OVERVIEW OF THE PROJECT

Maine Medical Center (MMC) is an approximately 600 bed hospital located in Portland, ME. "Maine Medical Center Data and Information" (the databook) is published quarterly by the MMC Planning Department. Publication of the databook is a labor intensive, time consuming process. It is the Planning Department's intention to eventually automate the production of the entire databook.

Semi-annually, a portion of the databook is dedicated to an analysis of MMC's share of market among statewide hospital discharges. When determining market share by geographical region, newborns were excluded from the discharge numbers. As a pilot project, the User Services Group within the DMS Data Management Department was charged with automating the process by which this market share section is prepared.

The system (which came to be known as MSHAP, for Market Share / Hospital Analysis Program), as it finally evolved, makes extensive use of the SAS® System's macro processing capabilities. All data processing is encapsulated in macros. SAS/Macro is used as a front end to control program flow and to obtain key values from the user. These values are stored in the global symbol table, from which they can be expanded as macro variables by macros submitted to the SAS® system. The final step in most of these macros is a SAS/GRAPH® PROC (GANNO, GCHART or GREPLAY). Output from the SAS/GRAPH® PROCs is stored in SAS® catalogs of graphs, from where they can be viewed, printed or combined into databook pages.

This is how we built the system ...

LIFECYCLE APPROACH

The User Services Group employs the lifecycle approach to software development. Thus, our first step was to analyze the task to be automated and create a specification for the system to be developed.

ANALYSIS

DESIRED OUTPUT

The market share section of the data book is divided into four components:

REGIONAL MARKET SHARE CHARTS

These are pie charts which graphically depict MMC and other Maine hospitals' market share in each of four referral areas, plus among State of Maine and Out of State Residents.

Hospitals whose market share is above a cutoff percentage are represented by a slice in the pie. Any hospital whose share of the market in the requested referral area is below that cutoff will be aggregated with other such hospitals into an OTHER category.

REGIONAL MARKET SHARE TABLES

These are printed tables which show MMC and other Maine hospitals' market share in each of four referral areas, plus State of Maine and Out of State Residents, over a period of years. Order in the table is determined by the present year's market share.

A separate percentage cutoff from that used to generate a chart for the same referral area may be used.

MDC MARKET SHARE / PERCENT CHANGE CHARTS

These are bar charts which graphically depict MMC's market share in each of twenty three Major Diagnostic Categories (MDCs); among all discharges; and among those discharges not otherwise groupable.

There are two types of charts on these pages - both of which contrast the market share held by MMC and six other selected hospitals in the present (base) year and a comparison year.

A MARKET SHARE chart contains a single bar for each of the seven hospitals, clustered by year, representing the percentage of statewide discharges within that MDC from that hospital.

A PERCENT CHANGE chart contains a single bar for each of the seven hospitals, representing the percentage change in absolute number of discharges for the hospital.
within that MDC from the comparison year to the base year. There is an eighth bar representing the percentage change in absolute number of discharges for all other hospitals.

Figures 1, 2, 3 and 4 show these components as they appeared when manually prepared.

HOW THINGS WERE DONE IN THE PAST

The charts were generated on a minicomputer from data manually keyed from a report supplied by the Maine Health Care Finance Commission (MHCFC), a state agency. They were plotted on a pen plotter, and labels were then added with a typewriter. The tables were manually compiled from MHCFC reports and manually typed.

FURTHER REQUIREMENTS

The guidelines of the project were as follows:

The system should run on personal computers.

The system should be menu driven. The user should be able to generate the desired output without the need to write, or even understand, any SAS® statements. Furthermore, the system should be compatible with MMC's standard user interface conventions.

The system should use data supplied in electronic form by the MHCFC as input. This data might be in the form of a SAS® dataset or a flat file, on disk or on tape.

The system should generate the required charts and tables with all labels and page numbers attached.

The system should allow viewing of the charts on screen and printing of the charts to a laser printer.

DESIGN DECISIONS

Successive iterations of top-down analysis identified the following processes involved in the creation of the databook:

Data Extraction and Summarization
MDC Data
Regional Data
Generation of Charts
MDC Charts
Market Share Charts
Percent Change Charts
Regional Charts

Viewing / Printing of Charts
MDC Charts
MDC Databook Pages
Regional Charts
Regional Databook Pages
Generation of Tables

This is the general structure to which our application conformed (see MSHAP Data Flow - Figure 3). We chose to encapsulate each of these processes into macros, to be called from a user interface.

The user interface was meant to isolate the user from the SAS® System, and vice-versa. The interface would allow the user to specify the action to be taken, and would accept values from the user that were needed for the execution of the desired action. A schematic of these relationships can be seen in Figure 6.

Through this technique of top-down design, we were able to develop and test the macros and the interface independent of each other.

THE USER INTERFACE

Since the MSHAP system was designed to rely heavily on macros, we at first attempted a macro window solution to the problem of a user interface, but soon found that there seems to be some memory management problems with the PC implementation of macro windows. We were therefore left with SAS/AF® and SCL as a front end engine.

Maine Medical Center is trying to standardize its applications to use a few standard keys for similar functions across applications. For this reason, we wanted to use only the <F10> key to initiate processing. This includes menu selections. Since SAS/AF® uses the <ENTER> key for menu selection and action initiation, we chose to write our own menu screens as PROGRAMS rather than as MENUS. The resulting system consists of 26 SCL PROGRAMS. The astute reader will realize that this prevents us from performing menu linking, but we felt that this was a justifiable trade off for consistency. We chose to reveal a few lines of the log window below the menu screens as an indication to the user that the SAS® system was indeed doing something.

Those PROGRAMS which do not lead to a further menu screen are meant to submit our macros to the SAS® system. This poses a problem in that:

1) we used a SUBMIT IMMEDIATE statement to submit the macro, which halts execution within the label that the statement is located in...
and

B) since we were using the END command, assigned to <Fl0>, to initiate execution, it was located in the TERM label.

This meant that we could not stay in the module after the macro was submitted to the SAS® system!

We skirted this problem by making the program its own parent, and returning to the higher menu level with a GOTO COMMAND when the CANCEL key was pressed. We would have liked to have assigned CANCEL to the <ESC> key, but could find no way to make such an assignment. We ended up using <Fl0>, which at least matches a number of mainframe applications. Status or Error messages to be displayed were passed back to the program's INIT label by means of a SYMPUT to the global SYSOUT table. SYMPUTs were also used to supply user input to the macros.

We made extensive use of SAS/AF's ability to attach help screens to not only fields, but screens also. The help screens were written in such a way that a collection of all screens could also serve as user documentation. A Main Menu item was added as an afterthought to allow the user access to all help screens from one place. The Main Menu screen from the MSHAP system can be seen in Figure 7.

THE MACRO

DATA EXTRACTION AND SUMMARIZATION

The MHCFC initially supplied Maine Medical Center with a 15 Megabyte file of state-wide information on the 162,000+ hospital visits for calendar year 1986. This was to be our test database during development of the system. After verifying the received data, by comparing tabular results with MHCFC supplied reports, system data needs were determined.

The data was loaded to a 15 Megabyte SAS® dataset and an intermediate SAS® dataset consisting of three variables was created: HospID and MDC Number values were taken from the file, Discharge was given a value of 1 for all observations since each record represented a single discharge. PROC SUMMARY was then used to create a summary SAS® dataset of discharges across hospital and MDC. This summary SAS® dataset would serve as input for the MDC Market Share Charts portion of the system.

Geographic origin information necessary for generation of the regional share data was not present in the data supplied by the MHCFC. A second data file was obtained, which did contain this data. A PROC SUMMARY was used to create a SAS® dataset summarizing discharges across hospital and geographic area. In the future, all data will be delivered in the same file, but two types of summary SAS® dataset will continue to be generated.

The summary SAS® datasets take approximately 8K for the MDC data and 17K for the Regional data, quite an improvement over 15M! Furthermore, the processing common to each step in the database generation process was done, reducing processing time for each chart and/or table considerably. The summary process took approximately one hour for each summary SAS® dataset.

The code used to create these summary SAS® datasets was converted to two macros, MDCSUM and REGSUM, with macro variables used to define the year to be extracted and whether this was mid-year or year end data. It is anticipated that there will ultimately be ten years of extract data retained. At the current time, the exact format of the final data which will be received from the MHCFC is unclear so some adjustment of the code may be necessary.

CHART GENERATION

The next step in the development process was to further analyze the manual process used to create the charts. Once an algorithm for this process was developed, we thought that coding with appropriate SAS/GRAPH® PROCs would be a relatively easy task.

As a first test, we developed the algorithm for generating MDC charts. Implementation of this algorithm was straightforward, though nearly every option available for the GCHART VBAR statement was needed to match the output dictated by the databook.

At first glance, generation of the pie charts seemed to be as straightforward, using the GCHART PIE statement. Three problems soon became apparent, however:

First, PROC GCHART places the OTHER slice last. Past practice within the Planning Department had been to place OTHER in order of the percentage represented.

Second, there was the possibility that MMC's market share for a particular region would be below the cutoff for OTHER. As this was MMC's databook, MMC's slice of the pie should always be separate, no matter how small its share of the market.

175
Third, and perhaps most deadly, was the fact that, at the edges of the pie, PROC GCHART tends to lose labels.

Our answer was to develop a generalized routine for generating an ANNOTATE dataset for use with PROC GANNO which simulates the action of GCHART PJE. The pie is designed to occupy the center third of the graphic window. The left and right thirds are divided into 50 equal portions. The label for a pie slice is placed in that portion of the window which corresponds to the percentage of the pie represented by the midpoint of the pie slice. A three segment line connects the label to the midpoint of its associated slice.

VIEWING AND PRINTING CHARTS

The output from the chart generating macros described above was stored in SAS° catalogs of graphs. Viewing or printing of the charts was simply a matter of retrieving the proper chart. Databook pages took a little more work, however, as the charts had to be reduced in size and a page number had to be added. In addition, MDC Databook pages required two charts to appear on the same page. This was achieved by creating templates for the databook pages, and combining the elements through PROC GREPLAY.

TABLE GENERATION

It also seemed at first glance that table generation would be an easy matter with PROC TABULATE. Further analysis revealed, however, that the process was a little more involved as the ranking of hospitals often changed from year to year, and the ordering of the table should be determined by the hospitals' standing in the most recent year. To perform this action was actually a very complex process, involving a number of PROC SUMMARY steps to create intermediate SAS° datasets which were combined in various ways to create the final output.

TYING IT ALL TOGETHER

We created a MSHAP subdirectory in the Planning Department's area on the network, and placed PLANSYS, PLANDATA and PLANGRAF subdirectories under it. Autexec.sas and config.sas files specific to this application were placed in the MSHAP directory. PLANSYS holds the SAS° catalog containing the SAS/AFO entries for the MSHAP system, along with the files containing the SAS° macro and ancillary SAS° datasets. Extracted SAS° datasets are kept in PLANDATA. The SAS° catalogs of graphs generated by MSHAP, as well as DATABASE.SCT, which contains the databook page templates, are kept in PLANGRAF. A batch file in Planning's root area, appropriately named MSHAP.BAT, starts the SAS° System. The autexec.sas file defines LIBNAMEs for the other directories. The last line of the autexec.sas file initiates the SAS/AFO window and starts the entry that begins the application.

OUR THOUGHTS ON THE WHOLE THING

User response to the system has been extremely favorable. A task which used to take months can now be accomplished in a matter of days. The results of our efforts can be seen in Figures 8, 9, 10 and 11.

With only a few exceptions, we found the SAS° system very easy to work with. One problem was that of memory constraints. Not only could we not get macro windows to work, but we were forced to break the MSHAP application into two parts, MSHAP and MSPRINT, because all the macros and the SAS° system could not be loaded at the same time. We've already mentioned that we would like to have been able to assign CANCEL to the <ESC> key. And our work around for initiating action with KND assigned to the <F10> key has the unpleasant side effect of "sticking" the first time the <TAB> key is pressed on a screen.

These things aside, however, the SAS° system allowed us to develop a data analysis / graphics generating application in record time. Maintenance is greatly facilitated by the macro encapsulation of the data processing. The Planning department is now considering the development of an adhoc report writer for pulling more information from the data files supplied by the MHCFC. Our tentative name? AHA! (Ad Hoc Analysis)

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Figure 6

Figure 7

Figure 8

Figure 9

Figure 10

Figure 11

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