment nonlinear analysis (Figure 15). The user can supply initial estimates or let the program use multiple regression to determine starting values (Figure 16). The starting values are fed into a PROC NUN step which can provide analysis and output equivalent to that of RS/1. One can also compare the models and develop F-tests to determine the best model. The prediction results for the different models can be stored and accessed via the PLOT step.

In the PLOT step (Figure 17) one can select from a variety of output devices. One can define a SELECT group for PC or 3179G so that only 1 or the other is selected. The user can also select LASER to produce laser graphics. All selections are automatically highlighted. The name of the dataset can be automatically filled by using the most recently entered dataset or can be selected by filling in a 'Y' in the entry field. The user might desire to plot one or more models on the same graph. This is provided in an interactive fashion via the "Y" entry. In this case, more than one selection is allowed by an option in the ATTR entry of the SAS/AF program. In this example, a title can be entered which can be displayed along with the graph as in Figure 18. In addition, one could design a SAS/AF program screen to include any number of options or headings, thereby, enhancing graph appearance. This points out a significant advantage over the one-question-at-a-time method of governing user interaction: one can select options as one desires in a full screen environment without paying a penalty in time while navigating additional screens or answering questions.

Comparison

The overall design considerations of using RS/1 or SAS are essentially the same. In typical pharmaceutical research information systems one needs a data entry module, a statistical analysis module, and a report/graphics module. One main difference between RS/1 and SAS is in how one can tie the various components together. With SAS software one can link the components via fully interactive and integrated menus; with RS/1 one needs to use a more linear, question-and-answer approach to guide user interaction. Both got the job done.

It is the feeling of both authors that the development time for both products is roughly the same depending, of course, on the intricacies of the system requirements. For example, if a system requires a nonparametric analysis and if the data is non-normal or has heterogeneous variances, a SAS approach would take much longer to develop than when RS/1 is used.

The overall appearance of finished information systems is important to both the user and developer. It is important to the user because he/she has to work with the product whenever it is used. It is important to the developer, because if the application looks professional and colorful, the user tends to be impressed and more satisfied. In addition, judicious use of colors can aid in reducing errors while entering data and successful interaction with the system. SAS has obvious advantages in this respect.
Conclusion

In this paper, we have attempted to provide an overview of how SAS software and RS/1 might be useful in meeting information needs. In addition, we have constructed a table (Table 1) indicating the authors' opinions on how RS/1 and SAS software compare on an item-by-item basis.
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<thead>
<tr>
<th>Item</th>
<th>SAS better</th>
<th>Equivalent</th>
<th>RS/1 better</th>
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<tbody>
<tr>
<td>Statistical Expert System</td>
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<tr>
<td>Most Complete Set of Pre-defined Statistical Procedures</td>
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<td>Software Access to Statistical Output</td>
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<tr>
<td>Experimental Design Software</td>
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<tr>
<td>2-D &amp; 3-D Plotting Camera-ready</td>
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<tr>
<td>Ability to Interactively Edit Graphs</td>
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<tr>
<td>Most Complete set of Pre-defined Graphic Types</td>
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<tr>
<td>Graphics Device Support</td>
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<tr>
<td>Ease of Computer Programming</td>
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<td>Availability of Programmed (Vector and Matrix) Functions</td>
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<tr>
<td>Ease of General Use by Novice</td>
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<tr>
<td>Ease of Graphical Programming</td>
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<td>Level of Vendor Support</td>
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<td>Availability of Menu Generation Capabilities</td>
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<td>Availability of Database Interfaces</td>
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<td>Menu Generation Capabilities Ease of Use</td>
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