

A Comparison of RS/1® and SAS® Software In Meeting Information Systems Development Needs

Mic S. Lajiness, The Upjohn Company

Introduction

RS/1 and SAS software are two of the most widely distributed multi-functional packages in use today for developing information systems. The goal in this publication is to provide some information about RS/1 and SAS software in an attempt to show some of the similarities and differences between RS/1 and SAS. Unfortunately, a detailed analysis of how RS/1 and SAS software can meet information systems needs would take many pages and would be way 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 limited 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

RS/1 software is advertised as a complete data management, statistical, decision support, and data analysis tool specifically devised for scientific, engineering, and manufacturing use. It is designed to streamline 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. RPL is analogous to SAS code.

RS/1 software is a fairly 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 lies in its management of collected data, curve fitting, modelling, statistical analysis, graphics, and report generation procedures. The number of statistical procedures is fairly limited but the existing ones are somewhat 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 also allow users to interactively access data to the

table cell level. In effect all output from any RS/1 procedure is easily accessible. 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 limited number of plotters. A very powerful feature of RS/1 is its interactive 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.

RS/Explore® software is a system that allows for graphical data investigation and statistical inquiry. It furnishes an extensive menu system that enables scientists to look at and analyze data relationships to gain insight into the underlying process. It provides a level of expert 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 relationships and automatically review them graphically to gain an understanding of complex data relationships.

RS/Discover® software is a problem-solving tool that enables scientists, engineers, and manufacturers to optimize their process by taking advantage of experimental design techniques. It renders a complete, menu-based environment for setting up and subsequently 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.

Also available in the RS/1 line of products is quality control software, RS/QCA™, an expert-system tool kit, RS/DECISION™, time series analysis software, BBN/Probe™, and clinical trial analysis software, BBN/CLINTRIAL®.

Strengths of RS/1

RS/1 is a full functioned multipurpose software package that provides a good tool for the analyst for development of information systems.

The use of tables to store output from procedures allows access to all calculated parameters. Another strength of RS/1 lies in its graphics editor which allows users to change and annotate the graph interactively.

RS/Explore gives the user expert advice as to the type of statistical test to be run for certain types of analyses. For example, in a completely randomized design scenario an analysis of the main effects might be requested. RS/1 would automatically choose a nonparametric test if the normality assumption or homogeneity of variance assumption is violated. 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.

RS/1 also produces an analysis log that can include graphics output. This log is essentially a report on the statistical analysis and includes appropriate interpretations based on the analysis and is written in standard english.

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

The RS/1 table editor is not a full screen editor. Data is addressed by moving the cursor cell by cell or with a jump command.

While RS/1 can produce the standard graphics such as pie charts, histograms, x-y plots, and text charts, other graphics are left out. Most notably RS/1 excludes cartographic plotting and 3-D graphs. Also, the number of supported devices is rather limited compared to SAS for example. In addition, the graphics are not camera-ready quality.

Another flaw is the lack of a full complement of statistical procedures. RS/1 does not provide procedures to support categorical analysis, discriminant analysis, cluster analysis, and survival analysis to name a few.

Although billed as having a "user friendly" interface interactive use is anything but easy. One must remember relatively complicated syntax to do anything but the most basic functions.

The organization of data in tables may be convenient in many instances, however, it makes the development of comprehensive databases cumbersome since one has to manage multiple tables, keeping track of the individual table names.

It is also the authors experience that it generally takes a longer amount of time to develop and debug applications using RS/1.

Also it has been the author's experience that vendor support for RS/1, particularly in the VM/CMS environment, has been poor. There is a lack of locally available training classes and support groups.

SAS 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 RS1 a number of features will be mentioned and described in some detail.

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 PROCs 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 applications lies in its collection of statistical and "other" procedures. These procedures provide a wide variety of automatic calculations which produce reasonable looking reports. 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, FSEDIT and FSVIEW. These procedures allow users to interactively access their data. With the use of SAS/SHARE® software (version 6.07) , 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 also has 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/CPE®, SAS/DM®, SAS/ETS®, SAS/IML®, SAS/OR®, and SAS/QC®. Also, near to completion is SAS/PH-Clinical™, pharmaceutical/clinical trial software.

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

Strengths of SAS Software

The greatest strength of SAS is its multitude of tools available in a single, integrated package. In particular, there are several notable features of SAS that can be considered its most important assets.

When people think of SAS software, they think primarily of statistical software and SAS software does contain one of, if not the best collection of multi-functional statistical software in a single package. This collection includes a general linear modelling (GLM) procedure, non-linear modelling (NLIN) procedure, linear regression (REG) procedure, categorical data modelling (CATMOD) procedure, cluster analysis procedures (CLUSTER, FASTCLUS), and discriminant analysis procedure (DISCRIM).

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 are 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.

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 totally erroneous analyses. 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-GRAF, 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 "tweaking" 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 small 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. Data was to be input from the terminal and fit to an open or closed 1, 2 or 3 compartment model based on the following equation.

$$y = A * e^{-a * x} + B * e^{-b * x} + C * e^{-c * x}$$

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

The RS/1 Solution

RS/1 software was used to develop a simple interactive interface. This development occurred in the mid 80's and is presented here unchanged.

The user invokes the application in a VM/CMS environment by entering the name of a REXX exec (see figure 1) which then invokes RS/1 and specifies the group home (example) and the virtual address (193). The user is then presented with a "*" prompt which signifies that the user is in the RS/1 environment. The user enters CALL #FITTING to initiate the application software. Figures 2 and 3 present displays that the user must respond to. It should be emphasized that these are not true full screen menus but are essentially line prompts.

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

Figure 1

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

Figure 2

```
Enter dose:
Enter title of the graph:
Enter file name (use !directory for
existing filenames):
```

Figure 3

Figure 4 illustrates the data entry method whereby the user enters data one cell at a time in a "spread sheet" manner. 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

Enter the y and time values	
Time	y
0.167	975000
1.0	861000
3.0	816000
6	715000
12	618000
24	475000
36	368000
48	283000
72	195000
96	146000
120	104000
144	85400
168	67700
192	53900
216	42700
240	35500

Figure 4

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)
```

Figure 5

ESTIMATED STARTING VALUES

```
A = 5.48e+5
a = 4.2e-1
B = 5.42e+5
b = 3.5e-1
C = 2.8e+5
c = 1.5e-1
```

Figure 6

```
ANOVA
PARAM SS      DF      MS      F      P
REGR 3.7e+12   6.00   6.3e+11  8588  1.3e-22
RESI 9.5e+8    13.0   7.3e+7
ANOVA FOR 3 COMPARTMENT MODEL
FIT CONVERGED? TRUE
MODELS 3 vs 2 WITH DF 2,13, p= 0.000004
```

Figure 7

Parameter Table				
Name	Final Value	Std Err	T	P
A	1.5e+5	2.0e+4	7.8	0.0001
a	2.12	7.2e-1	3.0	0.01
B	5.4e+5	4.6e+4	11.6	0.0001
b	3.9e-3	4.1e-3	9.8	0.0001
C	3.3e+5	5.0e+4	6.5	0.0001
c	9.4e-3	9.8e-4	9.6	0.0001

AUC = 4.8e+7

Figure 8

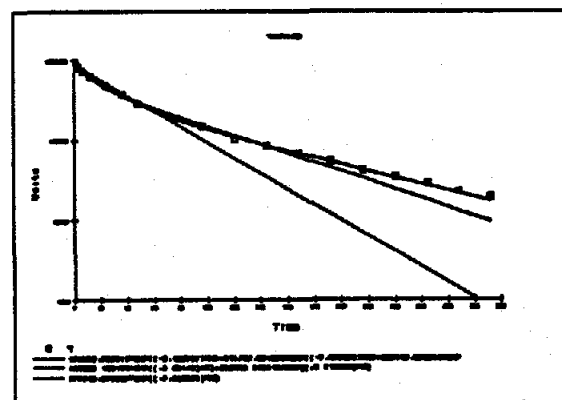


Figure 9

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 in this example 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 DATALISTC SCL 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.

```
/* Rxxx Exeo */
SASLINK 6.06
"SAS (AUTOEXEC='EXAMPLE SAS'"
EXIT
```

Figure 10

```
* EXAMPLE SAS AUTOEXEC PROGRAM:
LIBNAME RS1 'N';
DM 'AF C=RS1.SUGLMAIN1.PROGRAM' AF;
DM 'BYE';
```

Figure 11

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 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)

Select Data
Command ==>

Make one selection.

1.0 mg/kg
10 mg/kg
30 mg/kg

Figure 13

After defining the type of compartmental modelling to be done a BLOCK-style menu is displayed to the user (see figure 14) 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.

Primary Menu

Help Info

Enter XY Pairs

Analyze Data

Obtain Plots

Exit

Figure 14

```

      Analysis Menu
    +-----+
    | Help Info |
    +-----+
    | 1 Compartment |
    | 2 Compartment |
    | 3 Compartment |
    | Return       |
    +-----+

    Place Cursor on your selection and press "enter"
  
```

Figure 15

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 NLIN 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. The output from the statistical analyses are analogous to the RS/1-produced output.

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 in by using the most recently entered dataset or can be selected by filling in a "?" 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 "?" entry. In this case, more than one selection is allowed by setting 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.

```

Command ==>

Please Enter the Initial Values
for the parameters below other-
wise they will be estimated by
multiple regression techniques.

Model: SA = A * Exp (- alpha * time)

Initial Value
A= _____
Alpha= _____

Press FFS to continue
  
```

Figure 16

```

Command ==>

Please Select Output Desired

3179G
PC
LASER

Please Enter the Name of the dataset: _____

Which Models are to be plotted: _____

Title: _____

X-Axis label: _____

Y-Axis label: _____

Press FFS to continue
  
```

Figure 17

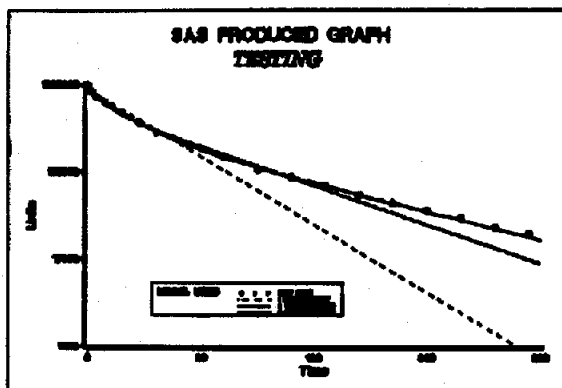


Figure 18

one is fortunate enough to have both on site.

It was probably no surprise that SAS, for example, is coming out with SAS/LAB a product that is similar to the RS/EXPLORE package, and that a SAS graphics editor is near to release. Competition between software vendors quite often results in better software that more closely matches users' needs.

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Comparison & Conclusion

In terms of functionality both RS/1 and SAS can be used to get the job done. Both packages have a reasonable collection of tools that allow for the development of fully functional information systems.

RS/1 advantages include existence of a statistical expert-like system for some analyses, experimental design and analysis software, easy access to all statistical analysis parameters, an ability to interactively edit graphs, and easier to use graphics programs.

SAS advantages include having the most complete set of statistical procedures, existence of the multiple engine architecture, ability to produce camera-ready plots, more powerful graphics functions, support of more graphics devices, more easily usable by novice users, existence of an excellent full screen data entry and menuing system, support of more vendor databases, and the ability to run on more hardware platforms.

It is the author's opinion that without a doubt SAS offers the best comprehensive collection of tools in a single package. This translates into being able to develop better looking and more powerful information systems in a shorter period of time. The adage "SAS saves time" does in fact appear to be true with respect to RS/1.

In addition it is the author's opinion that SAS is much more strongly supported across the many platforms it supports than is RS/1. There are more training classes available from SAS at more sites across the country than are available on RS/1.

While there is no straightforward data connection between RS/1 and SAS one can envision passing "flat" files from one to the other to make maximum use of the features of both packages if