

## 6.0 Process Scheduling

Process scheduling deals with the time-dependent operation of batch processes. Pro-Designer provides facilities for handling process scheduling and identifying scheduling-related bottlenecks. This chapter describes the process scheduling features and capabilities of Pro-Designer. More specifically, Section 6.1 of this chapter provides definitions of variables related to process scheduling. Section 6.2 provides information on the scheduling data that are related with each procedure, operation and the entire recipe. Section 6.3 describes the interface for initializing and viewing scheduling-related data. Finally, section 6.4 provides a brief description of the key scheduling calculations.

### 6.1 Definitions

**Setup Time:** the amount of time (per cycle) spent before each operation is carried in preparation for the actual execution of the operation. It may involve actions like cleaning, vacuuming, setting up of equipment, etc. which the user opted not to model explicitly.

**Process Time:** the amount of time (per cycle), that the operation's equipment is in use carrying out the operation. The process time is either specified by the user or calculated by the program if the hosting equipment is in rating mode (the size/capacity of the equipment is specified). For some purely cyclical unit operations, such as chromatography, the process time is always calculated. For inherently continuous unit operations (operating semi-continuously in a batch plant), the cycle time is always specified.

**Turnaround Time:** the amount of time (per cycle), that the operation's equipment is being prepared for the next cycle (cleaning, transferring of material, sterilization, etc. that is not explicitly modeled but simply lumped up inside the main operation).

**Operation Cycle Time:** the amount of time it takes for an operation's cycle to be performed. The Operation Cycle Time is the sum of the Setup Time, Process Time and the Turnaround Time.

**Procedure Cycle Time:** the amount of time it takes for an entire procedure (i.e. the sequence of all the operations inside the procedure) to be carried out once. The Procedure's Cycle Time is equal to the time elapsed between the start of the first operation in the procedure and the end of the last operation in the sequence. Note that it a procedure's cycle time is not necessarily equal to the sum of the operations' cycle times.

**Number of Cycles:** the number of times that a procedure's cycle must be repeated in order for the procedure to complete processing the entire amount required per batch.

**Procedure Time:** the total amount of time it takes for a procedure to be completed. It is equal to the product of the Number of Cycles times the Procedure Cycle.

**Start Time Shift:** the time elapsing between the start of an operation and a reference point in time. The reference point can be:

- (a) the start of the batch
- (b) the end (or start) of the previous operation in the sequence (whatever that may be)
- (c) the end (or start) of another operation in the same procedure
- (d) the end (or start) of another operation in another procedure

**Start Time Reference Operation:** if the Start Time of an operation is not defined with respect to the start of the batch (absolute start time), then it is defined with respect to either the start or the end of the another operation (in the same or another procedure).

**Holdup Time:** when a batch (cyclical) procedure, (e.g., chromatography), operates in a continuous flowsheet, the user must specify its holdup time. The holdup time represents the time interval required to accumulate as much material as needed to be processed per cycle of this cyclical procedure. Naturally, the specified value of holdup time must be greater or equal to the calculated cycle time of the batch procedure.

**Container Equipment or Host Equipment:** the physical piece of equipment used to carry out a procedure. Every icon depicted in your flowsheet represents a procedure that is being executed in one or more pieces of equipment (mixers, splitters and transportation steps present an exception since they have no associated process equipment).

**Equipment Sharing:** In a batch plant site, it is common to utilize the same piece of equipment for carrying out multiple procedures (equipment sharing). This is particularly common with stirred (jacketed) vessels that are used for handling mixing of materials, heating, cooling, reaction, evaporation, extraction, crystallization, etc. By default, whenever a procedure is introduced in the flowsheet, the system assumes that the procedure is carried out in its own piece of equipment. However, you have the option of selecting one of the existing equipment items that are compatible with the procedure.

**Equipment Occupation Time (or Occupation Time):** the total amount of time that a given piece of equipment is being occupied during the production of a single batch. If the equipment hosts only one procedure, then it equals to the Procedure Time of that procedure. However, if the equipment is the container of other procedures, then it equals to the time elapsed between the start of the earliest scheduled procedure and the end of the latest scheduled procedure carried out inside that piece of equipment.

**Annual Operating Time:** the amount of time annually that the equipment associated with this recipe (process) have available to run this recipe (process).

**Batch Time:** the time elapsing from the start of the first (earliest scheduled) operation to the end of the last cycle of the last (latest scheduled) operation required to carry out a single batch.

**Cycle Time:** the time between the start of two consecutive batches. It is always smaller or equal to the Batch Time and larger or equal to the Minimum Cycle Time. If a batch is started right after the previous one is ended (but not before) then the cycle time equals the batch time. If a batch is started before the previous batch is ended (more typical) then the cycle time is less than the batch time. Note that there is a constraint as to how soon we can start a batch (while the previous is still in progress).

**Cycle Time Slack:** The difference between the cycle time and the minimum cycle time (must always be positive). To maximize the number of batches per year, the cycle time slack should be 0.0.

**Minimum Cycle Time:** the minimum time possible between the start of two consecutive batches. It is equal to the longest Occupation Time amongst all pieces of equipment involved in this process.

**Maximum Number of Batches:** the maximum Number of Batches possible to process in a calendar year. This Number of Batches can be achieved when the process operates under the Minimum Cycle Time (or the Cycle Time Slack is 0.0).

**Number of Batches Per Year:** the number of times a batch is processed in a calendar year (within the available operating time window for this recipe).

**Campaign:** a string of uninterrupted batch executions (of the same recipe) during a calendar year. Oftentimes, a specific product produced in batch, is produced annually in several campaigns. During the time between campaigns for this product, the equipment is utilized for the execution of recipes leading to other products.

**Number of Campaigns:** the number of uninterrupted sequences of batches produced each year.

**Scheduling Bottleneck Equipment:** the equipment with the longest occupation time. The scheduling bottleneck equipment determines the minimum cycle time and the maximum possible number of batches per year.

## 6.2 Scheduling Data

Scheduling data are specified:

- (a) at the Operation Level (e.g. start time shift, setup time, etc.)
- (b) at the Procedure Level (e.g. number of cycles)
- (c) at the Recipe Level (e.g. annual operating time, cycle time slack, number of campaigns, etc.).

### 6.2.1 Scheduling Information for an Operation

For each operation (assuming the overall operating mode is batch) you must specify the following information:

- (a) Setup Time
- (b) Process Time  
(sometimes process time is calculated by Pro-Designer, see Notes below),
- (c) Turnaround Time
- (d) Start Time Shift, and
- (e) Start Time Reference Operation.

The operation level scheduling information can be set using any of the three scheduling interfaces:

#### Scheduling Interfaces

1. The operation's scheduling tab (see section 5.2.3)

2. The Operations Gantt Chart (see later in this chapter); from that chart you can not only see the contribution of each operation to the total scheduling of the process, but you can also edit the scheduling parameters of any of operations.

#### NOTES:

- a. The process time is either specified by the user or calculated by the program if the equipment is in rating mode (the size/capacity is specified). For some purely cyclical unit procedure, such as chromatography, the process time is always calculated. For inherently continuous unit operations (operating semi-continuously in a batch plant), the cycle time is always specified.
- b. For continuous procedures in an overall batch mode of operation for the process, the process time is taken to be equal to the cycle time and the start time is taken to be the beginning of the batch.
- c. Setting the setup time, process time, turnaround time and/or number of cycles could may not only affect the outcome of the scheduling calculations (plant batch time, number of batches etc.) but also the simulation results (sizing of process units, capital cost, etc.).
- d. Oftentimes, the timing (duration) of an operation is totally dependent upon the duration of another operation (e.g. the transfer time to a filtration unit, is totally regulated by the rate of filtration). In this case, you may assign a master-slave relationship between the two operations: i.e. designate the transfer operation to be the slave operation to the filtration operation. Having done that, then all three duration parameters of the transfer operation (setup time, process time and turnaround time) will be assumed as equal to the filtration's equivalent times and whenever the filtration parameters change, the transfer operation's parameter will also change accordingly.

## 6.2.2 Scheduling Information for a Unit Procedure

The only scheduling information at a procedure level specified by the user is the number of cycles and, under certain circumstances, the holdup time. You may set the number of cycles in a procedure from the dialog that appears when you select the **Operating Mode...** entry in the command menu of a procedure (for more on this topic, see section 5.1.2).

### The Number of Cycles

Setting the number of cycles in a procedure to anything other than 1 implies the following:

- (a) the amount of material processed per batch, will be divided equally amongst each cycle (thereby reducing the processing load per cycle),
- (b) the sequence of operations in that procedure will repeat themselves as many times as the number of cycles



#### Tip

Setting the number of cycles to anything other than 1 can have effects on both the sizing of new equipment (or the equipment utilization of existing equipment) as well as the overall batch time of the recipe.

### The Holdup Time

When a batch procedure (like chromatography, batch filtration, batch distillation, etc.) is set to operate in a continuous process, Pro-Designer needs to infer the amount of material that gets processed per cycle. In other words, the implicit assumption is that, in order for this procedure to function cyclically in an otherwise continuous environment, there must be a tank that accumulates material for a certain time (at least while the procedure is in progress) and then feeds the next cycle of the procedure. This time we call holdup time. Obviously, this time must be at least as long as the cycle of the procedure (but it could be longer). For procedures whose cycle time is set directly by the user (in other words, the cycle times of all contained operations have process times, setup times and turnaround times directly set by the user), the holdup time is assumed to be equal to the cycle time of the procedure. In that case, the user does not need to supply the procedure's holdup time (and it will not be editable in the procedure's operating mode dialog). However, at least one component making up the procedure's cycle time is calculated by the system (as is the case for chromatography columns) then the user must directly set the holdup time (the field is editable).

## 6.2.3 Scheduling Information for the Entire Recipe

For the entire design case, you must specify:

- a. the Annual Operating Time,
- b. the Number of Campaigns, and
- c. one of the following {Number of Batches, Cycle Time, Cycle Time Slack}

Using the above information for the plant, as well as the process step related scheduling information for all process steps, the program calculates as scheduling outputs:

- a. the Recipe's Batch Time,
- b. the Minimum Cycle Time,
- c. the Maximum Number of Batches Per Year,
- d. the Longest Procedure in the recipe,
- e. the Scheduling Bottleneck Equipment, and
- f. two of the following {Number of Batches, Cycle Time, Cycle Time Slack}

The recipe-related scheduling information can be set using the Recipe Scheduling Information dialog (see next section).

**NOTE** If the operating mode of a plant is set to be continuous, the Scheduling Information Dialog and the Gantt Chart interfaces are disabled, since, in that case, no scheduling calculations are performed.



### Tip

At the end of M&E balances, the program re-evaluates all scheduling constraints (at the equipment level and at the recipe level) and updates the scheduling outputs (recipe's batch time, cycle time, etc.). If any constraints are found to be violated, Pro-Designer will notify you about the violation and will put up a warning that some (or all) of the scheduling outputs (e.g. number of batches per year, etc.) may not be feasible.

## 6.3 Scheduling Calculations

Based on operation scheduling data (start times and durations) and procedure scheduling data (number of cycles), the system computes the equipment occupation times, and eventually the recipe's batch time (BT) and minimum cycle time ( $CT_{\min}$ ). Next, using the recipe's annual operating time (AOT), and the annual number of campaigns (k) the system will compute the maximum number of batches per year ( $NB_{\max}$ ) using the following relationship:

$$AOT = (NB_{\max} - k) CT_{\min} + k BT \quad (1)$$

Before performing any scheduling calculations, Pro-Designer verifies that no scheduling constraints are violated. Scheduling constraints are checked at:

- The Individual Equipment Scheduling
- The Overall Process Scheduling

At the individual equipment scheduling level, Pro-Designer will make sure of the following:

- (a) no two procedures have been scheduled to execute within the same piece of equipment with overlapping procedure times. If you don't employ equipment sharing, then no constraints at the equipment level exist.
- (b) All operations in a procedure, have (calculated) start time that are consistent with their execution order

The constraints at the recipe level have to do with the setting of unachievable goals. These constraints will be more apparent after we explain how Pro-Designer computes the process scheduling outputs.

First of all, Pro-Designer calculates the process's batch time (BT), as well as the minimum cycle time ( $CT_{\min}$ ) based on the each procedure's scheduling information. The minimum cycle time is calculated as the longest equipment occupation time, or in case that there is no equipment sharing, the longest procedure time. The equipment responsible for the longest occupation time is also recognized as the scheduling equipment bottleneck. Since the cycle time slack ( $CT_{\text{slack}}$ ) is defined as the difference between the cycle time (CT) and the minimum cycle time ( $CT_{\min}$ ) the following always holds:

$$CT_{\text{slack}} = CT - CT_{\min} \quad (2)$$

Pro-Designer computes the  $CT_{\min}$  (if the  $CT_{\text{slack}}$  is given) or it computes the  $CT_{\text{slack}}$  if the cT is supplied by the user. Furthermore, the following relationship between the annual operating time (AOT), the number of campaigns (k), the cycle time (CT), the batch time (BT) and the annual number of batches (NB) always holds:

$$(NB - k) CT + k BT \leq AOT \quad (3)$$

Since AOT and k are always supplied by the user and BT always computed, Pro-Designer uses the above relationship (as an equality) to calculate either the number of batches per year (NB) if CT or  $CT_{\text{slack}}$  has been supplied by the user, or to calculate the BT if the number of batches per year has been supplied by the user.

Furthermore, the above relationship (3) can be applied when CT is assumed to be equal to  $CT_{min}$ . In that case, NB represents the highest possible achievable number of batches per year:

$$(NB_{max} - k) CT_{min} + k BT \leq AOT \quad (4)$$

The following constraints must always hold:

$$CT_{slack} \geq 0$$

$$CT \geq CT_{min}$$

$$NB \leq NB_{max}$$

$$(NB - k) CT + k BT \leq AOT$$

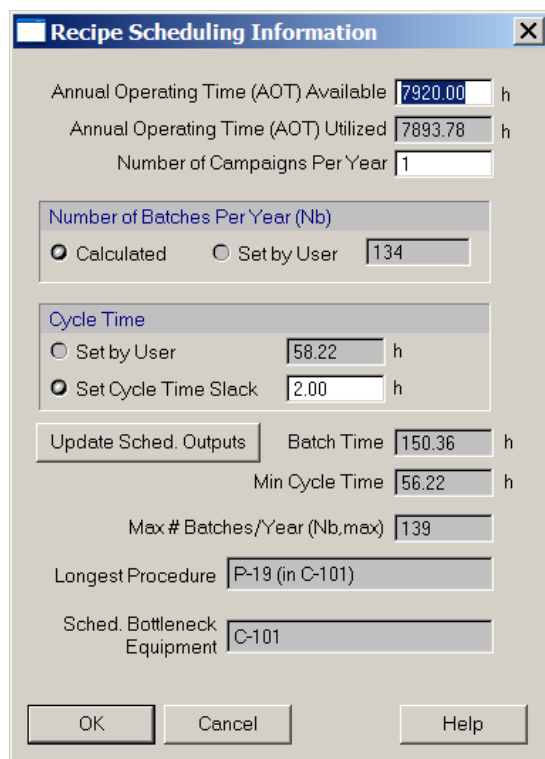
After every M&E balance calculation, the system attempts to validate the above scheduling constraints and will notify you if a constraint violation has been identified. For example, suppose you have set the annual operating time and the required annual number of batches. Then you modify the scheduling of a procedure in a way the prolongs the total batch time to the extent that in order to carry out the required number of batches the AOT is exceeded. The system will identify this constraint violation and warn you that your scheduling targets (in this case number of batches per year) may not be feasible

## 6.4 Scheduling and Equipment Sizing

Process scheduling decisions have an impact on equipment sizing and vice-versa. In design mode, longer cycle times for operations leading to longer cycle times for unit procedures increase the minimum cycle time. Specifying multiple procedure cycles per batch result in smaller equipment capacity demands (which is equivalent to lower capital investment) but at the same time they increase the cycle time too. Increase of the cycle time results in a reduction of the maximum number of batches per year (which is equivalent to reducing annual throughput). Sharing of equipment by multiple procedures has a similar effect. Most likely it increases the batch (and possibly cycle time) but reduces demand for capital investments. In designing new facilities, one should strive for a balance between capital investment, plant capacity, and flexibility for expansion.

## 6.5 The Recipe Scheduling Information Dialog

It is the dialog that is presented when you select the **Tasks/Recipe Scheduling Information...** option from the main menu. It allows you to edit the scheduling information required at the recipe level (see Fig. 6.1).



**Recipe Scheduling Information**

Annual Operating Time (AOT) Available  h

Annual Operating Time (AOT) Utilized  h

Number of Campaigns Per Year

**Number of Batches Per Year (Nb)**

☒ Calculated ☐ Set by User

**Cycle Time**

☐ Set by User  h

☒ Set Cycle Time Slack  h

Batch Time  h

Min Cycle Time  h

Max # Batches/Year (Nb,max)

Longest Procedure

Sched. Bottleneck Equipment

Figure 6.1: Setting the recipe-level scheduling data.

For the entire design case, you must specify:

- a. the Available Annual Operating Time,
- b. the Number of Campaigns,
- c. whether the number of batches is calculated or set (if set specify number of batches),
- d. whether the Cycle Time is calculated or set (if set specify the Cycle Time, if calculated specify Cycle Time Slack)

Using the above information for the plant, as well as the process step related scheduling information for all process steps, the program calculates as scheduling outputs:

- a. the Recipe's Batch Time,
- b. the Minimum Cycle Time,
- c. the Maximum Number of Batches Per Year,
- d. the Longest Procedure in the recipe,
- e. the Scheduling Bottleneck Equipment, and
- f. one / two of the following  
{ Number of Batches, Cycle Time, Cycle Time Slack }

## 6.6 The Operations Gantt Chart

The operations Gantt chart presents an overview of the entire schedule for either a single or multiple recipe executions as a Gantt chart. To display the operations Gantt chart for a single batch, select **Tasks / Gantt Charts / Operations GC...**

Each bar in the chart represents:



- ◆ Either an **activity summary** (i.e. an activity that can be de-composed or refined to other activities, e.g., a procedure) or
- ◆ an **elementary activity** (i.e. an activity that cannot be further refined, e.g. an operation in a cycle)

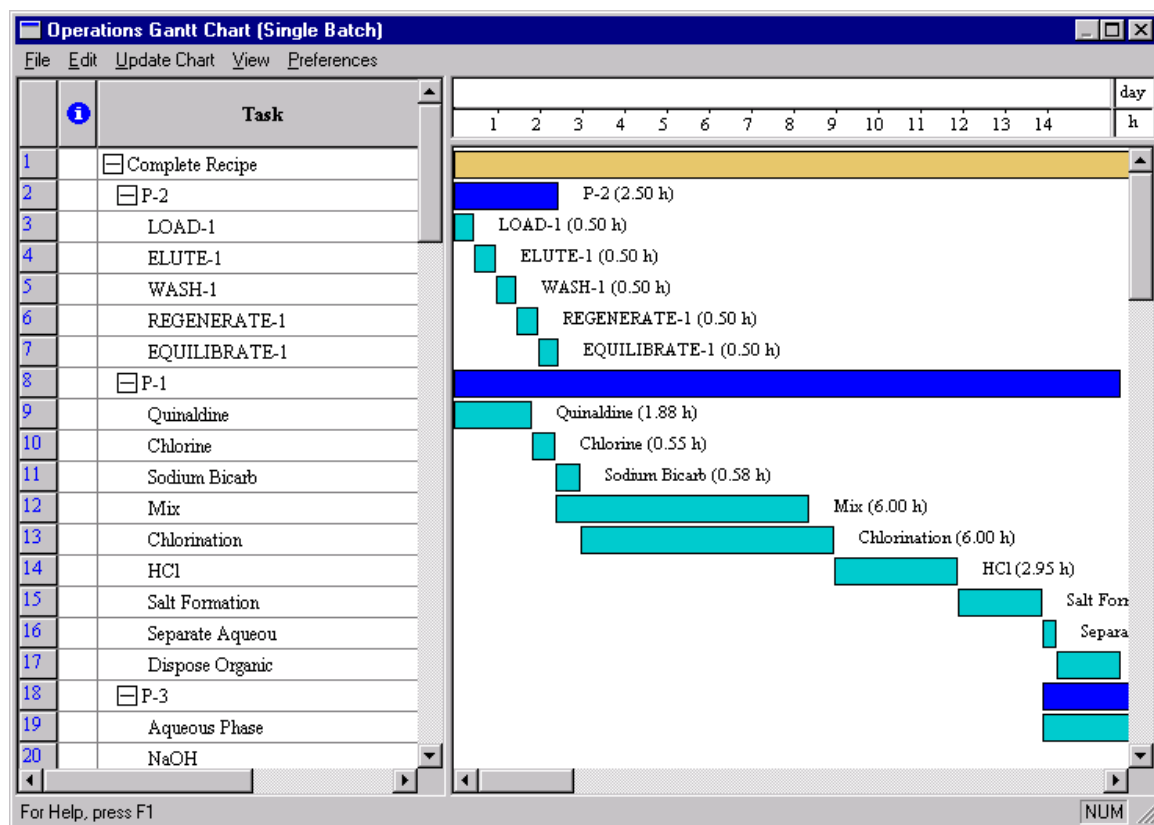


Figure 6.2: The Operations Gantt Chart.

The window is divided into two views:

- the left view (spreadsheet view): it displays in each line: the name, duration, start and end time for each activity whose bar line is shown straight across on the chart (all information is presented for viewing purposes only). You use the left view to expand and/or collapse activity summaries by clicking on the + or – rectangle showing at the left of the name of the activity.
- the right view (chart view): it displays, as a horizontal bar drawing against the time line, each activity participating in the overall scheduling and execution of the recipe. Right-click on a bar and a relevant command menu will come up. Selecting the first menu entry will bring up a dialog that will allow you to edit any scheduling information associated with that particular activity bar. At any time you can request to have the M&E balances redone and to have the Gantt Chart updated to reflect the new (calculated) scheduling settings for the recipe. Simply click on the **Update Chart** entry in the main menu of the interface. Note that since this command will re-run the simulation, it may result in the display of several simulation error and/or warning messages generated during simulation.

When you are done working with the Gantt Chart interface, you can close it down by selecting the **File / Exit** option from the main or simply close down the window.

You can choose to display the operations Gantt chart for a single batch or multiple consecutive batches. The second option may be of interest when there is batch overlapping (i.e., the second batch starts before the first is finished, or in other words, when the cycle time is less than the batch time). To display the Gantt chart for multiple batches, select **Tasks / Gantt Charts / Operations GC (Multiple Batches)**.



### Tip

The number of batches that Pro-Designer displays when the multiple batches Gantt Chart first comes up, is determined so that all future batch starts will show a pattern that is already included in the chart (shifted by some time offset). This number is computed from the following formula:

$$N_{\text{batches}} = [ BT / CT ] + 1, \text{ where}$$

BT is the batch time of the recipe,

CT is the cycle time of the recipe and

[ ] indicates taking the next integer value of the number in the brackets

You may, of course, change the number of batches shown at any time, by selecting the **Edit / Set Number of Batches** from the main menu, or **Set Number of Batches** from the context menu of the chart.

## 6.6.1 Accessing Scheduling and Simulation Data

From the Operations Gantt Chart interface (single or multiple batches) you can access all scheduling and most simulation data for the entire recipe. In that way, this interface becomes an alternative way *to view and work* with your recipe. To access the data, you must right-click over a chart's bar, and select the first entry from the command menu that pops up. The menu entry and the ensuing dialog depend on the type of bar you started.

- ↳ **For recipe summary bars:** The dialog allows you to edit the recipe-level scheduling data (annual operating time, number of campaigns, etc.)
- ↳ **For branch summary bars:** The dialog presents the member sections of that branch.
- ↳ **For section summary bars:** The dialog presents all section properties.
- ↳ **For procedure summary bars:** The dialog presents the procedure operating mode dialog that (among other things) allows you to change the number of cycles for that procedure.
- ↳ **For cycle summary bars:** The dialog presents some cycle-related information (for viewing purposes only).
- ↳ **For operation bars:** The dialog is the same as the i/o simulation dialog that you view from the main interface of Pro-Designer. It allows you to edit the operating conditions as well as the scheduling settings for that operation.

**Tip**

All changes made through any dialogs invoked during the time the Gantt Chart interface is active, are permanent and cannot be reversed. You cannot cancel out of any scheduling and/or simulation data modifications made while the Gantt Chart interface was open.

## 6.6.2 Exporting the Chart as a Picture

You can export the chart (as a picture) from Pro-Designer into another Windows applications (e.g. a word processor). The export can happen with one of two ways:



### *To copy the Gantt Chart using the Clipboard...*

1. Bring up the chart.
2. **Select Copy...**  
From the **Edit** menu select **Copy** ; alternatively, you may bring up the chart's context menu, by right-clicking on an unoccupied area of the chart, and select **Copy**. Note that the resource chart's interface does not have a main menu so the only way to issue the Copy command is from the context menu
3. **Go to target application and select Paste.**  
Activate the application that you would like to paste the chart picture. From the application's **Edit** menu select **Paste**. Note that **Paste Special...** and the options available to OLE items does not apply to charts; they can only be pasted (not paste-linked) as pictures.



### *To copy the Gantt Chart as a Metafile ('wmf' file)...*

1. Bring up the chart.
2. **Select Export as Metafile**  
From the **File** menu select **Export as Metafile**. Alternatively you may bring up the chart's context menu, by right-clicking on an unoccupied area of the chart, and select **Export Chart as Metafile...** .The usual **Save As...** file dialog will appear, prompting you to type the name of a file. Type in the filename that you wish to contain the description of the flowsheet in 'wmf' format. By convention, all such files should have a 'wmf' extension. The file need not already exist. In fact, if the program discovers that a previous file exist with the same name and in the same location on your hard disk, it will ask for your permission to overwrite it
3. **Go to target application and import the picture**  
After you have typed in the file name and clicked **OK**, wait a few seconds as the program will be creating the file and writing in it the necessary metafile-formatted description of the chart. When this process is done, you can go to the target application and import the file you have just created. For details on how to do that consult your applications manual or browse through their help utility.

### 6.6.3 Exporting the Scheduling Data into Excel

You can export all the scheduling information contained in a chart (i.e. all information around every procedure and/or equipment) into a file that can be read immediately by Excel (or other leading spreadsheets). Select **File / Export to Excel...** from the main menu (or the chart's command menu) and in the dialog that pops up, specify the pathname of the file that will contain the scheduling data. Then click on **OK**. You can now start Excel and open this file directly from Excel. When you open the file from Excel you may have to adjust the widths of the columns slightly in order to view all contents of the file (without overlapping).

### 6.6.4 Printing the Chart

Even though you cannot currently directly print a chart from Pro-Designer, you can simply copy and paste it into a word processing application (like MS-Word) or any other application and print it from there.

### 6.6.5 Zooming In and Out

When the a chart interface first comes up, it is set into '**Fit-to-Window**' mode, which means that the entire time horizon needed to describe the whole chart has been scaled down appropriately in order to fit into your window's width. If the maximum time that needs to be displayed is very large, or if the settings for minor/major scale and tickmark frequency for the time line are very small, the timeline may NOT display all minor and major tickmarks as expected. Therefore, some details along the time axis may have been omitted. In order to see the timeline spread out as expected you must switch out of 'Fit-to-Window' mode. Simply right-click on an unoccupied area of the graph and invoke the context menu for the chart. Notice that the **Fit-to-Window** entry has a checkmark in front of it, indicating that currently the contents of the chart are scaled down so that they can fit your window's width. If you select **Fit-to-Window** option once more, then it will turn the Fit-to-Window mode off and will display the timeline according to the timeline specifications. This may result in pushing the right end of your graph off the visible area of your window, so you may need to scroll to the right in order to see the rest of the graph. If further details need to be viewed in a chart, you may further expand the time scale by issuing a **Zoom In** command. Again, from the chart's context menu, select **Zoom In**. This will scale up the timeline and will present more details along the time line but less of the total graph will be visible within your window's area. The opposite effect happens when you issue a **Zoom Out** command. You may continue zooming in or out as needed (up to maximum / minimum scale).

### 6.6.6 The Time Line

When drawing a Gantt Chart, Pro-Designer must decide on the characteristics of the time line against which all activity bars will be drawn. The attributes that determine how the time line is drawn are the following:

- ◆ The maximum time displayed (defaults to as large as necessary)
- ◆ The unit of time used to draw the minor tickmarks (defaults to hours)
- ◆ The unit of time used to draw the major tickmarks (defaults to days)
- ◆ The minor tickmark frequency (defaults to 1)
- ◆ The major tickmark frequency (defaults to 1)

By default, the maximum time is calculated to provide a window of time large enough to accommodate the display of all activity bars. However, if you wish, you may set your own fixed maximum time, by visiting the Gantt Chart's Style (see next). If you do so, you must take care that the limit set is large enough to accommodate all data otherwise some activity bars will not be shown on the chart (Pro-Designer will warn you if that turns out to be the case).

### 6.6.7 The Visual Style

The visual appearance of a Gantt Chart (Operations or Equipment Occupation Time), depends on the following:

1. The contents of the Gantt Chart (i.e. type of activity summaries included)
2. The appearance of each activity-type bar
3. The appearance of the timeline

All of the above features can be edited from the Gantt Chart's Visual Style dialog.

#### 1. The Contents of the Gantt Chart

Users how do not distinguish several sections and/or branches in the description of their recipe, will not want to have the Operations and Equipment Gantt Chart include these levels of activity summary in their contents. In that case, the Operations Gantt chart will directly refine the recipe activity into procedure activity bars, and the Equipment Gantt Chart, will directly refine the equipment's occupation time, directly to procedures (skipping summaries for section and branch). To specify whether to include or exclude section and/or branch level summaries, please visit the Gantt Chart Visual Style dialog and from the first tab, make sure that the check-boxes referring to the contents of the chart are appropriately setup.

#### 2. The appearance of Each Activity Bar

Each summary bar, representing for instance, the total procedure time, or total recipe time, or total equipment occupation time, is drawn using a special fill-in color in order to be easily distinguishable from another activity summary bar. All visual attributes that dictate how each of the activity bar types are drawn are collectively mentioned as the style of each bar type. The user can edit the style for each type to match his/her liking. You may edit the style of each bar, by either visiting the Gantt Chart Visual Style dialog or by right-clicking over an unoccupied area of the chart, and selecting the appropriate activity type bar style entry. Either way, you will be presented with the Bar Style Dialog.

#### 3. The Appearance of the Timeline

When the Gantt Chart first comes up, its timeline follows the characteristics of the default timeline common to all time charts. However, you may choose to define special characteristics for that Gantt Chart alone. In order to do that, you may either visit the Gantt Chart Visual Style dialog and go to the Time tab or, as a shortcut, simply double-click on the timeline drawing itself.

### 6.6.8 The Visual Style Dialog

To access this dialog you can either select **Preferences / Gantt Chart** from the Gantt Chart main menu, or **Preferences / Default Style / Gantt Chart ...** from the flowsheet

context menu. From this dialog you can edit all the characteristics of a Gantt Chart's visual style. It has two tabs:

### 1. The Chart / Grid Tab

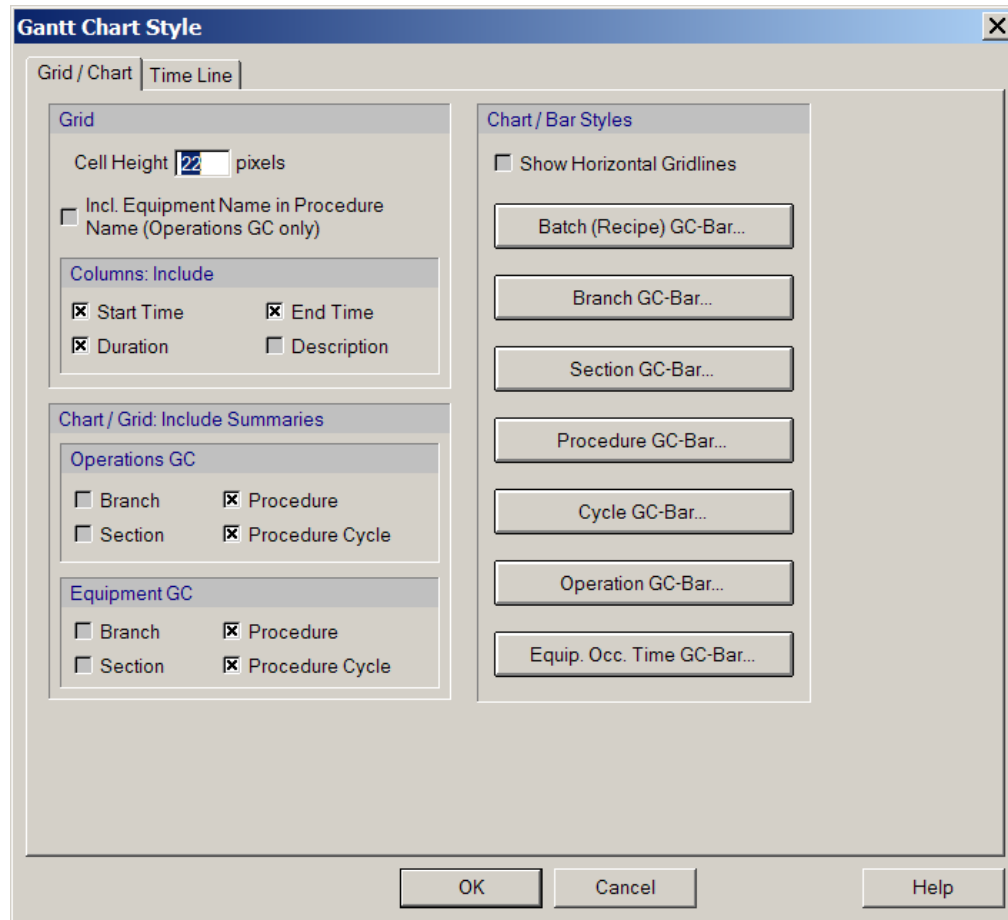


Fig 6.3: The Gantt Chart visual style dialog (Chart / Grid Tab).

From this tab you can :

- Specify whether you want the section-level, branch-level, procedure-level, and procedure cycle level, summary bars to be included in your Gantt chart (if you are not using sections and branches to describe your recipe you may want to exclude them from your charts).
- Specify the styles (visual attributes) of each of the activity bars; to edit any of the styles for a given activity bar (e.g. recipe bar, procedure bar, etc.) simply click on the corresponding button and describe the style that you wish in the dialog that follows. You can access the same bar style edit dialog by right-clicking over a specific bar and selecting the **Visual Style...** option.
- Specify the grid cell height used in the left-view of the chart (the spreadsheet view). Note that the grid cell height cannot be set to anything less than the height of the tallest activity bar (if their height is set by user). Also, in case where all activity bar heights are left to be adjustable (default) the grid cell height cannot be

set to anything less than the height of a character (so that it can display the text without cropping it).

## 2. The Time Line Tab

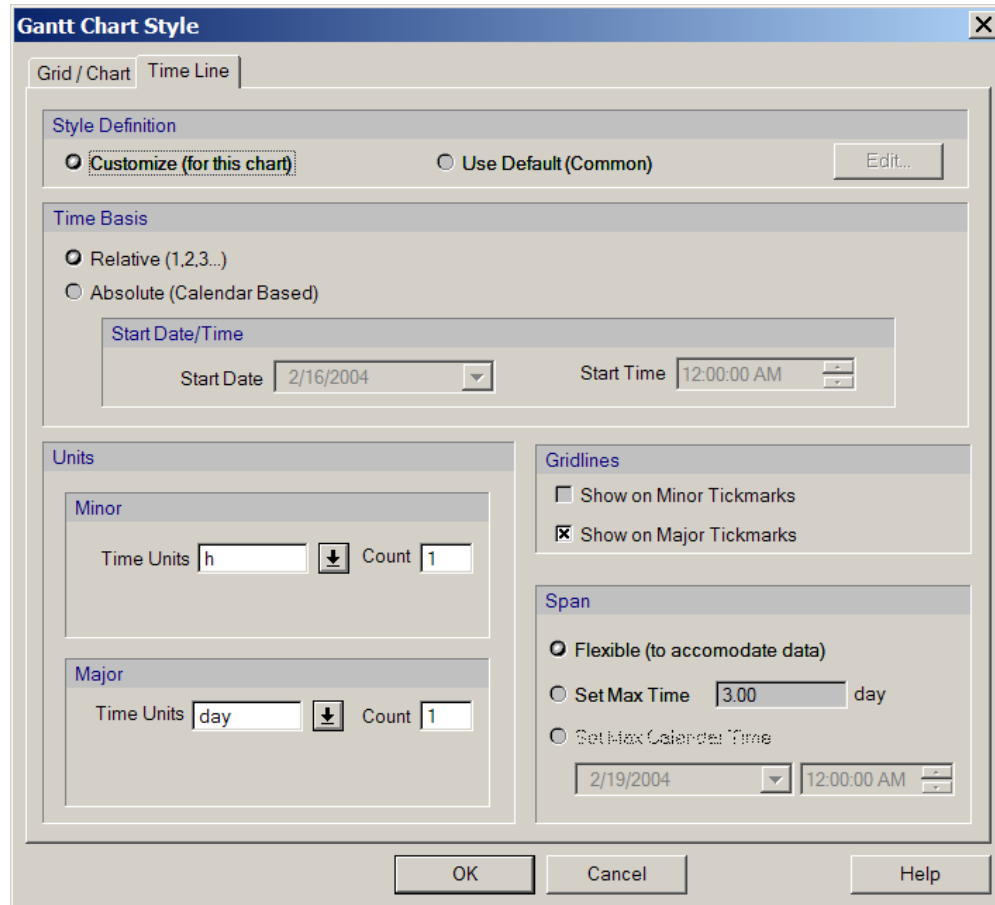


Fig 6.4: The Gantt Chart visual style dialog (Time Line Tab).

From this tab you can:

- Specify whether you want the time line style for this chart to follow the default characteristics or whether you want to customize its attributes for this chart alone.
- If you have chosen to use the default time line characteristics (i.e. selected the ‘**Use Default**’ button), notice that they are displayed at the lower half (left side) of the dialog but they are NOT EDITABLE. If you wish to modify them, then you must modify first the default timeline style. To do so, simply click on the button labeled **Edit...** next to the option ‘Use default’ (timeline). In the ensuing dialog, change the characteristics of the default timeline and after clicking **OK** you will be back in this tab where now the new characteristics will be displayed. Note that any changes you have made to the default time line will affect all charts that use the default time line (Gantt Charts, Resource Tracking Charts, Equipment Utilization Charts, etc.)
- If you chose to use a specialized time line for this chart, select the ‘**Customize**’ button, and modify any of the time line characteristics you wish in the lower half of

the dialog. Any changes to the time line will only apply to this chart and they will not affect the style of other time charts (Gantt Charts, Resource Tracking Charts, etc.)

### 6.6.9 The Bar Style Dialog

From this dialog you can edit all the visual attributes (style) of any of the activity bars displayed in a Gantt Chart.

In an **Operations Gantt Chart** (single or multiple batches) the following activity types (bar types) exist

- ◆ Recipe Summary Bar
- ◆ Branch Summary Bar
- ◆ Section Summary Bar
- ◆ Procedure Bar
- ◆ Cycle Bar
- ◆ Operation Bar
- ◆ Equipment Bar

In an **Equipment Occupation Time Gantt Chart** (single or multiple batches), the following activity type (bar types) exist:

- ◆ Recipe Summary Bar
- ◆ Equipment Bar
- ◆ Branch Summary Bar
- ◆ Section Summary Bar
- ◆ Procedure Bar
- ◆ Cycle Bar
- ◆ Operation Bar

The dialog for each bar can be accessed from the **Preferences** menu of the Gant Chart. This dialog has three tabs:

#### 1. Bar Options Tab

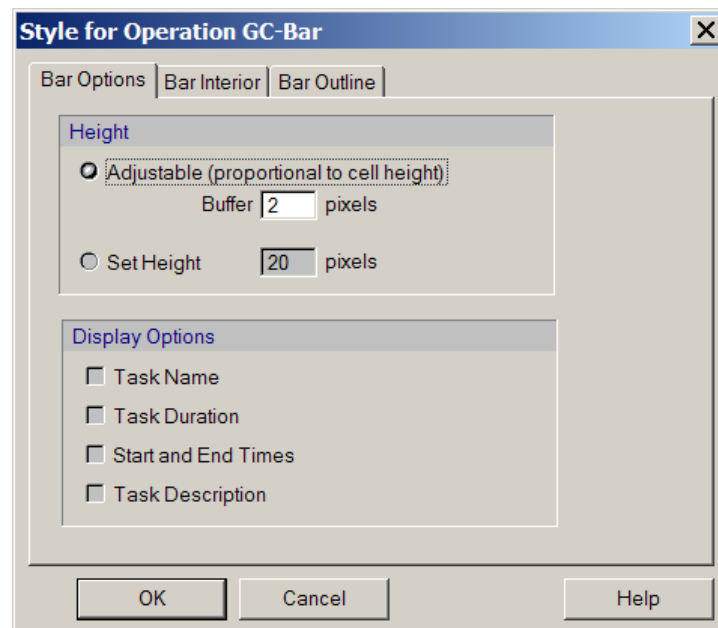




Fig 6.5: The Gantt Chart visual style dialog (Bar Options Tab).

From this tab you can :

- Specify if you want the task bar's height to be fixed and set the height in pixels, or if you let the bar's height to be adjustable (proportional to the grid cell's height). If you let the bar height be adjustable, then decreasing or increasing the cell height will also proportionally increase or decrease the height of the chart's bars.
- Specify if you want the name of the activity, its duration, the start and end times, and the task description, to be displayed directly on the chart (right next to the drawing of the bar itself); the name and duration are always displayed right across from the bar into the spreadsheet view of the Gantt Chart interface. However, sometimes it is desirable to have them re-drawn right next to the bar (especially in a large process).

## 2. Bar Interior Tab

Lets you choose options that dictate how the interior of the bar is drawn (fill-in color, fill-in pattern, etc.)

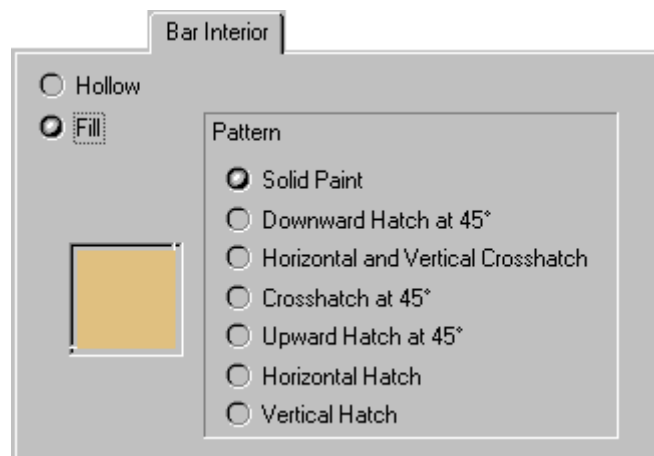


Fig 6.6: The Gantt Chart visual style dialog (Bar Interior Tab).

## 3. Bar Outline Tab

Lets you choose options affecting the outline of the bar (color, thickness, etc.)

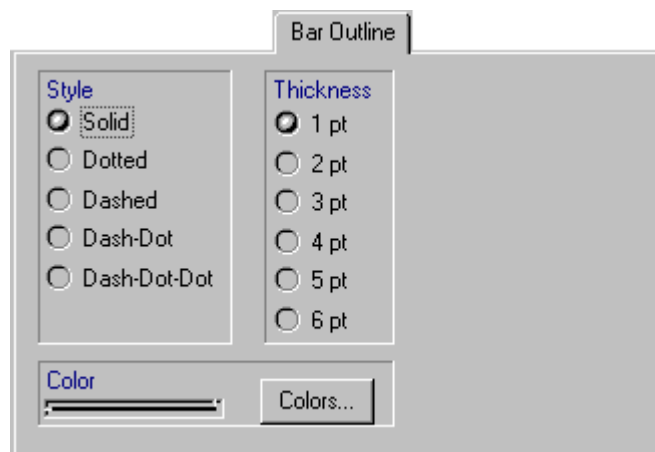


Fig 6.7: The Gantt Chart visual style dialog (Bar Outline Tab).

## 6.7 The Equipment Gantt Chart

This window presents an overview of the all equipment occupation time-schedule when executing a single recipe as a Gantt chart. To display the equipment occupation time Gantt Chart for a single batch, select **Tasks / Gantt Charts / Equipment GC**.

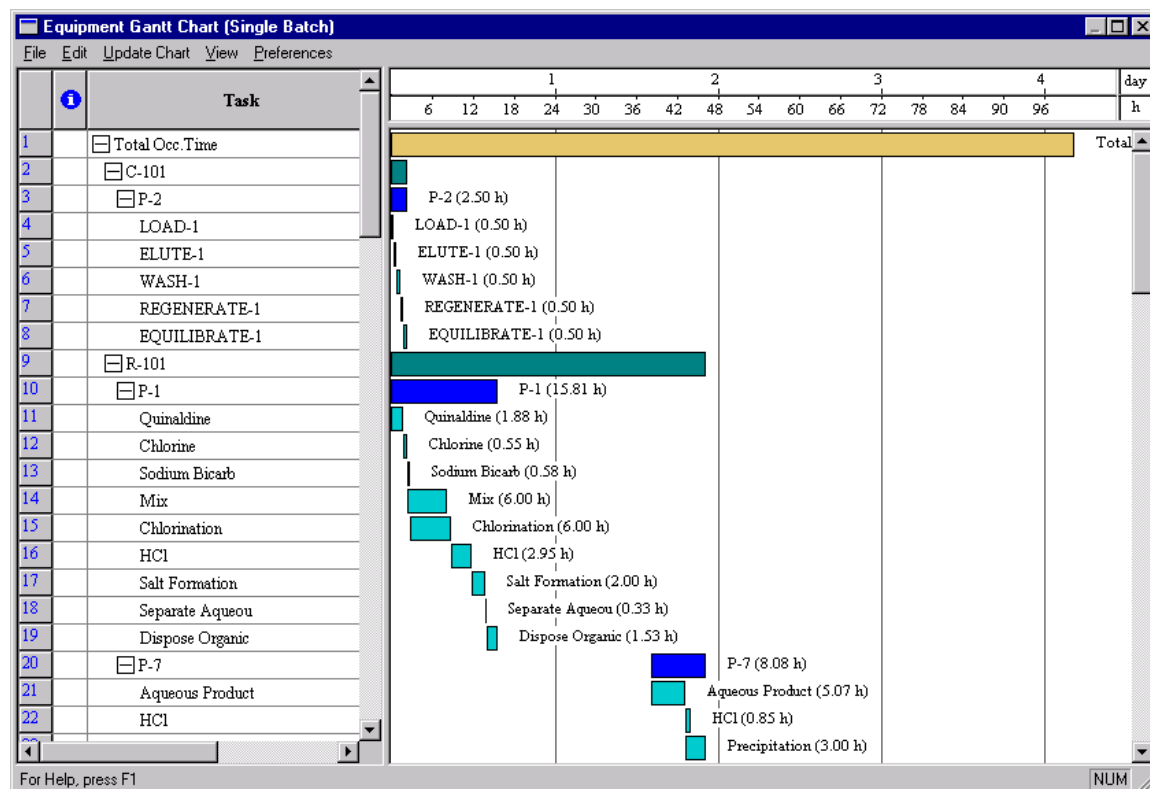


Figure 6.8: The Equipment Gantt Chart.

Each bar in the chart represents:

- ◆ either a **activity summary** (i.e. an activity that can be de-composed or refined to other activities, e.g. the time in an equipment taken by a single procedure, or the time in an equipment taken by an entire section, or an entire recipe), or
- ◆ an **elementary activity** (i.e. an activity that cannot be further refined, e.g. the time in an equipment taken by a single operation in a cycle).

The interface is divided into two views:

- (a) the left view (spreadsheet view): it displays in each line: the name, duration, start and end time for each activity whose bar line is shown straight across on the chart (all information is presented for viewing purposes only). You may use the left view to expand and/or collapse activity summaries by clicking on the + or – rectangle showing at the left of the name of the activity.
- (b) the right view (chart view): it displays, as a horizontal bar drawing against the time line, each activity participating in the overall equipment time usage for all the equipment involved in the recipe. Right-click on a bar and a relevant command menu will come up. Selecting the first menu entry will bring up a dialog that will allow you to edit any scheduling information associated with that particular task bar. At any time you can request to have the M&E balances redone and to have the Gantt Chart updated to reflect the new (calculated) scheduling settings for the recipe. Simply click on the **Update Chart** entry in the main menu of the interface. Note that since this command will re-run the simulation, it may result in the display of several simulation error and/or warning messages generated during simulation.

When you are done working with the Gantt Chart interface, you can close it down by selecting the **File / Exit** option from the main or simply close down the window.



### Tip

All changes made through any dialogs invoked during the time the Gantt Chart interface is active, are permanent and cannot be reversed. You cannot cancel out of any scheduling and/or simulation data modifications made while the Gantt Chart interface was open.

You can choose to display the equipment Gantt chart for a single batch or multiple consecutive batches. The second option may be of interest when there is batch overlapping (i.e., the second batch starts before the first is finished, or in other words, when the cycle time is less than the batch time). To display the Gantt chart for multiple batches, select **Tasks / Gantt Charts / Equipment GC (Multiple Batches)**.



### Tip

The number of batches that Pro-Designer displays when the multiple batches Gantt Chart first comes up, is determined so that all future batch starts will show a pattern that is already included in the chart (shifted by some time offset). This number is computed from the following formula:

$$N_{\text{batches}} = [ BT / CT ] + 1, \text{ where}$$

BT is the batch time of the recipe,

CT is the cycle time of the recipe and

---

[ ] indicates taking the next integer value of the number in the brackets

---

You may, of course, change the number of batches shown at any time, by selecting the **Edit / Set Number of Batches** from the main menu, or **Set Number of Batches** from the context menu of the chart.

---

### 6.7.1 Accessing Scheduling and Simulation Data

From the Equipment Gantt Chart interface (single or multiple batches) you can access all scheduling and most simulation data for the entire recipe. In that way, this interface becomes an alternative way *to view and work* with your recipe. To access the data, you must right-click over a chart's bar, and select the first entry from the command menu that pops up. The menu entry and the ensuing dialog depend on the type of bar you started.

- ↳ **For recipe summary bars:** The dialog allows you to edit the recipe-level scheduling data (annual operating time, number of campaigns, etc.)
- ↳ **For equipment summary bars:** The dialog presents the same dialog as when selecting the **Equipment Data...** option from the procedure's command menu. It presents a description of the equipment.
- ↳ **For branch summary bars:** The dialog presents the member sections of that branch.
- ↳ **For section summary bars:** The dialog presents all section properties.
- ↳ **For procedure summary bars:** The dialog presents the procedure operating mode dialog that (among other things) allows you to change the number of cycles for that procedure.
- ↳ **For cycle summary bars:** The dialog presents some cycle-related information (for viewing purposes only).
- ↳ **For operation bars:** The dialog is the same as the i/o simulation dialog that you view from the main interface of Pro-Designer. It allows you to edit the operating conditions as well as the scheduling settings for that operation.



#### Tip

All changes made through any dialogs invoked during the time the Gantt Chart interface is active, are permanent and cannot be reversed. You cannot cancel out of any scheduling and/or simulation data modifications made while the Gantt Chart interface was open.

---

### 6.7.2 Exporting the Chart as a Picture

You can export the chart (as a picture) from Pro-Designer into another Windows applications (e.g. a word processor). The export can happen with one of two ways:



### *To copy the Gantt Chart using the Clipboard...*

1. Bring up the chart.
2. **Select Copy...**  
From the **Edit** menu select **Copy** ; alternatively, you may bring up the chart's context menu, by right-clicking on an unoccupied area of the chart, and select **Copy**. Note that the resource chart's interface does not have a main menu so the only way to issue the Copy command is from the context menu
3. **Go to target application and select Paste.**  
Activate the application that you would like to paste the chart picture. From the application's **Edit** menu select **Paste**. Note that **Paste Special...** and the options available to OLE items does not apply to charts; they can only be pasted (not paste-linked) as pictures.



### *To copy the Gantt Chart as a Metafile ('wmf' file)...*

1. Bring up the chart.
2. **Select Export as Metafile**  
From the **File** menu select **Export as Metafile**. Alternatively you may bring up the chart's context menu, by right-clicking on an unoccupied area of the chart, and select **Export Chart as Metafile...** .The usual **Save As...** file dialog will appear, prompting you to type the name of a file. Type in the filename that you wish to contain the description of the flowsheet in 'wmf' format. By convention, all such files should have a 'wmf' extension. The file need not already exist. In fact, if the program discovers that a previous file exist with the same name and in the same location on your hard disk, it will ask for your permission to overwrite it
3. **Go to target application and import the picture**  
After you have typed in the file name and clicked **OK**, wait a few seconds as the program will be creating the file and writing in it the necessary metafile-formatted description of the chart. When this process is done, you can go to the target application and import the file you have just created. For details on how to do that consult your applications manual or browse through their help utility.

## 6.7.3 Exporting the Scheduling Data into Excel

You can export all the scheduling information contained in a chart (i.e. all information around every procedure and/or equipment) into a file that can be read immediately by Excel (or other leading spreadsheets). Select **File / Export to Excel...** from the main menu (or the chart's command menu) and in the dialog that pops up, specify the pathname of the file that will contain the scheduling data. Then click on **OK**. You can now start Excel and open this file directly from Excel. When you open the file from Excel you may have to adjust the widths of the columns slightly in order to view all contents of the file (without overlapping).

## 6.7.4 Printing

Even though you cannot currently directly print a chart from Pro-Designer, you can simply copy and paste it into a word processing application (like MS-Word) or any other application and print it from there.

## 6.7.5 Zooming In and Out

When the a chart interface first comes up, it is set into '**Fit-to-Window**' mode, which means that the entire time horizon needed to describe the whole chart has been scaled down appropriately in order to fit into your window's width. If the maximum time that needs to be displayed is very large, or if the settings for minor/major scale and tickmark frequency for the time line are very small, the timeline may NOT display all minor and major tickmarks as expected. Therefore, some details along the time axis may have been omitted. In order to see the timeline spread out as expected you must switch out of 'Fit-to-Window' mode. Simply right-click on an unoccupied area of the graph and invoke the context menu for the chart. Notice that the **Fit-to-Window** entry has a checkmark in front of it, indicating that currently the contents of the chart are scaled down so that they can fit your window's width. If you select **Fit-to-Window** option once more, then it will turn the Fit-to-Window mode off and will display the timeline according to the timeline specifications. This may result in pushing the right end of your graph off the visible area of your window, so you may need to scroll to the right in order to see the rest of the graph. If further details need to be viewed in a chart, you may further expand the time scale by issuing a **Zoom In** command. Again, from the chart's context menu, select **Zoom In**. This will scale up the timeline and will present more details along the time line but less of the total graph will be visible within your window's area. The opposite effect happens when you issue a **Zoom Out** command. You may continue zooming in or out as needed (up to maximum / minimum scale).

## 6.7.6 The Time Line

When drawing a Gantt Chart, Pro-Designer must decide on the characteristics of the time line against which all activity bars will be drawn. The attributes that determine how the time line is drawn are the following:

- ◆ The maximum time displayed (defaults to as large as necessary)
- ◆ The unit of time used to draw the minor tickmarks (defaults to hours)
- ◆ The unit of time used to draw the major tickmarks (defaults to days)
- ◆ The minor tickmark frequency (defaults to 1)
- ◆ The major tickmark frequency (defaults to 1)

By default, the maximum time is calculated to provide a window of time large enough to accommodate the display of all activity bars. However, if you wish, you may set your own fixed maximum time, by visiting the Gantt Chart's Style (see next). If you do so, you must take care that the limit set is large enough to accommodate all data otherwise some activity bars will not be shown on the chart (Pro-Designer will warn you if that turns out to be the case).

## 6.7.7 The Visual Style

The visual appearance of a Gantt Chart (Operations or Equipment Occupation Time), depends on the following:

1. The contents of the Gantt Chart (i.e. type of activity summaries included)
2. The appearance of each activity-type bar
3. The appearance of the timeline

All of the above features can be edited from the Gantt Chart's Visual Style dialog. For more on the chart style and how it can be edited, please see Sections 6.6.7 , 6.6.8 and 6.6.9.

## 6.8 Equipment Utilization Charts

When executing (in batch mode) the procedures that make up a recipe, it is very common to share equipment amongst procedures. Vessels represent the type of equipment that gets shared the most since they are very versatile. You can use them for mixing, reaction, extraction just to name a few of the several possible usage possibilities. Sharing of equipment contributes to keeping the cost of capital associated with a given recipe low. However, it introduces new constraints into the recipe that can affect the batch time of a recipe (i.e. how long it takes to carry out the entire recipe from beginning to end), the cycle time of a recipe (i.e. how long we have to wait after the beginning of a batch before we start the next batch), as well as the throughput of a recipe (i.e. how much we can process per batch)

The ramifications of equipment sharing on the throughput of the process, can be explored in more details in the Throughput Analysis and Debottlenecking (Chapter 9). In short, in order to make the most out of your existing equipment capacity, you must not allow the equipment to sit idle for too long in between batches. In order to visualize how long your equipment is being kept busy during the processing of a batch, Pro-Designer presents to you the equipment utilization chart (for main equipment). It shows exactly that: i.e. for each equipment, it will show you the periods that the equipment is being employed by some procedure and the periods that the equipment is just idle.

The cycle time is determined from the equipment that shows the longest occupation time (scheduling bottleneck). The equipment utilization chart for multiple batches will demonstrate exactly that. You will see that as you reduce the cycle time slack closer to zero, there will be a piece of equipment that will end up being used all the time (i.e. without any idle time); that equipment will also happen to have the longest occupation time (per batch), i.e. this is the scheduling equipment bottleneck.

Besides the main equipment, oftentimes, during the processing of a recipe, you are forced to share other auxiliary equipment. The most commonly shared equipment in recipe execution are CIP skids and SIP panels. Since CIP and SIP operation are very common amongst batch recipes, in the presence of limited number of CIP skids and SIP panels, sharing them during recipe execution can present scheduling conflicts. The issue becomes even more complex as you attempt to overlap batch executions. Pro-Designer, evaluates the occupation times for all skids that have been defined in a recipe and will warn you if a scheduling conflict is detected (i.e., if the same skids is used by more than one operation at any time during the execution of a recipe). There is therefore an option in the equipment utilization chart for including the CIP skids and SIP panels.

## 6.8.1 Equipment Utilization Chart

This chart comes up when you select **View / Equipment Utilization Chart / Single Batch**. It will present the occupation times for each equipment during a single batch execution.

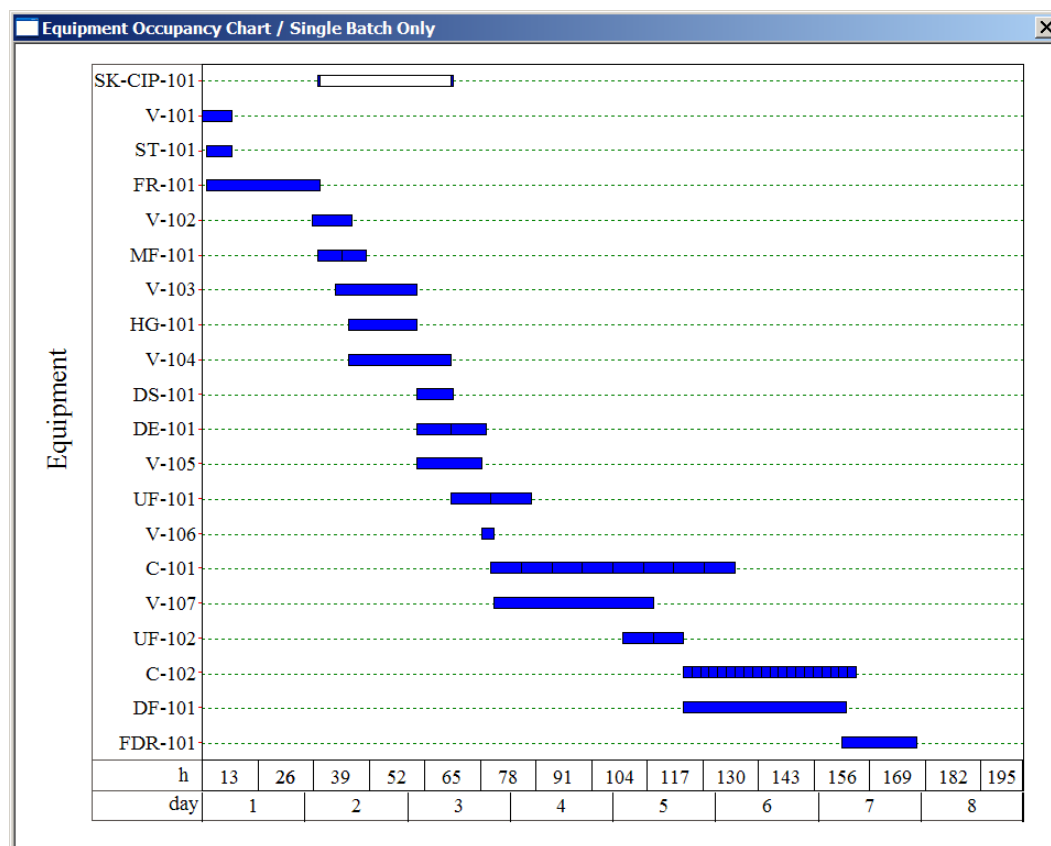


Fig 6.9: The Equipment Utilization Chart (Single Batch)

Every entry (bar) in the y-axis represents one of the equipment (CIP Skid, Reactor, Fermentor, Diafilter, Chromatography Column, etc.) involved in the execution of the current recipe, and the x-axis displays a timeline. For each equipment (y-entry) there may be one or more bars displayed. Each bar represents a distinct procedure that utilizes that piece of equipment in order to be executed. Note that occasionally, there may be a long idle time between uses of the same equipment by two different procedures. For instance, assume that a CIP skid is being used in two procedures, one during the early stages of the recipe and another during the later stages of the recipe. In such a case, the idle time is represented with two bars across from the entry representing that skid, each of small width, but very removed from each other. Note that Pro-Designer assumes that a piece of equipment is unavailable for any other use, while waiting to process amount from the same batch. In other words, Pro-Designer will not allow inter-batch operation mixing. The black vertical lines that appear above in some equipment, are used for indicating the beginning of a cycle ( see 6.8.7 for description of the visual style options)



Note that each bar does not necessarily represent a single piece of equipment. In the most general case, it represents multiple equipment operating in parallel if that is what the user has dictated or that is what has been selected by the design and sizing of the equipment based on maximum available equipment capacity.

You can choose to display the equipment utilization chart for a single batch or multiple consecutive batches. The second option may be of interest when there is batch overlapping (i.e., the second batch starts before the first is finished, or in other words, when the cycle time is less than the batch time). To display the Gantt chart for multiple batches, select **View / Equipment Utilization Chart / Multiple Batches**.

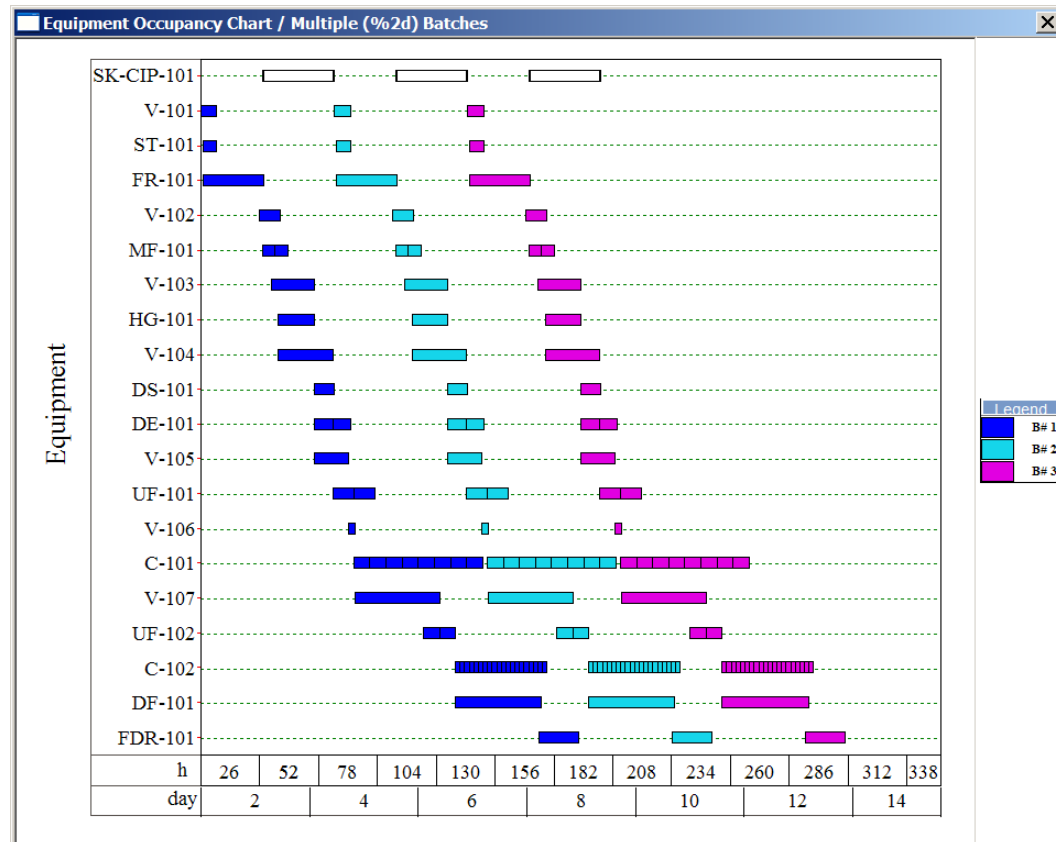


Fig 6.10: Equipment Utilization Chart (Multiple Batches)



### Tip

The number of batches that Pro-Designer displays when the multiple batches Gantt Chart first comes up, is determined so that all future batch starts will show a pattern that is already included in the chart (shifted by some time offset). This number is computed from the following formula:

$$N_{\text{batches}} = [ BT / CT ] + 1, \text{ where}$$

BT is the batch time of the recipe,

CT is the cycle time of the recipe and

[ ] indicates taking the next integer value of the number in the brackets

---

You may, of course, change the number of batches shown at any time, by selecting the **Edit / Set Number of Batches** from the main menu, or **Set Number of Batches** from the context menu of the chart.

---

Pro-Designer uses a color-coding scheme to distinguish between the occupation times of one batch from another. The legend for the color scheme is displayed at the top of the chart. You can turn the display of the legend on or off from the Equipment Utilization Chart's Style Dialog (see next)

## 6.8.2 Exporting the Chart as a Picture

You can export the chart (as a picture) from Pro-Designer into another Windows applications (e.g. a word processor). The export can happen with one of two ways:



### *To copy the Gantt Chart using the Clipboard...*

1. Bring up the chart.
2. Select **Copy...**  
From the **Edit** menu select **Copy** ; alternatively, you may bring up the chart's context menu, by right-clicking on an unoccupied area of the chart, and select **Copy**. Note that the resource chart's interface does not have a main menu so the only way to issue the Copy command is from the context menu
3. **Go to target application and select Paste.**  
Activate the application that you would like to paste the chart picture. From the application's **Edit** menu select **Paste**. Note that **Paste Special...** and the options available to OLE items does not apply to charts; they can only be pasted (not paste-linked) as pictures.



### *To copy the Gantt Chart as a Metafile ('wmf' file)...*

1. Bring up the chart.
2. **Select Export as Metafile**  
From the **File** menu select **Export as Metafile**. Alternatively you may bring up the chart's context menu, by right-clicking on an unoccupied area of the chart, and select **Export Chart as Metafile...** .The usual **Save As...** file dialog will appear, prompting you to type the name of a file. Type in the filename that you wish to contain the description of the flowsheet in 'wmf' format. By convention, all such files should have a 'wmf' extension. The file need not already exist. In fact, if the program discovers that a previous file exist with the same name and in the same location on your hard disk, it will ask for your permission to overwrite it
3. **Go to target application and import the picture**  
After you have typed in the file name and clicked **OK**, wait a few seconds as the program will be creating the file and writing in it the necessary metafile-

formatted description of the chart. When this process is done, you can go to the target application and import the file you have just created. For details on how to do that consult your applications manual or browse through their help utility.

### 6.8.3 Exporting the Scheduling Data into Excel

You can export all the scheduling information contained in a chart (i.e. all information around every procedure and/or equipment) into a file that can be read immediately by Excel (or other leading spreadsheets). Select **File / Export to Excel...** from the main menu (or the chart's command menu) and in the dialog that pops up, specify the pathname of the file that will contain the scheduling data. Then click on **OK**. You can now start Excel and open this file directly from Excel. When you open the file from Excel you may have to adjust the widths of the columns slightly in order to view all contents of the file (without overlapping).

### 6.8.4 Printing the Chart

Even though you cannot currently directly print a chart from Pro-Designer, you can simply copy and paste it into a word processing application (like MS-Word) or any other application and print it from there.

### 6.8.5 Zooming In and Out

When the a chart interface first comes up, it is set into **'Fit-to-Window'** mode, which means that the entire time horizon needed to describe the whole chart has been scaled down appropriately in order to fit into your window's width. If the maximum time that needs to be displayed is very large, or if the settings for minor/major scale and tickmark frequency for the time line are very small, the timeline may NOT display all minor and major tickmarks as expected. Therefore, some details along the time axis may have been omitted. In order to see the timeline spread out as expected you must switch out of **'Fit-to-Window'** mode. Simply right-click on an unoccupied area of the graph and invoke the context menu for the chart. Notice that the **Fit-to-Window** entry has a checkmark in front of it, indicating that currently the contents of the chart are scaled down so that they can fit your window's width. If you select **Fit-to-Window** option once more, then it will turn the Fit-to-Window mode off and will display the timeline according to the timeline specifications. This may result in pushing the right end of your graph off the visible area of your window, so you may need to scroll to the right in order to see the rest of the graph. If further details need to be viewed in a chart, you may further expand the time scale by issuing a **Zoom In** command. Again, from the chart's context menu, select **Zoom In**. This will scale up the timeline and will present more details along the time line but less of the total graph will be visible within your window's area. The opposite effect happens when you issue a **Zoom Out** command. You may continue zooming in or out as needed (up to maximum / minimum scale).

### 6.8.6 The Time Line

When drawing a Gantt Chart, Pro-Designer must decide on the characteristics of the time line against which all activity bars will be drawn. The attributes that determine how the time line is drawn are the following:

- ◆ The maximum time displayed (defaults to as large as necessary)
- ◆ The unit of time used to draw the minor tickmarks (defaults to hours)
- ◆ The unit of time used to draw the major tickmarks (defaults to days)
- ◆ The minor tickmark frequency (defaults to 1)
- ◆ The major tickmark frequency (defaults to 1)

By default, the maximum time is calculated to provide a window of time large enough to accommodate the display of all activity bars. However, if you wish, you may set your own fixed maximum time, by visiting the Gantt Chart's Style (see next). If you do so, you must take care that the limit set is large enough to accommodate all data otherwise some activity bars will not be shown on the chart (Pro-Designer will warn you if that turns out to be the case).

### 6.8.7 The Visual Style

All attributes of the equipment utilization chart's style can be set from the dialog that appears after selecting **Edit Style...** from the context menu of any equipment utilization chart (single batch / multiple batches)

- ◆ The height of the bars in the chart
- ◆ The appearance of the bar interior (fill-in color, etc.)
- ◆ The appearance of the bar outline (color and thickness of the line)
- ◆ The format of the timeline (minor/major time units, tickmarks and gridlines)

The equipment utilization chart's visual style dialog lets you customize all of the above. To view the dialog, select **Edit Style...** from the chart's context menu. The following dialog appears:

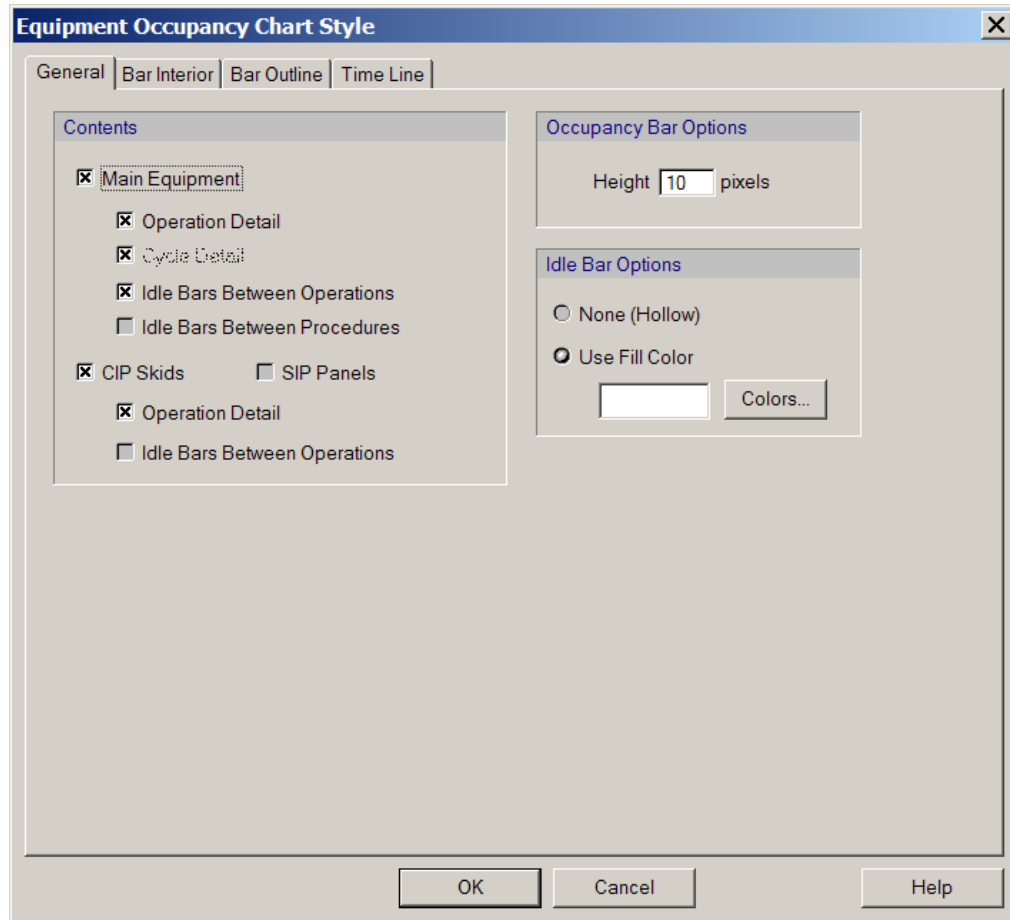


Fig 6.11: The Equipment Utilization Chart's Visual Style Dialog.

The dialog has four tabs. The first tab (General) allows you to set the contents of the chart and the height of the bar in the chart. If the chart displays multiple batches, there will be one more option that determines if the color-coding of the batches is displayed as a legend at the top of the chart.

In terms of the contents you can specify whether to include main equipment, CIP Skids, and CIP Panels to the chart. For main equipment you can request the chart to indicate use of the equipment on an operation or a cycle level and for idle time between procedures / operations to be indicated. For CIP Skids and SIP panels you can request the same information on operation level.

The other three tabs (Bar Interior, Bar Outline and Time Line) are identical to the Gantt Chart's bar style dialog (see section 6.6.9).

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