SAS/OR® 15.1 User's Guide
Project Management
The PM Procedure

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SAS/OR® 15.1 User's Guide: Project Management

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Chapter 5
The PM Procedure

Contents

Overview: PM Procedure

The PM procedure is an interactive procedure that can be used for planning, controlling, and monitoring a project. The syntax and the scheduling features of PROC PM are virtually the same as those of the CPM procedure. However, because the PM procedure is interactive, there are a few extra options that are available and a few other options that have a default behavior that is different from the CPM procedure. These differences are noted in the section "Syntax: PM Procedure" on page 308 and the section "Summary of Differences" on page 331. One major difference is that only the Activity-On-Node representation of the

project is supported in PROC PM. In other words, TAILNODE and HEADNODE statements from PROC CPM are not supported.

For a complete description of the syntax and the scheduling algorithm for the CPM procedure, see Chapter 4, "The CPM Procedure."

When PROC PM is invoked with the activity network representation, an interactive window is opened that displays a Table View of the project on the left and a Gantt View of the project on the right. You can add activities and edit the project data by using the Table View. You can also use the Gantt View to move activities, change the durations of the activities, and add precedence constraints between the activities. These features are described in the section "Details: PM Procedure" on page 311.

The PM procedure is designed to facilitate its inclusion in a Project Management application. Any changes that are made to the activity network or to the activity durations, resource requirements, alignment specifications, and other activity information need to be saved in the resulting Schedule output data set. Further, you should be able to use this output data set as input to a future invocation of PROC PM and continue to manage the project. Thus, there are some differences in the design of the Schedule data set (defined in Chapter 4, "The CPM Procedure") to enable the integration of PROC PM into a Project Management application. The differences between the Schedule data sets in the two procedures are described in the section "Schedule Data Set" on page 331.

Getting Started: PM Procedure

Consider the simple software development project described in the "Getting Started" section of Chapter 4, "The CPM Procedure." Recall that the Activity data set, SOFTWARE, contains the activity descriptions, durations, and precedence constraints. The following statements (identical to the PROC CPM invocation) initialize the project data and invoke the PM procedure.

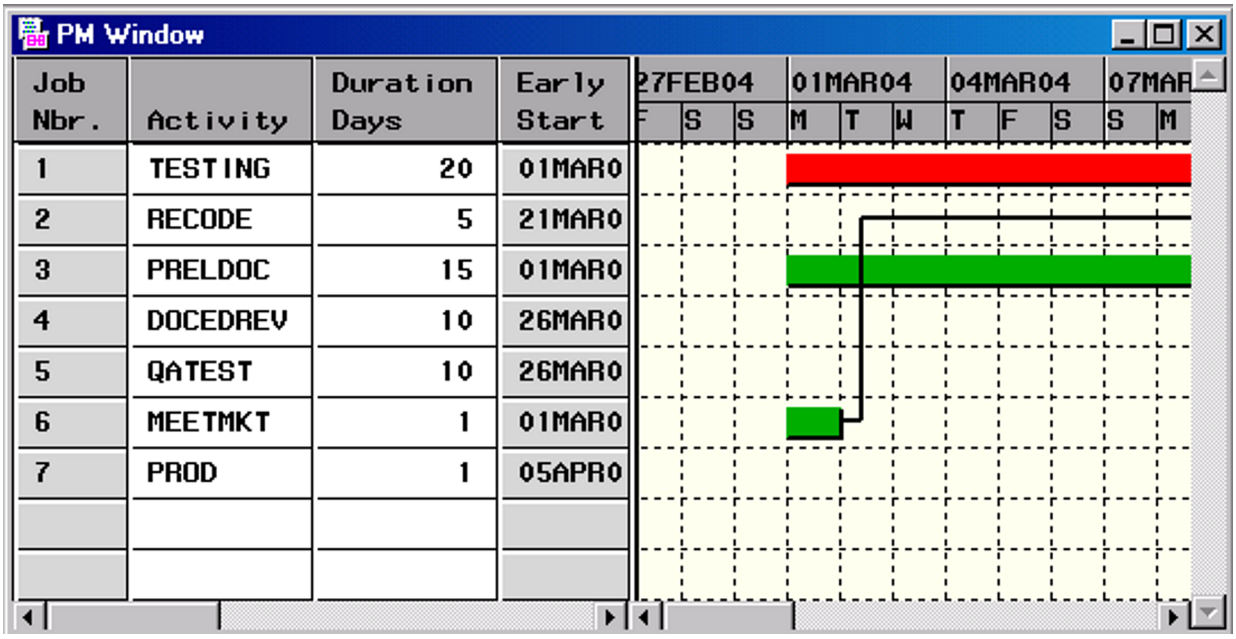
```
data software;
   input Descrpt  $char20.
         Duration 23-24
         Activity $ 27-34
         Succesr1 $ 37-44
         Succesr2 $ 47-54;
   datalines;
Initial Testing       20  TESTING   RECODE
Prel. Documentation   15  PRELDOC   DOCEDREV  QATEST
Meet Marketing        1   MEETMKT   RECODE
Recoding              5   RECODE    DOCEDREV  QATEST
QA Test Approve       10  QATEST    PROD
Doc. Edit and Revise  10  DOCEDREV  PROD
Production            1   PROD
;
```

```
proc pm data=software
        out=intro1
        interval=day
        date='01mar04'd;
   id descrpt;
   activity activity;
   duration duration;
   successor succesr1 succesr2;
run;
```

When you invoke the PM procedure, the PM window appears (see Figure 5.1), consisting of the Table View and the Gantt View of the project. The activities are listed in the order in which they are defined in the Activity data set. The two views are separated by a dividing line that can be dragged to the left or right, controlling the size of the two views. Further, the two views scroll together in the vertical direction but can scroll independently in the horizontal direction.

The Table View contains several editable columns (in white) that can be used to edit the project data as well as add new activities to the project. Some of the columns (in gray), such as the Schedule times, are not editable. The Gantt View contains a Gantt chart of the project and displays the precedence relationships between the activities. You can use the Gantt View to add or delete precedence constraints between activities and to change the durations or alignment constraints of the activities by dragging the schedule bars. Details of the interface are described in the section "Details: PM Procedure" on page 311.

Figure 5.1 Software Development Project



Syntax: PM Procedure

The syntax for PROC PM is virtually identical to that for PROC CPM. The main difference is that you replace the PROC CPM statement with the PROC PM statement.

The TAILNODE and HEADNODE statements from PROC CPM are not supported in PROC PM.

The form of the PROC PM statement is

PROC PM *options* **;**

PROC PM Statement

PROC PM *options* **;**

All the options that are available in the PROC CPM statement can also be specified in the PROC PM statement. See Chapter 4, "The CPM Procedure," for details. However, there are a few additional options available with PROC PM, and some of the other PROC CPM options are not needed as they are the default behavior in PROC PM. See "Summary of Differences" on page 331 for more details about these differences.

Options Specific to PROC PM

The following options can be specified on the PROC PM statement.

NODISPLAY
invokes the procedure in a noninteractive mode. The schedule for the project is still computed and the requested output data sets are created and saved. However, the PM window is not displayed. This option is useful for scheduling large projects that do not need to be updated interactively. Note that invoking PROC PM with the NODISPLAY option is similar to invoking PROC CPM; however, because the format of the Schedule output data set is different for the two procedures, you might see some differences in the order and content of the observations. See "Schedule Data Set" on page 331 for details.

PROJECT=*SAS-data-set*
identifies a SAS data set that can be used to save and restore preferences that control the project view. For example, preferences such as the font, column order, column widths, filters, and so forth, can be saved from one invocation to another. See "PROJECT Data Set" on page 327 for more details about this data set and the preferences that can be saved in it.

PROJECTNAME=*'string'*

PROJNAME=*'string'*

NAME=*'string'*
specifies a descriptive string identifying the name of the project. This string is used to label the PM window.

SUMMARYNAME=*'string'*

SUMMARY=*'string'*

PROJECTSUMMARY=*'string'*

specifies a descriptive string identifying the summary task. By default, when there is more than one root parent activity in a project, PROC PM creates a summary task named "Summary" (or "Project Summary" if the input format for the activity variable is 15 or greater). So, if there is already a child activity named "Summary" (or "Project Summary") in the input data, the resulting schedule forms a cycle. The SUMMARYNAME= option enables you to override the default by specifying a different name for the summary task, thereby avoiding the previously described problem.

Default Options for PROC PM Statement

The following options of PROC CPM are turned on by default in PROC PM.

ADDACT

ADDALLACT

EXPAND

indicates that an observation is to be added to the Schedule output data set (and the Resource Schedule output data set) for each activity that appears as a value of the variables specified in the SUCCESSOR or PROJECT statements without appearing as a value of the variable specified in the ACTIVITY statement. In other words, the Schedule output data set produced by PROC PM contains one observation for every activity that appears as a value of the ACTIVITY, SUCCESSOR, or PROJECT variables (as long as it has not been deleted in the current invocation of the procedure). It also contains an observation for every activity that is added to the project using the graphical user interface.

XFERVARS

indicates that all relevant variables are to be copied from the Activity data set to the Schedule data set. The procedure carries over to the output data set all the relevant variables from the input data set. Thus, the Schedule output data set contains all the project information that is necessary to schedule it.

Default Options for ACTUAL Statement

AUTOUPDT

requests that the procedure assume automatic completion (or start) of activities that are predecessors to activities already completed (or in progress).

ESTIMATEPCTC

ESTPCTC

ESTPCTCOMP

ESTPROG

indicates that a variable named PCT_COMP is to be added to the Schedule output data set (and the Resource Schedule output data set) that contains the percent completion time for each activity (for each resource used by each activity) in the project.

SHOWFLOAT

indicates that activities that are completed or in progress have nonzero float.

Default Options for PROJECT Statement

ADDWBS

WBSCODE

WBS

indicates that the PM procedure is to compute a WBS code for the activities in the project using the project hierarchy structure specified. This code is computed for each activity and stored in the variable WBS_CODE in the Schedule output data set.

DESCENDING

DESC

indicates that, in addition to the ascending sort variables (ES_ASC, LS_ASC, and SS_ASC) that are requested by the ESORDER, LSORDER, and SSORDER options, the corresponding descending sort variables (ES_DESC, LS_DESC, and SS_DESC, respectively) are also to be added to the Schedule output data set.

ESORDER

ESO

indicates that a variable named ES_ASC is to be added to the Schedule output data set; this variable can be used to order the activities in such a way that the activities within each subproject are in increasing order of the early start time. Note that this order is not necessarily the same as the one that would be obtained by sorting all the activities in the Schedule data set by E_START.

LSORDER

LSO

indicates that a variable named LS_ASC is to be added to the Schedule output data set; this variable can be used to order the activities in such a way that the activities within each subproject are in increasing order of the late start time.

ORDERALL

ALL

is equivalent to specifying the ESORDER and LSORDER options (and the SSORDER option when resource constrained scheduling is performed).

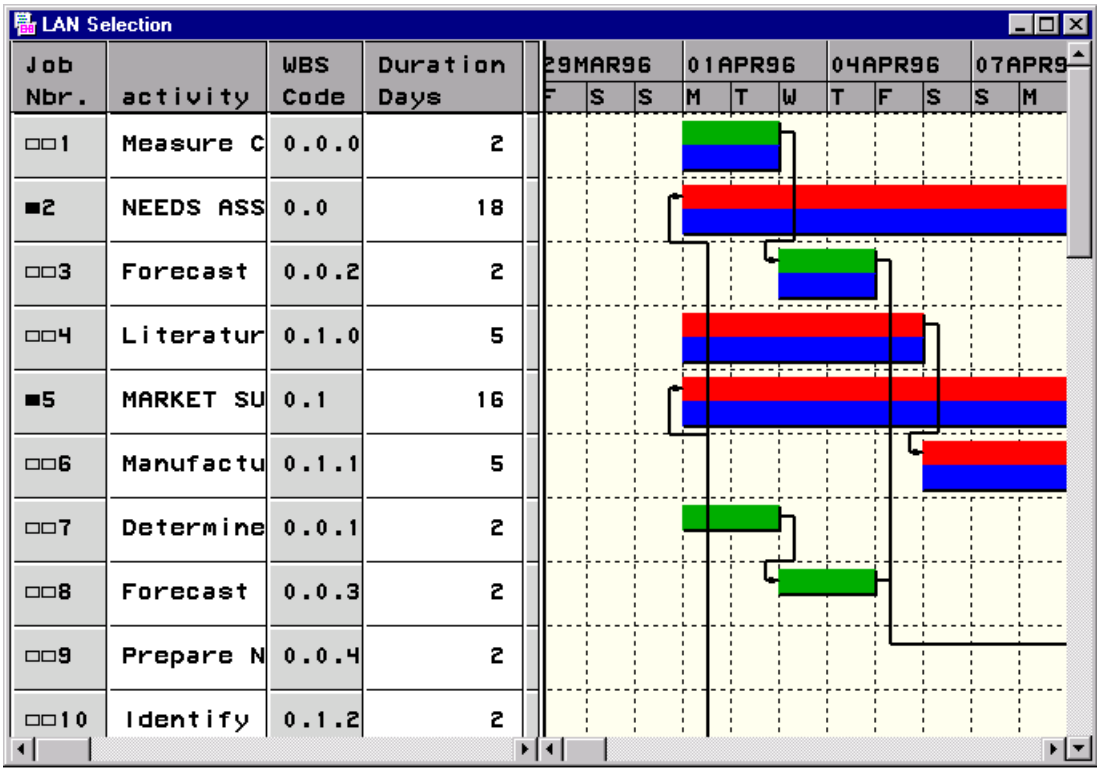
SSORDER

SSO

indicates that a variable named SS_ASC is to be added to the Schedule output data set; this variable can be used to order the activities in such a way that the activities within each subproject are in increasing order of the resource-constrained start time.

Details: PM Procedure

Figure 5.2 LAN Selection Project



The PM window provides the standard editing and viewing functions of a typical project management tool. It can be displayed by invoking the PM procedure. For an existing project, the PM window is populated with the activities in the project. For a new project, the PM window is empty. Figure 5.2 displays the PM window for a sample project.

After you have finished editing the project, you can close the PM window to save the new project data in the Schedule output data set that was specified in the invocation of the PM procedure.

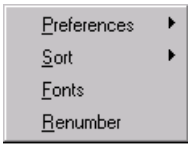
User Interface Features

This section describes some of the typical features of the PM window's graphical user interface. The PM window provides both a Gantt View and a Table View of the project. The size of each view can be changed by pointing to the dividing line between the two views until the pointer changes to a double arrow and then dragging it to the right or left.

Only part of the project may be visible in the PM window; horizontal and vertical scroll bars enable you to scroll the project data in both directions. Note that the Gantt and the Table Views are attached to each other so that they scroll together vertically. Each view can be scrolled horizontally, independently of the other.

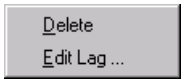
The menu associated with the PM window provides access to several project management functions under the **Edit**, **View**, and **Project** menus. For example, the **Project** menu is shown in Figure 5.3. The commands available through the menus are described in detail in the appropriate sections.

Figure 5.3 Project Menu



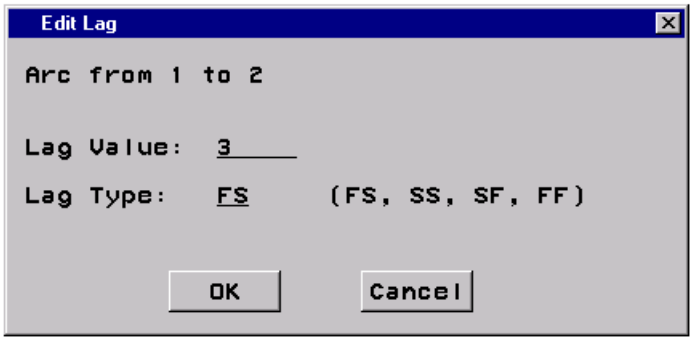
In addition to the drop-down menus, context-sensitive pop-up menus are available in the Table and Gantt Views, the time axis, along the arcs, and from select columns in the Table View. You open a pop-up menu by right-clicking on a particular object. For example, right-clicking on an arc in the Gantt View displays the arc pop-up menu shown in Figure 5.4.

Figure 5.4 Arc Pop-up Menu



In some situations, the pop-up menu selection can lead to a dialog box that requires you to type a value in one or more of the fields in the box. For example, selecting **Edit Lag** from the arc pop-up menu leads to the dialog box displayed in Figure 5.5. (See "Create Nonstandard Precedence Relationships" on page 325 for a discussion of nonstandard precedence constraints.)

Figure 5.5 Edit Lag Dialog Box



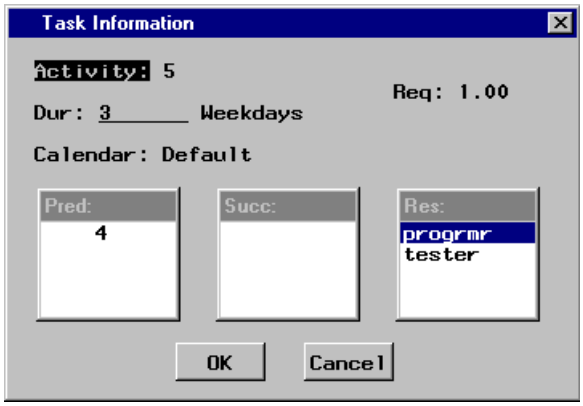
The Table View displays project data in a tabular format. Some of the columns are editable (white background) while other columns, which are computed by the procedure, are not editable (gray background). The Gantt View always displays the early start schedule of the project. In addition, it also displays the resource-constrained schedule (if resources are present), the actual schedule (if the project has started and is in progress), and the baseline schedule (if a baseline schedule is saved for the project). The display of all the schedule bars (except the Early Schedule bar) can be toggled on or off using the pop-up menu from the Gantt View.

Note that each row of the combined Table View and Gantt View represents one activity (also referred to as *task* in this chapter). Any change in data or movement of a row in one view is also reflected in the other.

In addition to the drop-down and pop-up menu actions, several drag-and-drop actions are available within the PM window. You can move the columns and rows of the Table View by selecting a row or column and dragging it to the desired position. You can also change the width of the columns by dragging the column dividers in the Table header region.

You can manipulate the durations of the tasks using the **Task Information** dialog box (see Figure 5.6) by right-clicking on the bar shown in the Gantt View or by changing the length of the Early Schedule bar in the Gantt View. You can also move the task in time by dragging the Early Schedule bar to a new position. This affects the Target Date for the associated task.

Figure 5.6 Task Information Dialog Box



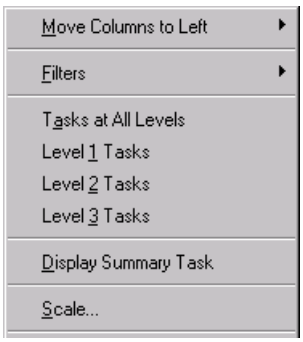
Any of the preceding actions may result in a change to the project schedule that is immediately reflected in the Table and Gantt Views. All editing abilities and the corresponding changes to the schedule are described in detail in the following sections.

Project Hierarchy

The PM procedure displays a hierarchical project structure if it is invoked with the PROJECT statement. If the procedure is invoked without a PROJECT statement, the supertask and subtask relationship is not supported, and all the activities are considered to be at the same level, belonging to a single project.

If the PROJECT statement is used, then a task's level in the project hierarchy is indicated in the Table View by small square boxes to the left of the activity number in the Job Nbr. column. Empty boxes indicate that the activity does not have any subtasks (it is a *leaf* activity), while filled boxes indicate that the activity is a supertask. Further, a Project Summary task is included to represent the root task (or Summary Task) of the project. This task is positioned at the top of the list of activities, and its display can be toggled on or off by selecting **Display Summary Task** from the **View** menu (see Figure 5.7).

Figure 5.7 View Menu



In the Gantt View, supertasks are indicated by vertical cones at the end of their corresponding schedule bars.

Note that the durations of the supertasks are determined by the overall duration of their subtasks. Thus, you cannot change the duration of a supertask.

If there is no PROJECT statement, all menu selections that correspond to the multi-project structure are unavailable for selection. For example, the **Display Summary Task** selection in Figure 5.7 will appear dimmed.

Table View

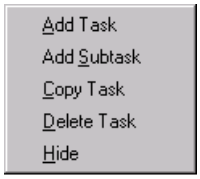
The Table View displays information about a project in tabular form. It displays activities along with their descriptions, various activity schedules, resource requirements, calendars, and target dates. The hierarchical information about an activity is provided in the Job Nbr. column by a number of small square boxes to the left of the activity number. The number of square boxes corresponds to the level of the activity in the project hierarchy. Empty boxes indicate that the activity does not have any subtasks (it is a leaf activity), while filled boxes indicate that the activity is a supertask. Some columns in the Table View are editable while others are write-protected. The editable columns are lighter in color than the noneditable ones. In general, you can type into all columns that provide input to the project, while all other columns that contain output values from PROC PM are write-protected. For example, in Figure 5.2, the WBS Code column cannot be edited, while the activity and Duration columns can be edited.

In the Table View, you can add or delete activities, add subtasks, change the order of the columns or the activities, edit activity information, and so on. These tasks are described in the following sections.

Add/Copy/Delete Tasks

Right-clicking any task in the Table View displays the pop-up menu shown in Figure 5.8. From this pop-up menu, you can Add/Copy/Delete the selected task. If you select the **Add Task** menu item, the new task is added immediately following the selected task. You can also add a subtask to the selected task by selecting the **Add Subtask** menu item. If you select the **Copy Task** menu item, a copy of the selected task is added to the bottom of the Table View. The new task has the same duration and calendar as the selected task. If the selected task is a supertask, all its subtasks (and any internal precedence constraints) are also copied.

Figure 5.8 Table View Pop-up Menu



Change Column Width

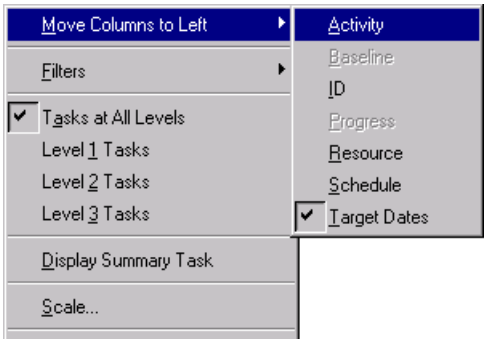
The width of a column in the Table View can be increased or decreased by dragging (with the left mouse button) the column dividers in the Table Header region of the Table View. When the pointer is positioned on the column divider, it changes to a double arrow. Dragging it to the right or left increases or decreases the width of the column.

Change the Order of the Columns

The display order of columns in the Table View can be changed in several ways:

- Drag the column in the header row to the destination.
- Select **View** from the menu and then select **Move Columns to Left** (see Figure 5.9). Choosing any of the available options moves the corresponding columns to the leftmost portion of the Table View.

Figure 5.9 Move Columns Menu



Edit Durations

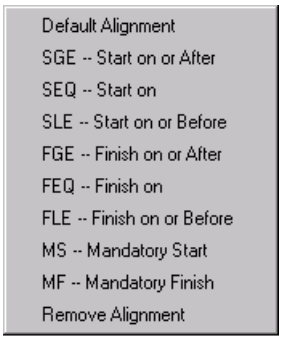
To change the duration of an activity, edit the Duration column in the Table View. Note that changing an activity's duration to 0 changes the activity into a Milestone. Activity durations can also be changed in the Gantt View.

Edit Alignment Constraints

Scroll to columns named Target Date and Target Type. Enter one of the values SGE, SLE, MS, MF, FGE, or FLE in the Target Type column. You can either type the values or select them from the pop-up menu displayed by right-clicking the Target Type column (see Figure 5.10). Enter the appropriate date in the Target

Date column. You can also view these columns by selecting **View ►Move Columns to Left ►Target Dates** from the menu (Figure 5.9). You can also change an activity's alignment constraints in the Gantt View.

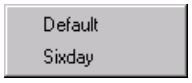
Figure 5.10 Target Type Pop-up Menu



Edit Calendars

To change an activity's calendar, you can enter the calendar number in the Activity Calendar column or the calendar description in the Calendar Name column. The calendars that can be assigned to an activity are predefined in the Calendar data set. To see a list of the calendars, you can right-click in one of the calendar columns. This will pop up a list of calendars, from which you can select the activity's calendar. See Figure 5.11 for an example of a calendar pop-up menu with two calendars.

Figure 5.11 Calendar Pop-up Menu



Edit Resource Requirements

You can change the amount of resources required for an activity by editing the Resource columns in the Table View. Changing the resource requirement causes the project to be rescheduled using the new resource specifications. See "Edit Resource Requirements" on page 326 for more details.

Edit Progress Information

You can edit the actual start, actual finish, percent complete, or remaining duration for an activity by editing one of the Progress Information columns in the Table View. Note that by changing one of these columns, all the other related progress columns might also be affected. For example, entering 100 in the Percent Complete column for an activity that is in progress updates the Remaining Duration column to 0, and the Actual Finish column is filled in appropriately. You can also modify the progress information of an activity in the Gantt View.

Expand/Collapse Supertasks

Double-clicking on a supertask in the Table View toggles the expand/collapse switch. This action enables you to either view or hide all the subtasks of the supertask.

Hide Tasks

An individual task can be hidden by right-clicking the task in the Table View and selecting **Hide** from the menu shown in Figure 5.8. Tasks can also be hidden from view using several filters described in the section "Setting Activity Filters" on page 326.

Move Tasks

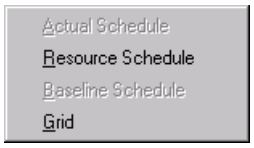
Starting anywhere in the row corresponding to an activity you want to move, drag it to the destination.

Gantt View

In the Gantt View, activity schedules are depicted by horizontal bars. There is one bar for each of the early, resource, actual, and baseline schedules. For the Early Schedule bar, critical activities are marked in different colors from the noncritical activities. Weekends are marked by shaded vertical rectangles running through the chart. Supertasks are differentiated from leaf activities by anchoring vertical cones at the ends of their Early Schedule bars.

The Gantt View is displayed with a rectangular grid that can be turned on or off by selecting **Grid** from the pop-up menu (see Figure 5.12) that is displayed by right-clicking anywhere outside of the schedule bars in the Gantt View.

Figure 5.12 Gantt View Pop-up Menu

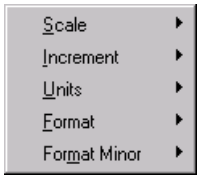


The pop-up menu in the Gantt View also enables you to toggle the display of the Actual, Resource, or Baseline Schedule bars. Note that these bars can be displayed in the Gantt View only if the project data contain the actual, resource-constrained, or baseline schedules, respectively.

In addition to displaying the activity schedules in an easy-to-view format, the Gantt View in the PM window can also be used to change the durations of the activities, add or delete precedence constraints, set activity alignment constraints, set progress information, and provide access to calendar, precedence, and resource information.

You can also change several of the display attributes of the Gantt View by using the **Time Axis** pop-up menu (see Figure 5.13) to set the scale of the axis, format the time axis labels, set the units of display, and so forth. All of these tasks are described in the following sections.

Figure 5.13 Time Axis Pop-up Menu

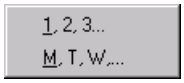


Change the Format of the Time Axis

The format of the major axis can be changed by right-clicking on the header row of the Gantt View and selecting **Format** for the major axis. For the minor axis, select **Format Minor.** Some example selections available for the formats are shown in Figure 5.14 and Figure 5.15. In addition to the formats explicitly listed for the major axis, you can specify any valid numeric format by selecting **Other** and filling in the appropriate fields in the dialog box that is opened as a result.

Figure 5.14 Major Axis Format Pop-up Menu

Figure 5.15 Minor Axis Format Pop-up Menu



Change Increments

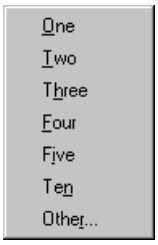
Increments in the Gantt View define the number of tick marks on the minor axis per tick mark on the major axis. They can be changed by right-clicking on the header area and selecting **Increment** from the pop-up menu. The available selections are shown in Figure 5.16.

Figure 5.16 Increment Pop-up Menu

Change the Scale of the Time Axis

Move the pointer to a tick mark on the major axis in Gantt View. The pointer changes to a double arrow. Drag the tick mark horizontally to change the scale. You can also change the scale by using the **Scale** pop-up menu (see Figure 5.17) from the **Time Axis** pop-up menu.

Figure 5.17 Scale Pop-up Menu



Change Units

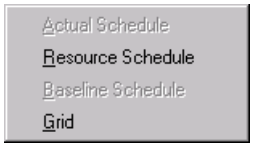
The Time Axis Units in the Gantt View can be changed by right-clicking on the header bar in the Gantt View and selecting **Units** (see Figure 5.18). The default value of the units used for display is based on the specification of the INTERVAL= parameter in the invocation of the PM procedure.

Figure 5.18 Units Pop-up Menu

Display/Hide Selected Schedules

A display/hide switch for a given schedule can be toggled by right-clicking in the main panel of the Gantt View and selecting the desired schedule (see Figure 5.19).

Figure 5.19 Gantt View Pop-up Menu



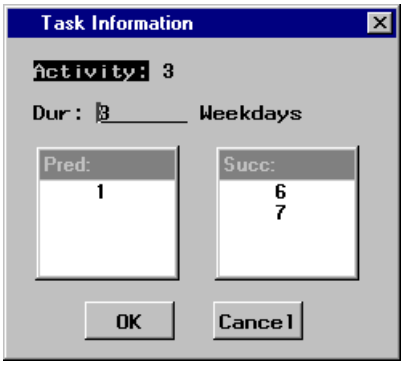
Display Task Information

You can display detailed information for an activity by right-clicking any of its schedule bars and selecting **Task Information** from the resulting pop-up menu (see Figure 5.20).

Figure 5.20 Schedule Bar Pop-up Menu

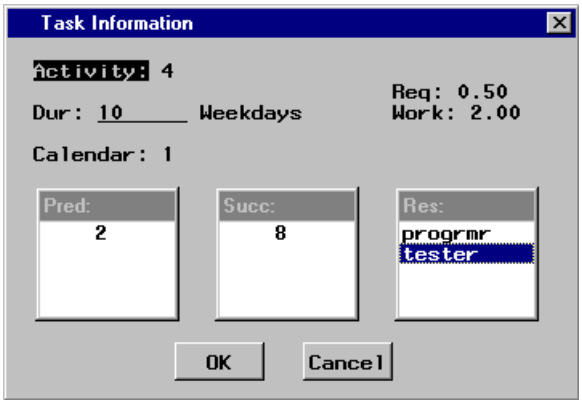
The ensuing **Task Information** dialog box (see Figure 5.21) displays the job number, duration, duration units, a list of predecessor activities, and a list of successor activities, as well as applicable calendar and resource information for the selected activity. You can also edit the activity duration from the **Task Information** dialog box.

Figure 5.21 Task Information Dialog Box



If any calendars have been defined to the project, the activity calendar is also displayed. If the project utilizes any resources, there is a list box that lists the resources required by the activity (see Figure 5.22). Selecting a resource from this list box displays the quantity required by the activity in the **Req** field. Furthermore, if the selected resource drives the duration of the activity, then the appropriate work value is also displayed in the **Work** field.

Figure 5.22 Task Information Dialog Box (Calendar and Resources)



Modify Activity Alignment Constraints

An activity's Early Schedule bar can be moved using the left mouse button. When the pointer is positioned over the activity bar, it changes to a cross-hair type. You can then drag the bar horizontally to a new position. This sets an alignment constraint of type 'SGE' for the selected activity with the align date corresponding

to the one at the left edge of the bar's new position. Other types of alignment constraints can be entered by editing the Target Date and Target Type columns as described in "Edit Alignment Constraints" on page 315.

Modify Durations

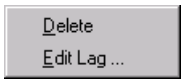
You can modify the duration of an activity in several ways. In the Gantt View, you can enter it directly by using the **Task Information** dialog box as described in "Display Task Information" on page 319, or change it indirectly by altering the width of the schedule bar. To change the duration of an activity, point to the right edge of the activity's Early Schedule bar, and drag to the left or the right depending on whether you want to decrease or increase the duration. You can also edit activity durations in the Table View.

Modify Precedence Information

You can add precedence constraints by depressing the left mouse button at either end of the predecessor activity bar and releasing it at either end of the successor activity bar. The type of constraint (FS, FF, SS, or SF) depends on which end of the bars the constraints are drawn from.

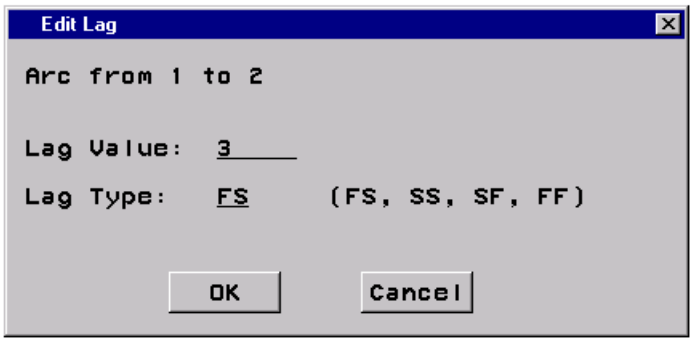
You can delete precedence constraints by right-clicking on the arc and selecting **Delete** (see Figure 5.23).

Figure 5.23 Arc Pop-up Menu



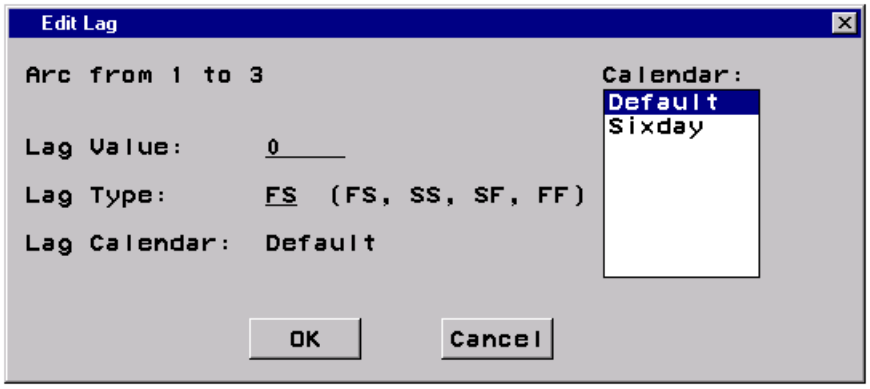
You can modify the type of the precedence constraint or the lag value associated with the precedence constraint by right-clicking on the arc and selecting **Edit Lag**. The ensuing dialog box is shown in Figure 5.24. Enter the value of the lag duration in the first field and the type of the lag in the second field. Valid values of lag are Finish-to-Start (FS), Start-to-Start (SS), Start-to-Finish (SF), and Finish-to-Finish (FF).

Figure 5.24 Edit Lag Dialog Box



If calendars are defined in the project, the **Edit Lag** dialog box includes the lag calendar associated with the selected precedence constraint. You can change the lag calendar by selecting from the list of available calendars that is displayed within the **Edit Lag** dialog box shown in Figure 5.25.

Figure 5.25 Edit Lag Dialog Box (Multiple Calendars)



Modify Progress Information

To modify the Progress using the Gantt View, you must include the Actual Schedule in the view. You can drag the actual schedule bar for the activity to change the amount of progress on the activity; you can also move the activity's actual bar to change the Actual Start of the activity.

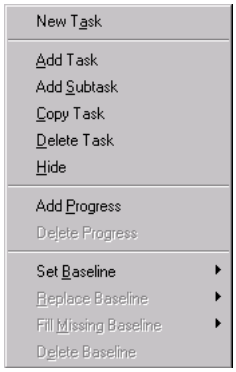
When the project contains progress information, a Timenow line is drawn in the Gantt View, indicating the TIMENOW date. You can move the Timenow line by dragging it. When you change the value of TIMENOW, the progress information changes for all the activities. A confirmation window requires you to confirm that you do want to change the progress information for all the activities. (See also "Macro Variable TIMENOW" on page 330.)

You can also edit the progress columns in the Table View.

Creating and Editing Projects

The PM window provides an easy-to-use interface to enter basic project information such as a list of activities, their durations, order of precedence, resource requirements, and so forth. You can also use the **Edit** menu (see Figure 5.26) to add or delete progress, baseline, and other information. These functions are described in the following sections.

Figure 5.26 Edit Menu



Add Activities

An activity (or task) can be added to the Project in the PM window by right-clicking in the Table View. If **Add Task** is selected from the pop-up menu, then an activity is added at the same level as the selected activity. Subtasks of an activity can be added by selecting **Add Subtask**. These actions are also available from the **Edit** menu (Figure 5.26) whenever an activity is selected in the Table View. Note that the selected activity is highlighted.

To add a new task at the topmost level of the project hierarchy, select **New Task** from the **Edit** menu.

Add Precedence Constraints

To add precedence constraints in the Gantt view, point at the right edge of the predecessor activity until the pointer changes to a cross-hair and drag it vertically up or down to the left edge of the successor activity. By starting and dropping at different ends of the activity bar, you can create nonstandard precedence relationships between the activities. You can view the predecessor and successor tasks for an activity from the **Task Information** dialog box.

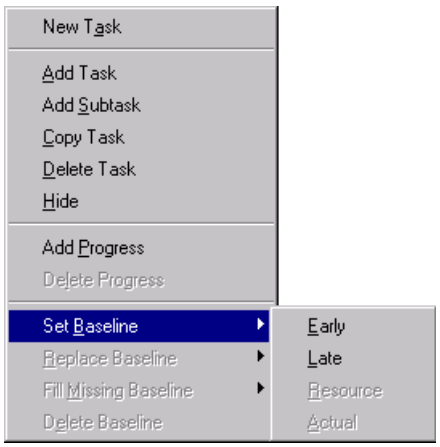
Add Baseline Information

Baseline information is saved in a project so that the current status of a project can be measured against some base schedule. The baseline information can be set in several different ways; most of the actions relating to the Baseline schedule can be performed using the selections available from the **Edit** menu (see Figure 5.26).

- If the project data include a Baseline schedule, saved in the variables B_START and B_FINISH, the PM window displays the Baseline schedule when it is first invoked. This schedule can be replaced by selecting **Replace Baseline** from the **Edit** menu. This selection can be used to reset the Baseline schedule to a new schedule corresponding to one of the current schedules.

- If the project data do not include a Baseline schedule, the Baseline schedule can be set in the PM window by selecting **Set Baseline** from the **Edit** pull-down menu (see Example 5.3). This selection can be used to set the Baseline schedule to one of the current schedules (see Figure 5.27). Thus, selecting **Resource** from the **Set Baseline** menu sets the baseline schedule to the current resource-constrained schedule. By saving the current resource-constrained schedule, you can perform some what-if analysis by changing some of the resource requirements or other parameters of the project and comparing the resulting schedule with the saved baseline schedule.

Figure 5.27 Set Baseline Pull-down Menu



- The individual Baseline values can also be edited in the Table View by changing the values in the Baseline Start and Baseline Finish columns.
- If new activities are added to the project, the Baseline values for the new tasks are missing. These can be set to correspond to the current schedule values by selecting **Fill Missing Baseline** from the **Edit** menu.
- If you want to delete the Baseline information from the project data, you can select **Delete Baseline** from the **Edit** menu.

Add Progress Information

Progress information can be included by using the ACTUAL statement, which is similar to the one for PROC CPM. If the PM window is invoked without the ACTUAL statement, then progress information can be added to the Project from the **Edit** menu (Figure 5.26) by selecting **Add Progress**.

Progress information is updated by dragging the actual schedule bars horizontally (in a manner similar to the one for changing durations) in the Gantt View or by modifying the values in the Progress columns in the Table View. See "Modify Progress Information" on page 322 and "Edit Progress Information" on page 316.

For details about how the progress information is used to update the project schedule, see "Progress Updating" on page 111. See also Example 5.6.

Change Duration

The duration of an activity can be changed directly from the Duration column of the Table View or the **Task Information** dialog box of the Gantt View. It can also be changed indirectly by dragging the activity bar at the right edge in the Gantt View.

Copy Activities

An activity (or task) can be copied in the PM window by right-clicking in the Table View. If **Copy Task** is selected from the pop-up menu, then a copy of the selected activity is added at the end of the activities listed in the Table View. The new task has the same duration and calendar as the selected task. If the selected task is a supertask, all its subtasks (and any internal precedence constraints) are also copied.

Create Milestones

You can create milestones by adding an activity and assigning it zero duration.

Create Nonstandard Precedence Relationships

A Finish-to-Start relationship between two activities is considered to be a standard precedence constraint. You can create it in Gantt view by dragging the precedence constraint from the right end of the predecessor activity bar to the left end of the successor activity bar. Nonstandard precedence constraints are created by starting and ending at different ends of the two activity bars. For example, a Start-to-Finish relationship is created by dragging from the left end of the predecessor activity bar to the right end of the successor activity bar.

In addition to specifying the type of the precedence constraint, you can also specify a lag or lead time between the two activities. This lag value can be edited from the Gantt View. See "Modify Precedence Information" on page 321 for more details.

Create Subtasks

Subtasks can be created only if the PM procedure is invoked with the PROJECT statement. To create a subtask, right-click on the parent activity in the Table View. Then select **Add Subtask** from the background menu. The newly created subtask has one more little square box than the parent task in the Job Nbr. column in the Table View. The empty square boxes denote that it is a leaf activity (a task with no subtasks). The number of boxes denote a task's level in the project hierarchy, starting with level 0 for the Project Summary task.

Delete Activities

An activity can be deleted in the Table View by right-clicking anywhere in the task row and selecting **Delete Task**. If the selected task is a supertask, all its subtasks are also deleted. Note that, in this case, a confirmation dialog box confirms the **Delete Supertask** action.

Delete Precedence Constraints

To delete a precedence constraint, right-click anywhere on the arc and select **Delete** from the pop-up menu. You can view the predecessor and successor tasks for an activity from the task information window.

Edit Activity Alignment Constraints

Activity alignment constraints can be added/modified as described in "Edit Alignment Constraints" on page 315and "Modify Activity Alignment Constraints" on page 320, respectively.

Edit Baseline Information

To edit the baseline schedule, scroll to the Baseline Start and Baseline Finish columns and type in the new values of the baseline start and finish times. Note that you cannot change the baseline values by moving the Baseline Schedule bars. See "Add Baseline Information" on page 323 for more details.

Edit Calendar Specifications

Calendars are defined by the CALEDATA= option in the PROC PM statement. This option is similar to the corresponding option in PROC CPM. After calendars are defined in the Project, an activity's calendar can be changed or set in the Table View by editing the Activity Calendar or Calendar Name columns. You can either type the values or select them from the menu displayed by right-clicking in either of the Calendar columns. See "Edit Calendars" on page 316. You can also view the activity calendar from the task information window.

Edit Resource Requirements

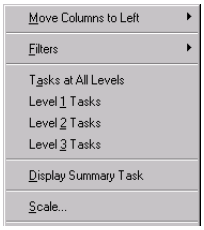
The resource requirement information for each activity is displayed and can be edited in the Table View. A column for a resource is created in the Table View when it is specified in the RESOURCE statement of the PROC PM invocation. For details about the RESOURCE statement, the Resource data set, and Resource Allocation, see Chapter 4, "The CPM Procedure." Changing the resource requirement causes the project to be rescheduled to use the new resources. You can also view the resource requirements for an activity from the task information window.

If alternate resources are used by the scheduling algorithm, an extra set of columns is added to the Table View. These columns (one for every resource in the project) display the resources that were actually used. These Usage columns for the resources cannot be edited.

Setting Activity Filters

Activity filters can be set by using the project hierarchy or by selecting from a list of activity attributes, as described in this section.

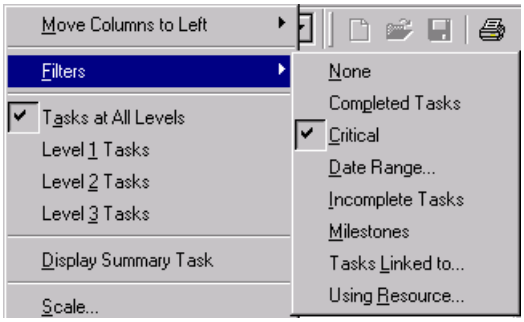
Figure 5.28 View Menu



Activities at different levels in the hierarchy can be viewed by selecting **View** from the menu (Figure 5.28) and selecting the appropriate level of the project hierarchy to filter out the higher level tasks. For example, selecting **Level 2 Tasks** displays only the tasks that are at Level 2 or lower. All activities can be viewed by selecting **Tasks at All Levels** from the **View** menu.

Activities can also be filtered using different criteria by selecting **View ►Filters** from the **View** menu (see Figure 5.28). The available filters are shown in Figure 5.29. By default, no filter is in effect (the selection is **None**); you can save the filter of your choice in the Preference data set (see "Saving and Restoring Preferences" on page 327).

Figure 5.29 Filters Pull-down Menu



Saving and Restoring Preferences

When the PM window is displayed for the first time for a given project, the order and width of the columns in the Table View, the font used for the display, the size of the window, the boundary between the Table and the Gantt Views, and several other attributes of the display are determined by the procedure. As you add activities and edit the Table View, you can change some of these attributes according to your preference. You can also select a different level of display or set some activity filters (see "Setting Activity Filters" on page 326).

PROJECT Data Set

PROC PM enables you to save the attributes of the display in an indexed data set that is specified in the PROC PM statement by using the PROJECT= option. The following preferences can be saved from one invocation to another:

- text font
- time increment
- time units
- major time axis format
- minor time axis format
- schedule bars displayed (for example, Actual, Baseline, and so forth)
- chart grid
- chart scale
- table column widths
- table column order
- Table View-Gantt View dividing line
- activity filters

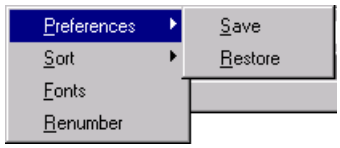
- activity level
- project summary
- window dimensions

The Project data set uses three variables to save the preference information:

- PROJATTR—contains a keyword identifying the project attribute. Each attribute has either a numeric value or a character value. The length of this variable is 8.
- PRATNVAL—used for numeric data corresponding to the attribute.
- PRATCVAL—used for character data corresponding to the attribute. The length of this variable is 200.

You can save and restore the preferences from the **Project** menu, which contains the **Preferences** submenu (Figure 5.30). Note that you have to explicitly save the project preferences using the **Save** selection from this menu. Closing the PM window saves only the activity data of the project; it does not automatically save the project preferences. When you restore preferences, the state used is the one that was last saved for the project in the specified preference data set.

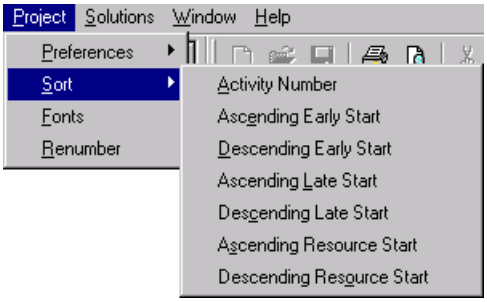
Figure 5.30 Preferences Menu



Sorting Activities

Activities can be sorted by activity number, early start, late start, and resource start by selecting **Project ►Sort** from the **Project** pull-down menu (see Figure 5.31). Once the activities are sorted, the Schedule output data set contains the activities in the new sorted order. See "Renumbering the Activities" on page 329.

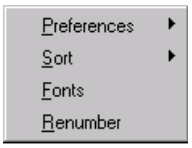
Figure 5.31 Sort Menu



Setting the Project Font

When the PM window is first displayed, the font used in all the text areas of the window is the same as the SAS font used in other windows. You can use the **Fonts** selection in the **Project** menu (Figure 5.32) to change the font used in the PM window. You can select the various fonts and their sizes from the font manager thus obtained. This font can also be saved (and restored) in the Project data set.

Figure 5.32 Project Menu



Renumbering the Activities

When the PM window is first displayed for the specified project, the activities are listed in the order in which they are defined in the Activity data set. The activity numbers displayed in the Job Nbr. column correspond to this same order. Even if the activities are rearranged, either by moving selected activities or by sorting, these numbers do not change. Likewise, no renumbering takes place automatically if activities are deleted from the project.

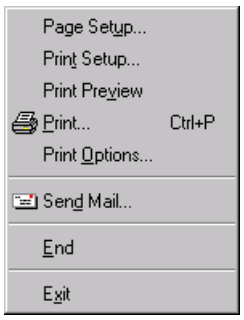
You can use the **Renumber** selection in the **Project** menu (Figure 5.32) to reassign consecutive numbers to the activities, starting from the first activity displayed.

When you close the PM window, saving all the activity information to the Schedule data set, the activities are numbered according to the order in which they were displayed at the end of the editing session. In other words, the **Close** action implicitly invokes the **Renumber** command on the project activities. These activity numbers are, in fact, saved as the values of the ACTID variable (see "Schedule Data Set" on page 331).

Printing

The PM window provides functionality to print the Gantt View, the Table View, or both, provided that a printer has been selected and the correct information has been set in the Printer Setup window. **Print Preview** can be used to view the information before printing, and the printed output can be saved to a file. All the printing functions are available from the **File** menu (Figure 5.33).

Figure 5.33 File Menu



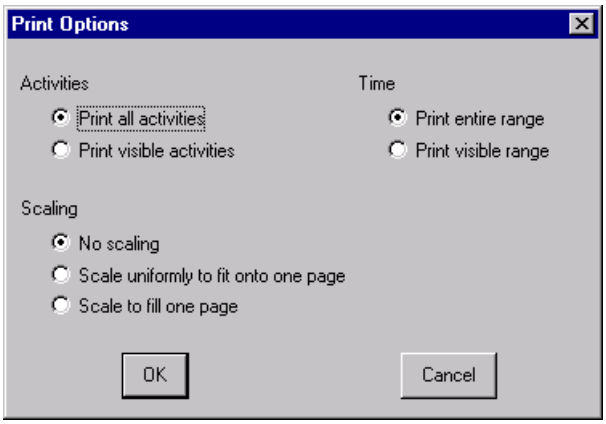
Preview the Printed Output on the Screen

You can view the printed output on screen before actually printing it by selecting **Print Preview** from the **File** menu.

Print Options

Select **Print Options** from the **File** menu. There are options for selecting time and activity axis range and scaling of the printed output. See Figure 5.34.

Figure 5.34 Print Options Dialog Box



Save the Printed Output to a File

The printed output can be saved to a file by selecting **File ►Print ►Print to File**.

Macro Variable TIMENOW

The PM window can be used to add and edit progress information to a project. When progress information is added, the Schedule data set contains all the progress variables; see “Progress Updating” on page 111.

However, all the values of the progress variables are reconciled and revised on the basis of the value of the TIMENOW parameter. Since the PM procedure enables you to move the TIMENOW line as well as

implicitly change the value of TIMENOW by updating the Actual Start or Finish times of the activities, the value of TIMENOW at the end of the editing session is an important parameter of the project. This value is saved in a macro variable called TIMENOW and can be used in subsequent editing sessions of the same project. See Example 5.6 for an example of the use of the TIMENOW macro variable.

Summary of Differences

The computation of the schedule, the resource-constrained scheduling algorithm, the resource usage information, and all other aspects of the scheduling engine for PROC PM are the same as the ones for PROC CPM. Refer to Chapter 4, "The CPM Procedure," for details. Some minor differences that pertain to the Schedule Data set and ALIGNTYPE statement are explained in the following sections.

Schedule Data Set

The Schedule data set produced by PROC PM is very similar to the Schedule data set produced by PROC CPM. See "OUT= Schedule Data Set" on page 101.

However, unlike PROC CPM, the PM procedure is interactive in nature; it enables you to add activities, set precedence constraints, reorder the activities, and so on. Thus, the output data set produced by PROC PM is designed to capture the original project data as well as all the changes that are made to the project in the course of the interactive session.

There are several differences between the forms of the Schedule output data sets produced by the PM and CPM procedures:

- The PM procedure automatically includes all relevant variables that are needed to define the project. Thus, the ACTIVITY, SUCCESSOR, LAG, DURATION, ALIGNDATE, and ALIGNTYPE variables are included in the output data set by default. If the RESOURCE statement is used, all the resource variables are also included. Likewise, if actual progress is entered for the project during the course of the interactive session, all the progress-related variables are added to the output data set.

- The PM procedure contains three sets of observations, identified by three different values of a new variable, OBS_TYPE. The first set of observations contains one observation for every activity in the project. The value of the OBS_TYPE variable for these observations is `'SCHEDULE.'` These observations contain all the activity information such as the duration, the start and finish times and the resource requirements. The second set of observations contains one observation for every precedence constraint in the project. The value of the OBS_TYPE variable for these observations is `'LOGIC.'` These observations contain all the precedence information such as the activity, successor, and lag information.

  The third set of observations is present only if the project has resource-driven durations. The value of the OBS_TYPE variable for these observations is `'WORK.'` These observations specify the WORK value for each resource used by each activity in the project.

- The order of the activities in the Schedule data set produced by PROC PM corresponds to the order in which the activities appear in the Table View at the end of the interactive session. Likewise, when the procedure is first invoked, the order of the activities in the Table View corresponds to the order in which the activities are defined in the Activity input data set. If, during the course of the session, some

of the activities are reordered or deleted, or if some new activities are added, the Schedule output data set contains all the activities that are defined in the Table View at the end of the session.

- The PM procedure also assigns a numeric identifier for each activity. These values are assigned by PROC PM consecutively in the order of the activities in the Table View and are saved in a variable called ACTID (see "Renumbering the Activities" on page 329). In addition to the ACTID variable, the Schedule data set also contains a numeric variable called SUCCID, which contains the numeric identifier for the successor activities in the observations for which OBS_TYPE='LOGIC.' If the PROJECT statement is used in the invocation of the PM procedure, a numeric variable called PNTID is added to the Schedule data set; this variable identifies the parent task for each activity.

  NOTE: If the ACTIVITY variable in the Activity input data set is a character variable, the ACTID, SUCCID, and PNTID variables are added to the Schedule data set in addition to the ACTIVITY, SUCCESSOR, and PROJECT variables. On the other hand, if the ACTIVITY variable in the Activity input data set is numeric, the new ACTID, SUCCID, and PNTID variables replace the numeric ACTIVITY, SUCCESSOR, and PROJECT variables, respectively.

ALIGNTYPE Statement

In PROC PM, if an ALIGNTYPE variable is specified but no ALIGNDATE variable is specified, then no error message is generated; PROC PM ignores the ALIGNTYPE variable and generates a schedule. However, in PROC CPM, this results in an error message with no schedule generated.

RESOURCE Statement

In PROC CPM, the NORESOURCEVARS option in the RESOURCE statement requests that the variables specified in the RESOURCE statement be dropped from the Schedule data set. However in PROC PM, this has no effect.

Examples: PM Procedure

This section illustrates some of the interactive features of PROC PM by using a few simple examples that lead you through different stages of entering and editing project data. A simple software development project is used in all the examples. The output data set from one example is used as input to the next example. Where necessary, additional data sets are created, or the input data set is modified using simple DATA step code.

Example 5.1: Defining a New Project

In this example, a simple software development project is built from scratch, starting with an empty Activity data set. PROC PM is invoked with an Activity data set that has no observations and just a few variables that are required to start the procedure. In addition to the Activity data set, a Project data set is also defined that is used to save the display attributes of the PM window to be used between successive invocations of the procedure. The following program invokes PROC PM and opens a PM window that enables you to enter project data. The initial window is shown in Output 5.1.1.

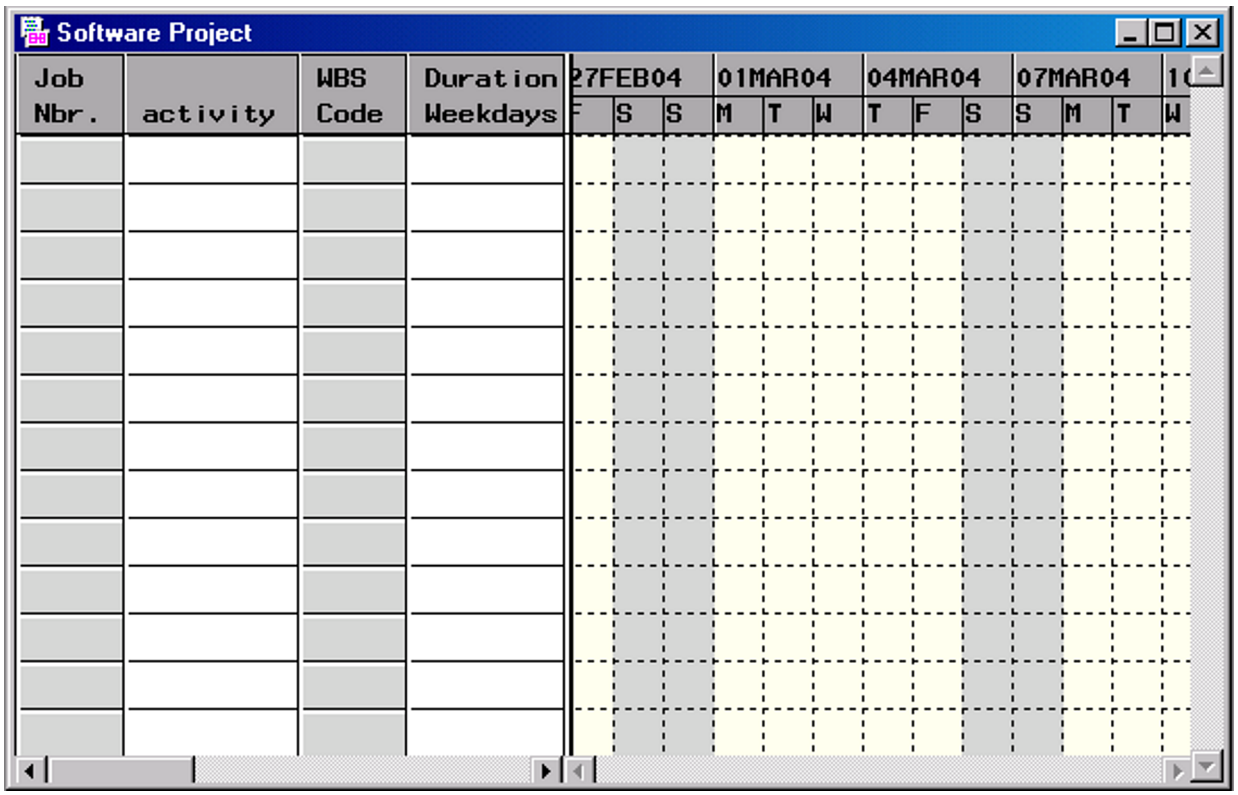
Note that the PROJNAME= option is used in the PROC PM statement. This value is used to label the PM window. Also specified in the PROC PM statement is the PROJECT= option that identifies the project attribute data set. The activities in the project follow a weekday calendar which is indicated to PROC PM by specifying the INTERVAL=WEEKDAY option. In the PM window, the weekends are shaded gray in the Gantt View.

```
/* Initialize the Activity data set */
data software;
   length activity $20.;
   input activity $ actid succid pntid duration;
   datalines;
;

data softattr;
   length projattr $8. pratcval $200.;
   input projattr pratnval pratcval;
   datalines;
;

proc pm data=software project=softattr
        date='1mar04'd interval=weekday
        projname='Software Project'
        out=softout1;
   act actid;
   succ succid;
   project pntid;
   duration duration;
   id activity;
   run;
```

Output 5.1.1 Initial PM window

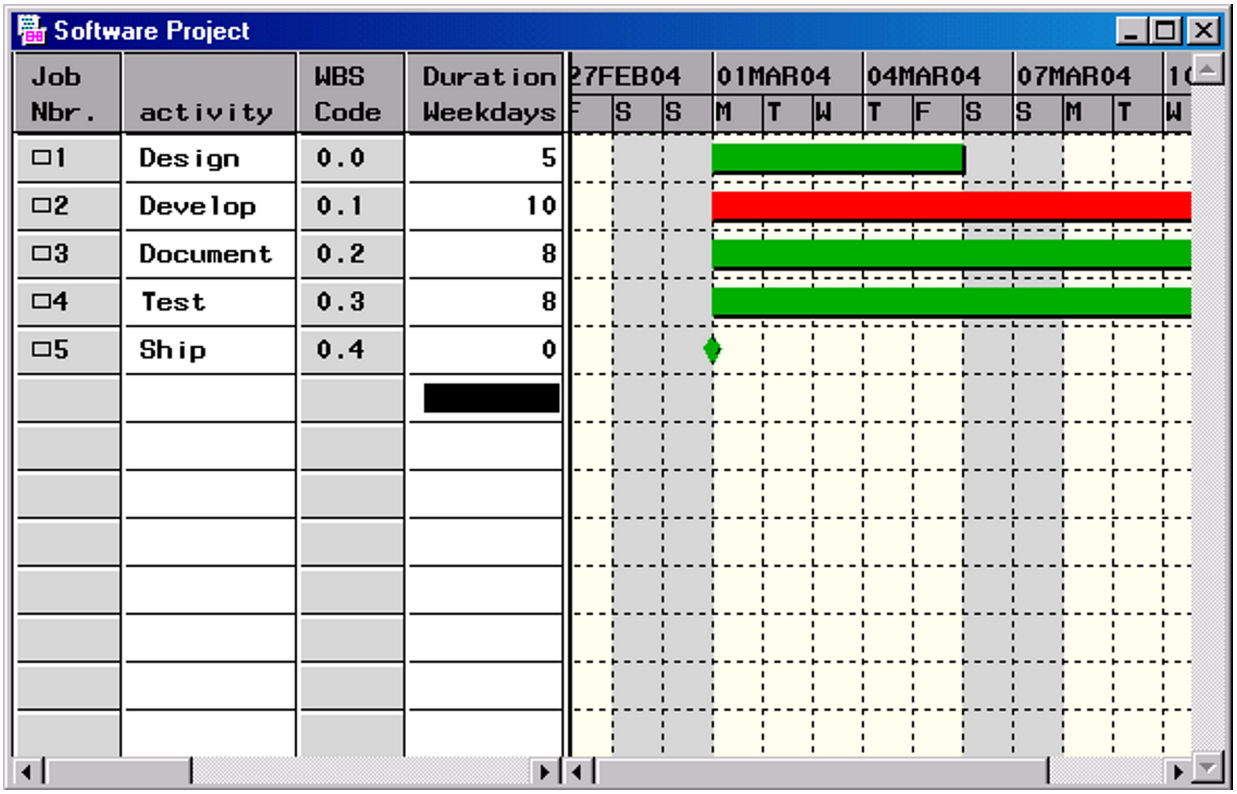


In the PM window, enter the following tasks with the corresponding durations in the Table View:

```
Design          5
Develop        10
Document        8
Test            8
Ship            0
```

As each task is entered, the Schedule columns in the Table View are updated with the early and late start times, and the Early Schedule bars appear in the Gantt View. Output 5.1.2 shows the PM window after the five tasks have been entered. To view the Schedule columns, you can scroll the Table View to the right or use the **View** menu (Figure 5.7) to move the Schedule columns to the left.

Output 5.1.2 List of Tasks in the Software Project

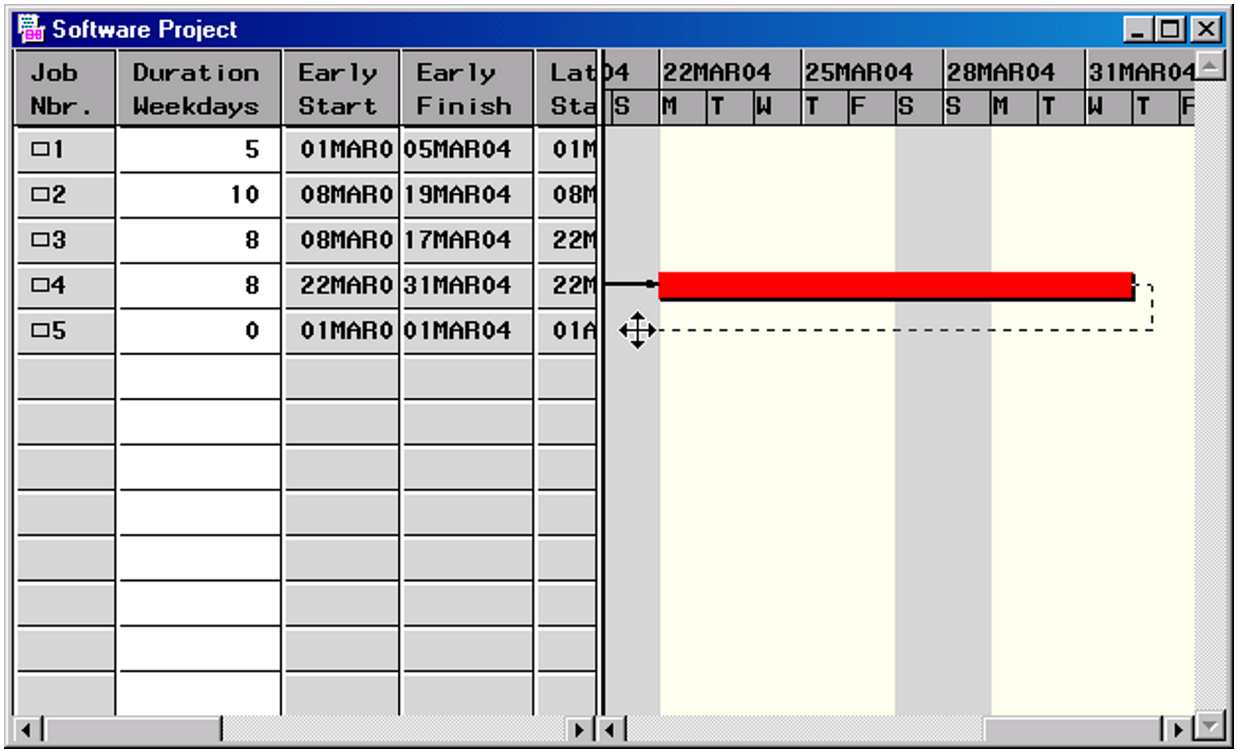


To enter precedence constraints between two activities, such as ‘Design’ and ‘Develop,’ draw an arc, using the left mouse button, from the end of the predecessor task to the beginning of the successor task. Use the Gantt View to enter the following precedence constraints:

```
Design  --> Develop
Design  --> Document
Develop --> Test
Test    --> Ship
```

Output 5.1.3 shows the Software Project as the last precedence constraint is being drawn. Note that, in this view of the PM window, the Schedule columns have been moved to the left, the grid lines in the Gantt View have been turned off (using the menu in Figure 5.12), and the Gantt View has been scrolled to the right to bring the end of the schedule bar for ‘Test’ into view.

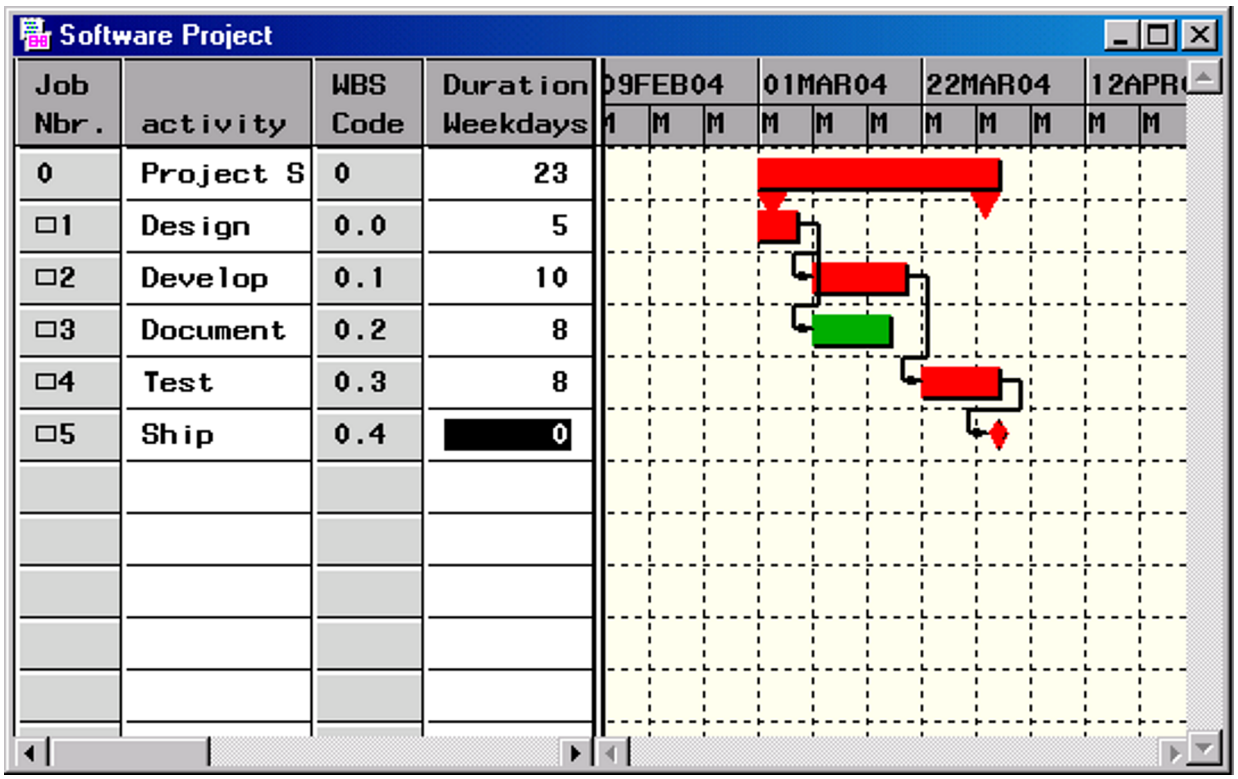
Output 5.1.3 Drawing Precedence Constraints



To check the overall project status, you can bring the Project Summary task into view by selecting **Display Summary Task** from the **View** menu (Figure 5.7). Note that the project duration is 23 days. The critical activities are shown in red while the noncritical ones are green. The Summary Task is indicated by vertical cones at the end of its schedule bar.

For the next few examples, the units used in the Gantt View are changed to "Weeks" by using the **Axis** pop-up menu shown in Figure 5.13, the Summary Task is displayed at the top of the list of activities, and the Activity description columns are shown in the Table View. To save these window settings in the Project data set, select **Project ►Preferences ►Save** from the **Project** menu. The view of the project corresponding to these settings is shown in Output 5.1.4. You can end the interactive editing session by closing the window. All the activity and precedence information is saved in the output data set, SOFTOUT1, displayed in Output 5.1.5. Note the two sets of observations in this data set: the first contains all the schedule information for all the activities, and the second lists all the precedence relationships between activities.

Output 5.1.4 Project Schedule



Output 5.1.5 Schedule Data Set

Schedule Data Set

Obs	OBS_TYPE	PNTID	PROJ_DUR	PROJ_LEV	WBS_CODE	ACTID	SUCCID	duration
1	SCHEDULE	.	23	0	0	0	.	23
2	SCHEDULE	0	.	1	0.0	1	.	5
3	SCHEDULE	0	.	1	0.1	2	.	10
4	SCHEDULE	0	.	1	0.2	3	.	8
5	SCHEDULE	0	.	1	0.3	4	.	8
6	SCHEDULE	0	.	1	0.4	5	.	0
7	LOGIC	.	.	.		1	2	5
8	LOGIC	.	.	.		1	3	5
9	LOGIC	.	.	.		2	4	10
10	LOGIC	.	.	.		4	5	8

Obs	PARENT	activity	SUCCESSR	LAG	ALGNDATE	ALGNTYPE	E_START	E_FINISH
1		Project Summary			.		01MAR04	31MAR04
2	Project Summary	Design			.		01MAR04	05MAR04
3	Project Summary	Develop			.		08MAR04	19MAR04
4	Project Summary	Document			.		08MAR04	17MAR04
5	Project Summary	Test			.		22MAR04	31MAR04
6	Project Summary	Ship			.		01APR04	01APR04
7		Design	Develop		.		.	.
8		Design	Document		.		.	.
9		Develop	Test		.		.	.
10		Test	Ship		.		.	.

Obs	L_START	L_FINISH	T_FLOAT	F_FLOAT	ES_ASC	ES_DESC	LS_ASC	LS_DESC
1	01MAR04	31MAR04	0	0	0	0	0	0
2	01MAR04	05MAR04	0	0	1	5	1	5
3	08MAR04	19MAR04	0	0	2	4	2	4
4	22MAR04	31MAR04	10	10	3	3	3	3
5	22MAR04	31MAR04	0	0	4	2	4	2
6	01APR04	01APR04	0	0	5	1	5	1
7	.	.	.	.	.	.	.	.
8	.	.	.	.	.	.	.	.
9	.	.	.	.	.	.	.	.
10	.	.	.	.	.	.	.	.

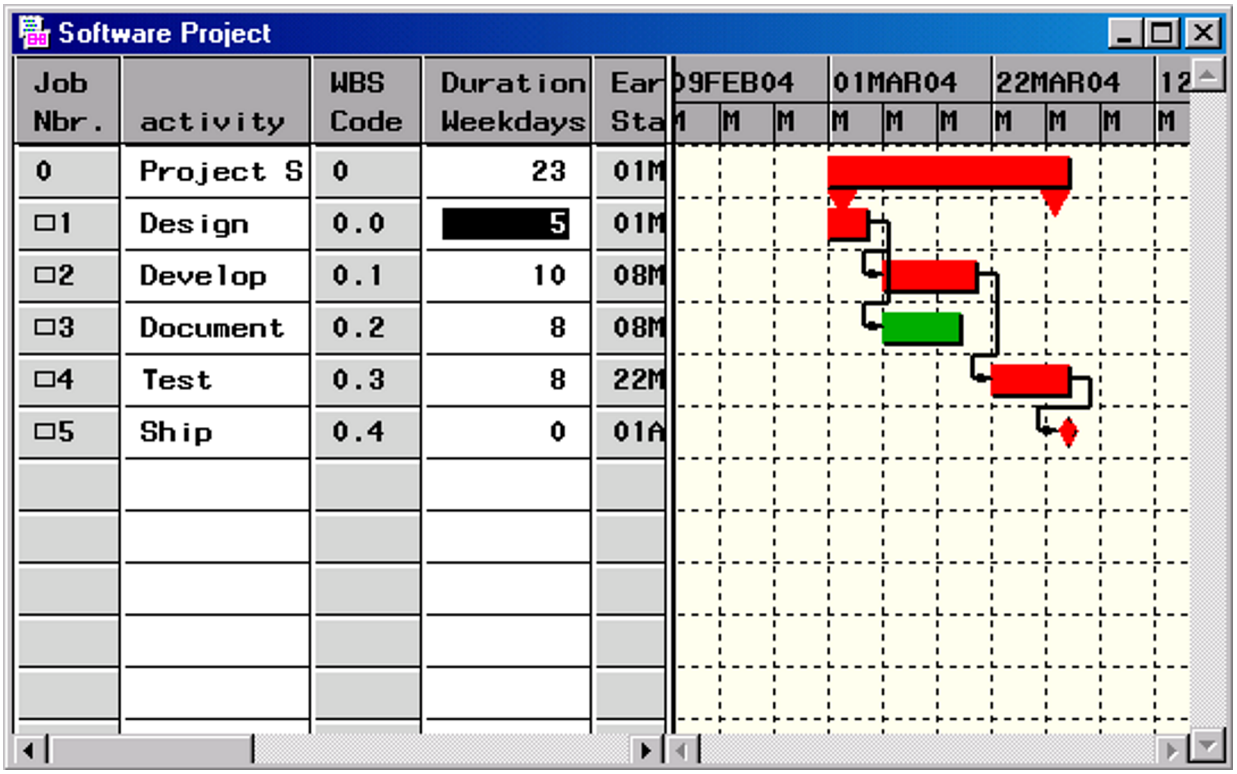
Example 5.2: Adding Subtasks to a Project

In this example, the output data set from Example 5.1 is used as input to PROC PM. The following statements bring up the saved view of the project as shown in Output 5.2.1. Note that this view is identical to the view saved in Output 5.1.4.

```
proc pm data=softout1 project=softattr
        date='1mar04'd interval=weekday
        projname='Software Project'
        out=softout1;
```

```
act actid;
succ succid;
project pntid;
duration duration;
id activity;
run;
```

Output 5.2.1 Project Schedule



In the invocation of PROC PM, the output data set name is the same as the input data set. Thus, it is possible to make changes to the Activity data set using PROC PM and then save the results back to the original data set.

In the current view of the Software Project, you want to add some subtasks to the 'Design' and 'Develop' tasks. Suppose that these two tasks are broken into two subtasks each: one for 'Module 1' and the other for 'Module 2.' Further, you want to remove the precedence constraint between the 'Design' and 'Develop' phases and add constraints between the respective modules. You can accomplish these tasks by making the following editing changes in the PM window.

1. Use the Table View pop-up menu to add the following subtasks to 'Design':

   ```
   Module 1:    5 days
   Module 2:    3 days
   ```

2. Add a link from 'Module 1' to 'Module 2.'

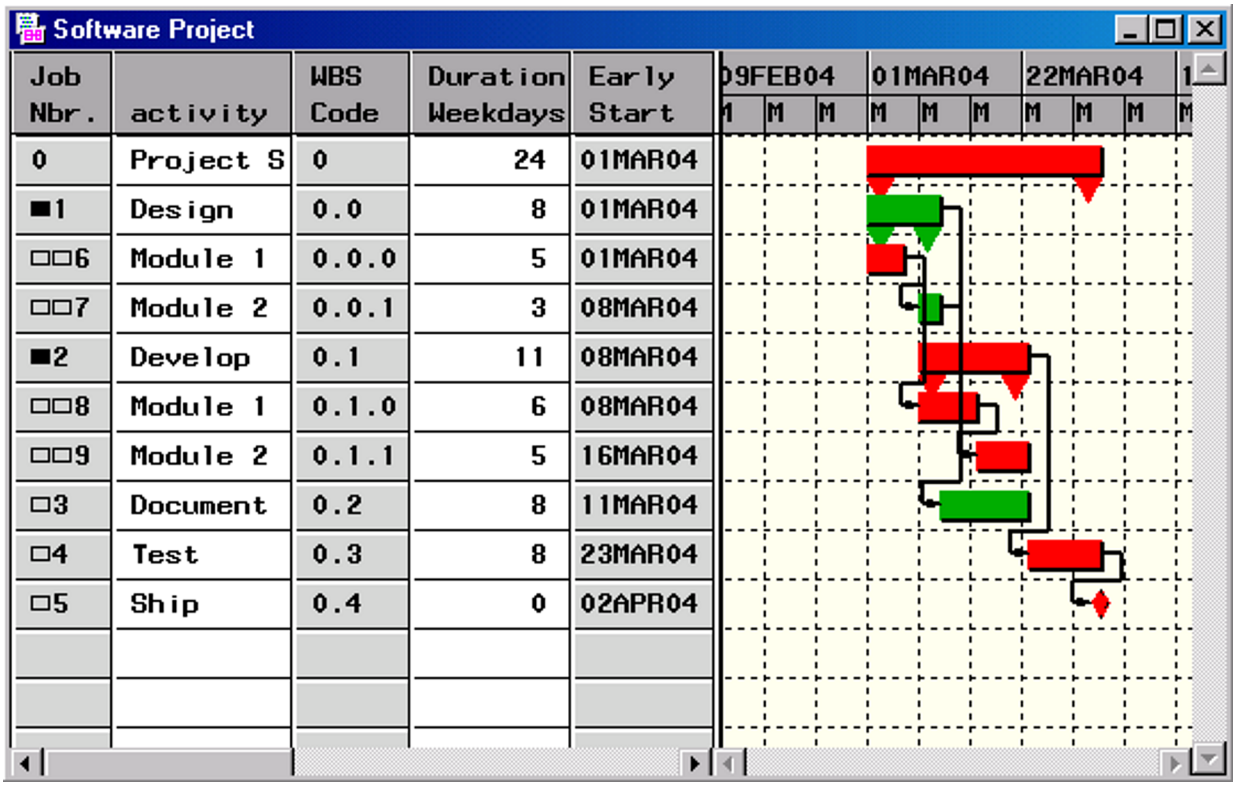
3. Use the Table View pop-up menu to add the following subtasks to 'Develop':

```
Module 1:     6 days
Module 2:     5 days
```

4. Add a link from ‘Module 1’ to ‘Module 2.’
5. Remove the link between the supertasks ‘Design’ and ‘Develop’ by clicking on the arc and selecting **Delete** from the pop-up menu.
6. Add a link from ‘Module 1’ under ‘Design’ to ‘Module 1’ under ‘Develop.’
7. Add a link from ‘Module 2’ under ‘Design’ to ‘Module 2’ under ‘Develop.’

The resulting project schedule is displayed in Output 5.2.2 and saved in the data set SOFTOUT1. Note that the new project duration is 24 days.

Output 5.2.2 Project Schedule



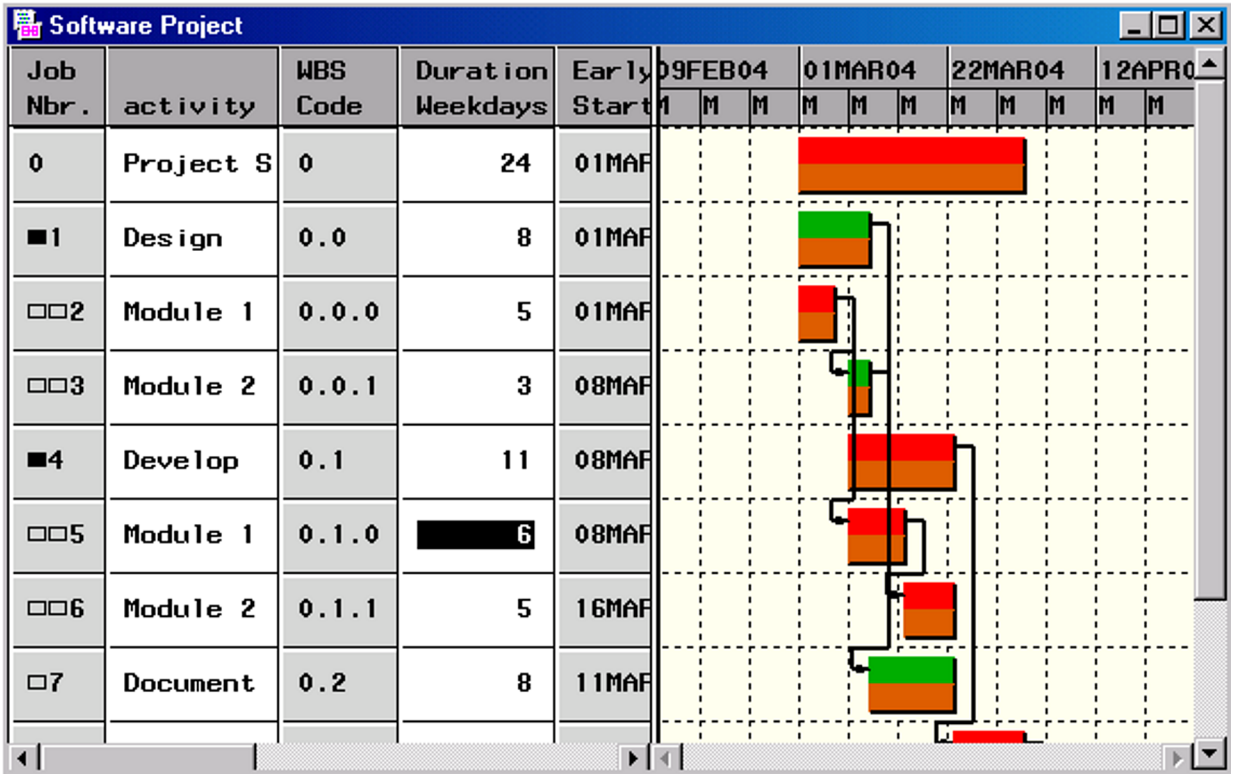
Example 5.3: Saving and Comparing Baseline Schedules

This example shows you how to save a baseline schedule and use it for comparing new schedules. Recall that in Example 5.2 the Schedule data are saved in the data set SOFTOUT1. Thus, the following invocation of PROC PM displays the Software project in its last saved state (as in Output 5.2.2, but with the WBS codes filled in). At the end of the editing session, the schedule is saved in the data set SOFTOUT3.

```
proc pm data=softout1 project=softattr
        date='1mar04'd interval=weekday
        projname='Software Project'
        out=softout3;
   act actid;
   succ succid;
   project pntid;
   duration duration;
   id activity;
   run;
```

Use the **Edit ►Set Baseline** pull-down menu (Figure 5.27) to save the current Early Schedule as a Baseline Schedule. The resulting display is shown in Output 5.3.1. Note that the Gantt View now shows the Baseline Schedule in addition to the Early Schedule. Also, the activities have been numbered to be sequential in the current view (see the section "Renumbering the Activities" on page 329).

Output 5.3.1 Using Baseline Schedules



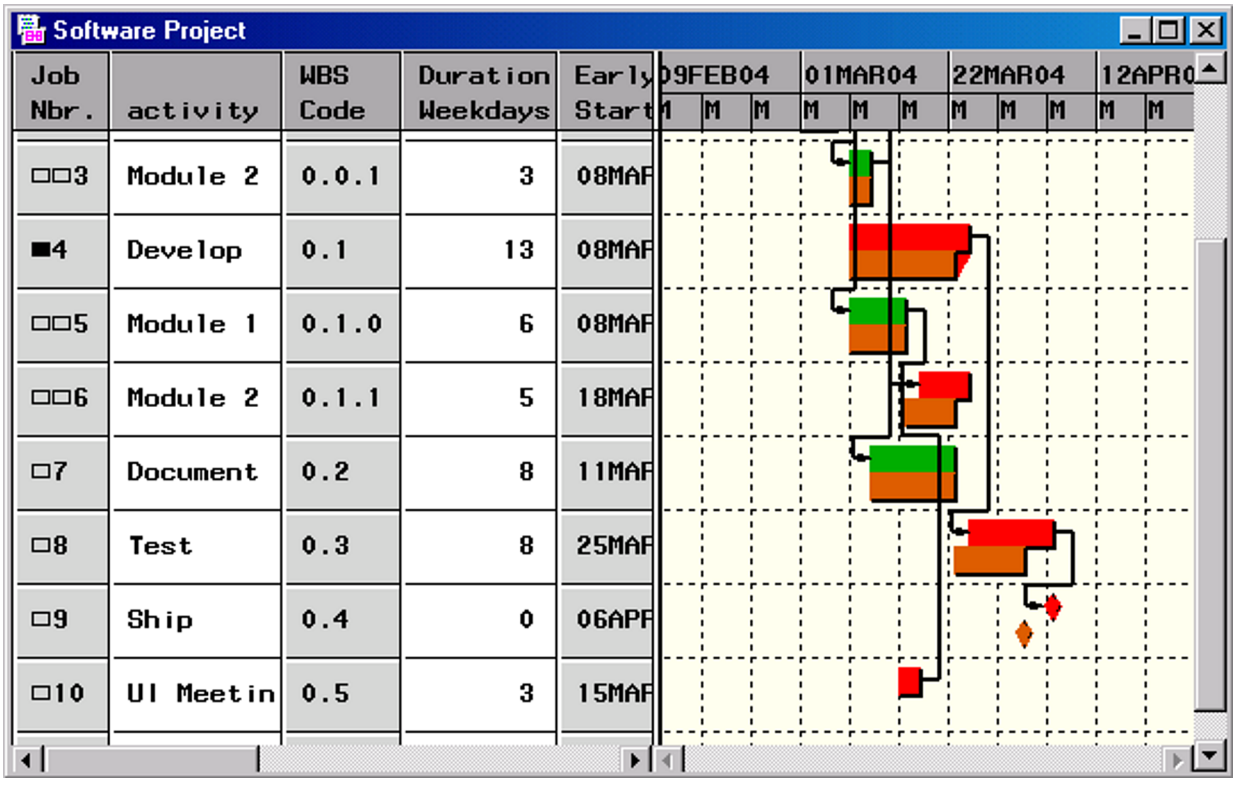
The baseline schedule is useful in determining the effect of changes to the project on the schedule. For example, suppose there is a directive from the director of your division that all the developers are required to attend a User Interface Standards Meeting before starting the development of Module 2. This meeting has been scheduled to start on March 15, 2004, and is expected to take 3 days. What is the effect of this directive on your project schedule?

To see the effect, you can make the following changes in the PM window:

1. Add a new task to the project by selecting **New Task** from the **Edit** pull-down menu.
2. To edit the newly entered task, you may need to scroll down.
3. Type in the name of the task: 'UI Meeting.' Set its duration to 3.
4. In the Gantt View, draw a link from this new task to Task 6 ('Module 2' under 'Develop.')
5. Also in the Gantt View, drag the task, 'UI Meeting,' to the tick mark corresponding to 15Mar04.

The resulting view is shown in Output 5.3.2. Note that the view may differ depending on the display parameters of your device. It is easy to see that, due to the 3-day meeting that is mandated, there is a delay in the project schedule (the project duration is now 26 days).

Output 5.3.2 Effect of UI Meeting on Schedule



You can get a complete picture of the effect on the schedule by examining all the Schedule columns that are shown in the Table View. Output 5.3.3 shows the Schedule columns, the Baseline columns, and the Target Date and Type columns in the Table View. To obtain this view, some of the columns have been moved and the Baseline Schedule bars (in the Gantt View) have been hidden from the display.

Output 5.3.3 Table View Showing All Schedules

Software Project

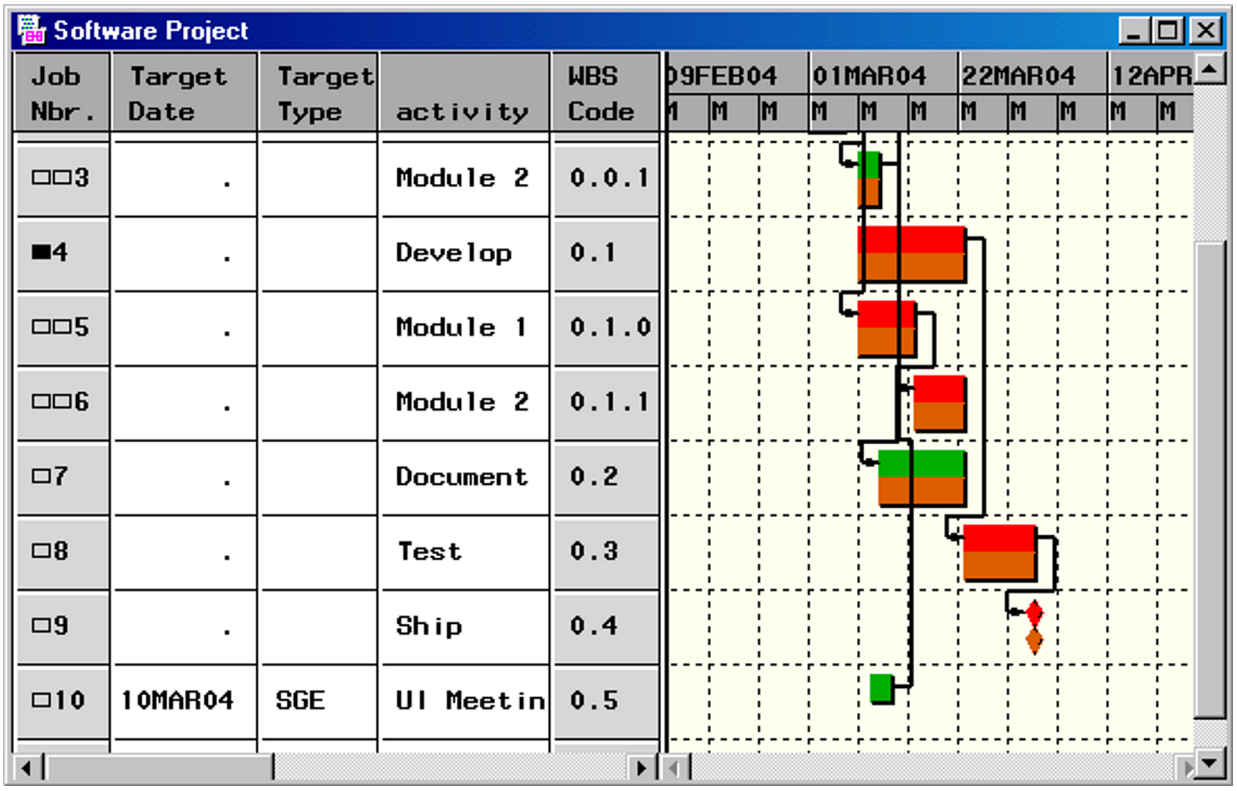
Job Nbr.	activ	Dura Week	Early Start	Early Finish	Late Start	Late Finish	Baselin Start	Baselin Finish	Target Date	Targ Type
0	Proje	26	01MAR04	05APR04	03MAR04	05APR04	01MAR04	01APR04	.	
■1	Desig	8	01MAR04	10MAR04	03MAR04	17MAR04	01MAR04	10MAR04	.	
□□2	Modul	5	01MAR04	05MAR04	03MAR04	09MAR04	01MAR04	05MAR04	.	
□□3	Modul	3	08MAR04	10MAR04	15MAR04	17MAR04	08MAR04	10MAR04	.	
■4	Devel	13	08MAR04	24MAR04	10MAR04	24MAR04	08MAR04	22MAR04	.	
□□5	Modul	6	08MAR04	15MAR04	10MAR04	17MAR04	08MAR04	15MAR04	.	
□□6	Modul	5	18MAR04	24MAR04	18MAR04	24MAR04	16MAR04	22MAR04	.	
□7	Docum	8	11MAR04	22MAR04	25MAR04	05APR04	11MAR04	22MAR04	.	
□8	Test	8	25MAR04	05APR04	25MAR04	05APR04	23MAR04	01APR04	.	
□9	Ship	0	06APR04	06APR04	06APR04	06APR04	02APR04	02APR04	.	
□10	UI Me	3	15MAR04	17MAR04	15MAR04	17MAR04	.	.	15MAR04	SGE

If the project delay resulting from the UI Meeting is of concern, you may want to schedule the meeting on an earlier date. Suppose the revised start date of the meeting is March 10, 2004. To see the effect of the change, you can do the following:

1. Revert to the saved project preferences so that both the Table and the Gantt Views are visible.
2. Use the **View** menu to move the Target Date column to the left in the Table View.
3. Scroll down, if necessary, to bring the task ‘UI Meeting’ into view.
4. Change the Target Date column for this task to `'10Mar04.'`

The resulting view is displayed in Output 5.3.4. Note that, as a result of this change, all the activities are back on schedule as the new schedule coincides with the saved baseline schedule. The last activity was defined after the baseline schedule had been saved in Example 5.2; hence, there is no baseline schedule bar for this activity. You can use the **Fill Missing Baseline** selection from the menu shown in Figure 5.26 to set the baseline schedule for the ‘UI Meeting’ to be the current early schedule.

Output 5.3.4 Editing Target Date



Example 5.4: Effect of Calendars

Continuing with the project scenario in the preceding examples, you want to explore other ways of shortening the project duration. One possible alternative is to work overtime. As the project manager, you would like to see the effect on the schedule if you change the calendar for all the development tasks to a six-day calendar.

Calendars are defined using the Calendar data set, as in the CPM procedure. This example defines a Calendar data set and invokes PROC PM as follows. Note that, in order to use calendars, the Activity data set needs to have a CALID variable, which is added in a simple DATA step.

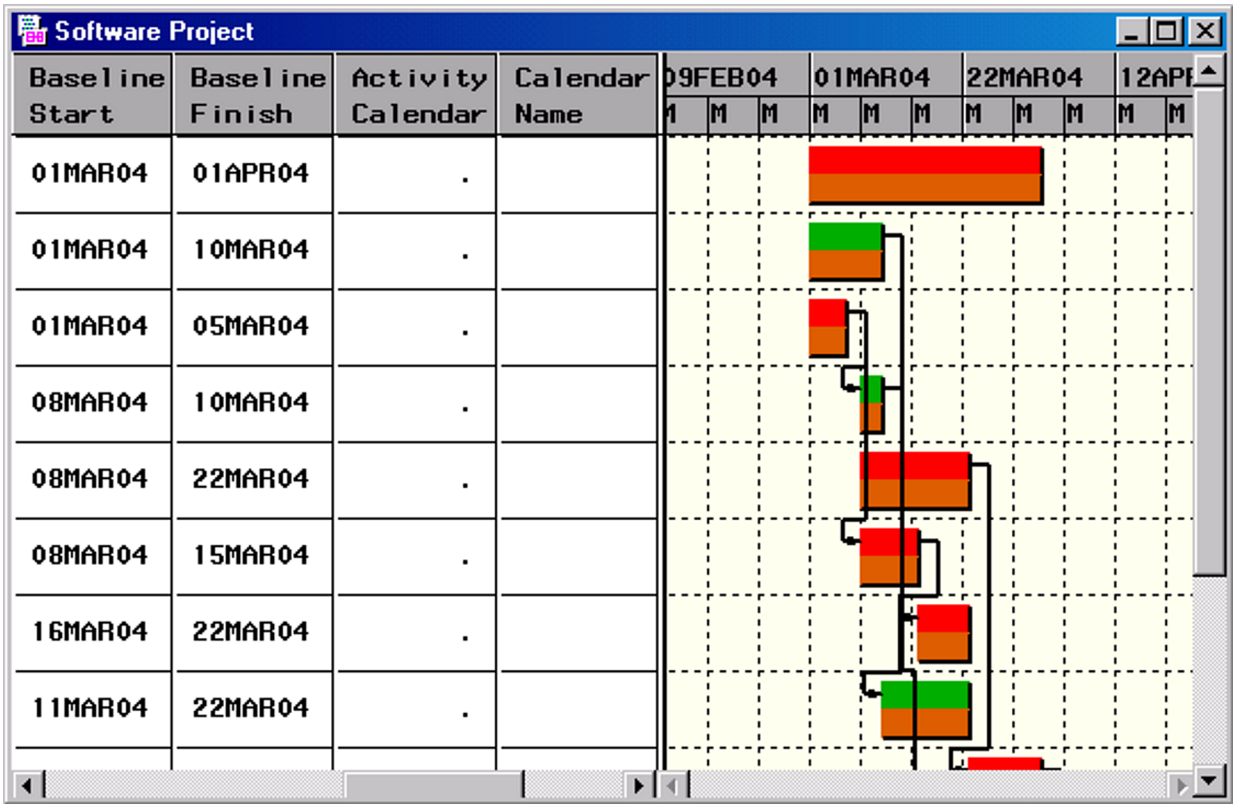
```
*  Define a Calendar data set identifying          ;
*  Saturday as a workday                           ;
data calendar;
   input calid calname $ _sat_ $;
   datalines;
1 Sixday WORKDAY
;

*  Add the CALID variable to the Activity data set  ;
*  saved in the preceding example                   ;
data softout3;
   set softout3;
   calid=.;
   run;
```

```
*  Use softout3 as the Activity data set and specify ;
*  the preceding calendar data set                    ;
proc pm data=softout3 project=softattr
        calendar=calendar
        date='1mar04'd interval=weekday
        projname='Software Project'
        out=softout4;
   act actid;
   succ succid;
   project pntid;
   duration duration;
   id activity;
   calid calid;
   run;
```

When the PM procedure initializes the PM window, it attempts to restore all the display settings using the values in the Project data set, SOFTATTR. However, the new Activity data set has an extra variable, calid, which leads to two new columns in the Table View, one for the Activity Calendar (which displays the Calendar ID) and the other for the Calendar Name. These columns are added at the right end of the Table View and can be seen by scrolling to the right. The resulting view is displayed in Output 5.4.1.

Output 5.4.1 Calendar Columns



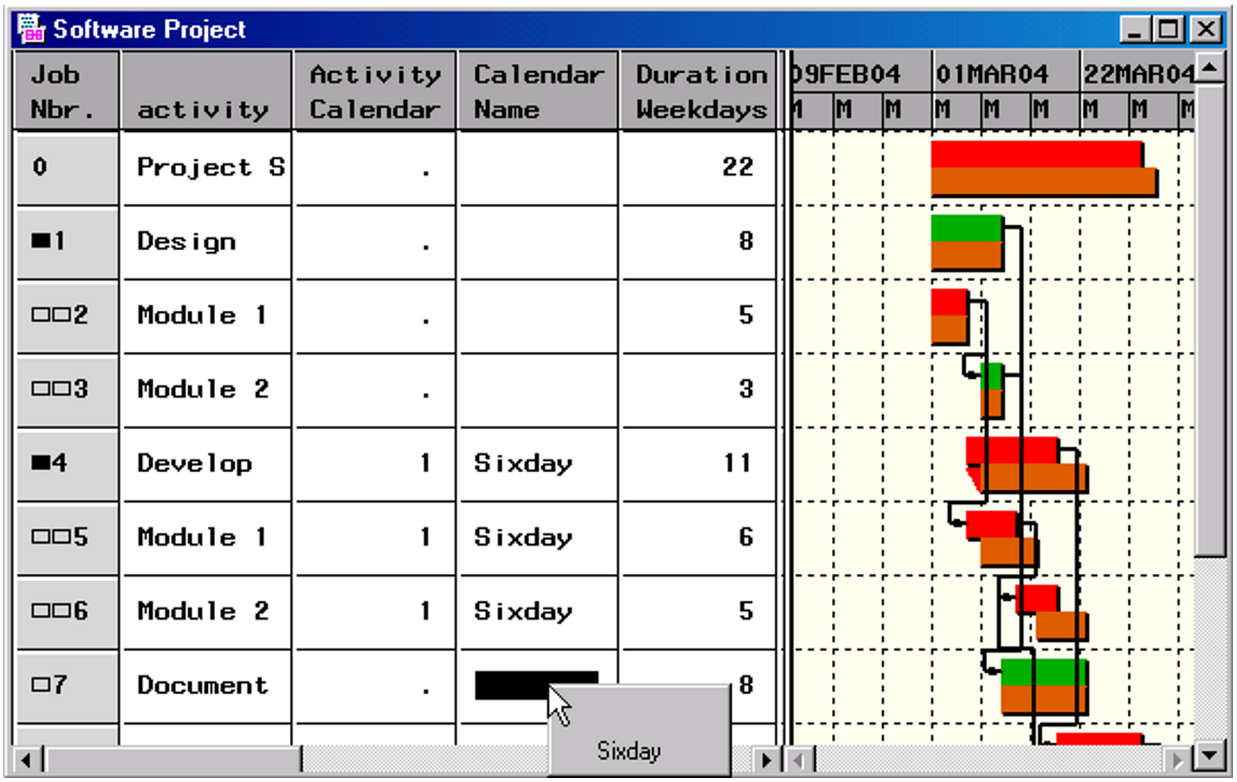
By default, all the activities are assumed to follow the standard five-day calendar. Now, you want to change the calendar for the supertask 'Develop' and all its subtasks to be the six-day calendar defined in the data set CALENDAR. Note that, in the calendar definition, it is sufficient to specify that Saturday is a working

day. All the other days of the week default to the default calendar's work pattern; see "Default Calendar" on page 104 in Chapter 4, "The CPM Procedure."

To facilitate the editing of the calendar values and to see the effect on the project duration, reorder the columns (drag the columns in the Table Header) to display the activity, Activity Calendar, Calendar Name, and Duration columns in the Table View. You may need to move the dividing line between the Table and Gantt Views.

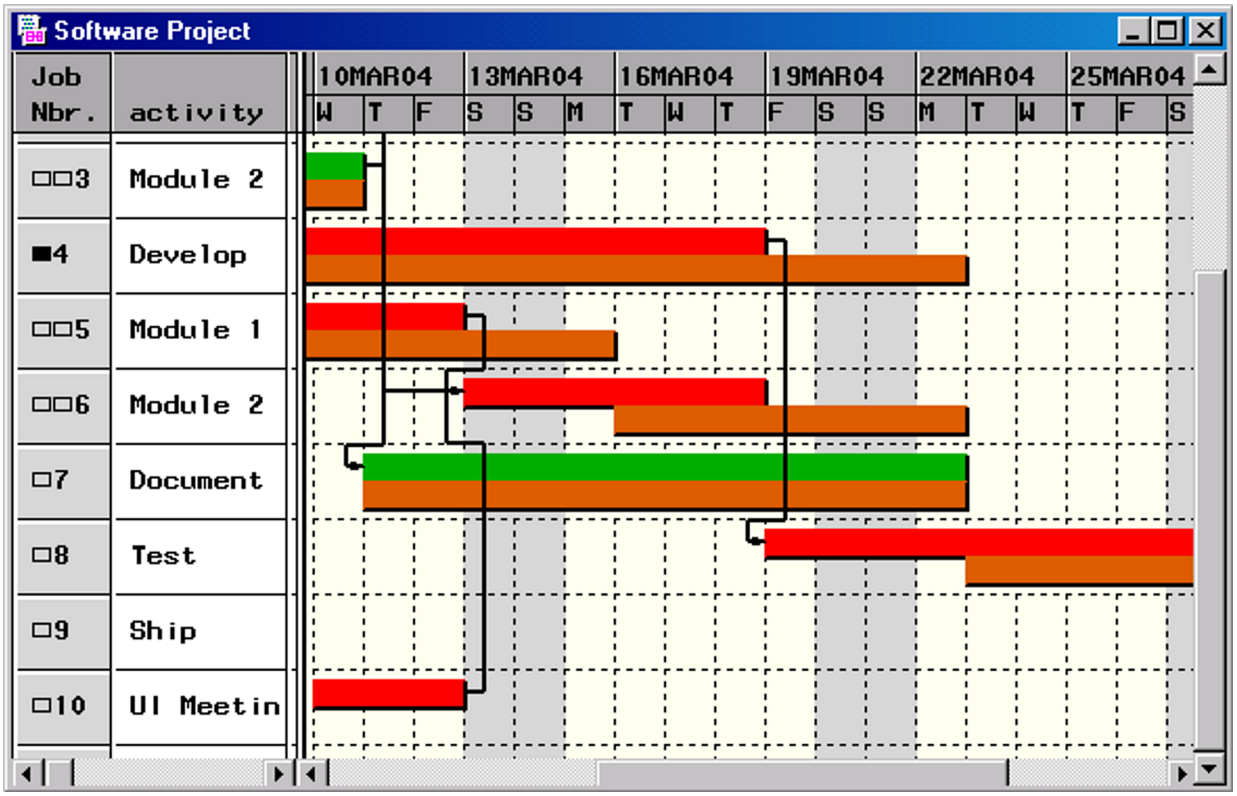
You can enter the Calendar values by typing the number 1 in the Activity Calendar column or the value `'Sixday'` in the Calendar Name column. You can also use the Calendar pop-up menu in one of the calendar columns to select the desired calendar (see Output 5.4.2). Note that the project duration has reduced to 22 days as a result of the six-day calendar.

Output 5.4.2 Effect of Six-Day Calendar



To see the effect on the individual activities, change the units to "Days" in the Gantt View and enlarge the Gantt View, as shown in Output 5.4.3.

Output 5.4.3 Gantt View of Calendar Effect



Example 5.5: Defining Resources

In all the preceding examples, it was assumed that you had enough resources to work on the different tasks. Unfortunately, as a project manager you need to schedule your project using the limited set of resources available to you. In this example, you will assign some project resources and schedule the project subject to resource constraints.

In order to assign resources to the tasks, you need to add resource variables to the Activity data set as well as define a resource availability (Resource) data set.

Suppose that the resources that you are interested in are Tester and Programmer. The following statements set up the project data needed to perform resource-constrained scheduling with PROC PM using the output data produced in Example 5.4.

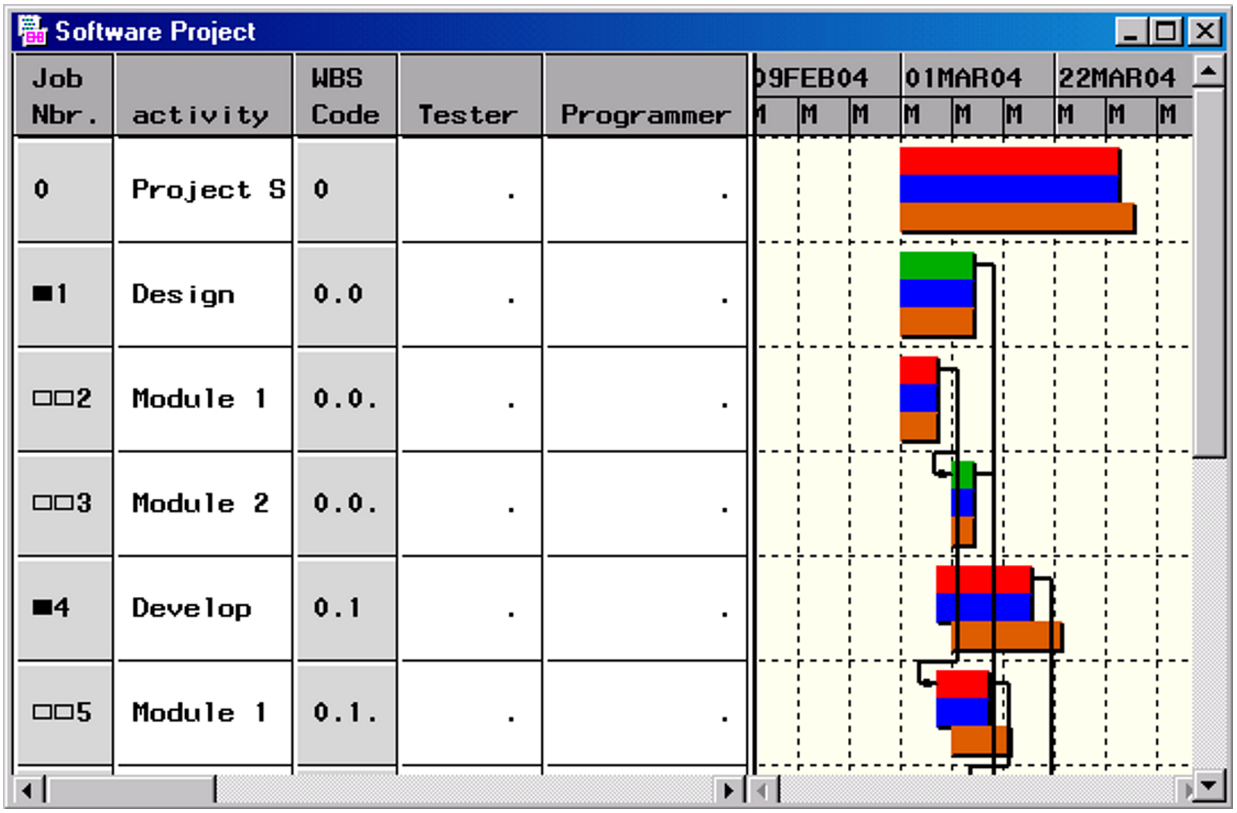
```
*  Define a Resource data set specifying   ;
*  1 Tester and 1 Programmer as the        ;
*  available resources                     ;
data resources;
   input _date_ date7. Tester  Programmer;
   datalines;
01jan04  1  1
;

*  Add the resource variables Tester and       ;
*  Programmer to the Activity data set         ;
```

```
*  (the output data set saved in last example) ;
data softout4;
   set softout4;
   Tester=.;
   Programmer=.;
   run;

*  Use softout4 as the Activity data set and    ;
*  specify the preceding Resource data set.     ;
*  Save the schedule in softout5.               ;
proc pm data=softout4 project=softattr
        calendar=calendar
        resourcein=resources
        date='1mar04'd interval=weekday
        projname='Software Project'
        out=softout5;
   act actid;
   succ succid;
   project pntid;
   duration duration;
   id activity;
   calid calid;
   resource Tester Programmer / per=_date_;
   run;
```

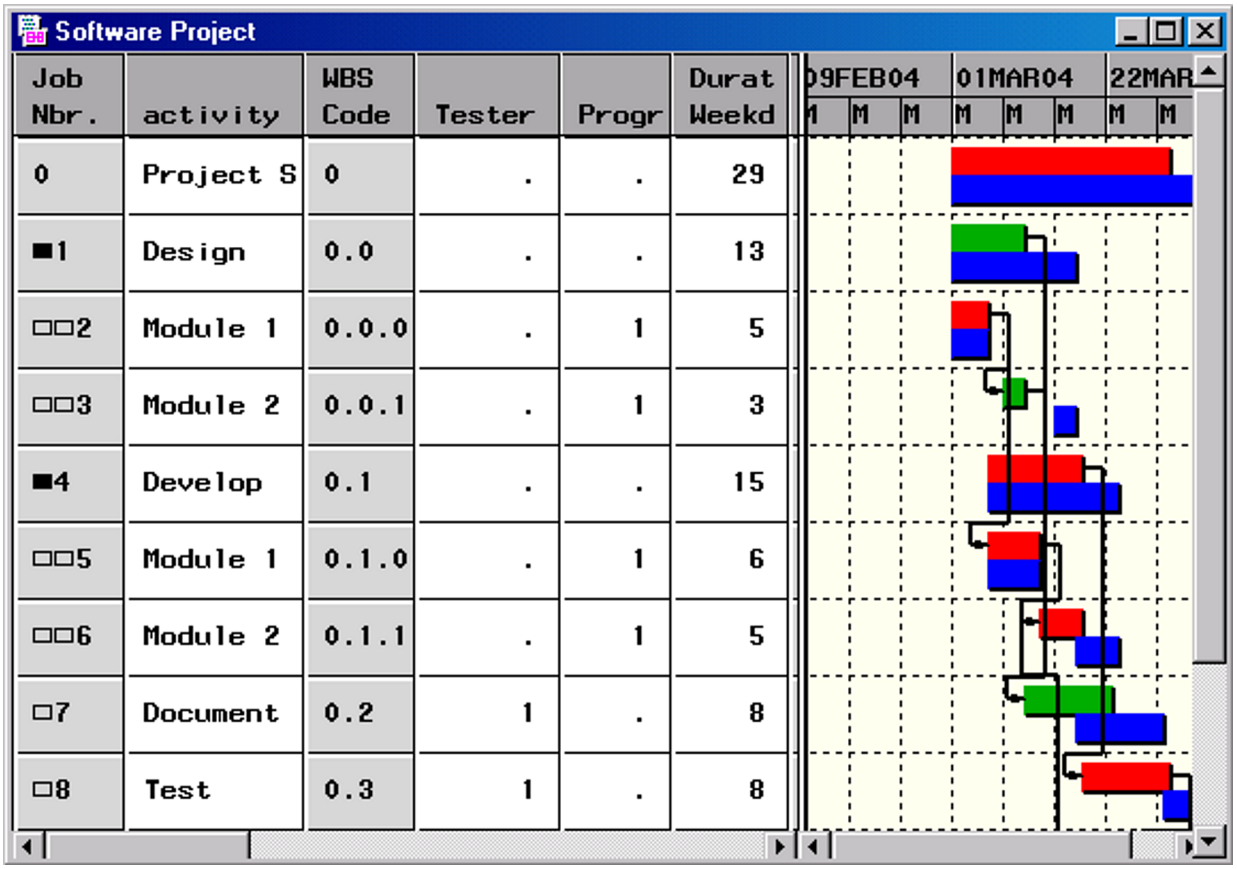
Output 5.5.1 Adding Resources to the Project



Output 5.5.1 shows the Table and Gantt Views of the project after rearranging some of the columns and moving the dividing line to show the resource columns. The Resource Schedule bars are also brought into display by right-clicking on the background in the Gantt View and selecting **Resource Schedule**. The Resource Schedule bar is shown (in blue) between the Early Schedule bar and the Baseline Schedule bar. Note that the resource schedule coincides with the early schedule because no resource requirements have been specified for either of the two resources.

You can now use the Table View to enter the resource requirements for each task. Set the requirement for the resource Tester to `'1'` for the tasks 'Document' and 'Test,' and the requirement for the resource Programmer to '1' for the tasks numbered '2,' '3,' '5,' and '6.' The resulting schedule is displayed in Output 5.5.2. In this view, the baseline schedule is not displayed. You can see that several of the tasks have been delayed, resulting in lengthening the project duration to 29 weekdays.

Output 5.5.2 Editing Resource Requirements



You can set the resource-constrained schedule as a baseline to do some "what-if" analysis. For example, suppose you would like to determine the effect of adding another programmer to the project. In order to change the resource availability, you need to save the current project, edit the Resource availability data set to add another programmer, and then reinvoke the PM procedure.

First, in the PM window displayed in Output 5.5.2, do the following:

1. Display the Baseline Schedule bar again.
2. Use the **Replace Baseline** selection from the **Edit** menu to select the Resource Schedule as the new baseline schedule.
3. Save the project preferences.
4. Close the PM window.

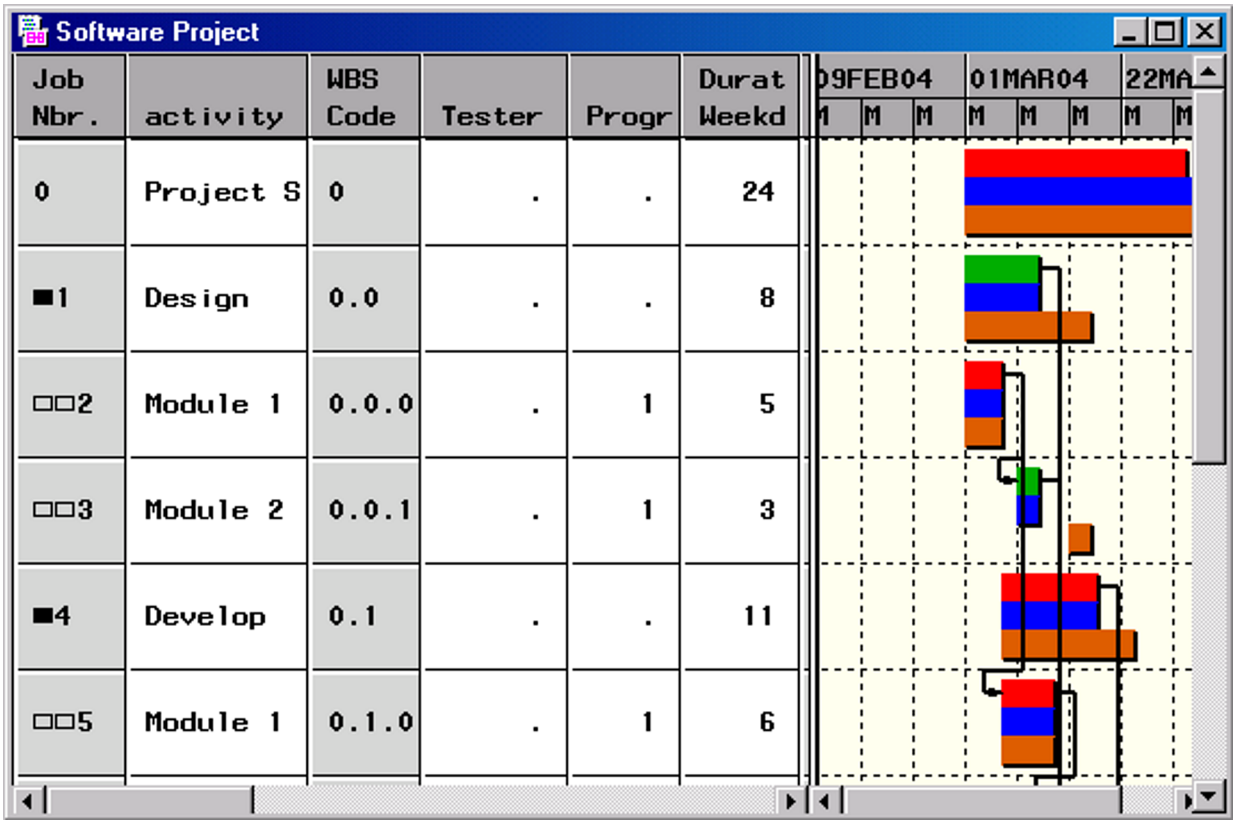
Use the following statements to reinvoke PROC PM after defining a new resource availability:

```
*  Change the resource availability for Programmer to 2 ;
data resources;
   input _date_ date7. Tester  Programmer;
   datalines;
01jan04  1  2
;

*  Use softout4 as the Activity data set and specify ;
*  the preceding Resource data set.                  ;
*  Save the schedule in softout5.                    ;
proc pm data=softout4 project=softattr
        calendar=calendar
        resourcein=resources
        date='1mar04'd interval=weekday
        projname='Software Project'
        out=softout5;
   act actid;
   succ succid;
   project pntid;
   duration duration;
   id activity;
   calid calid;
   resource Tester Programmer / per=_date_;
   run;
```

Using the new resource availability, you reduced the project duration by five days. The resulting schedule is displayed in Output 5.5.3, which also shows the baseline schedule corresponding to the earlier resource availability data set.

Output 5.5.3 Comparison of Two Resource Schedules



Example 5.6: Editing Progress

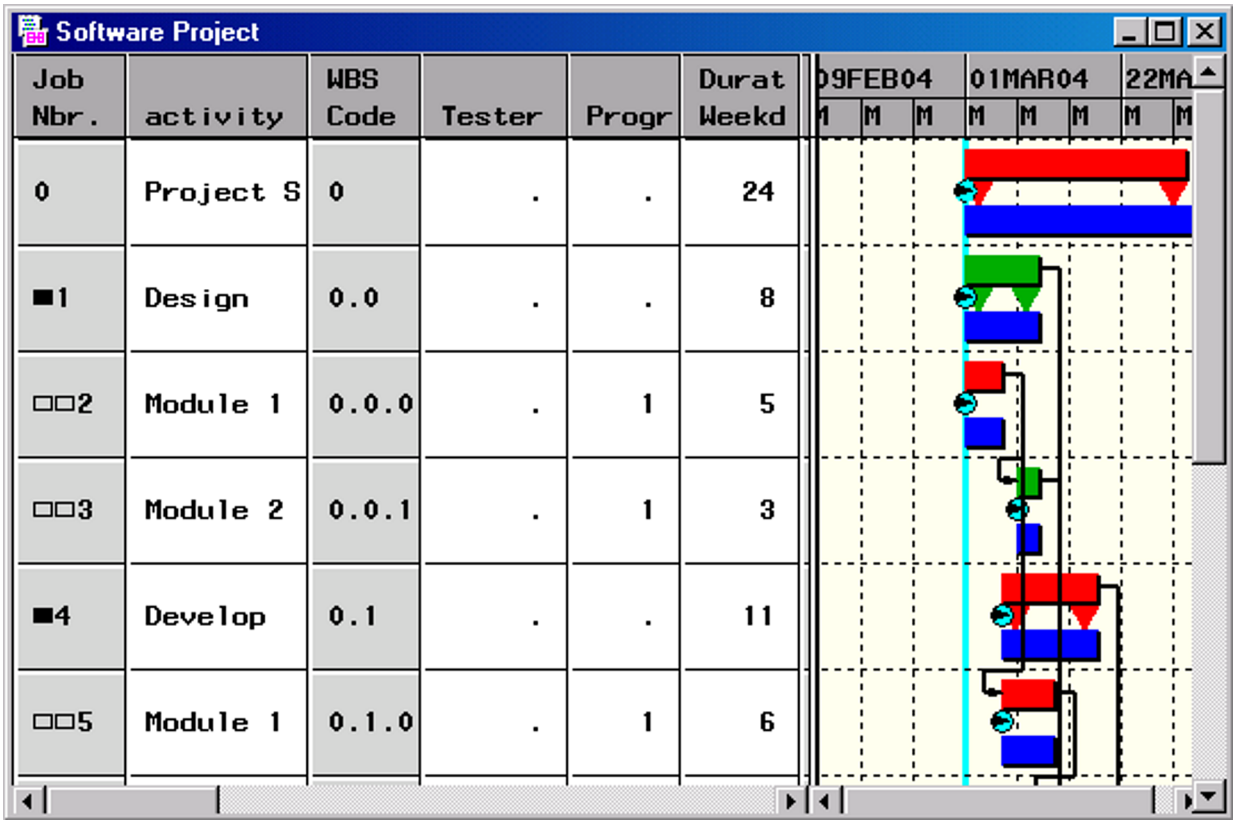
Once a project plan has been established and the project is under way, a major part of a project manager's responsibility is to monitor the project as it progresses. This example uses the PM window to add progress information to the project and discusses some of the related editing functions.

In the final window of Example 5.5 (shown in Output 5.5.3), do the following:

1. Delete the baseline schedule using the **Edit** menu.
2. From the **Edit** menu, select **Add Progress**.

The resulting display is shown in Output 5.6.1. The Gantt View now shows the Actual Schedule bar between the Early Schedule bar and the Resource Schedule bar. It also displays a Timenow Line. Since no progress information has been entered, the Timenow Line is drawn at the beginning of the project and all the Actual Schedule bars show only a handle that can be used to drag progress for a particular task.

Output 5.6.1 Adding Progress Information to Project

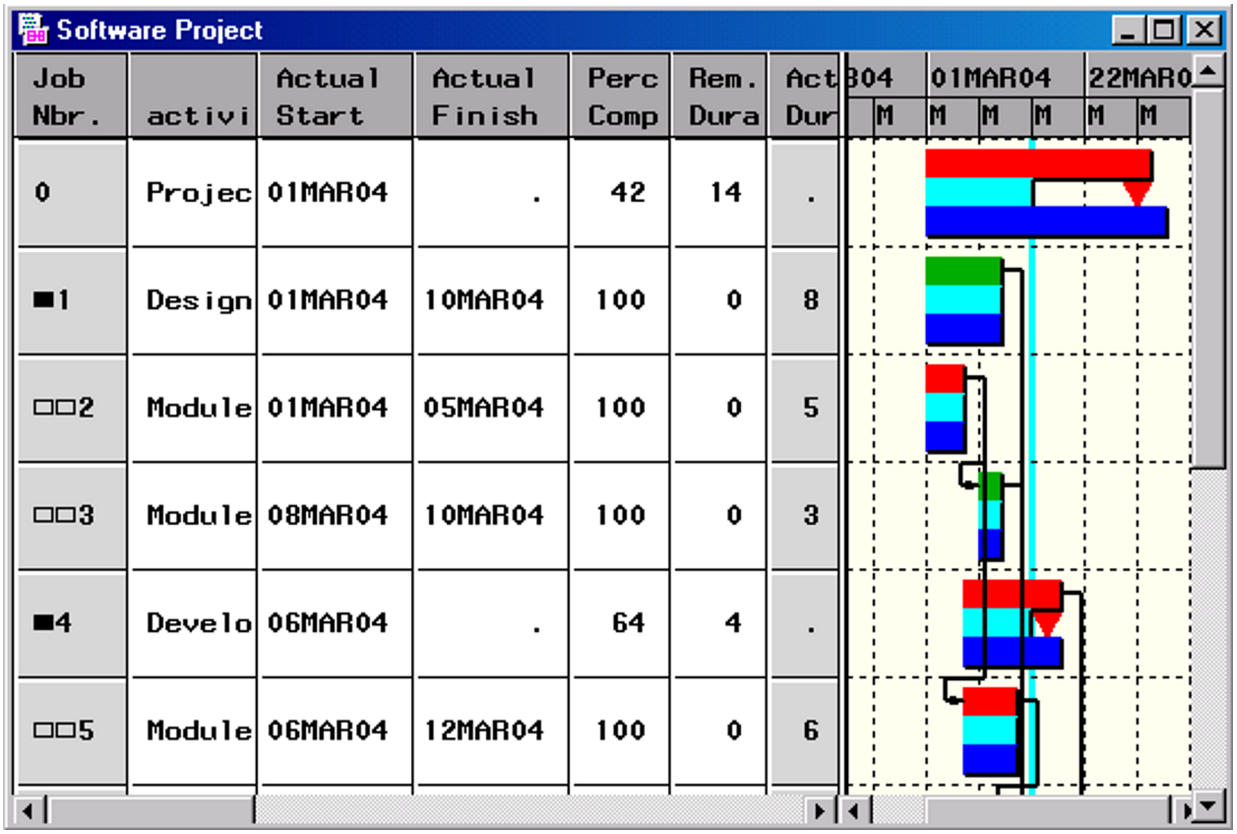


You can enter progress information in several ways:

- Drag the Timenow Line to update progress information for several tasks at once. The actual start and finish times (until the Timenow date) are set assuming that the tasks follow the resource-constrained schedule. (If there are no resource constraints, the tasks are assumed to follow the early schedule.)
- Use the handle on the Actual Schedule bar for a given task to drag the progress bar.
- Bring the Progress columns into view in the Table View and edit one of the Progress columns.

As an example, drag the Timenow Line to the tick mark corresponding to 15MAR04. The resulting window (after reordering and resizing some columns and scrolling the Gantt View) is shown in Output 5.6.2.

Output 5.6.2 Moving the Timenow Line



Note that some of the activities are completed while others are still in progress. If the project data are saved at this point, the Schedule data set will have all the Progress variables (A_START, A_FINISH, PCT_COMP, and REM_DUR). However, for the PM procedure to be able to recapture the exact state of the schedule as it was saved, it also needs to know the value of TIMENOW when the project data was last saved. This value (`'15Mar04'` for the current example) is saved as a macro variable named TIMENOW (see the section "Macro Variable TIMENOW" on page 330).

To see how the Actual information can be used from one invocation of PROC PM to the other, save the project as displayed in Output 5.6.2 and then reinvoke PROC PM to continue editing the progress information.

Recall from the last invocation of PROC PM that the data are saved in the data set SOFTOUT5. To use the saved progress information, invoke PROC PM as follows:

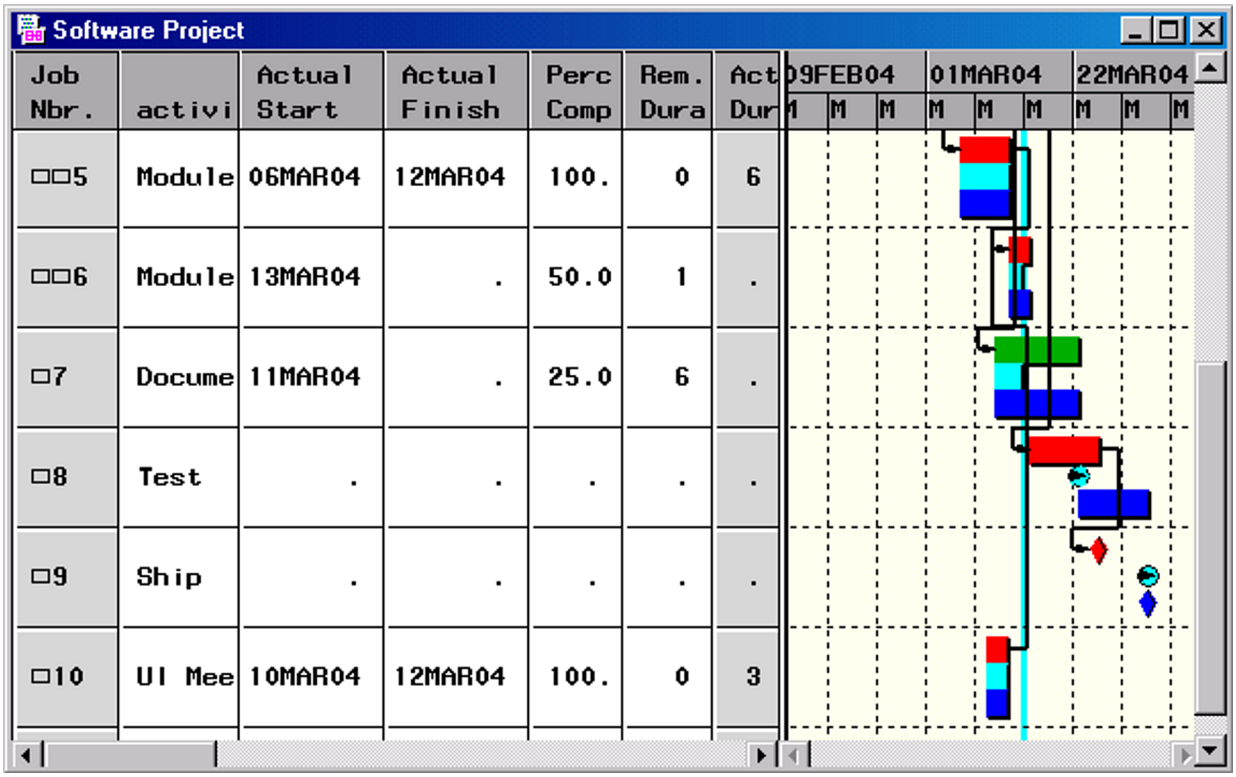
```
*  Use softout5 as the Activity data set and specify  ;
*  the Resource data set defined in the last example. ;
*  Save the schedule in softout6.                     ;
proc pm data=softout5 project=softattr
        calendar=calendar
        resourcein=resources
        date='1mar04'd interval=weekday
        projname='Software Project'
        out=softout6;
   act actid;
   succ succid;
   project pntid;
```

```
duration duration;
id activity;
calid calid;
*  Use the ACTUAL statement to specify the Progress variables  ;
*  and the value of TIMENOW saved from the previous invocation ;
actual / as=a_start af=a_finish
         remdur=rem_dur pctcomp=pct_comp
         timenow=&timenow;
resource Tester Programmer / per=_date_;
run;
```

The preceding program displays the PM window for the updated Software project. Now use the Table View to edit some of the Progress columns. To do so, you can either scroll to the Progress Columns or move these columns to the left in the Table View using the appropriate selection from the **View** menu (Figure 5.9).

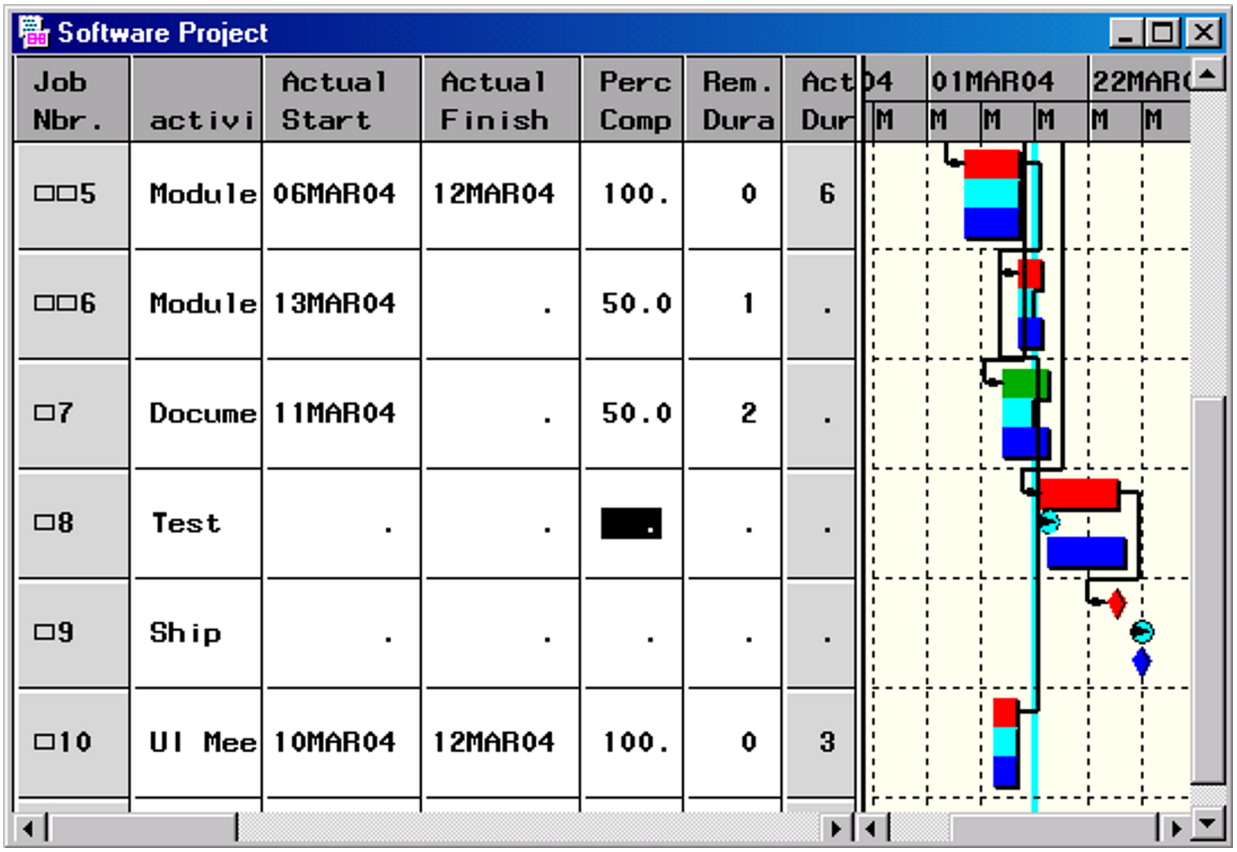
Task number 6 (‘Module 2’ under ‘Develop’) has a Remaining Duration value of 4. Now, you may notice that you have misjudged the amount of work involved and that you need only one more day to finish the task. Enter 1 in the Remaining Duration column. This editing change immediately causes the Percent Complete column to update to 50, indicating that 50% of the work is completed. The resulting effect on the project schedule is shown in Output 5.6.3 (the window has been scrolled down so that the second half of the project is visible). Note that reducing the duration of the ‘Module’ task did not affect the project end date; the duration of the project is still 24 days. Studying the schedule of the ‘Document’ and ‘Test’ tasks, you notice that the delay to the project is caused by the fact that the resource-constrained schedule of the task ‘Test’ is delayed due to resource constraints.

Output 5.6.3 Editing the Remaining Duration Column



In addition to revising the progress information for ‘Module 2,’ you also realize that the ‘Document’ task is 50% complete as of the Timenow date. Edit the Percent Complete column in the Table View, changing the value from 25.0 to 50.0. Immediately, the Remaining Duration column changes to 2. The resulting window is shown in Output 5.6.4. The project end date (for the resource-constrained schedule) is 28Mar04. Thus, the project duration is now reduced to 20 days.

Output 5.6.4 Editing the Percent Complete Column



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