The project management procedures in the SAS/OR* modules provide the capability to plan and manage projects of varying complexity and size. With the addition of the SAS/AF* product, this capability can be simplified for the user through the creation of a menu-driven project management application. This paper will describe one user's experience with this kind of application.

BUSINESS BACKGROUND

Basin Electric Power Cooperative is a member-owned electrical power generation and transmission supplier. It serves an area of more than 400,000 square miles in portions of Colorado, Iowa, Minnesota, Montana, Nebraska, North Dakota, South Dakota and Wyoming. The Cooperative provides wholesale electricity for 120 rural electric systems which serve about 1.2 million consumers. Basin Electric owns and operates electrical generating plants in Stanton, ND; Beulah, ND; Velva, ND; Vermillion, SD and manages and partially owns a plant in Wheatland, WY. Each plant has one or more electric generating units. The maximum capacity of the units range from 50 to 550 megawatts (MW). The cooperative manages a total generation capacity of 3365 megawatts of which it owns 2428 megawatts. All the North Dakota plants use lignite coal for generation. The Wyoming plant uses sub-bituminous coal. The South Dakota plant is a peaking station used only when the demand requires additional generation. This peaking plant is powered with fuel oil.

Basin Electric schedules a major outage for each generating unit every two years. A major outage involves shutting down a unit, disassembling major components and checking for wear and required repairs. Periodic maintenance is performed on the entire generating unit before it is brought back into production. In addition, any required maintenance or repairs identified during the previous operating period are completed. These repairs were postponed until a major outage since their completion required that the unit be shut down and they were not critical to safe or efficient operations. An outage is scheduled years in advance and planned months in advance. It is scheduled for a specific period and must be completed as expeditiously as possible. Depending on the generating unit and the electric load factor, each day a unit is non-operational constitutes a revenue loss of between $43,000 and $639,000 for Basin Electric.

In October 1986, as part of a conversion of its data processing systems to IBM, version 5.08 of SAS was installed. In July 1987, the system was upgraded to version 5.16. The cooperative has basic SAS*, SAS/FSP*, SAS/AF*, SAS/OR* and SAS/GRAPH*. Two people are responsible for supporting the SAS* software; one full-time and one part-time.

OVERVIEW OF SAS/OR* PROJECT MANAGEMENT PROTOTYPE

Included in the installation of SAS* was a menu-driven SAS/OR* prototype that SAS Institute developed. This prototype provides SAS/AF* menus and programs for each SAS/OR* procedure, including project management. The SAS/OR* project management prototype provides the ability to schedule multiple-activity projects within a specified period of time. With SAS/AF* menus and fill-in screens the planner identifies the name of each activity, its unique identifier, the duration of the activity in days and the total amount of resource information. The planner may identify the kind and amount of resources required for each activity and the total amount of resources available. SAS* will use these dates as constraints in developing the project schedule. An additional option provided by the SAS/OR* project management prototype is the use of resource information. The planner may identify the kind and amount of resources required for each activity and the total amount of resources available. SAS* will use these constraints in scheduling the project. The system will schedule a five-day work week project (Monday thru Friday) or a seven-day work week. Holidays can also be identified and incorporated into the schedule.

PLANNING THE OUTAGE

In January 1987, the SAS/OR* project management prototype provided by SAS Institute was shown to the plant maintenance schedulers at the Antelope Valley Station in Beulah, North Dakota. This facility was scheduled to conduct a major outage in April and had not previously used an automated project management system. The plant personnel were asked to view functions of the system to see if it would be beneficial in scheduling their April outage. They were also asked to point out changes to the prototype that they would need to use it. Through discussion
it was decided that only simple and easily-coded modifications would be made to the prototype for the April outage. The time available before the start of the outage planning was limited and the SAS* support personnel were still learning the product. These two factors made it infeasible to do a major rewrite of the prototype in time for its use. In addition, the plant personnel agreed that they would be in a better position to identify major enhancements to the prototype after using it for a complete outage. Consequently, all changes were constrained by the ability of the SAS* support personnel to make them quickly. After the outage, an application would be developed that was specifically designed for the project management of a plant outage.

During the demonstration of the SAS/OR* project management prototype, the plant personnel pointed out the following changes that would enhance the prototype to reflect procedures used in the plant.

- The duration and schedule of each activity should be shown in hours instead of days.
- The menu-driven calendar and the GANTT chart should reflect the resource constrained schedule instead of the early start schedule.
- The application should schedule a six-day work week (Monday thru Saturday) instead of a five-day or seven-day work week.
- The system should be able to produce hard copy schedules and GANTT charts. This was a unique problem for Basin Electric. SAS* is loaded on TSO under MVS but all printers are controlled by RSCS under VM.

INITIAL MODIFICATIONS

To change the schedule to reflect activity duration in hours instead of days required several changes to the prototype. Because the ability to input actual hours on the screen would have required additional programming to convert the hours to fractions of workdays, the plant personnel agreed to input the duration as a fraction of the eight-hour work day. Thus an activity that required four hours to complete was input as .5 workdays. SAS/OR* automatically converted the fraction of a workday to the appropriate hours using a twenty-four hour workday. The prototype was changed to convert the fraction using an eight-hour workday beginning at 7:30 a.m.

The calendar and GANTT chart were changed to reflect the resource-constrained schedule by changing the variables that were used. Resource-constrained variables were used instead of early-start variables. At the same time, the project schedule report was changed to show only the resource-constrained schedule and the early-start, late-start, early-finish and late-finish schedules were dropped from the report. The order of activities on the project schedule report was changed by sorting on the resource-constrained start variable instead of the early-start variable.

The best way to provide for a six-day schedule was to have the plant personnel enter each Sunday of the project period as a holiday. They agreed to do this.

The printer problem was solved by using PROC PRINTTO to send the printed output to an external print file. A batch job was then submitted by SAS* to send the report to a specified printer. The high-resolution GANTT chart was sent to the same graphics printer by using the GOPTIONS DEVICE= and DEVADDR= options.

REQUESTED MODIFICATIONS TO THE PROJECT MANAGEMENT APPLICATION

At the conclusion of the outage the maintenance planners compiled the following list of enhancements they would like to have included in a SAS/OR* project management application.

- The application must have the ability to lock individual activities into a specific time span. During a plant outage some activities have to take place during a specific window of time and all other activities must be scheduled around that time span. In most cases, this requirement is caused by the need to have an outside consultant on site for the duration of the activity. These consultants must be scheduled well before the outage so the system must be capable of locking certain activities into a specific time span regardless of additions or changes to the schedule. During the outage the prototype had rescheduled all activities when a new activity was added or when resource requirements for an activity were changed.

- The application must also be able to rank activities so more critical activities are completed before those of lesser priority. The outage is originally scheduled based on activities that are known during the planning phase. During disassembly of major components of the generating unit and inspection of areas not accessible during normal operations, additional maintenance and repair activities are identified. These are added to the schedule but no provision is made for increasing the deadline by which the project must be completed nor for increasing the manpower resources available during the outage. The plant personnel must identify activities that can be postponed until after the outage is complete and the project management application must be able to schedule according to the lower priorities of these activities.

- Provide the capability in the application to input the duration of each activity as hours instead of a fraction of a day. The application should then convert these hours to...
fractions of a workday. This need arose when work on the outage fell behind schedule because of the addition of new activities and the plant maintenance personnel began working ten-hour days. The problem was that activity durations in the prototype had been entered as fractions of an eight-hour workday and the internal processing was scheduling based on an eight-hour workday. The plant personnel wanted the ability to provide the application with the duration of each activity in hours and the length of the planned workday and have the application convert the activity hours to the correct fraction of the appropriate workday length.

- Provide the ability to show the actual start and finish date of completed activities during the outage. The system should then schedule from the current date only those activities not yet completed using the resources available as of that date.

- Provide the ability to produce a copy of the project schedule report, calendar and GANTT chart without having to walk through all the menus and programs of the application. The prototype, as used during the outage, required the plant personnel to view the edit screen of each file before requesting a report.

- Provide the ability to produce multiple copies of the project schedule report, calendar and GANTT chart at one time. During the planning of the project, a copy of the project schedule report was given to each maintenance supervisor for review and comment. The prototype required the planner to walk through the entire application, including all edit screens, for each copy of the project schedule report.

- Add the asset number of each piece of equipment to the activity file and have the asset number displayed on the project schedule report. Each activity is associated with a specific piece of equipment and the planners had to continuously cross-reference with another information file to determine the asset number with which they were dealing.

- Provide a blank line associated with each activity on the project schedule report. This would be used by the maintenance supervisors for scheduling notes during the outage and communicating plans and changes to the plant maintenance planners.

- Change the resource utilization report so that it reflected only the resource constrained schedule. During the outage the report was used to identify activities and time periods during which additional resources would be required. The report currently shows resource requirements for the early-start and late-start schedule in addition to the resource-constrained schedule. This is unnecessary and confusing information because a major outage is always scheduled with resource constraints.

- Include the work request number and the activity description on the GANTT chart. Most communication about the outage is linked on the work request number which is the unique identifier for each activity. Without this information on the GANTT chart, the plant planners and maintenance supervisors were frequently confused in trying to communicate changes about the schedule.

- Include the system date and time in the heading of each report and chart. Particularly during the planning phase, frequent changes to the project schedule on the same day caused confusion about which was the most current project schedule report.

- Provide an additional report that shows which activities are scheduled to be in progress by date.

- Change the project schedule report so that start and finish times are reflected as dates instead of datetime values. The application will still schedule by datetime, but the report need only reflect the start and finish date of each activity.

- Change the printing of the GANTT chart so the heading information shows only at the beginning of the first page. The chart should also be continuous instead of breaking at the end of each printer page.

COMPLETED ENHANCEMENTS AND FUTURE PLANS

The Antelope Valley Station's 1988 annual outage was scheduled from March 18 through April 15. Prior to the beginning of planning for that outage the Outage Project Management application was enhanced with the capability to lock critical activities into a specific time span. The scheduling personnel are now assured that the scheduling of date constrained activities will not change as new activities are added or the duration of existing activities is changed. A procedure was also added to permit the scheduler to print the activity file without having to go through the entire scheduling process. This report is used to coordinate activity lists with the first line supervisors before the creation of the project schedule. The remaining requested enhancements were delayed because of lack of available manpower.

The next major enhancement planned for the project management application is to link it to the cooperative's Computerized Maintenance System (CMS). The information on all planned maintenance is maintained on this system including the outage activities. By linking the SAS project management to CMS the outage activities could be automatically loaded into the SAS dataset prior to each scheduled outage. Once this is completed, the entire system could be used in planning and scheduling daily maintenance activities throughout the year.
The SAS/OR* project management prototype was an efficient tool in planning and scheduling the major plant outage at the Antelope Valley Station. With minor modifications provided by support personnel having limited SAS* experience, the prototype proved to be a viable planning and scheduling tool. The plant personnel at the Antelope Valley Station estimated that, during the original planning and scheduling of the project, they saved one man-month of time in the first sixty days of use.

Completed and planned enhancements will make the software even more useful by utilizing more of the available capabilities of SAS/OR*. The enhanced SAS/OR* project management application will provide the cooperative with both an effective tool in scheduling a major outage and a cost-effective method of planning, scheduling and managing daily maintenance tasks at any Basin Electric plant location.

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