User Manual

DELMIA Process Engineer®

Automatic Line Balancing – Application

Foreword

This manual describes Process Engineer operation and basic functions you need to be familiar with when dealing with Automatic Line Balancing module. Automatic Line Balancing has been developed in a cooperation of Daimler Chrysler AG Sindelfingen (PP/DPP) and DELMIA GmbH Fellbach.

While developing these functions we have made every effort to create a clearly organized, easy-to-understand program structure.

A user-friendly interface as well as a clear menu guide will enable you to quickly learn how to operate the program and to get familiar with its functions so that you can carry out your planning tasks in a quick and reliable way.

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1. Introduction

The Automatic Line Balancing (ALB) manual explains how to use Process Engineer Automatic Line Balancing for your planning purposes.

The Automatic Line Balancing program module is used for assembly planning. Use this program module to specify the number of work positions included in a station and the number of stations that are available for assembly of particular product variants.

1.1 How to Use this Manual

This manual enables you to get familiar with the operation and functions of Automatic Line Balancing. This manual briefly describes:

- Automatic Line Balancing views
- Main menus
- Program start
- Use of the menu functions

Note

When handling the basic Automatic Line Balancing functions, please remember that there is a general introduction to the Process Engineer in the Basic Manual.

Click General Introduction to access the manual.

1.2 Documentation Conventions and Symbols

The symbols used in this manual are intended to provide you with keys to the contents in an immediately understandable manner.

This symbol is used to introduce key concepts that are covered in the sections immediately following this symbol. As a result, this symbol most frequently appears at the beginning of chapters or sections.

Note

This symbol is used to mark notes, which provide you with additional information you need to have for further work. You will either find the Note sign at the beginning of a chapter or in a particular text passage in the chapter. Texts bearing this sign are additionally marked with ***Note****. The text is always in italics.*

Caution

This symbol indicates that the text that follows describes particular circumstances that you must avoid to avoid potential errors with the operation of the program or harm to data. You will either find the Caution sign at the

beginning of a chapter or near a particular text passage in the chapter. Texts that are introduced by this sign are additionally marked with ***Caution****. The text is always in italics.*

Example

This symbol marks examples which serve to illustrate a certain situation.

1)

This symbol marks the individual operational steps involved in a particular operating instruction. Operating instructions describe operational steps, for example, how to open a menu or execute a function.

▪

This symbol marks listed subjects. The symbol for listed subjects can be either used to structure a continuous text or to list main subject keywords.

➢

This symbol marks list inside a bulleted or numbered list.

This symbol marks cross reference information that is available in another manual.

1.3 New Functions in Automatic Line Balancing

- Locked Areas
  Locked areas can only be manipulated in locked area dialog box and are static in balancing 2d view. Now you can assign plan-type for the locked area in ALB configuration on project level. The **Locked Area** dialog box is also enhanced to include Start (X, Y) coordinate of locked area, length, and width of the locked area.
- Reordering of Part Bins in Shelf
  You can rearrange the part bins inside shelf in a sequential way. You can also reassign a part bin from one level to another level or just rearrange within a level.
- Save Issue in ALB
  You may get an error message when part bin name includes more than 1000 characters.

2. ALB in Course of Time

The division of labor order principle was already known to Taylor. The production of a high number of different product variants requires clear and well-coordinated production sequences to yield optimal results.

The continuous flow production principle, which is primarily used in final assembly of standard products, is one of the classic organization principles of industrial production. Production has virtually undergone a change in the last decades as for example. the product manufacture technique has constantly been improved and the degree of automation has been increased. As a result, the production conditions have crucially been changed.

Moreover, customer behavior has fundamentally changed. Thus, during the planning of each new strategy, companies must constantly bear in mind the ever increasing number customer demands. Companies from the automobile industry, for example, produce several thousand different vehicle types that can vary with regards to their technical construction and their equipment features. Hence, the workload of each production line or station has to be well-planned. The production systems also have to be designed so that they can be used in a flexible way to meet the changing demands resulting from sudden changes. Consequently, high demands are made on the product range even during the planning phase.

New Concepts for the Production Process

New concepts have been increasingly developed for this production process to meet these demands. Precisely balanced flow production processes have continually gained importance for production process planning and the demands made on production plans have increased. Manually performed planning cannot sufficiently meet these complex and varied requirements. Therefore, these manual planning methods will gradually be replaced by IT systems.

Automatic Line Balancing used to balance operation times of assembly lines fulfils these current requirements of IT based planning systems. Assembly systems used for manufacturing can thus react quickly towards changes in production quantities by adjusting the production process to the current situation without a great loss of time.

Individual computer-aided processes are based on the Operations Research methods thereby significantly enhancing the quality and the continuity of planning. There has been a constant increase in computer performance leading to a distinct decrease in the time required for planning. Automatic Line Balancing thus makes planning of assembly more efficient and flexible.

2.1 ALB Application Areas

Automatic Line Balancing is a procedure aiming at the interactive automatic balancing of manual assembly lines.

Using Automatic Line Balancing

- Optimization and efficiency of manual assembly lines.
- Interactive and graphical balancing.
- Selection, distribution, and arrangement of operational steps.

- Spatial arrangement of materials along the assembly line.
- Storage and documentation of the planning results.

Yielding Planning Results

Optimized efficiency of the assembly line according to the following criteria:

- Conditions of sequence
- Cycle times
- Conditions of assignment
- Conditions of position
- Area restrictions

Comparing with Planning Alternative

- Station assignment
- Identification numbers (number of colleagues, number of stations, average balancing compensation, average station times, and maximum station times)
- Quick and quality-increased assembly planning

3. Overview

3.1 Opening Automatic Line Balancing

Open the Automatic Line Balancing in the resource structure on the corresponding hierarchical level – conveyor.

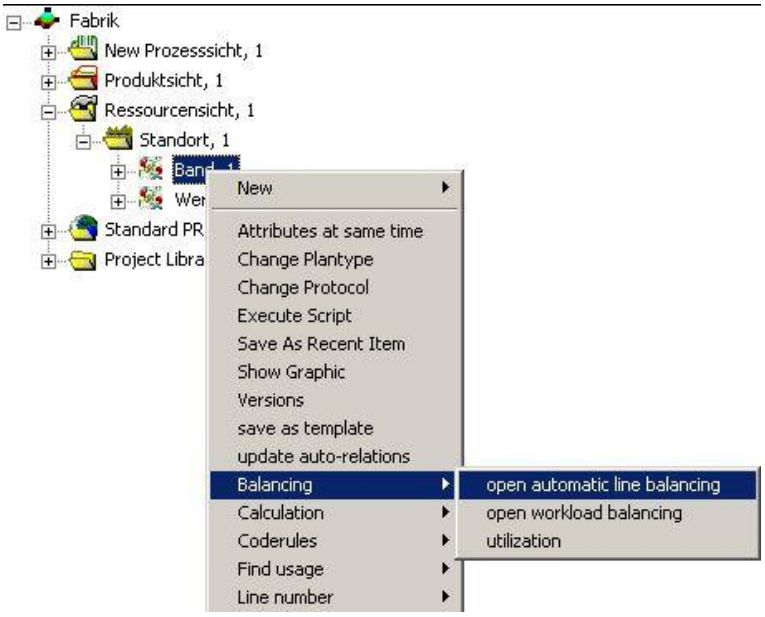


Figure 1: Opening Automatic Line Balancing

To Open Automatic Line Balancing

1) Open the PPR Navigator resource structure until you reach the conveyor hierarchy.

2) Press the right mouse button. Click **open Automatic Line Balancing** in the open popup menu. *Please refer to the* Figure 1.

Automatic Line Balancing area overview includes the following. *Please refer to the* Figure 2.

- (1) Menu bar. *Please refer to the* Figure 3.
- (2) Tool bar. *Please refer to the* Figure 5.
- (3) Work area. *Please refer to the* Figure 52.
- (4) Status bar
- (5) Material supply area. *Please refer to the* Figure 143.

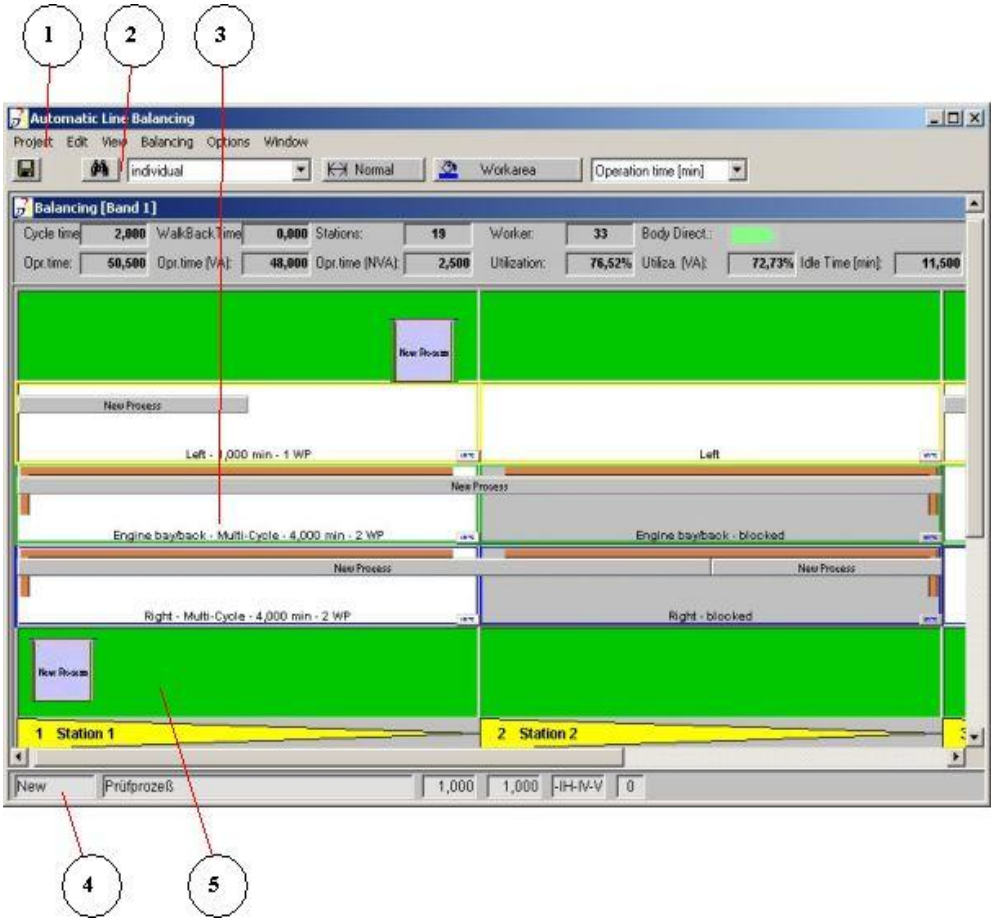


Figure 2: Automatic Line Balancing Display – Including Menu and Tool Bar

3.2 ALB Menu Bar

All main menus and their corresponding editing functions for the balancing are arranged in the Automatic Line Balancing menu bar. You are already familiar with the **View** menu. You will be provided with an overview of further main menus in the following section:

Figure 3: Automatic Line Balancing Menu Bar

3.2.1 Opening Menu Function

1) Left-click a menu name (project, edit, view...) in the menu bar. The corresponding menu with its functions will be opened.
2) Click menu function to open it. Either a dialog or a list will then be opened depending on the menu function enabled.
3) Additional menu functions are provided in an extra menu. These menu functions are marked by an arrow.
4) Use the left mouse button to open the additional menu functions. (*Please refer to the* Figure 4).

Figure 4: Example of a Function with Additional Functions

3.3 ALB Tool Bar

If you use the buttons and icons in the tool bar, you will quickly be provided with information needed for the work in Automatic Line Balancing.

Figure 5: Toolbar in Automatic Line Balancing

Save

Use this icon to save processes in Automatic Line Balancing.

Reload Processes

The icon enables you to update processes without closing the ALB. After starting the **Process reload**, the changed process data is displayed in the dialog. Only changed process data is recognized during loading.

Note

This option is also available in the Project menu.

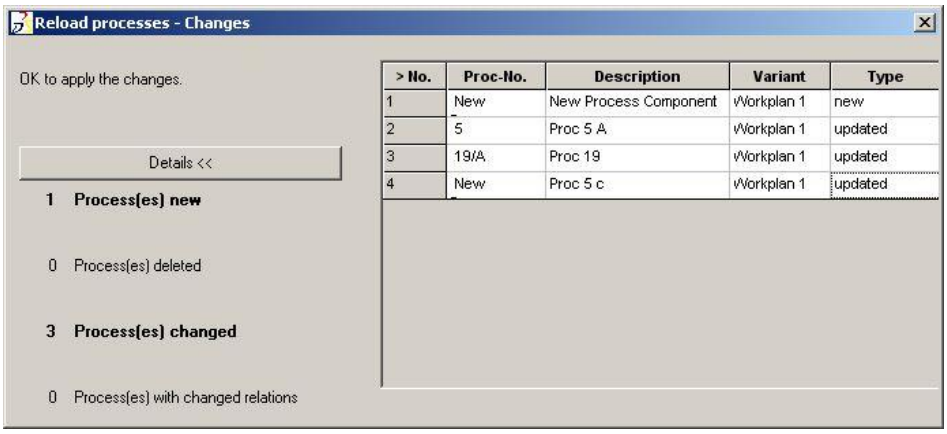


Figure 6: Reload Processes Dialog

The following changes are recognized during the reloading of processes:

- Changes in the properties dialog of a process, such as changed process time or description.
- New and deleted processes.
- Changes in the relationship between processes – *Please refer to the* Figure 212.

Note

Any changes with products and parts bins or relations between processes, products and parts bins, are not recognized during reloading with the Reload processes option.

Finder

Use this icon to quickly search for processes.

Representing Process Length and Body Point

These buttons offer several selection options. *Please refer to the* Displaying Process Length and Displaying Work Areas.

Using Selection List

The selection list provides several representation options for the Automatic Balancing view. *Please refer to the* Balancing View.

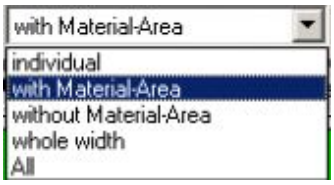


Figure 7: Selection List for Automatic Balancing Representation

The Balancing view can either be displayed with or without material area.

1) Select option from the selection list.

For a quick overview of the balancing process proceed as follows:

2) Select **All** from the selection list. This display will represent all stations of a balancing process with the material supply areas.

Individual Size Representation of Balancing

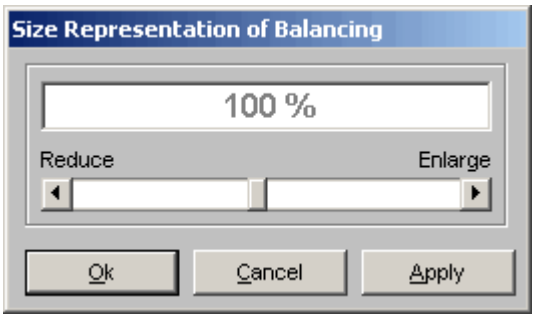


Figure 8: Size Representation of Balancing

Use this dialog to individually set the size of the Automatic Balancing view. Use the arrow keys to set the size. You cannot enter the percentage directly in the field.

3) Either use the left or the right dialog arrow key. The specified percentage will be displayed.

4) Click **Apply** to display the view in the corresponding size. You can still make changes without closing the dialog.

5) Click **OK** to confirm the entry.

Displaying Process Duration

Use this selection list to set the process duration display in minutes or percentages. The display of percentages shows the process duration in relation to the cycle time. *Please refer to the* Figure 9.

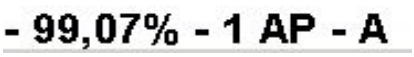


Figure 9: Process Duration Displayed in Percentages

3.4 Changes in the Default Settings

1) Open ALB Configuration on the DPE Project (Right-click DPE project > **Extra** > **Balncing ALB Configuration** > **ALB Customization**).OR Open **ALB Main Menu** > **Tools** > **Options** > **Settings**.

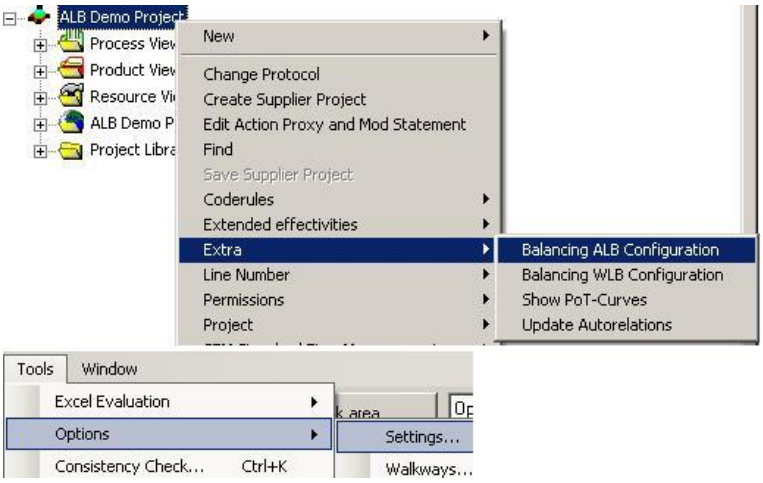


Figure 10: Opening ALB Customization Dialog

2) The default value for **Material Planning** > **Logistics Planning** > **Model Mix** is changed to **No duplicate parts bins for same Parts inside material area.**

3) The default value for **Scaling** > **Show 2D View scaled** > is changed to **Only workplace width**.

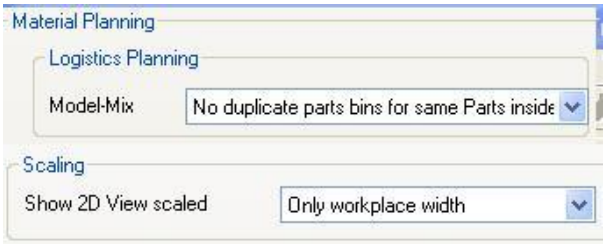


Figure 11: Default Settings for Material Planning and Scaling

4) Click **Load Default Values** button in **ALB Customization** dialog box to load the default values.

Note

These new settings are effective from R20 only. Projects upgraded from R19 or previous versions, does not have these settings by default. You have to change them manually.

4. ALB Menu Bar Description

4.1 Project Main Menu

Use the Project main menu to finish Automatic Line Balancing and to save data. Use the **Save as** menu function to save a balancing process as a new name. Use the **Save as** function to generate a complete saving of a balancing process.

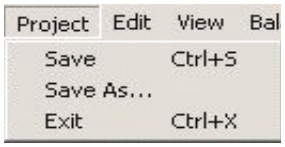


Figure 12: Project Main Menu

4.1.1 Save as Menu Function

Use the **Save As** menu function to save a balancing process under a new name. This generates a copy of the balancing process which can be further edited independently. In version PE 5.13 you can select whether the process graph should be stored along with it. All generated balancing processes are displayed in a dialog.

1) In the menu select **Save As**... Type in a new name in the field **Name**.
2) Click **Copy Process Graph when Saving** field if you want to save the process graph. You can edit this process graph independently. There are no longer any dependencies on the initial process graph.
3) Click **OK**. The balancing process and all of the corresponding data will be saved as a new name.

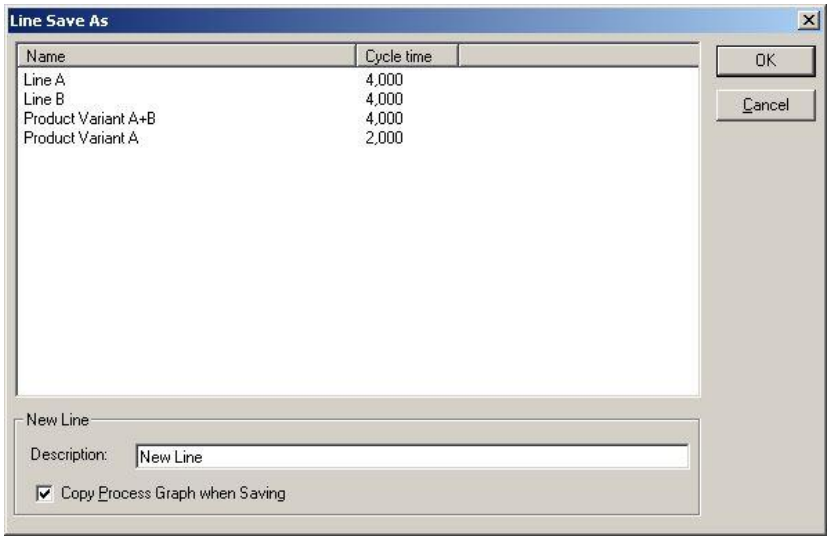


Figure 13: Example – Save As Dialogs

4.2 Edit Main Menu

Use the Edit main menu to copy work contents from the work area as for example the Balancing view or the Priority Graph view. The copied view will be saved to the clipboard. It then can be copied into a Word file.

The **Redo** and **Undo** menu functions belong together. Use the **Redo** function to return to the original situation. The **Undo** function can be used until all of the activities are undone. As a basic rule it can be said that if a particular state is saved in Automatic Line Balancing, both menu functions will be disabled unless you carry out one or several processes in Automatic Line Balancing.

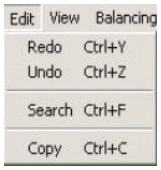


Figure 14: Edit Main Menu

4.2.1 Quick Search for a Process

Use the Automatic Line Balancing Finder to quickly find processes. When searching for processes, you can specify the attributes, comparative operators, and values. The **AVO Search** dialog size is adaptable. The processes resulting from the search are displayed in a black box found in the job view.

Common attributes such as the process description, process number, or time are generally configured for searching processes in the ALB. However, it is possible to configure specific attributes for individual searches at any time.

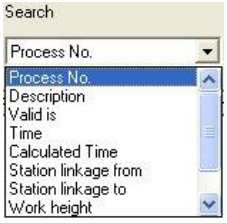


Figure 15: Common Configured Attributes

For more information on *How to configure user defined attributes*, *please refer to the* Administration Manual.

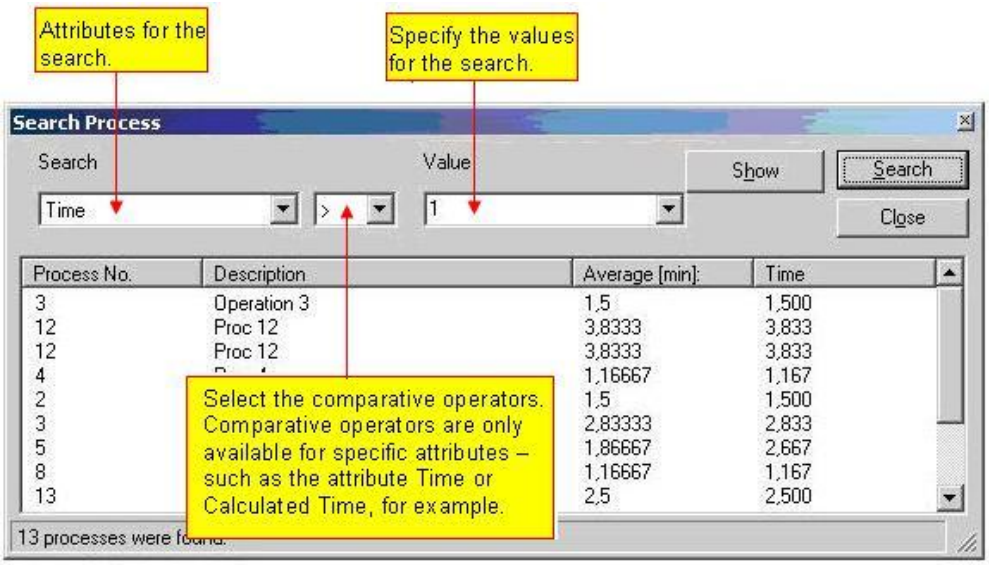


Figure 16: Search for the Process Dialog

Table 1 explains attribute usage.

Table 1: Using Attributes to Search for Processes

Attributes for the Search	Comparative Operators	Specify Values
Process number and description	None	The process number and description can enable one to search for processes using a single portion or full description of a process - for example, if one enters a number or letter found in the process number or description, then all processes which contain these values will be displayed.
Valid time is	None	The **Valid time is** attribute enables you to search for the time that is valid for the process – for example, the calculated time or estimated time. **Tip**: By not entering a value in the field, all processes are displayed. This broad overview enables one to quickly determine the valid speed for a process.
Time	> = <> > >= < <=	The **Time** attribute enables you to search for the estimated time. Enter the search criterion by way of the comparative operators. The value entered should be numerical. For example, by entering the comparative operator greater than with the time parameter 1, all processes with an estimated time value greater than one minute will be displayed.
Calculated time	> = <> > >= < <=	The **Calculated Time** attribute settings are similar to the Time attribute in that it enables you to display processes for which the calculated time is valid.
Station linkage from Station linkage to	> = <> > >= < <=	The **Station linkage from / to** attribute enables you to search for processes with an existing Station linkage. The comparative operators are to be used analogous to the time parameters. The value entered should be numerical.
Work height	None	The **Work height** attribute enables you to search for processes that have an existing working height value – these values can be between 1 and 5.
Max.Car	True True False	The **Max.Car** attribute enables you to search for processes using the values true or false and then display the corresponding processes according to the value chosen.
Production Line	None	The **Production Line** attribute enables you to search for processes that have been preset for a particular production line. The value given must be numerical, in line 10 for example, the numerical value is 10.

4.2.1.1 Searching for a Process

After you have entered the search criterion, click **Search** button. The result is displayed in the dialog.

4.2.1.2 Showing Processes

Processes can be displayed in the Automatic Balancing view. All of the processes found during the search are marked by a black box in the Automatic

Balancing view. This marking remains as long as the **AVO Search** dialog is open.

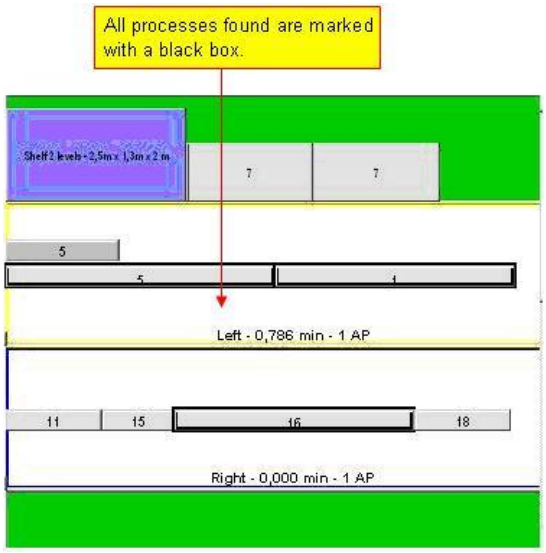


Figure 17: Search Dialog

Once the dialog is closed the processes are again displayed as before – for example, processes with a weighting of less than 100%, are once again marked with a red box.

Note

You may continue to work in ALB with an open Search dialog, in the job view.

To Show a Process

To highlight a process in the Automatic Balancing view, select the process in the AVO dialog Search.

Click **Show**. *Please refer to the* Figure 19.

The Automatic Balancing view automatically shows the location of the selected process. The selected process will be indicated by a frame with node points. *Please refer to the* Figure 18.

Example

Figure 18: Example of a Selected Process

Another option to show a process is to double-click the selected process.

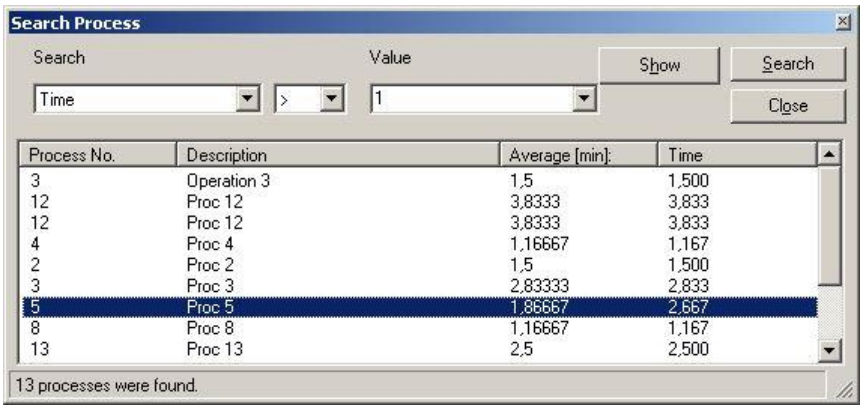


Figure 19: Showing Processes

4.3 View Menu

The display of views in Automatic Line Balancing is based on Windows technology. You can set all views using the View menu.

You can use several menus, for example, the View or Extras menu, to balance processes in Automatic Line Balancing. The edit views you will need for the corresponding activity are provided in the Views menu. You can open several views simultaneously. When opening the Balancing menu, you automatically open the balancing view.

Frequently used functions such as the Finder icon or the selection list for a particular display of calculated stations are arranged in the tool bar.

There are generally two view types:

- Information views
- Edit views

4.4 Balancing Main Menu

The main data for generating a balancing process will be specified in the Automatic Balancing main men. Performance parameters are used in Automatic Line Balancing. Performance parameters are default values such as cycle times, way times, and subtimes.

This chapter will guide you through the dialogs and functions used to perform an automatic balancing process. The operational chapter of this manual will introduce you to the dialogs you use for the first balancing process of a conveyor only. (*Please refer to the* Working with Automatic Line Balancing)

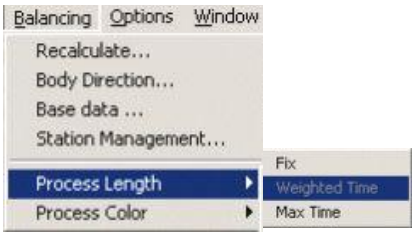


Figure 20: Automatic Balancing Main Menu

4.4.1 Recalculating Balancing Process

Note

All data referred in the following dialogs are general data and valid for the entire balancing process of a conveyor.

In Automatic Line Balancing, you can recalculate an already generated balancing process, for example, by changing process data or material supply area data. To generate the first balancing process for a conveyor, you can use the same dialogs used for the recalculation of a conveyor already balanced.

Click **Recalculate** to start the process. The performance parameters are to be specified in the dialogs described in the following section after the start of the recalculation. *Please refer to the* Figure 20.

4.4.1.1 Body Alignment Dialog

Use this dialog to specify the position of a vehicle on the conveyor. The conveyor traverse direction does not change regardless of the vehicle position selected. This dialog is also available for the first balancing process of a conveyor. *Please refer to the* Figure 21.

You can directly call up and edit this dialog without having to recalculate the balancing process.

To Open Body Alignment Dialog

Click **Body Direction**. *Please refer to the* Figure 20.

Caution

The arrangement of charge carriers/containers may change if you select another body position. Hence, it is advisable to ensure that the work positions and material supply are arranged on the right side. You should be able to arrange things formerly situated on the left side on this same side again without mixing them up unless you do want to change the arrangement.

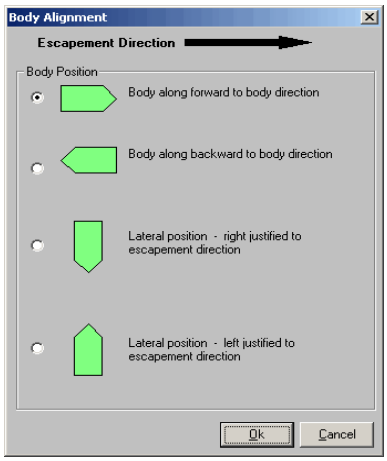
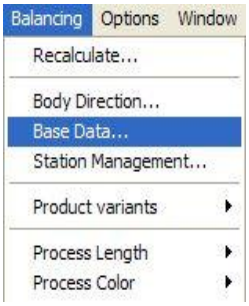


Figure 21: Specifying Body Position Dialog

4.4.1.2 Parameter for Automatic Balancing Dialog



Use this dialog to specify the performance parameter for the cycle time, the return path, the station length, and the material supply area width. This dialog is also available for the first balancing process of a conveyor. *Please refer to the* Figure 22.

Reason

As the number of vehicle variants increase, the required space for the material to be provided will increase, too. The material supply area is limited on the one hand by the station length and on the other hand by the surroundings of the conveyor; for example, by adjacent paths or by further production lines. For this reason, automatic balancing has to be dealt with in the context of material supply planning (*Please refer to the* Figure 28). Hence, the available area can be considered as a further restriction. In Automatic Line Balancing, you can arrange workplaces where processes are performed in a flexible manner. You can arrange a workplace at a station either on the left or on the right side. The number of workplaces available at a station is to be specified with the first balancing process. You cannot change them with recalculation. The Automatic Line Balancing program identifies and generates stations and work positions automatically with the first balancing process of a conveyor. *Please refer to the* Working with Automatic Line Balancing.

In Automatic Line Balancing, processes can be executed at one or several stations. A MultiCycle is a work pool (to be performed at two or more stations due to its size) assigned to a station. A work pool consists of all processes

executed by workers or robots. What are the potential effects on the balancing process? As far as the planned use of Multi Cycles in the balancing process is concerned, this may lead to an increase in the number of workers at a manual station or - in case of an automatic station – to the use of robots with a higher performance frequency.

This procedure will extend the spectrum of activities and the individual work speed will be less closely linked to a cycle or station. Work time fluctuations can thus be reduced.

You can, in addition, reduce the physical strain of workers by creating process sequences that combine heavy and light work.

Furthermore, MultiCycles offer a great potential for increasing utilization. The first balancing process in Automatic Line Balancing will only generate MultiCycles if the average specified time of one or more process(es) exceeds the difference generating from cycle time and way time thereby forcing a parallelism. To plan MultiCycles, you have to enter a value in the Max. capacity field in the **Parameter for Automatic Balancing** dialog. The higher the value, the greater the number of MultiCycles permitted. *Please refer to the* Figure 22.

4.4.1.3 Specifying Entries for Performance Parameters

You cannot make any entries in either of the **Line** and **Process Graph** fields. You can enter a name for the balancing process in the **Description** field. You will need to enter a name if you carry out several conveyor balancing processes with different performance parameters and save the corresponding results as a file with another name.

Using the **Save as** function in the Project menu, you can save as many balancing process results as you like. This function enables you to generate several balancing process variants for a conveyor. The different results are available for planning at any time and can be compared to each other.

You can directly call up and edit this dialog without having to recalculate the balancing process.

To Specify Entries for Performance Parameters

1) Click **Balancing** > **Base Data**.
The **Parameter for Automatic Balancing** dialog appears:

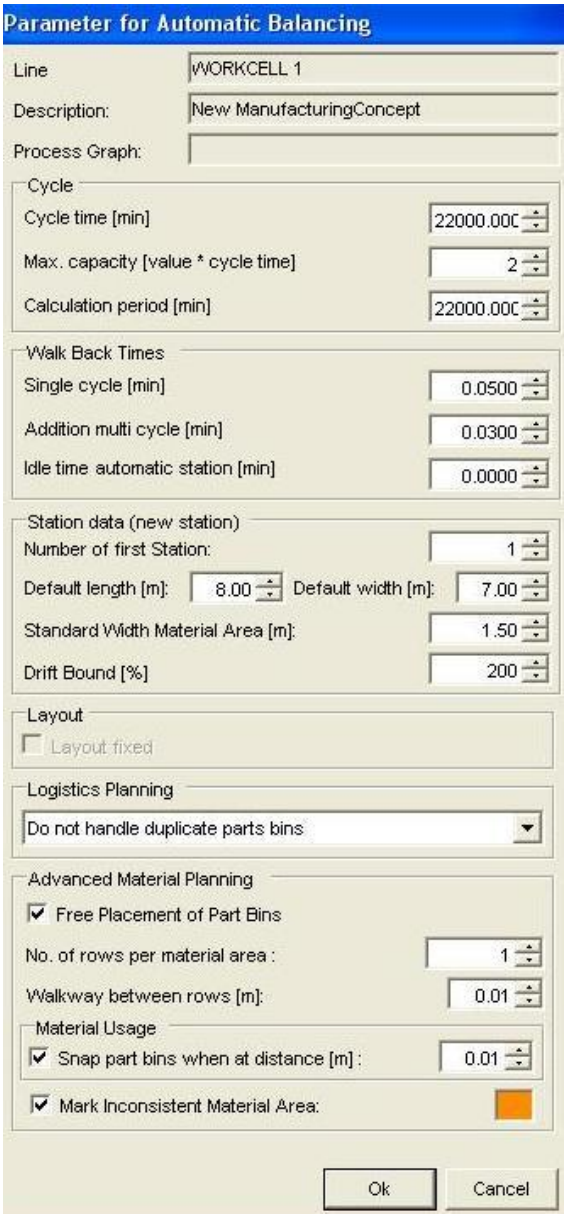


Figure 22: Specifying Parameters for Automatic Balancing

Cycle

2) Specify the cycle time needed to transport a vehicle on the conveyor in the **cycle** area. Cycle time is specified in minutes.

3) The number of stations where a MultiCycle can be used is specified in the **Max. capacity** field. It is 2 in the example.

Calculation Period: The calculation period enables you to adjust the calculated cycle times to longer time periods, the duration of a shift, for example, by default, this field contains the pre-set cycle time. The times are adjusted and projected according to the pre-set calculation period.

During projection, the times described below are taken into account and adjusted accordingly:

- Total time for an activity
- Productive activity time
- Unproductive activity time

- Cycle compensation

The times for the calculation period are based on this formula:

Example of the total activity time

Total Time for an Activity = total process times x calculation period/cycle time.

This message appears when the calculation period is larger than the cycle time.

4) If the projected times for the calculation period are to be shown, confirm the message by clicking **No**.

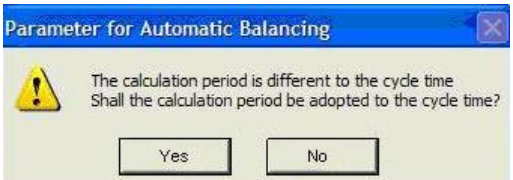


Figure 23: Calculation Period Message

Walk Back Times

5) Enter the **SingleCycle** time
This time corresponds to the return path of a cycle needed by a worker to get to the start again.

6) Enter the **Addition MultiCycle** time
The allowance is specified for the return path with MultiCycles. Normally, less time is set because the worker will already be moving and no standstill is taken into account.

7) Enter the **Idle time automatic station** time
The time specified is dependent on the robot type used at a station. It is the time a robot needs to reach the right work position for executing the processes.

Note

The way time is specified in minutes.

Station Data of New Station

8) Enter the station numberin **Number of first Station** you want to start as the first station of a balancing process. The other station numbers have to be entered accordingly.

9) Enter the **Default length and width**
Length and width are specified in meters. In this field you specify the width and length of all stations of the balancing process. The standard width value includes the material area width.

10) Enter the **Material Area standard width**
Width is specified in meters. In this field, you specify the material supply width for all stations.

11) Enter the percentage rate for drift bound. *Please refer to the* Entering a Percentage Rate for Drift Bound.

12) Select the checkbox **Layout fixed** for Layout.

13) Select **Logistics Planning** from the drop-down list.

14) Click **OK**.

4.4.1.4 Entering a Percentage Rate for Drift Bound

The percentage rate for drift bound only affects the Automatic Line Balancing. The **percentage rate for drift bound** specifies at which percentage rate the subsequent station should be locked for the execution of processes. This value should always be higher than **a 100%**.

During balancing the Automatic Line Balancing takes the corresponding weighting of processes into account. Under this aspect the occupancy of the stations is calculated.

A high number of processes can be executed simultaneously at a 100% in order to be able to manufacture certain product variants. In the maximum case this would mean that all processes determined for a station should be executed simultaneously at a 100%. All processes are therefore added up.

With regard to the occupancy of a station this means that the occupancy increases to 220%, for example, when taking the weighting occupancy into account that is utilized 100% on average.

In example, the percentage rate for the drift bound is entered at **200%**. In the case of occupancy **220%**, this value is exceeded by 20%. Automatic Line Balancing automatically locks the subsequent station because of the entered percentage rate of 200% for the drift bound. If the occupancy is below this value, the subsequent station is not locked.

Therefore, you should already consider how high the maximum occupancy for certain product variants could be before the planning process. Based on this you should determine the percentage rate for the drift bound. In the case of MultiCycles, i.e. processes that are executed at several stations, the percentage rate does not make any difference to the drift bound.

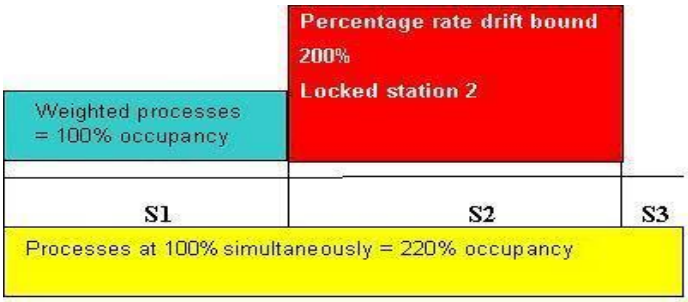


Figure 24: Schematic Display – Locked Station

4.4.2 Specifying Performance Parameter for Calculation

Use this dialog to specify the method according to which you want to calculate the balancing process. *Please refer to the* Figure 25.

The Automatic Line Balancing process logic is based on the priority relations specified in the Priority Graph. A priority relation describes the order of processes. In Automatic Line Balancing, the ranking values are calculated on this basis. The ranking value is an abstract value used for calculation. The process times serve to calculate process ranking values.

To Specify Performance Parameter for Calculation

1) Enter the Process Graph name
2) Enter the balancing line
3) Specify the rule for processes. *Please refer to the* Automatic Calculation.

Automatic Calculation

There are two main aspects for Automatic Calculation:

- Ranking value calculation according to the sum of successors.
- Ranking value calculation according to the maximum of successors. This calculation determines the critical path.

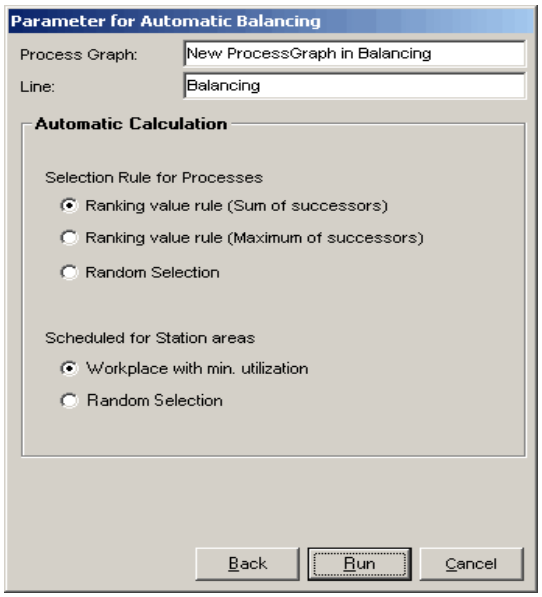


Figure 25: Specifying the Calculation Dialog

Example

The processes for calculating the balancing process are referred according to the selection made.

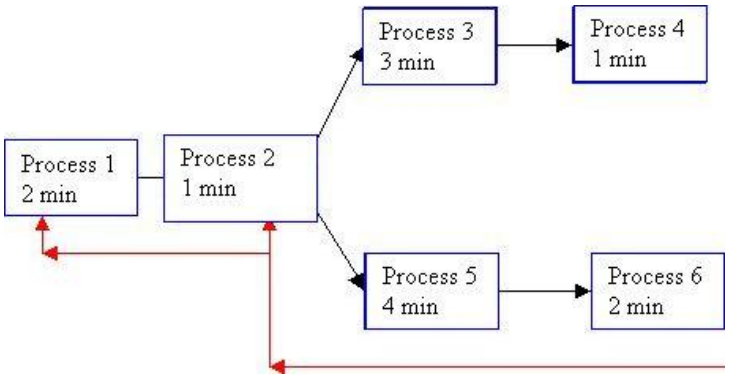


Figure 26: Example of Ranking Value Calculation – Critical Path

The Method

The priority relations will be specified in the Priority Graph. Ranking values are determined by these relations. Ranking values are specified by the time.

Thus, **process 4** is assigned **ranking value 1** because the process time lasts 1 minute. **Process 6** is assigned **ranking value 2** because the process time lasts 2 minutes. If there are no succeeding relations with these two processes, the ranking value will be calculated by the precise process time. *Please refer to the* Figure 26.

The further process ranking values will be determined by the priority relations: There are different ranking values for a single process depending on the method used.

Example

Ranking Value Example for Process 1:

- Ranking value according to sum of successors: Ranking value 13 (13 minutes).

- Ranking value according to maximum of successors: Ranking value 9 (9 minutes)

The example provides a detailed description of the two methods.

Ranking Value Calculation according to Maximum of Successors:

The red arrows indicate this relation. *Please refer to the* Figure 26.

Ranking value selection rule:

- **Process 6** = Ranking value 2 (corresponds to a process duration of 2 minutes)
- **Process 5** = Ranking value 6 (corresponds to a process duration of process 6 and 5 and the sum of 6 minutes)
- **Process 2** = Ranking value 7 (corresponds to a time of 7 minutes, which is the sum of the two previous processes as well as its own process time).
- **The process 1** = Ranking value 9

Ranking Value Calculation according to Sum of Successors

Please refer to the Figure 26.

- **Process 4** = Ranking value 1
- **Process 3** = Ranking value 4
- **Process 2** = Ranking value 11: This ranking value is determined by the sum of the times of processes **6, 5, 4**, and **3**.
- **Process 1** = Ranking value 13.

Conclusion

In the maximum ranking value selection, processes corresponding to these determined values will be balanced successively. The sum ranking value selection will not deal with the critical path. Processes will be balanced successively according to the ranking values and priority relations. In addition, there is a further principle: Random selection Here, processes will be balanced. Ranking values will not be taken into account.

4) Specify the schedule for selection areas. *Please refer to the* Planning of Station Areas.

Planning of Station Areas

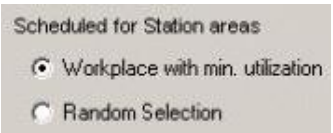


Figure 27: Planning of Station Areas

This area is the local area in which a process is to be executed.

- **Workplace with minimum utilization:** This balancing process first concentrates on the workplaces with minimum utilization.
- **Balancing process according to Random Selection:** The utilization of a workplace will not be considered here.

5) Click **Run**. The balancing process will be recalculated.

4.4.3 Station Management Dialog

Work areas (workplaces and material supply areas) which are not to be assigned processes or bins are blocked in the **Station Management** dialog. When work areas are blocked, current situations which may result from ongoing planning are considered. All stations and workplaces of the balancing process dialog are available for blocking workplaces and material supply areas. *Please refer to the* Figure 28.

Note

You cannot use the Station Management dialog unless you have executed a balancing process for a conveyor.

To Open Station Management Dialog

1) Click **Station Management** to open the **Station Management** dialog. *Please refer to the* Figure 20.

The following items can be blocked:

- Workplaces and material supply areas at the station.

Work areas assigned by processes or bins cannot be blocked at all. The display of this dialog may change. Only work areas specified with the first balancing process of a conveyor will be displayed.

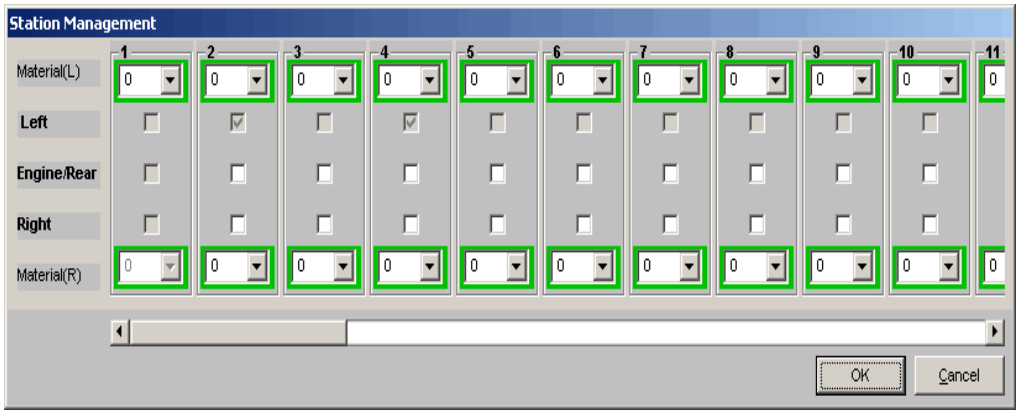


Figure 28: Station Management Dialog

Blocking Workplaces

Workplaces can only be blocked if they have not yet been assigned by a process. Blocked workplaces are marked by a grey box in this dialog. If blocking is made by a MultiCycle (marked by a red rectangle, *Please refer to the* Figure 29) i.e. a process comprising at least two stations, it is marked by a checkmark in the grey field. Boxes next to the workplaces that are not greyed out can be blocked.

2) To block a workplace, click empty box. A blocked workplace cannot be checkmarked. *Please refer to the* Figure 29.

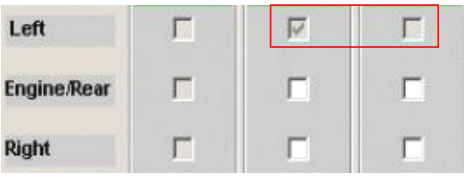


Figure 29: Blocked and Unassigned Workplaces

4.4.3.1 Locking the Material Supply Area

You can lock individual portions of the material supply area of a station, with the aid of the **Locked area**… menu item in the job view. The locked area of an occupied material supply area can only be changed, if the locked space is at the end of the station area. Open areas can be designated as locked space at any given time. *Please refer to the* Unlock or Lock Material Supply Area.

Figure 30: Locking the Material Supply Area

To Lock the Material Supply Area

1) Specify the area which is to be blocked for the purpose of material supply at a station.
   The area is specified in meters. There are two default values to select from in the selection list: the station length and the zero value if the material area has not yet been blocked.

Figure 31: Default Values

2) Left-click the field and mark the number. The next step is to enter the value for the blocking. In the example, an area of 4 meter on the right side of the station is blocked. The grey area indicates the blocked area. *Please refer to the* Figure 32.

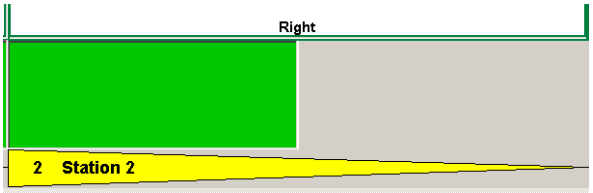


Figure 32: Example for a Blocked Area

4.4.4 Displaying Process Length

Use the **Process Length** menu item to display processes differently in the Automatic Balancing view. The processes can either be displayed with priority relations or with weighted times – depending on the usage. Use the tool bar buttons to select the views.

Figure 33: Process Length Menu Item

Displaying Process Length with Equal Length

This display corresponds to the **Fixed** menu item. This display includes all processes with equal length and priority relations independently of the process duration. This display offers you a quick overview of all processes and priority relations of a balancing process.

Displaying Process Length with Weighted Time

This display corresponds to the Weighted Time **Fix** menu item. This display contains all processes according to the weighted process duration without priority relations. In addition, potential waiting times between processes due to

a priority relation or to the station linkage are displayed. You can use this display to view the actual assignments of the processes to the stations that can then be edited manually for example, to reduce waiting times.

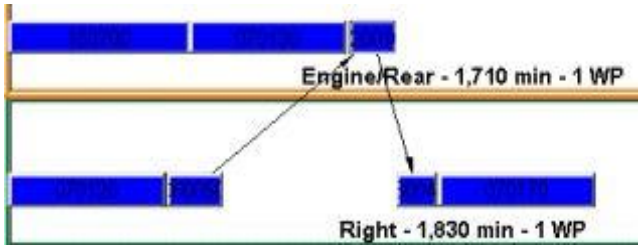


Figure 34: Displaying Waiting Times between Buffers

Example

Between processes **002700** and **003100** (workplace rear) there is an actual waiting time due to the priority relation between both processes **080410** (workplace on the left) and process **003100**.

Left-click the process to display the priority relation.

Each balancing process aims at the avoidance of waiting times between processes. If, nevertheless, you cannot avoid waiting times, you will be able to quickly correct the waiting time in this display. For example, by assigning the workplace processes manually. *Please refer to the* Figure 34.

4.4.4.1 Marking Processes for Max. Car – 100% Display

This display corresponds to the **Maximum Time** menu item. *Please refer to the* Figure 33.

In this display, all processes are represented with the actual process duration. The weighting is 100% here. This display does not consider waiting times.

Note

If for a balancing process you use processes of which none have been marked as Max. Car, no processes are shown in the 100% display.

- In this display only the processes marked as Max. Car in the properties dialog of a process are displayed.
- As of Version R16 the processes are marked as **Maximum Vehicle** only in the balancing in the properties dialog of the process. In contrast to previous versions, the mark applies only to this balancing. In the standard configuration, the processes are marked as **Maximum Vehicle** after the balancing has been started. Changes to this mark must therefore be made directly in every balancing.
- Marked processes as Max. Car of such processes are used for the vehicle which has the highest percentage of process time volume.

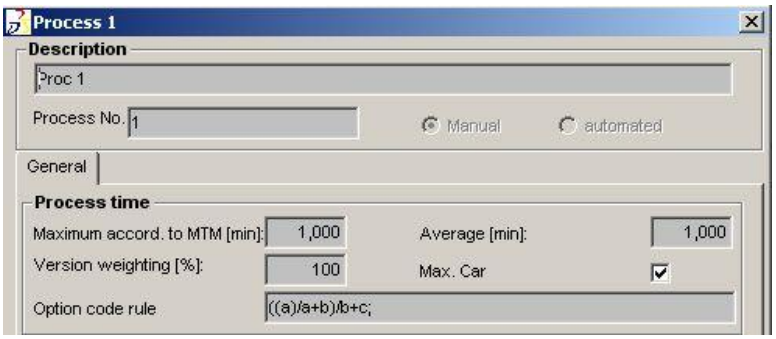


Figure 35: Marking Process in the Properties Dialog as Max. Car

For the planning of alternative processes *Please refer to the* Planning Alternative Processes in the Process Graph.

4.4.5 Displaying Work Areas

Using the **Process Color** menu item, you can, by highlighting, display the processes either according to the working height or the work position at the vehicle. Working height data and the work position of a process are to be specified in the Properties dialog. You can change the display according to the corresponding usages. You can also select the views using the tool bar buttons.

Figure 36: Process Color Menu Item

Displaying Processes according to Working Height

According to the slightly altered rule: Automatic Line Balancing offers menu by providing optical process tracking. With coloring of processes, you will be provided with a quick overview of the height at which a process is carried out at a workplace. You will see this display using the Priority Graph and Automatic Balancing views.

Displaying working height colors	
	very high
	high
	centered
	low
	very low

Figure 37: Displaying Working Height Colors

Displaying Processes according to Working Height

Processes will be displayed here according to the work position on the car body. There are two main types:

- Processes executed out at a single workplace only.
- Processes positioned in an intersection – i.e. processes that can be executed at two workplaces. Each vehicle workplace is marked by a color.

Processes only carried out at a single workplace have the same color as the workplace. Processes in an intersection are colored grey.

Processes carried out at single workplaces are marked by a circle with the respective color.

Example

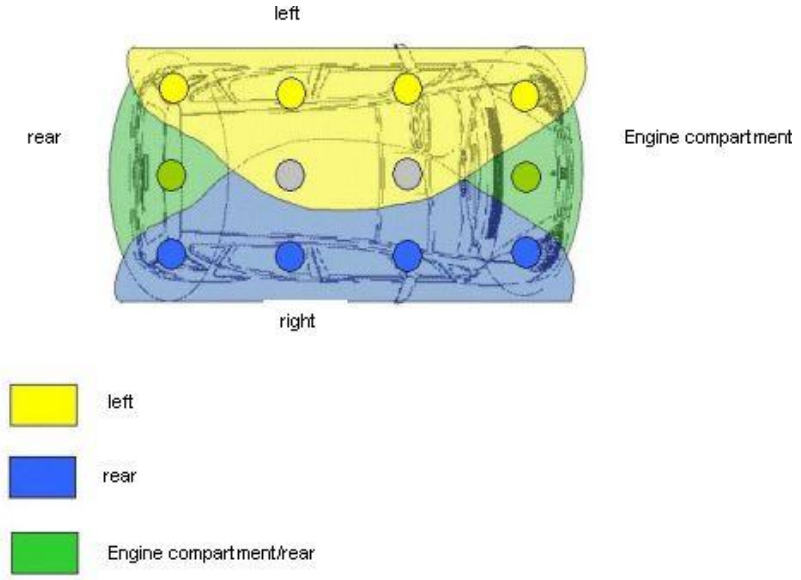


Figure 38: Example for Assignments of Colors to Body Point

4.5 Extras Main Menu

Use the **Extras** main menu to print the valuations of a station assignment, process list, and Group overview in an Excel table. The three Automatic Line Balancing valuation options will provide you with a quick overview of the important performance data of a balancing process. The **Consistency Check** dialog displays the processes which caused an error in the balancing process and provides an error description. Following that description, an error might result by disregarding priority relations.

Figure 39: Extras Main Menu

4.5.1 Getting to know Automatic Line Balancing Valuations

There are three valuation types:

- Station assignment, *Please refer to the* Figure 40 and Figure 41.
- Process list, *Please refer to the* Figure 42.
- Group overview: You will be provided with each field of the valuation list in chapter: Group Overview View.

4.5.1.1 Station Assignment Valuation

	A	B	C	D	F	G	H	J	K	L	M	N	O	P	Q	R	S	T
1			Station				Process	Product variant		Average process duration		MaxCar	Max. Process time	Part			Partsbin	
2	No	Type	Area	Worker	Resources	No	Description	PV Name	PV %	.min	%		.min	No.	Name	Name	Count	Body Location
3			1 Left	1		1	Proc 1	Workplan 1_1	6000,00%	1,000	1	x	1,667	1	Part 1	Container 1	Fixed surface	Station 1, Left
														2	Part 2	Container 2	Fixed surface	Station 1, Left
														3	Part 3	Container 3	Fixed surface	Station 1, Left
4						1	Proc 1	Workplan 1_2	4000,00%	0,667	1	x	1,667	1	Part 1	Container 1	Fixed surface	Station 1, Left
														2	Part 2	Container 2	Fixed surface	Station 1, Left
														3	Part 3	Container 3	Fixed surface	Station 1, Left
5						+	Walk Time			0,000								
6										**1,667**								
7	1	manual				19	Proc 19	Workplan 1_1	6000,00%	0,500	1	x	0,833					
8						20	Proc 20	Workplan 1_1	6000,00%	0,325	0,25	x	2,167					
9			2 Right	1		2	Proc 2	Workplan 1_1	6000,00%	1,300	1	x	2,167	1	Part 1	Container 1	Fixed surface	Station 1, Right
														4	Part 4	Container 4	Fixed surface	Station 1, Right
														5	Part 5	Container 5	Fixed surface	Station 1, Right
10						2	Proc 2	Workplan 1_2	4000,00%	0,867	1	x	2,167	1	Part 1	Container 1	Fixed surface	Station 1, Right
														4	Part 4	Container 4	Fixed surface	Station 1, Right
														5	Part 5	Container 5	Fixed surface	Station 1, Right
11						+	Walk Time			0,000								
12										**2,992**								
13						5	Proc 5	Workplan 1_1	6000,00%	1,600	1	x	2,667					
14			1 Left	1		5	Proc 5	Workplan 1_2	4000,00%	1,067	1	x	2,667					
15						+	Walk Time			0,000								
16										**2,667**								
17	2	manual				3	Proc 3	Workplan 1_1	6000,00%	1,700	1	x	2,833					
18						4	Proc 4	Workplan 1_1	6000,00%	0,700	1	x	1,167	6	Part 6	Container 6	Fixed surface	Station 2, Right
19			2 Right	1		3	Proc 3	Workplan 1_2	4000,00%	1,133	1	x	2,833					
20						4	Proc 4	Workplan 1_2	4000,00%	0,467	1	x	1,167	6	Part 6	Container 6	Fixed surface	Station 2, Right
21						+	Walk Time			0,000								
22										**4,000**								
23			1 Left	1		8	Proc 8	Workplan 1_1	6000,00%	0,700	1	x	1,167	11	Part 11		Fixed surface	Station 3, Left
														12	Part 12		Fixed surface	Station 3, Left
														13	Part 13		Fixed surface	Station 3, Left
24						8	Proc 8	Workplan 1_2	4000,00%	0,467	1	x	1,167	11	Part 11		Fixed surface	Station 3, Left
														12	Part 12		Fixed surface	Station 3, Left
														13	Part 13		Fixed surface	Station 3, Left
25						+	Walk Time			0,000								
26										**1,167**								
27						6	Proc 6	Workplan 1_1	6000,00%	1,000	1	x	1,667	7	Part 7	Container 7	Fixed surface	Station 3, Right
28	3	manual				7	Proc 7	Workplan 1_1	6000,00%	0,600	1	x	1,000	10	Part 10	Container 8	Fixed surface	Station 3, Right
														8	Part 8		Fixed surface	Station 3, Right
														9	Part 9		Fixed surface	Station 3, Right
29						11	Proc 11	Workplan 1_1	6000,00%	0,400	1	x	0,667					
30			2 Right	1		6	Proc 6	Workplan 1_2	4000,00%	0,667	1	x	1,667	7	Part 7	Container 7	Fixed surface	Station 3, Right
31						7	Proc 7	Workplan 1_2	4000,00%	0,400	1	x	1,000	10	Part 10	Container 8	Fixed surface	Station 3, Right
														8	Part 8		Fixed surface	Station 3, Right
														9	Part 9		Fixed surface	Station 3, Right
32						11	Proc 11	Workplan 1_2	4000,00%	0,267	1	x	0,667					
33						+	Walk Time			0,000								
34										**3,333**								
35						12	Proc 12	Workplan 1_1	6000,00%	1,700	1	x	2,833	2	Part 2	Container 2	Fixed surface	Station 4, Left
36						9	Proc 9	Workplan 1_1	6000,00%	0,700	1	x	1,167	14	Part 14		Fixed surface	Station 4, Left
37	4	manual	1 Left	1		12	Proc 12	Workplan 1_2	4000,00%	1,133	1	x	2,833	2	Part 2	Container 2	Fixed surface	Station 4, Left
38						9	Proc 9	Workplan 1_2	4000,00%	0,467	1	x	1,167	14	Part 14		Fixed surface	Station 4, Left

Figure 40: Station Assignment for a Balancing Process – Part 1 of the List

Station

This table column area shows the station and workplace which are assigned processes. The table description starts at the left. It includes the following:

- Station number, process type: manual process (manu) or an automatic station (auto).
- Process type: There are two possible entries: **manu** which designates a manual process and **auto** which designates an automatic process (robot).
- Name of the workplace where the car body process is executed (on the left, rear, etc.).
- Number of workers (MA) and operating equipment required for the execution of this process.

Process Number - Description

- Process number with a short description of the execution type of the process. *Please refer to the* Figure 40 and Figure 41.

Average process duration		Max. process duration	
min	%	min	%
8.000	57,14%	8.000	57,14%
4.260	30,43%	4.260	30,43%
1.700	12,14%	1.700	12,14%
0,000	0,00%	0,000	0,00%
0,000	0,00%	0,000	0,00%
13.960	**99,71%**	**13.960**	**99,71%**
2.700	38,57%	2.700	38,57%
1.700	24,29%	1.700	24,29%
0,000	0,00%	0,000	0,00%
4.400	**62,86%**	**4.400**	**62,86%**
0,820	11,71%	0,820	11,71%
0,500	7,14%	0,500	7,14%
0,640	9,14%	0,640	9,14%
0,600	8,57%	0,600	8,57%
0,000	0,00%	0,000	0,00%
2.560	**36,57%**	**2.560**	**36,57%**
7.750	55,36%	7.750	55,36%
4.000	28,57%	4.000	28,57%
1.850	13,21%	1.850	13,21%
0,400	2,86%	0,400	2,86%
0,000	0,00%	0,000	0,00%
14.000	**100,00%**	**14.000**	**100,00%**
3.915	55,93%	3.915	55,93%
3.000	42,86%	3.000	42,86%
0,017	0,24%	0,017	0,24%
6.915	**99,02%**	**6.932**	**99,26%**
2.890	41,29%	2.890	41,29%
2.890	41,29%	2.890	41,29%
1.201	17,15%	1.201	17,15%
0,000	0,00%	0,000	0,00%
6.981	**99,72%**	**6.981**	**99,72%**
2.700	38,57%	2.700	38,57%
2.665	38,06%	2.665	38,06%
1.600	22,86%	1.600	22,86%
0,000	0,00%	0,000	0,00%
6.965	**99,49%**	**6.965**	**99,49%**

Figure 41: Station Assignment for a Balancing Process – Part 2 of the List

Average Process Duration

These two columns display the weighted time in minutes. The percentage corresponds to the percentage share of weighted process time in the cycle time.

Maximum Process Duration

The maximum process time corresponds to the actual process duration without weighting. The percentage corresponds to the actual percentage share of weighted process time in cycle time.

MultiCycles

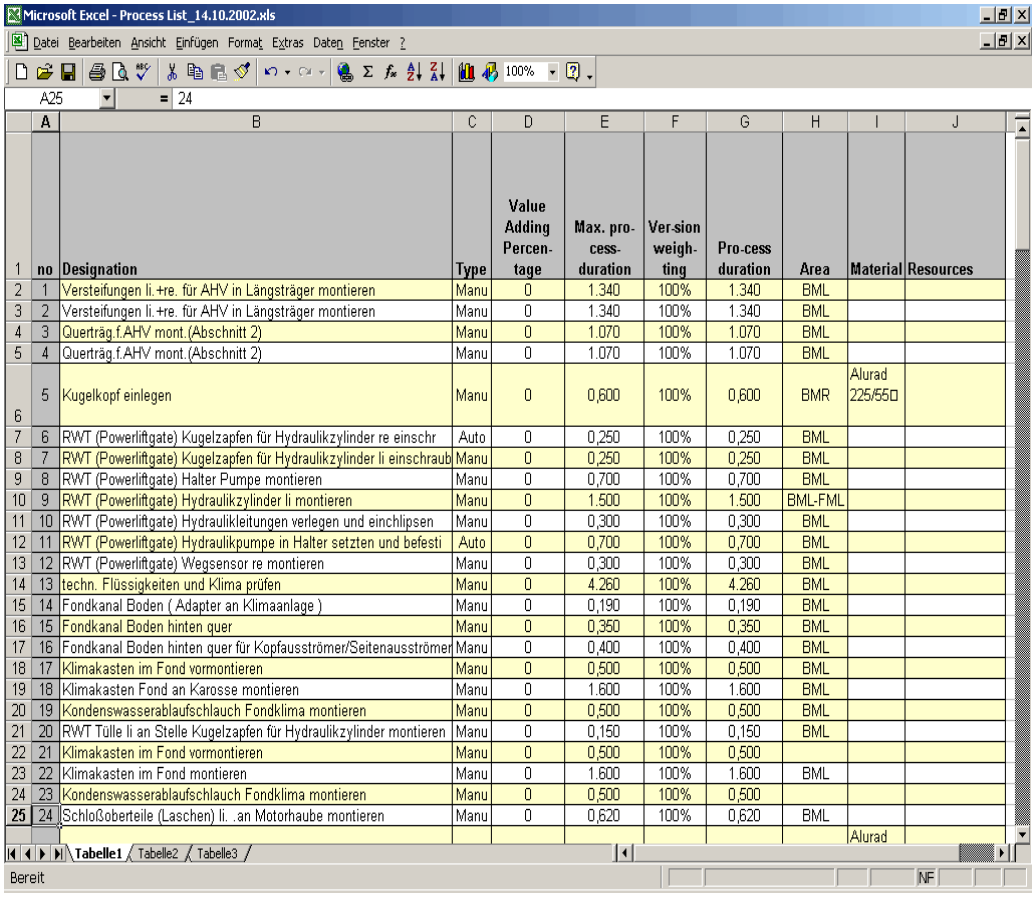
The percentage shares are calculated according to the number of cycles in the case of MultiCycles.

4.5.1.2 Process List Evaluation

Designation of columns and lines are fixed in Automatic Line Balancing and therefore cannot be changed.

Note

You will find a description of the evaluation list fields in the Process list view chapter. Please refer to the Process List View.



no	Designation	Type	Value Adding Percen-tage	Max. pro-cess-duration	Ver-sion weigh-ting	Pro-cess duration	Area	Material	Resources
1	Versteifungen li.+re. für AHV in Längsträger montieren	Manu	0	1.340	100%	1.340	BML		
2	Versteifungen li.+re. für AHV in Längsträger montieren	Manu	0	1.340	100%	1.340	BML		
3	Querträg.f.AHV mont.(Abschnitt 2)	Manu	0	1.070	100%	1.070	BML		
4	Querträg.f.AHV mont.(Abschnitt 2)	Manu	0	1.070	100%	1.070	BML		
5	Kugelkopf einlegen	Manu	0	0,600	100%	0,600	BMR	Alurad 225/55□	
6	RWT (Powerliftgate) Kugelzapfen für Hydraulikzylinder re einschr	Auto	0	0,250	100%	0,250	BML		
7	RWT (Powerliftgate) Kugelzapfen für Hydraulikzylinder li einschraub	Manu	0	0,250	100%	0,250	BML		
8	RWT (Powerliftgate) Halter Pumpe montieren	Manu	0	0,700	100%	0,700	BML		
9	RWT (Powerliftgate) Hydraulikzylinder li montieren	Manu	0	1.500	100%	1.500	BML-FML		
10	RWT (Powerliftgate) Hydraulikleitungen verlegen und einchlipsen	Manu	0	0,300	100%	0,300	BML		
11	RWT (Powerliftgate) Hydraulikpumpe in Halter setzten und befesti	Auto	0	0,700	100%	0,700	BML		
12	RWT (Powerliftgate) Wegsensor re montieren	Manu	0	0,300	100%	0,300	BML		
13	techn. Flüssigkeiten und Klima prüfen	Manu	0	4.260	100%	4.260	BML		
14	Fondkanal Boden (Adapter an Klimaanlage)	Manu	0	0,190	100%	0,190	BML		
15	Fondkanal Boden hinten quer	Manu	0	0,350	100%	0,350	BML		
16	Fondkanal Boden hinten quer für Kopfausströmer/Seitenausströmer	Manu	0	0,400	100%	0,400	BML		
17	Klimakasten im Fond vormontieren	Manu	0	0,500	100%	0,500	BML		
18	Klimakasten Fond an Karosse montieren	Manu	0	1.600	100%	1.600	BML		
19	Kondenswasserablaufschlauch Fondklima montieren	Manu	0	0,500	100%	0,500	BML		
20	RWT Tülle li an Stelle Kugelzapfen für Hydraulikzylinder montieren	Manu	0	0,150	100%	0,150	BML		
21	Klimakasten im Fond vormontieren	Manu	0	0,500	100%	0,500			
22	Klimakasten im Fond montieren	Manu	0	1.600	100%	1.600	BML		
23	Kondenswasserablaufschlauch Fondklima montieren	Manu	0	0,500	100%	0,500			
24	Schloßoberteile (Laschen) li. .an Motorhaube montieren	Manu	0	0,620	100%	0,620	BML		
								Alurad	

Figure 42: Process List Evaluation Example

4.5.2 Setting the Balancing Options

General data for the display of a balancing process are to be specified in the Options dialog. The **Settings** dialog is divided into General, Balancing, Load/Save, and Display.

General

1) Select the Checkbox **Enable Undo** to enable **Undo** function.

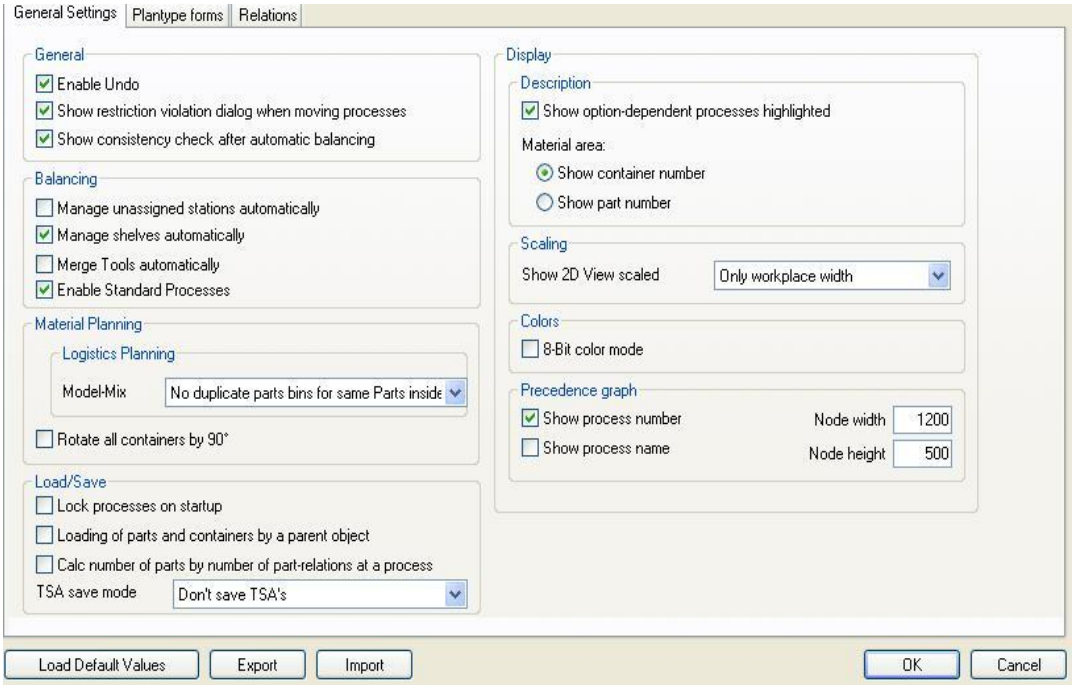


Figure 43: Dialog for Setting Options

Show Restriction Violations on Moving

This function is activated in the standard configuration. If you deactivate Show restriction violations on moving, the violation of restrictions will no longer be displayed in the performance view of the work load balancing when the processes are moved.

Show Consistency Check after doing an Automatic Balancing

This function is active in the standard configuration. If you deactivate **Show consistency check after doing an automatic balancing**, consistency checks will no longer be displayed after starting or re-starting the work load balancing. *Please refer to the* Figure 51.

Balancing

2) Select the checkbox **Manage unassigned stations automatically** to enable the functions described below that option.

Manage Shelves Automatically

If you enable Automatically manage shelves:

- Empty shelves are removed in the balancing processes.
- When moving a process to another station to which part bins placed in a shelf are assigned, a new shelf is generated in this station as long as no appropriate shelf is available in this station.

Manage undefined station heights automatically

This function is active in the standard configuration. If you have activated Manage undefined station heights automatically, the previously defined working height of the first process is applied to the station when the process is inserted. *Please refer to the* Figure 45.

Merge Tools Automatically

When you assign tools to processes, ALB instantiate such tools in the respective stations. If a tool is required by two different processes in one workplace, the software should instantiate only one single tool.

The DPE calculates the right number of necessary tools at the line. When saving the data to the hub, it create instances of the tools. The tool information is used by ALB to instantiate the right number of tools at the right place in the line. That means, if Tool 1 is required by Process 1 in Station 1/Workplace1 (S1/WP1), and another Tool 1 is required by Process 2 in the same workplace, the algorithm has to put only one tool in S1/WP1.

If the Process 2 is moved to another workplace, such a Tool 1 needs to be instantiated in this workplace too, if not already existing there.

In ALB if **Tools** < **Options** < **Settings** < **Automatically merge tools** mode ON, the tools view (**ALB** < **Tools** < **View**) is visible and Station tool nodes are available in DPE.

In ALB if **Tools** < **Options** < **Settings** < **Automatically merge tools** mode OFF, the tools view is not visible and Station tool nodes are not available in DPE.

In ALB, if you move process from one workplace to another. The corresponding changes appear in tools view, the process get listed in workplace to which it has moved.

In ALB, if you delete a tool process relation in DPE for which a station tool node exists. The corresponding ALB tool node is removed in DPE also.

Show individual tools for each workplace

- **Tools View**: There is a view showing the individual tools for each workplace. The view is shown on all workplaces with tools. For each workplace it shows the tool instances. For each of these tools it show its processes performed at that workplace.
  1) Select **View** from Context menu in Workplace.
  2) Select **View** menu > **Tools**.
  3) Select Tools in the context menu of the Balancing List View
  4) For tools list **Main Menu** > **View Balancinglist** >Right Click Context menu > **Balancing List View**.
  All these commands are enabled only if “Merge tools automatically” is checked in ALB settings.

- **Different Behaviors**

➢ From OFF to ON: The tool instances are calculated immediately. When saved, the instances are saved too.

➢ From ON to OFF: The tool instances are removed immediately. When saved, the instances are removed in the E5 hub too.

➢ From ON to OFF to ON, then save changes: The tool instances are removed immediately. Then they are created again, but with different object IDs. So when saving, the existing instances are deleted and new instances are created.

Default setting for Merge Tools

- You can change the default setting for “Merge tools automatically” by doing a customization at the project level.

- By default, the option “**Merge Tools automatically**” is unchecked. You can confirm this by clicking the “**Load Default Values”** option in the left corner of the **ALB Customization** dialog box. If this check box is checked, then the default setting for new balancing will be checked in ALB Settings. You can change this in ALB under **Options > Settings**.

Pre-Requisites: Configuration in the DPE Global Library

- Before starting ALB, check if plantypes are properly configured. The plan type of the **Tool** should be properly configured and it should be a child of the Plan type **Station**.

Pre-Requisites: Relation between the Tools and Processes

- Before starting ALB, ensure for valid Wokplan and all the processes in the work plan should be properly related to the Tool in the Project Library. Tools are created in the Project Library and then it is linked (Drag & Drop) to the Processes.

- **Process Uses Resource** is the relation used for linking a tool to process.

Note

The correct calculation of tools is not available for tools that are used by two parallel workers e.g. in two "Multi-Man" processes. The software does not distinguish between movable (e.g. screw driver) and immovable(e.g. welding robot) tools The software does not show the graphical representation of the tool in ALB 2D/3D View. It does not recognize the objects that were created outside the ALB and does not allow to load them.

Logistics Planning Mode

The Enhanced logistics planning mode is set in the configuration dialog of ALB.

- It is basically set globally at the project level: Context Menu of the **Project** < **Extras** < **ALB configuration**

- It can be overwritten locally for the specific user in the ALB application menu: **Tools** < **Options** < **Settings**.

Load/Save

3) Select the checkbox **Lock Process on Startup.**
   Enabling this field, the processes used for the balancing process cannot be edited in the PPR-Navigator. Therefore enabling this field ensures, for example, that process times can be changed while working with the balancing process.

Parts and Containers are linked by Parent Object

Enable this field only if you want to plan different product variants (Parts A...Z) using a so-called organizational position variant. In this type of planning the relations (process and part bins) are formed exclusively via the parent object.

You must first take into consideration the method you will use to plan the individual variants (Part A…Z) in the structure; for example, using temporal effectivities for the variants.

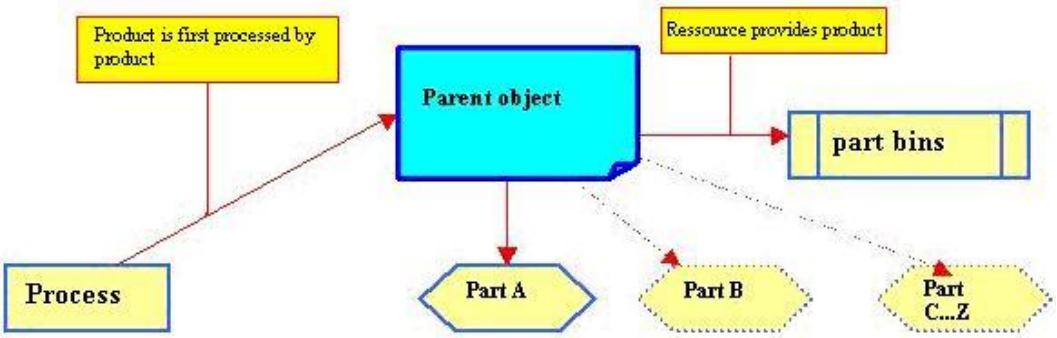


Figure 44: Use Parent Object for Planning Schema

Calculate Number of Parts by Number of Part Relations at a Process

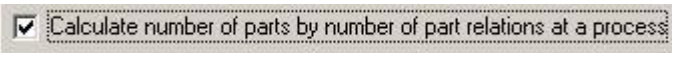


Figure 45: Calculate the Number of Parts by the Number of Part Relations at a Process Checkbox

3) If you activate the **Calculate the number of parts by the number of part relations at a process** option, all identical parts must be linked individually with a process – structural model.

4) By deactivating the **Calculate the number of parts by the number of part relations** *at a* **process** option, all parts can be linked with a process at the same time – reference model.

Display

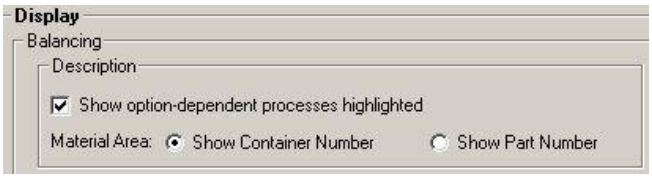


Figure 46: Display

5) Select the Checkbox **Show option-dependent processes highlighted** to optically display processes which are assigned special equipment parts. Processes are assigned special equipment parts according to a code rule.

Material Surface

6) If you activate **Show parts bin number**, the corresponding **parts bin number** for a loading unit is shown.

7) If you activate **Show part number**, the corresponding **part number** of the part for the loading unit that is assigned to this loading unit is shown.

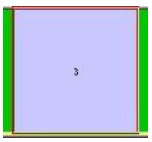


Figure 47: Example of a Palette with Parts Number

2D View Scaled Display

Select the option for 2D View in other scale modes.

By default the 2D View is not displayed scaled. With the help of the two options (**Only Workplace Width, All**) you can display the 2D View in other scale modes. This might be helpful if the width of the workplace is too small so that the process cannot be displayed within the workplace.

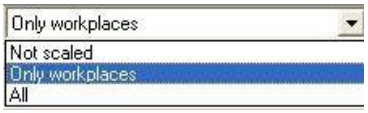


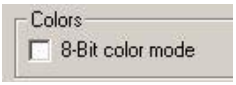
Figure 48: 2D View Scaled Display Options

Option Only Workplace Width

With this option you can scale the width of a workplace, so that all assigned processes of the workplace can be shown. You should be aware that as a result of this, the length and width of the station has not the same scale.

Option All

With this option you can scale the whole view in a larger scale. The view is scaled in that way that the workplace width is so big that the processes can be displayed within the station. Because the station length and the material area geometries are also scaled with this factor, this can lead to an unhandy size of the material areas or stations.



Activate 8-bit Color Mode

Activate this mode only if you can display the graphics on the computer in 8-bit color mode.

Priority Graph

This area specifies data for the display of processes in the Priority Graph view.

Figure 49: Priority Graph

8) Select the Checkbox **Show process number** and **Show process name** to display the processes with the corresponding names and numbers in the Priority Graph view.

9) The **Node width** and **Node height** fields are both used to specify the size for displaying the process in the Priority Graph view. Node width and node height are to be specified in pixels.

10) Select **OK**.

4.5.2.1 Show Options for Walkways

In the **Walkways** dialog you can determine the generally valid base data for viewing the walkways. These settings apply to all stations and workplaces of the balancing which is currently to be edited. *Please refer to the* Figure 50.

The Base data determine:

- Over which length the body should be viewed in millimeters
- Over which width the body should be viewed in millimeters
- How the start position of a body should be and how the viewing of the walkways should be started.
- At what walking speed an employee should cover the walkways.

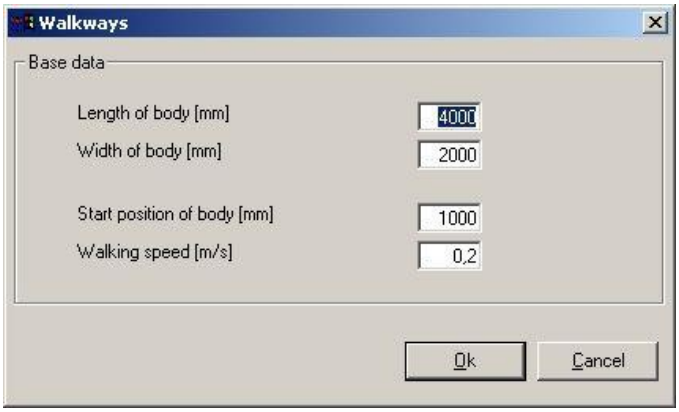


Figure 50: Entering Base Data for Walkways Viewing Dialog

By determining the start position of the body the position for the first process is defined, in addition, the viewing of all further walkways for the workplace

should be shown. The walkways are shown between the processes as well as between processes and material containers.

4.5.3 Executing Consistency Check

In the Consistency Check dialog the consistency of a balancing process is checked. In case of a recalculation of a balancing process, Automatic Line Balancing will automatically execute the consistency check. *Please refer to the* Figure 51.

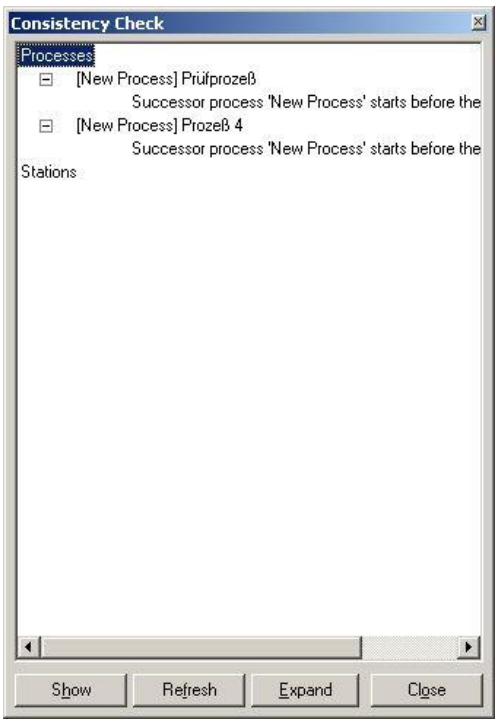


Figure 51: Consistency Test Dialog

You can execute a consistency check at any time during the manual editing of a balancing process. The dialog will display the violations. Each displayed violation of consistency will briefly be described.

Violations of consistency may occur if:

- Material planning has not been completed.
- Priority relations have been violated; for example, a station has manually been assigned a wrong process.

1) Click **Refresh** to display the current violations of consistency.

Quick Search for Processes that Violate Consistency

You can display consistency violating processes in the Consistency Check dialog.

2) Select a process from the dialog. Click **Show** to display the selected process in both of the Automatic Balancing and Priority Graph views.

3) Alternatively, you can select a process by double-clicking on it to display it in both views. *Please refer to the* Figure 51.

Expanding

All violations of consistency are opened and displayed with the **Expand** button.

5. Display of Views

There are several view display types:

Lists, Dialogs, Priority Graphs, Diagrams, and Balanced conveyors displayed in the Balancing view

5.1 Balancing View

All calculated stations, work positions, and assigned processes will be displayed in the Balancing view. Use this view to perform manual balancing. This means that you can assign processes to new work positions using drag and drop in this view. (*Please refer to the* Working with Automatic Line Balancing). There are two different kinds of stations: manual stations (*Please refer to the* Figure 52) and automatic stations (*Please refer to the* Figure 53). The Balancing view can be displayed either with or without the Material Area. *Please refer to the* Balancing Work Areas.

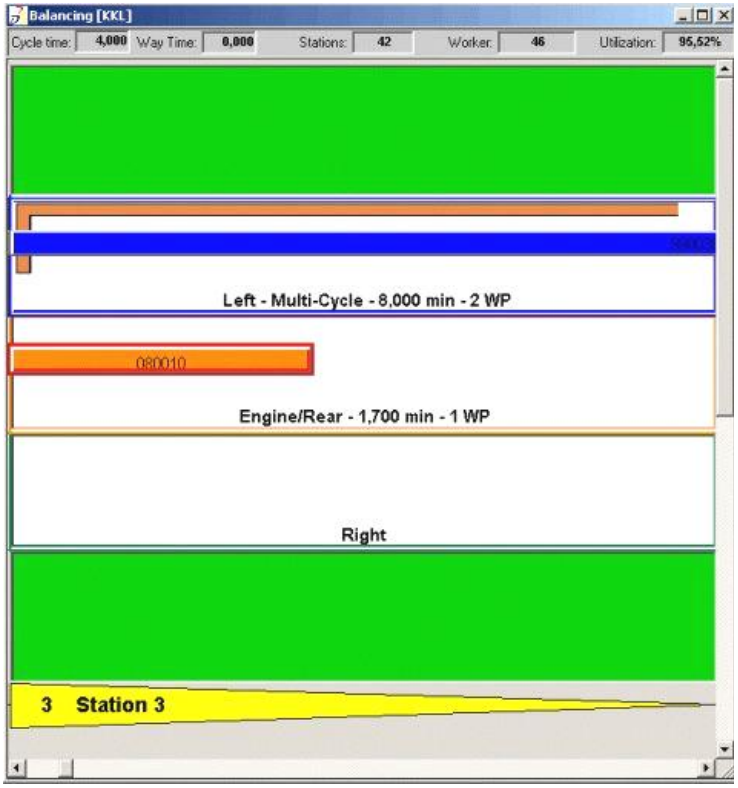


Figure 52: Example – Station Balancing Conveyor Display

Example

Display of an automatic balancing station: Automatic stations use handling robots to insert car windshields or to perform similar activities. With automatic stations, activities are mainly performed by the machines used. An automatic station is marked by the Auto sign in the rhomb.

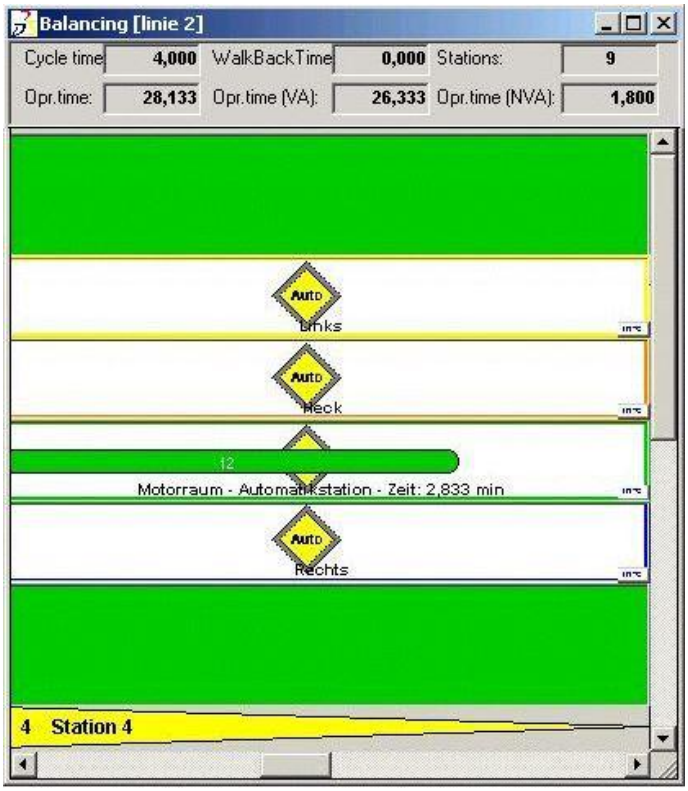


Figure 53: Example – Automatic Station Display

5.1.1 Balancing Work Areas

The balancing view consists of two main work areas. On the one hand, there are the areas for the material supply that are usually on the left or right side of the displayed stations. On the other hand, there are work areas with the assigned processes. All work areas are highlighted. All displayed work area performance data are specified when generating the balancing process. *Please refer to the* Balancing Main Menu.

5.1.1.1 Performance Data

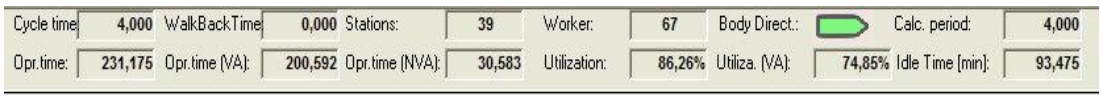


Figure 54: Performance Data of the Balancing Process

This line displays all performance data. The green arrow indicates the transfer direction specified. *Please refer to* the Body Alignment Dialog, Figure 54 and Summarized Group Overview.

Operating time (Opr.time)
The operating time is the sum of all process times at a workplace.

Compensation (min)
The displayed result for the compensation is calculated based on the following formula:

Compensation = cycle time – net time - idle time

5.1.1.2 Work Position with Assigned Processes

Figure 55: Example – Work Position with Assigned Processes

All work positions are equally described. A work position is identified by the descriptions below:

Left - 9,681 min - 1 WF

- The description of the position indicates the place where processes are performed – for example, Left. This means that processes will be performed on the left side of the station. The work position display changes according to the local performance of processes: for example, Rear, engine compartment, or Right.
- The process duration. The process duration is the sum of all work position process times. It is the 9,681 minutes in the example (this value can also be displayed in percentages).
- The number of workers (**1WP**) calculated for this work position. The example in Figure 55 refers to one worker.

- The processes are displayed by the process number in the Balancing view. Processes can either be displayed by a rectangle (against a grey background as shown in the example) or by a rhomb. The display size depends on the duration of each process. The longer the process duration, the greater is the size of the process display. Processes with a station linkage are displayed by a rhomb. The process station linkage may refer to one or several stations. *Please refer to the* Displaying Processes and Figure 52.

5.1.1.3 Material Provision Area

Figure 56: Example - Material Supply Area

The material supply area indicates the space required for a station. The assigned bins will be displayed in this area. This is the blue colored area with the number 820720 in the example. *Please refer to the* Figure 56.

Show Loading Units of the Material Provision Area

You can show the number of loading units of a material provision area with specific data of the loading unit via the context menu entry **Info**.

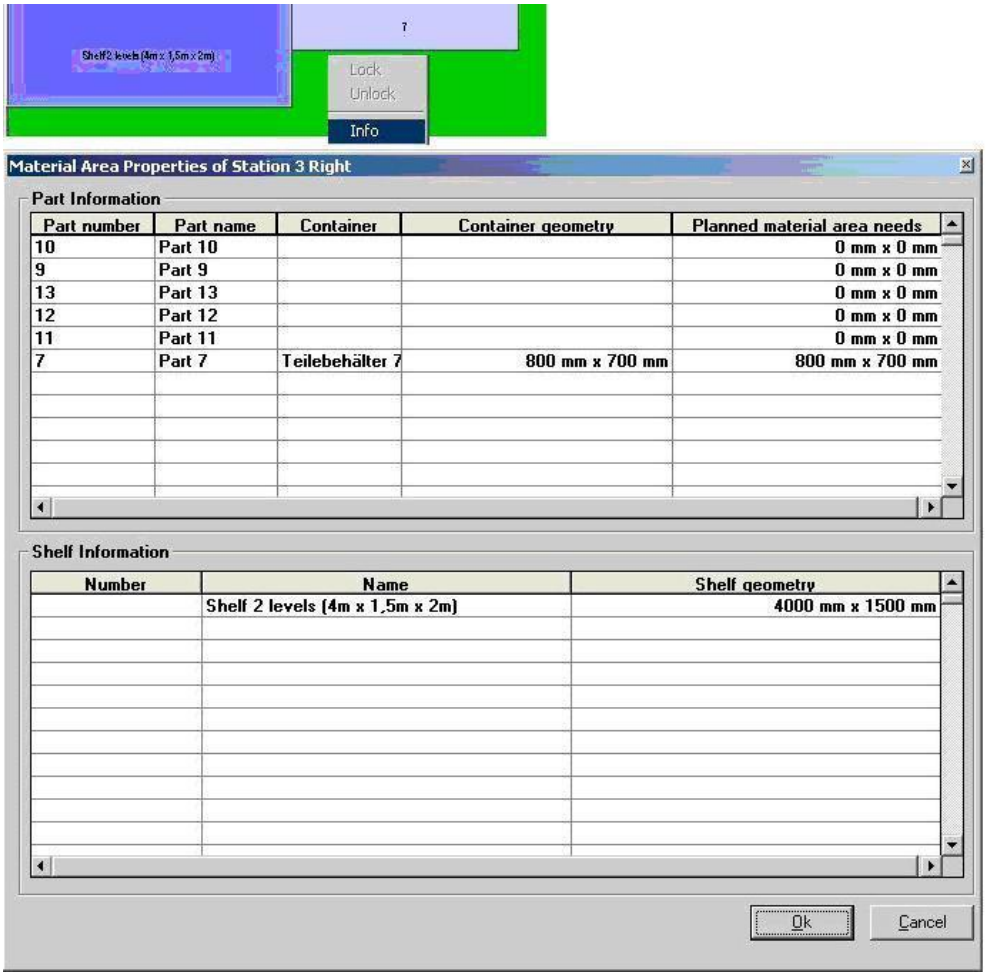


Figure 57: Loading Units are shown with Specific Data

5.1.1.4 Station Description

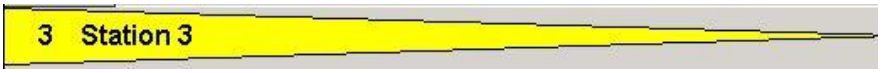


Figure 58: Example – Station Description

Example

Balancing process stations are marked by a station number. Station numbers are sequence numbers. Normally, the first station is numbered **station number 1**. Station numbers in Automatic Line Balancing may be handled in a flexible manner according to business requirements: for example, if you view several linked conveyors in the balancing process, you will be able to specify overall station numbers for these conveyors. You will specify the number for the first station when generating the balancing process in the duration dialog.

Thus, the first station at conveyor 1 would be numbered **station number 1** whereas the first station at conveyor 2, according to the stations calculated for conveyor 1, would be numbered station number 10. As a conclusion, the last station of conveyor 1 would be numbered station number 9. *Please refer to the* Figure 53 and Figure 58.

5.2 Precedence Graph View

The Precedence Graph view displays the processes and priority relations between the processes. The displayed process order is based on the Process Graph used for the balancing process. The priority relations will be specified in the Process Graph. This view cannot be edited. Changes will have to be made

in the Process Graph. Double-click a process to open the **Properties** dialog that displays the process performance data.

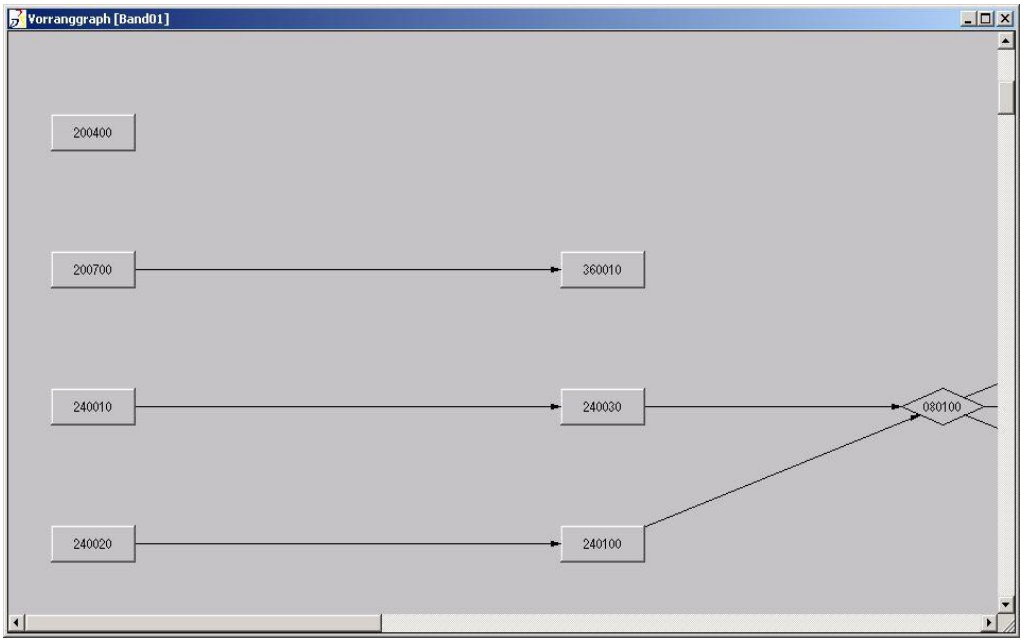
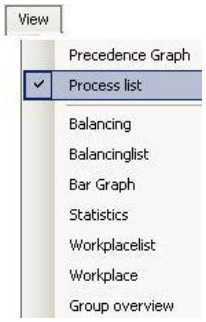


Figure 59: Example of a Priority Graph View Display

5.3 Process List View



In the Process List view you can display all processes for the Automatic Line Balancing (**All Processes** button). Double-click a process to open the **Properties** dialog that displays the process performance data.

All three pages of the Process List that are available display the only processes belonging to the active Automatic Line Balancing – you may for instance balance the workload according to the **model mix** mode. In this mode you can balance the workload of several variants.

Upon start of the Automatic Line Balancing, you can decide whether you wish to calculate the work load from processes for individual stations automatically, as previously, or if you wish to add the processes manually to the Automatic Line Balancing (*Please refer to the* Manually Balancing Processes).

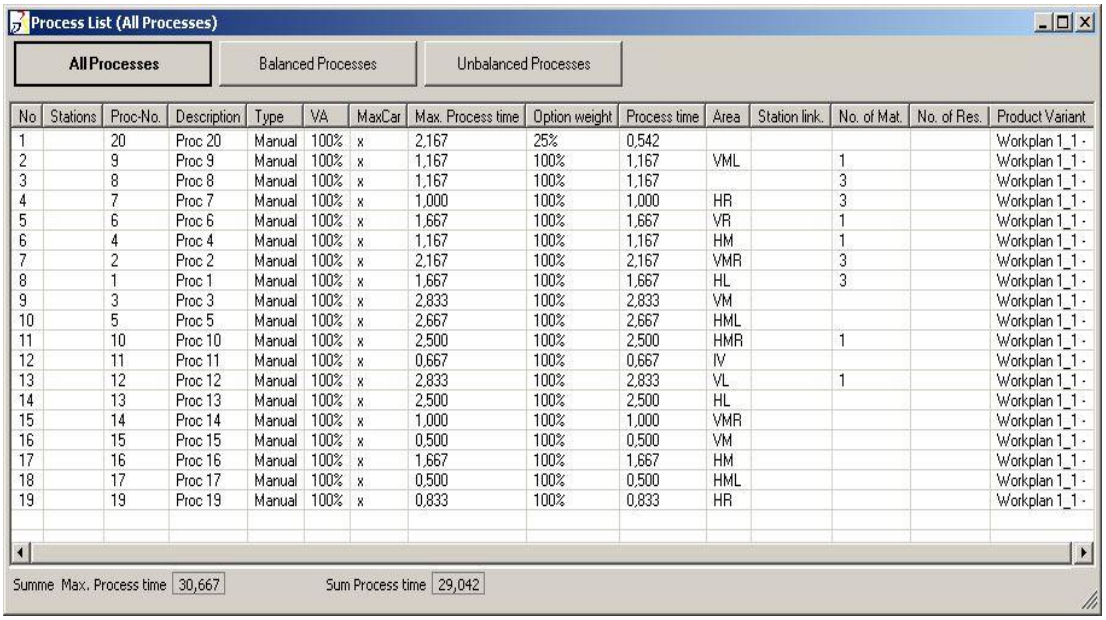
In the title bar of the Process List, three buttons are provided for selection of pages:

- All Processes: Show all process
- Balanced Processes: Show all balanced process
- Unbalanced Processes: Show all unbalanced process

The **All Processes** page displays all balanced and unbalanced processes. On the two pages **Balanced Processes** and **Unbalanced Processes** the processes are displayed on the basis of their assignment.

On the next few pages you will learn how to control the display features of the new Process List – *please refer to the* Efficient use of the Process List for Automatic Line Balancing.

To display a page, click the respective button. When the page is activated, the label appears in bold type – in the Figure 60 the page All Processes is highlighted and therefore activated.



No	Stations	Proc-No.	Description	Type	VA	MaxCar	Max. Process time	Option weight	Process time	Area	Station link.	No. of Mat.	No. of Res.	Product Variant
1		20	Proc 20	Manual	100%	x	2,167	25%	0,542					Workplan 1_1 -
2		9	Proc 9	Manual	100%	x	1,167	100%	1,167	VML		1		Workplan 1_1 -
3		8	Proc 8	Manual	100%	x	1,167	100%	1,167			3		Workplan 1_1 -
4		7	Proc 7	Manual	100%	x	1,000	100%	1,000	HR		3		Workplan 1_1 -
5		6	Proc 6	Manual	100%	x	1,667	100%	1,667	VR		1		Workplan 1_1 -
6		4	Proc 4	Manual	100%	x	1,167	100%	1,167	HM		1		Workplan 1_1 -
7		2	Proc 2	Manual	100%	x	2,167	100%	2,167	VMR		3		Workplan 1_1 -
8		1	Proc 1	Manual	100%	x	1,667	100%	1,667	HL		3		Workplan 1_1 -
9		3	Proc 3	Manual	100%	x	2,833	100%	2,833	VM				Workplan 1_1 -
10		5	Proc 5	Manual	100%	x	2,667	100%	2,667	HML				Workplan 1_1 -
11		10	Proc 10	Manual	100%	x	2,500	100%	2,500	HMR		1		Workplan 1_1 -
12		11	Proc 11	Manual	100%	x	0,667	100%	0,667	IV				Workplan 1_1 -
13		12	Proc 12	Manual	100%	x	2,833	100%	2,833	VL		1		Workplan 1_1 -
14		13	Proc 13	Manual	100%	x	2,500	100%	2,500	HL				Workplan 1_1 -
15		14	Proc 14	Manual	100%	x	1,000	100%	1,000	VMR				Workplan 1_1 -
16		15	Proc 15	Manual	100%	x	0,500	100%	0,500	VM				Workplan 1_1 -
17		16	Proc 16	Manual	100%	x	1,667	100%	1,667	HM				Workplan 1_1 -
18		17	Proc 17	Manual	100%	x	0,500	100%	0,500	HML				Workplan 1_1 -
19		19	Proc 19	Manual	100%	x	0,833	100%	0,833	HR				Workplan 1_1 -

Figure 60: Process List Example

If unbalanced processes exist, the view display the unbalanced processes if the view is opened. Otherwise it is opened in Mode “All Processes”.

Process can be highlighed in all open windows either by clicking/selecting a process. You can select process in any open view and it will get higlighted in other opened view.

Assign processes from the unbalanced processes pool to a workplace:

<u>Process List Window</u>

- Drag and Drop from Process List window to Balancing2D View.
- Drag and Drop from Process List window to BalancingList View.
- By context menu on one or more unbalanced process(es): the context menu shows a list with all stations/workplaces that exist in the balancing.

Unbalance a process

<u>Balancing2D View</u>

- By context menu on a process: The context menu has an entry called Unbalance.
- By Drag and Drop to the process List window. Drag and Drop is possible if the Process List shows the unbalanced processes, otherwise the mouse pointer icon shows that drag and drop is not possible.

<u>BalancingList View</u>

- By context menu on a process: The context menu has an entry called Unbalance.
- By Drag and Drop to the process List window. Drag and Drop is possible if the Process List shows the unbalanced processes, otherwise the mouse pointer icon shows that drag and drop is not possible.

For a new balancing all processes are put to the unbalanced process pool. After you run the automatic balancing, all processes have been balanced (the unbalanced process list must be empty),

Process can be moved from the unbalanced pool to the balancinglist:

- If the process is moved on another process, the moved process must be inserted **behind** the destination process.
- If a process is moved on a workplace, the moved process must be inserted as first process if the original station number is smaller than the destination station number; otherwise the moved process has to be inserted as last process.

Process can be moved from the balancing list to the unbalanced process pool by context menu or drag and drop.

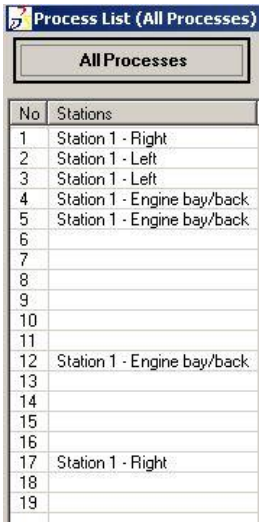
5.3.1 Column Information of Displayed Processes

The single Process List processes are arranged in lines and given a serial number. The Process List structure corresponds to an Excel sheet. Important process information will be displayed in the assigned columns.

- By clicking the column header with the mouse, you can sort respective column of the Process List.

Station and Workplace

In the Stations column, the stations and workplaces for already balanced processes are displayed. If the process is still unbalanced, the line in this column remains empty.



No	Stations
1	Station 1 - Right
2	Station 1 - Left
3	Station 1 - Left
4	Station 1 - Engine bay/back
5	Station 1 - Engine bay/back
6	
7	
8	
9	
10	
11	
12	Station 1 - Engine bay/back
13	
14	
15	
16	
17	Station 1 - Right
18	
19	

Figure 61: Station and Workplace Column

Description

This column displays the name of the process.

Type

This column describes the process type. If the process is performed by workers, it will be described as manual. If the process is performed by machines, it will be described as automatic.

Value Added (VA)

This column displays the value-added process share in percentages. If the value is 90%, the value-added share will amount to 90% and the non-value

share will be 10%. The non-value added share of a process indicates the share that still needs to be optimized. *Please refer to the* Figure 60.

MaxCar
Processes, which are displayed in the Automatic Line Balancing on the basis of the **MaxCar** option, are indicated by an “X” in this column.

This display corresponds to the menu entry Maximum process duration.

Maximum Process Duration
The column displays the actual process time of the processes, i.e. weighted 100%. Idle times are not taken into account.

Variant Loading
This column displays the process usage frequency with a product variant in percentages.

Process Duration
This column displays the weighted process time of a process in minutes. The weighted time always depends on percentage of the variant weighting: for example, if the process variant weighting is 50%, the weighted process time is 50% of the actual process duration. The weighted time indicates how often a process is used for a product variant i.e in a layer.

Area
This column indicates the local area where the process is performed on the product.

Station Linkage
This column indicates whether the process can only be performed at particular stations. A 5-10 entry would mean that this process was linked to stations 5-10 and was therefore only performed at these stations. The data of this column correspond to the station numbers.

Number Material
This column indicates whether additional material is used to perform the process. For example, assemble a windshield wiper. The number in this field indicates the number of additional parts needed for the process: number **1** indicates that **1** additional part is needed, which is a windshield wiper.

Amount of Operating Equipment
This column indicates whether additional operating equipment is used to perform the process. The number in this field indicates the amount of additional operating equipment still needed for the process. *Please refer to the* Figure 60.

Product Variant
The column Product Variant displays the process graphs on which the planning of the processes for the Automatic Line Balancing of the product variant is based. Only the processes of the active variant are displayed.

5.3.2 Reordering of Columns

1) Open ALB in a New Line. *Please refer to the* Figure 1.

2) Go to **ALB Main Menu** > **View** > click **Process List**/ **Balancing List**/ **Workplace**.

You can sort\re-order the columns by drag and drop to different position. Yiou can drag and drop only one column at a time.

The position of the columns are retained as the same on re-opening the ALB.

The position of columns after reordering is retained:

- When the list view window is opened again in the same session of ALB.
- When ALB is closed and opened on the same or another line & list views are opened.
- When ALB and DPE are closed and launched again and list views are opened.

The sorting\re-order of the columns can also be done to the user defined attributes.

5.3.3 Efficient use of the Process List for Automatic Line Balancing

To balance processes manually, use the **Unbalanced Processes** page in the Process List. The two pages for **All Processes** and **Balanced Processes** essentially serve to provide information concerning the processes. With the aid of the **Recalculate** option you can later automatically balance the processes. *Please refer to the* Manually Balancing Processes.

For balancing of processes, the **Unbalanced Processes** page has special meaning. Only from this page you can assign processes to the line balancing by drag and drop.

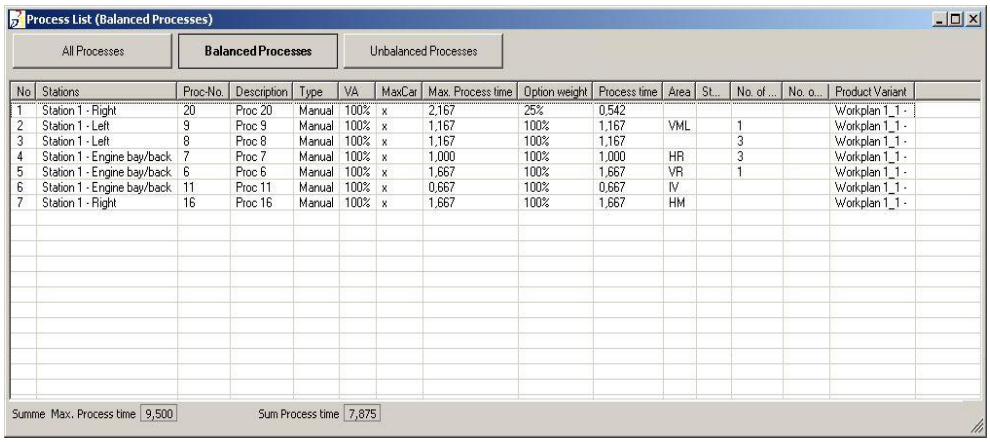
All Processes Page

The **All Processes** page displays all processes that may be used for the Automatic Line Balancing. Processes which have already been planned for Automatic Line Balancing, are marked in the **Stations** column, the name of the station and the workplace are indicated.

Balanced Processes Page

The **Balanced Processes** page displays all processes already used for the Automatic Line Balancing. In the **Stations** column, the station and workplace to which the process has been assigned are shown. Additionally, this page, as the other two pages, displays further information concerning process properties.

The Figure 62 shows an example of an activated page for already balanced processes with all available data.



No	Stations	Proc-No.	Description	Type	VA	MaxCar	Max. Process time	Option weight	Process time	Area	St...	No. of ...	No. o...	Product Variant
1	Station 1 - Right	20	Proc 20	Manual	100%	x	2,167	25%	0,542					Workplan 1_1 -
2	Station 1 - Left	9	Proc 9	Manual	100%	x	1,167	100%	1,167	VML		1		Workplan 1_1 -
3	Station 1 - Left	8	Proc 8	Manual	100%	x	1,167	100%	1,167			3		Workplan 1_1 -
4	Station 1 - Engine bay/back	7	Proc 7	Manual	100%	x	1,000	100%	1,000	HR		3		Workplan 1_1 -
5	Station 1 - Engine bay/back	6	Proc 6	Manual	100%	x	1,667	100%	1,667	VR		1		Workplan 1_1 -
6	Station 1 - Engine bay/back	11	Proc 11	Manual	100%	x	0,667	100%	0,667	IV				Workplan 1_1 -
7	Station 1 - Right	16	Proc 16	Manual	100%	x	1,667	100%	1,667	HM				Workplan 1_1 -

Figure 62: Balanced Processes Page

5.3.3.1 Assigning Processes to the Automatic Line Balancing using Drag and Drop

By drag and drop from the Process List, processes are assigned exclusively to the Balancinglist. Assigned processes are displayed in the Balancinglist and in the Balancing view.

As in automatic calculation, the stations are automatically created when processes are manually assigned. The number of stations created, on the one hand depends on the cycle time, and on the other on the number of processes planned for Automatic Line Balancing – the basis for the number of processes is the Precedence Graph.

The stations are created in both views – Balancinglist and Balancing view.

Processes can only be assigned from the **Unbalanced Processes** page to the Balancinglist. Processes which have been assigned to the Automatic Line Balancing can be removed from the balancing list and the balancing view by means of the context menu item **Unbalance** or with the delete key on the keyboard. *Please refer to the* Removing Processes.

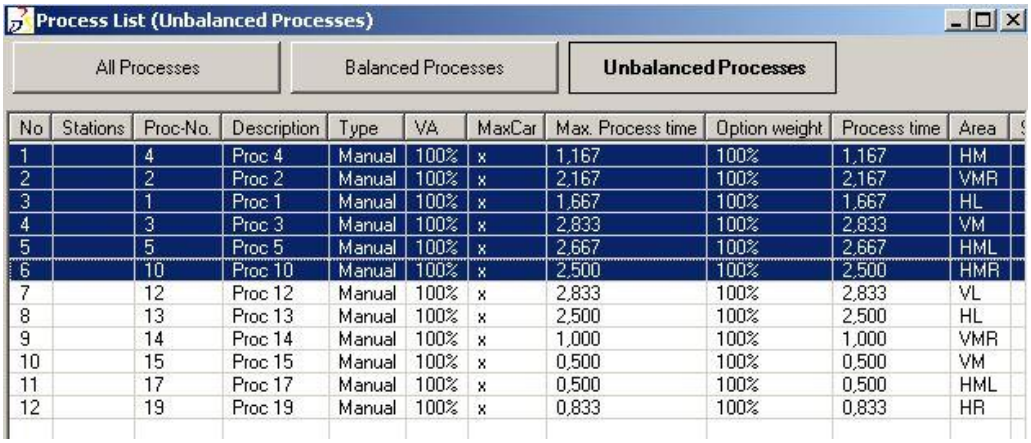
Different ways of Assigning Processes

To Assign Processes to the Balancinglist

1) Press the left mouse button and pull the processes onto the station in the Balancinglist.

➢ Several processes that directly follow one another can be selected by using the shift key.

The Figure 63 shows processes that have been selected using the shift key.

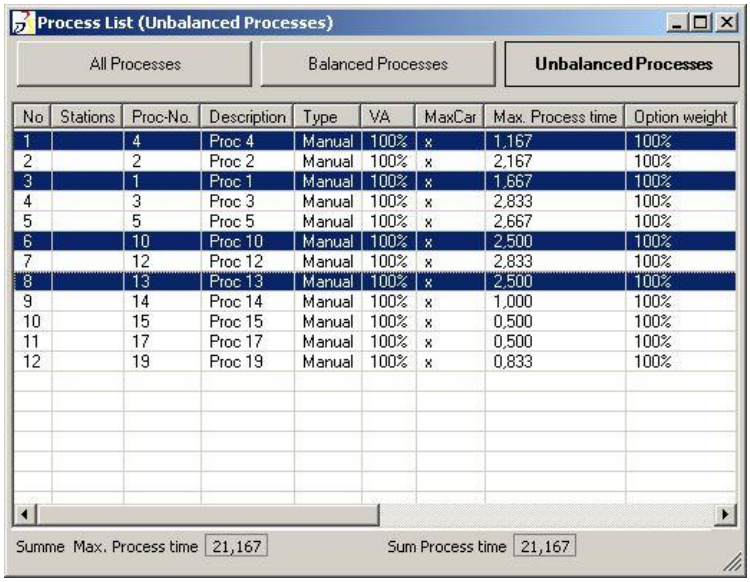


No	Stations	Proc-No.	Description	Type	VA	MaxCar	Max. Process time	Option weight	Process time	Area
1		4	Proc 4	Manual	100%	x	1,167	100%	1,167	HM
2		2	Proc 2	Manual	100%	x	2,167	100%	2,167	VMR
3		1	Proc 1	Manual	100%	x	1,667	100%	1,667	HL
4		3	Proc 3	Manual	100%	x	2,833	100%	2,833	VM
5		5	Proc 5	Manual	100%	x	2,667	100%	2,667	HML
6		10	Proc 10	Manual	100%	x	2,500	100%	2,500	HMR
7		12	Proc 12	Manual	100%	x	2,833	100%	2,833	VL
8		13	Proc 13	Manual	100%	x	2,500	100%	2,500	HL
9		14	Proc 14	Manual	100%	x	1,000	100%	1,000	VMR
10		15	Proc 15	Manual	100%	x	0,500	100%	0,500	VM
11		17	Proc 17	Manual	100%	x	0,500	100%	0,500	HML
12		19	Proc 19	Manual	100%	x	0,833	100%	0,833	HR

Figure 63: Processes which have been selected with the shift key

2) Use Ctrl key to select several individual processes.

The Figure 64 shows processes that have been selected using the Ctrl key.



No	Stations	Proc-No.	Description	Type	VA	MaxCar	Max. Process time	Option weight
1		4	Proc 4	Manual	100%	x	1,167	100%
2		2	Proc 2	Manual	100%	x	2,167	100%
3		1	Proc 1	Manual	100%	x	1,667	100%
4		3	Proc 3	Manual	100%	x	2,833	100%
5		5	Proc 5	Manual	100%	x	2,667	100%
6		10	Proc 10	Manual	100%	x	2,500	100%
7		12	Proc 12	Manual	100%	x	2,833	100%
8		13	Proc 13	Manual	100%	x	2,500	100%
9		14	Proc 14	Manual	100%	x	1,000	100%
10		15	Proc 15	Manual	100%	x	0,500	100%
11		17	Proc 17	Manual	100%	x	0,500	100%
12		19	Proc 19	Manual	100%	x	0,833	100%

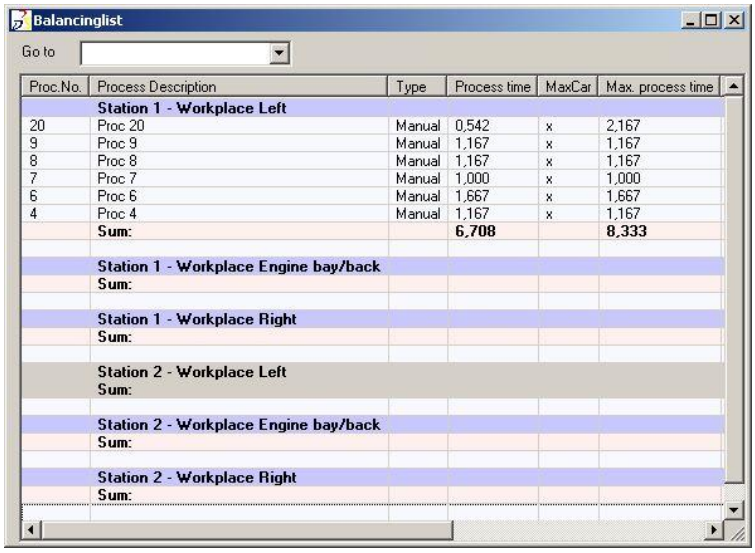
Figure 64: Processes which have been selected with the Ctrl key

5.3.2.2 Displaying Balanced Processes

Balanced processes are displayed in the Balancinglist, the Balancing view, and Balanced Processes page.

Some sample displays:

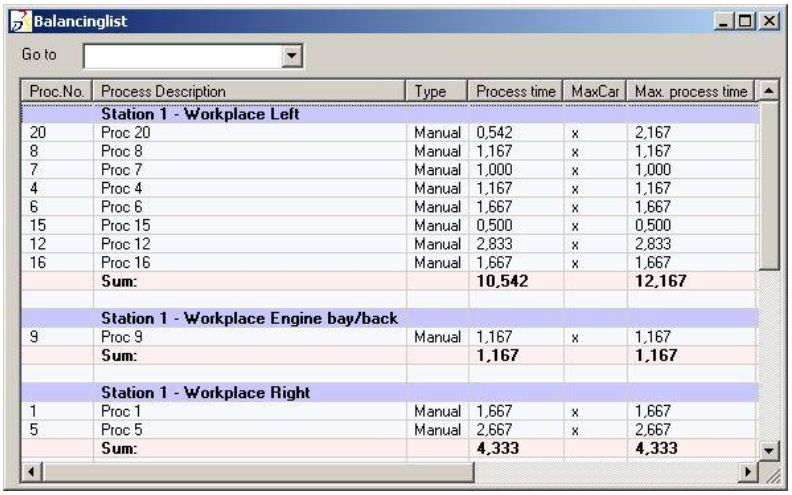
- **Balancinglis**t: The Balancinglist shows the assigned processes alongside the stations. For editing Balancinglist, *Please refer to the* Display of Views*.*



Proc.No.	Process Description	Type	Process time	MaxCar	Max. process time
	Station 1 - Workplace Left				
20	Proc 20	Manual	0,542	x	2,167
9	Proc 9	Manual	1,167	x	1,167
8	Proc 8	Manual	1,167	x	1,167
7	Proc 7	Manual	1,000	x	1,000
6	Proc 6	Manual	1,667	x	1,667
4	Proc 4	Manual	1,167	x	1,167
	Sum:		**6,708**		**8,333**
	Station 1 - Workplace Engine bay/back				
	Sum:				
	Station 1 - Workplace Right				
	Sum:				
	Station 2 - Workplace Left				
	Sum:				
	Station 2 - Workplace Engine bay/back				
	Sum:				
	Station 2 - Workplace Right				
	Sum:				

Figure 65: Example 1 – Balancinglist

The Figure 65 and Figure 66 show processes that have been assigned to different stations.



Balancinglist

Go to

Proc.No.	Process Description	Type	Process time	MaxCar	Max. process time
	Station 1 - Workplace Left				
20	Proc 20	Manual	0,542	x	2,167
8	Proc 8	Manual	1,167	x	1,167
7	Proc 7	Manual	1,000	x	1,000
4	Proc 4	Manual	1,167	x	1,167
6	Proc 6	Manual	1,667	x	1,667
15	Proc 15	Manual	0,500	x	0,500
12	Proc 12	Manual	2,833	x	2,833
16	Proc 16	Manual	1,667	x	1,667
	Sum:		**10,542**		**12,167**
	Station 1 - Workplace Engine bay/back				
9	Proc 9	Manual	1,167	x	1,167
	Sum:		**1,167**		**1,167**
	Station 1 - Workplace Right				
1	Proc 1	Manual	1,667	x	1,667
5	Proc 5	Manual	2,667	x	2,667
	Sum:		**4,333**		**4,333**

Figure 66: Example 2 – Balancinglist

- **Balancing View**: Processes that have been assigned to the Balancinglist, are immediately created with stations and workplaces and are then shown in the Balancing view. *Please refer to the* Figure 67.

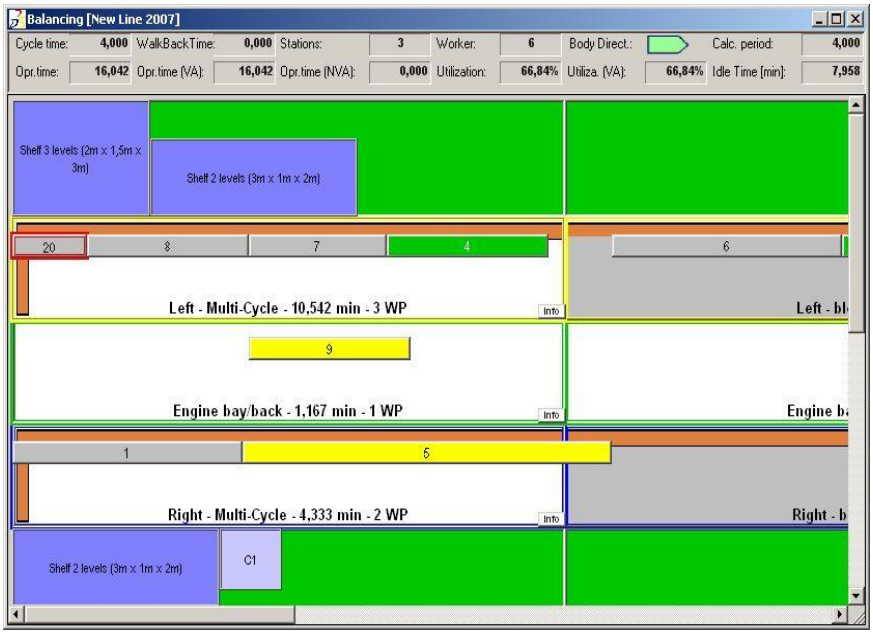
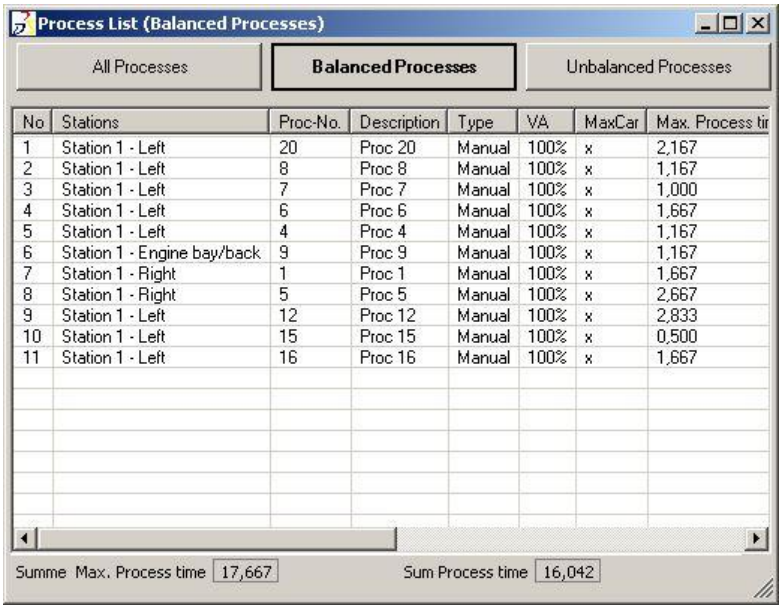


Figure 67: Example – Balancing

- **Balanced Processes View**: On this page, too, the balanced processes are displayed without delay upon their assignment – as is the case in the other two views, this includes display of stations and workplaces. *Please refer to the* Figure 68.



No	Stations	Proc-No.	Description	Type	VA	MaxCar	Max. Process ti
1	Station 1 - Left	20	Proc 20	Manual	100%	x	2,167
2	Station 1 - Left	8	Proc 8	Manual	100%	x	1,167
3	Station 1 - Left	7	Proc 7	Manual	100%	x	1,000
4	Station 1 - Left	6	Proc 6	Manual	100%	x	1,667
5	Station 1 - Left	4	Proc 4	Manual	100%	x	1,167
6	Station 1 - Engine bay/back	9	Proc 9	Manual	100%	x	1,167
7	Station 1 - Right	1	Proc 1	Manual	100%	x	1,667
8	Station 1 - Right	5	Proc 5	Manual	100%	x	2,667
9	Station 1 - Left	12	Proc 12	Manual	100%	x	2,833
10	Station 1 - Left	15	Proc 15	Manual	100%	x	0,500
11	Station 1 - Left	16	Proc 16	Manual	100%	x	1,667

Figure 68: Example – Process List – Balanced Processes Page

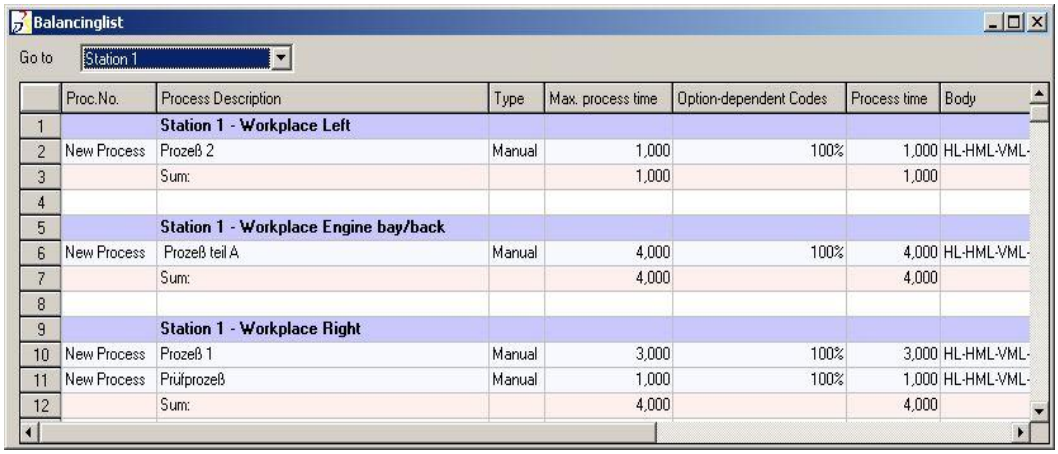
5.4 Balancing Process List View

All calculated stations, work positions and assigned processes are displayed in the Balancinglist view. You can manually edit the balancing process both in this view and in the Balancing view:

- Processes can be moved either by drag and drop or in the popup menu.
- New stations can be inserted in the right mouse button's popup menu.
- Free stations which have not been assigned any processes or material containers can be deleted in the popup menu.
- Free station areas can be locked and unlocked in the popup menu.
- Drift areas can be set up for free station areas.
- Selected lines of the Balancinglist can be unlocked in the popup menu.
- Processes selected in the Balancinglist are also selected (cross-highlighted) in the Balancing view.

The Balancinglist is an additional opportunity to the Balancing view to manually edit the balancing process. The display of the station and the assigned processes provides an individual free space for editing the balancing process. Material provision surfaces and load containers cannot be edited in this view.

This chapter will show you how to edit the Balancinglist. Popup functions previously described in the chapter on balancing are not described in this chapter. *Pease refer to the* Context Functions in Automatic Balancing and Table 4.



	Proc.No.	Process Description	Type	Max. process time	Option-dependent Codes	Process time	Body
1		**Station 1 - Workplace Left**					
2	New Process	Prozeß 2	Manual	1,000	100%	1,000	HL-HML-VML-
3		Sum:		1,000		1,000	
4							
5		**Station 1 - Workplace Engine bay/back**					
6	New Process	Prozeß teil A	Manual	4,000	100%	4,000	HL-HML-VML-
7		Sum:		4,000		4,000	
8							
9		**Station 1 - Workplace Right**					
10	New Process	Prozeß 1	Manual	3,000	100%	3,000	HL-HML-VML-
11	New Process	Prüfprozeß	Manual	1,000	100%	1,000	HL-HML-VML-
12		Sum:		4,000		4,000	

Figure 69: Balancinglist View

5.4.1 Popup Menu Functions

You can edit processes with the help of the popup functions. Processes can either be assigned to a new station or placed at another location within a station. The same restrictions as those in the Balancing view apply to editing the Balancinglist. Messages indicate possible restriction violations. *Please refer to the* Restriction Violations during Manual Editing.

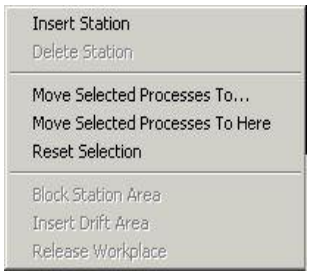


Figure 70: Selected Process Popup Menu

5.4.1.1 Moving Processes

You can move processes either by drag and drop or in the popup menu, or you can directly assign them to a new workplace.

Moving Processes by Drag and Drop

You can also select and move multiple processes simultaneously. Processes cannot be assigned to a locked area.

1) To select a process, click corresponding line with the left mouse button. To select several processes in the Balancinglist at the same time, click successively in the respective lines of the Balancinglist and also keep the control key pressed.

	Proc.No.	Process Description	Type	Max. process time	Option-dependent Codes
1		**Station 1 - Workplace Left**			
2	New Process	Prozeß 2	Manual	1,000	100%
3		Sum:		1,000	
4					

Figure 71: Selecting Processes in the Balancinglist

2) With the left mouse button pressed, drag the process (or several selected processes) to the new station, and insert the process in the corresponding location. The process is inserted immediately as long as there is no restriction violation. If there is a restriction violation, this is indicated by a message.

12		Station 2 - Workplace Left		
13	New Process	Prozeß 2	Manual	1,000
14	New Process	Prozeß teil A	Manual	4,000
15		Sum:		5,000

Figure 72: Inserting a Process in a New Station

Resetting the Selection

Selected processes must always be reset again with the popup function **Reset Selection**.

Move Selected Processes To...
Move Selected Processes To Here
Reset Selection

Figure 73: Reset Selection Popup Function

3) Open the popup menu in the Balancinglist. Then click menu item **Reset Selection**.

Assigning Processes to a New Station in the Popup Menu

Processes must always be selected in the Balancinglist first if they are to be assigned to a new workplace with the popup function **Move Selected Processes To**…; multiple and single selections are both possible.

Move Selected Processes To...
Move Selected Processes To Here
Reset Selection

Figure 74: Move to Popup Function

1) Select at least one process so that the popup menu entry **Move Selected Processes To**… is active.

2) To open the dialog, open the popup menu and click **Move Selected Processes To**…. *Please refer to the* Figure 75.

3) In the selection list under **New Workplac***e* select the workplace to which the new processes are to be assigned.

4) The previously assigned processes are displayed in the selected workplace. Select the process before which the new processes are to be inserted. The newly inserted processes are always inserted in front of the selected process.

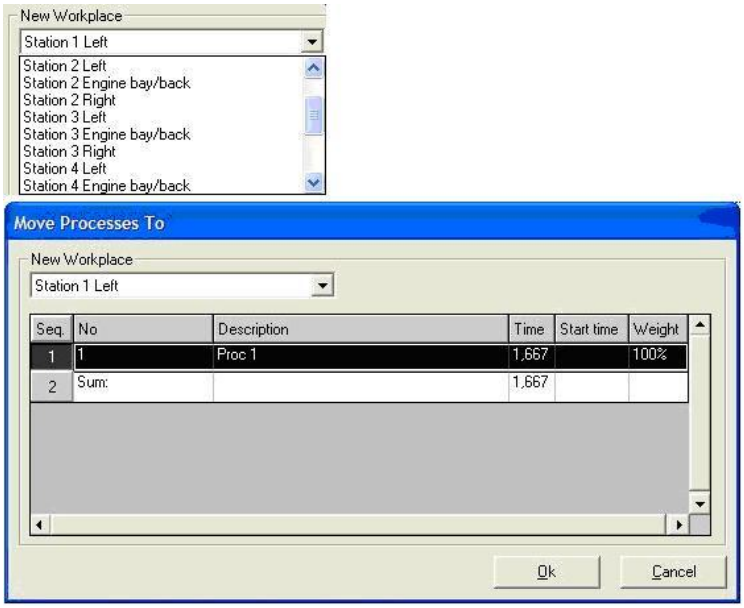


Figure 75: Move Processes to Dialog – Stations Selection List

Example

Two new processes have been assigned to **Station 2 – left.** *Please refer to the* Figure 76.

	Station 2 - Workplace Left				
1	Process 1	Manual	3,000	x	3,000
2	Process 2	Manual	1,000	x	1,000
3	Process 3	Manual	2,000	x	2,000
	Sum:		6,000		6,000

Figure 76: Two New Processes assigned to Station 2 – left

Move Selected Processes Here...

As an alternative to the function **Move Selected Processes To**..., you can add selected processes directly to the balancing process list.

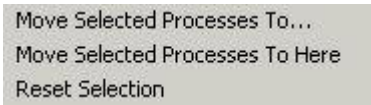


Figure 77: Function Move Selected Process

Proceed as follows:

1) Select the processes which are to be added to another location. Single – multiple selection is possible here.

2) Move the mouse pointer to the line in the Balancinglist where you want to insert the processes.

3) Open the context menu by right clicking the mouse. Select **Move Selected Processes To Here**. The processes are then inserted.

Cross-Highlighting for Processes

Processes selected in the balancinglist are highlighted by cross-highlighting in the Balancing view, and vice-versa; processes selected in the Balancing view are displayed in the balancinglist as well as in the Precedence Graph view.

To Show Cross-Highlight for Processes

1) Arrange both views on your screen (perhaps horizontally or vertically to each other).

2) Select the process in the balancinglist. The selected process is displayed in the Balancing view. The example shows that additional information on

the process, such as the process name, are highlighted in the balancinglist.

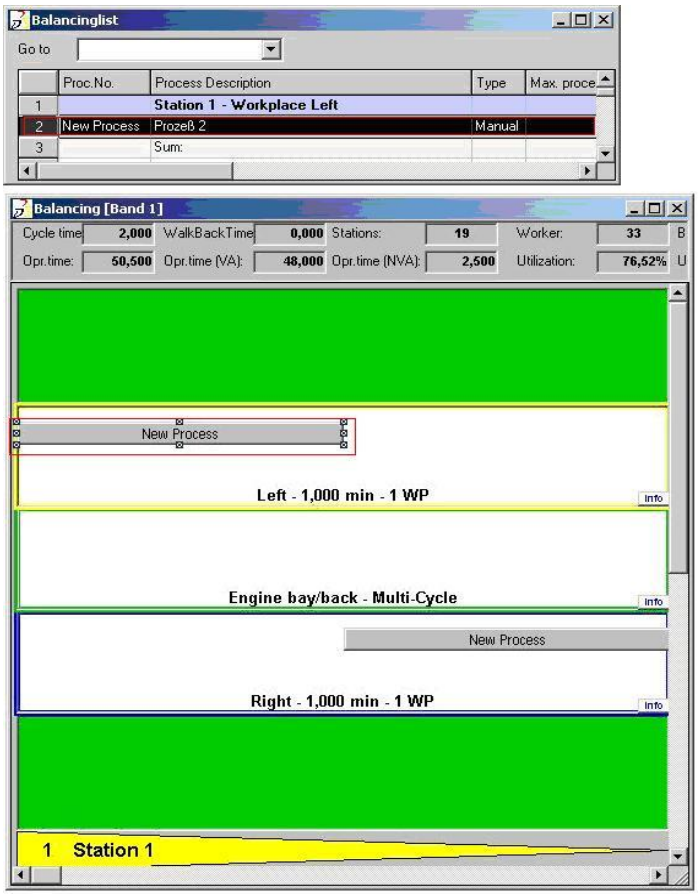


Figure 78: Display of Selected Processes – Cross-Highlighting

5.4.1.2 Removing Processes

By means of the **Unbalance** menu item and the delete key on the keyboard, you can remove processes from the Balancinglist and the Balancing view.

Processes that have been removed from these two views are assigned to the Process List and are shown on the **Unbalanced Processes** page as the last in the list of existing processes.

To Remove a Process

Select the process and open the context menu or press the delete key directly. In the context menu select the **Unbalance** entry.

The Figure 79 shows removing of processes from the Balancinglist by means of the **Unbalance** menu item.

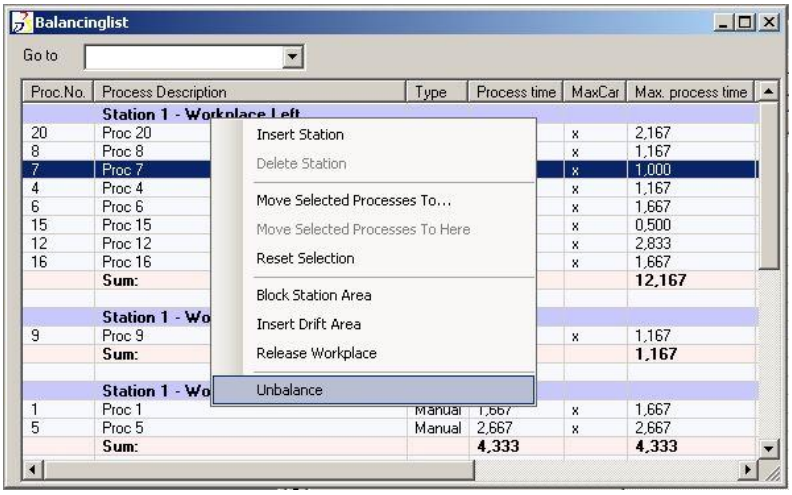
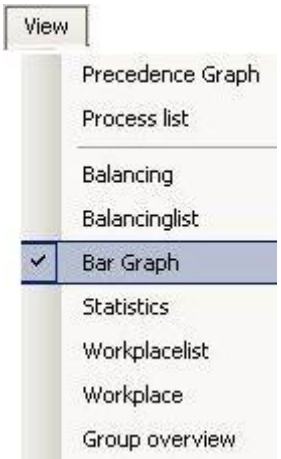


Figure 79: Unbalance Processes – Use of the Unbalance Menu Item

5.4.2 Bar Graph View



In the Bar Graph view, the balanced processes are represented as bars per station and workplace.

This view does not allow editing; the Bar Graph view simply is a further display option for the Automatic Line Balancing function.

If you plan several variants in one Automatic Line Balancing, all processes of the variants are shown side by side for each workplace.

If you add new processes to the balancing list or move processes with this list, these changes in the bar chart will be automatically reconstructed. The columns indicate the processes. The column height corresponds to the process time and the continuous line corresponds to the defined cycle time.

This view is a read-only view. You cannot move a process directly in the bar graph view. When you selects a process in the Balancing 2D view, the same process get highlighted in the bar graph view. When processes are moved in other views, the bar graph view gets updated. No of workes in bargraph view is named “No. of Multi-cylces” in the workplace-view.

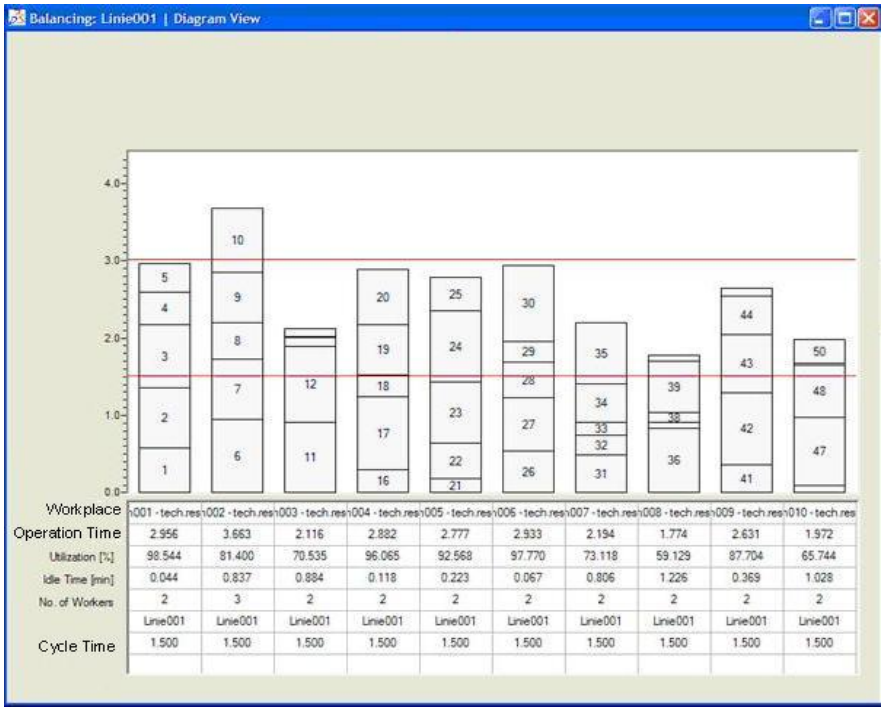


Figure 80: Bar Graph View

Operation Time (min)

The sum of all process times for a workplace is displayed in this field. *Please refer to the* Figure 80.

Utilization (%)

The utilization (%) for a workplace is displayed in this field. *Please refer to the* Figure 80.

Idle Time (min) – Waiting Time

The idle time for a workplace is displayed in this field. *Please refer to the* Figure 80.

Number of Workers

The calculated number of workers for a workplace is displayed in this field. The calculated result is rounded up to the next integer. *Please refer to the* Figure 80.

Cycle Time (min)

The cycle time is displayed in this field. *Please refer to the* Figure 80.

5.5 Statistics View

The Statistics view provides you with a statistical evaluation of the balancing. To evaluate balancing, you can use two information windows in the **Statistics** dialog. *Please refer to the* Figure 81.

When balancing an entire system, you compare the minimal work load position to the maximum work load position. The scatter of the entire balancing will be specified and the result will be displayed with a standard deviation. Thus, you will be offered another option to compare the results of different balancing processes. The **Statistics** dialog cannot be edited.

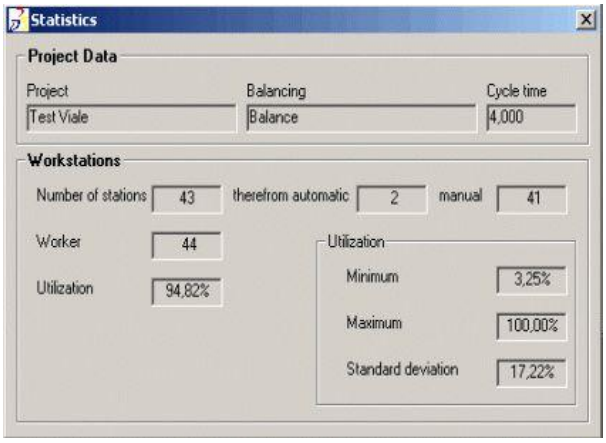


Figure 81: Example – Statistics Dialog

5.5.1 Information on the Statistics Dialog Boxes

Project Data

The project data line provides you with the following information, *Please refer to the* Figure 81.

- **Project**: Project name in the Project field.
- **Balancing**: Balancing prompt in the Balancing field. Automatic Line Balancing allows you to generate copies of a balancing. When you recalculate this copy and have thus generated a changed balancing with different performance data, you can save this balancing to a different prompt. Use the basic data tab in the performance data menu to change the prompt.
- **Cycle time**: This field displays the balancing process cycle time in minutes.

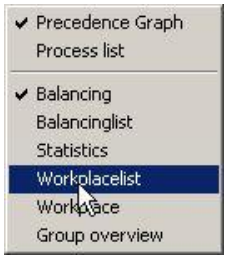
Workstations

This field displays the number of specified stations of the entire balancing – divided up into automatic stations, manual stations, number of workers, and average utilization of a station.

Utilization

These two fields display either the minimum or the maximum utilization of a station. The workstation with the minimum utilization will be compared to the workstation with the maximum utilization.

5.6 Workplacelist View



Example

In the Workplacelist view all stations are displayed, which have been determined during balancing, for example the station of a conveyor or a line. All process times, the efficiency of workplaces and the walkways of employees are displayed. The workplace list cannot be edited; corrections have to be made directly in the Automatic Line Balancing, for example in the Automatic Balancing view or in the process and resource structures Properties dialogs.

Use the workplace list, for example, to recognize time portions that are not optimal or are too high with regard to walkways of a workplace or optimize these time proportions or walkways according to the workplace list. When viewing the individual time portions, the actual working time is compared to the

planned gross working time. When determining the efficiency, product variants are taken into consideration and are displayed in relation to their weighting.

In the workplace list all stations are displayed with workplaces, efficiency and specifications of the walkways in meters.

Workplace Band 1

Seq.	No.	Station	Time [min]	Net Time [min]	Idle Time [min]	Utilization [%]	Utilization at 100% [%]	Walkway [m]	Walkway [min]
1	1	Station 1 Left	1,00	1,00	1,00	50,0	50,0		
2	2	Station 1 Engine bay/back							
3	3	Station 1 Right	2,00	1,00	1,00	50,0	50,0		
4	4	Station 2 Left							
5	5	Station 2 Engine bay/back							
6	6	Station 2 Right	5,00	5,00	1,00	83,3	83,3		
7	7	Station 3 Left	4,00	4,00	-2,00	200,0	200,0		
8	8	Station 3 Engine bay/back							
9	9	Station 3 Right							
10	10	Station 4 Left	4,00	4,00		100,0	100,0		
11	11	Station 4 Engine bay/back							
12	12	Station 4 Right							
13	13	Station 5 Left							
14	14	Station 5 Engine bay/back	6,00	4,00		66,7	66,7		
15	15	Station 5 Right							
16	16	Station 6 Left							

Figure 82: Example: Workplace List for a Line

Every workplace list column can be sorted in ascending or descending order.

5.6.1 Column Information of Displayed Workplaces

Station

When opening the workplace list, all stations are displayed in ascending order with their station name. Under **Station** all planned workplaces of a station are displayed, such as engine compartment/rear or workplace left. *Please refer to the* Figure 82.

Time and Net Time

The entry in the **Time** column corresponds to the sum of all resulting process times plus waiting times of a workplace. The entry in the **Net Time** column corresponds to the sum of all process times of a workplace that actually result. The time is specified in minutes.

Efficiency and Efficiency at 100%

The entry in the **Efficiency** column corresponds to the sum of all weighted process shares of a workplace. The weighted time is used to express how high the process share is at a workplace in order to be able to manufacture certain product variants. If, for example, a variant weighting of the process shares is 50%, the weighted process shares would be 50% of the process time actually needed for a workplace on average. As a conclusion, this would mean that these processes could only be used with every second vehicle. As a rule this type of viewing is used for further planning in Automatic Balancing.

Example

Processes **for variant V-A** would approximately correspond to that of a basic model.

Processes **for variant V-B** would approximately correspond to that of a certain product variant.

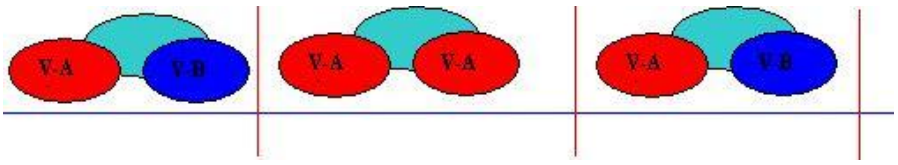


Figure 83: Example: Variant Weighting for Product Variants

The **Efficiency 100%** entry corresponds to the sum of the process times that actually result if they are executed.

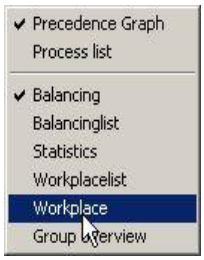
Walkway (m, min)

The walkways are specified in meters and minutes and correspond to the sum of walkways in meters and minutes for this workplace.

Balancing Compensation (min)
The displayed result for the balancing compensation is calculated based on the following formula:

Formula: Balancing compensation = Net Time – Idle Time

5.7 Workplace View



The Workplace view displays all of the assigned processes. The header view displays the corresponding performance data, for example, cycle time, utilization, and way time for the selected workplace. You can edit the workplace list (*Please refer to the* Figure 84).

- Use the selection list to display any work station. (*Please refer to the* Figure 85).
- Use the left mouse button to reassign processes in the work list. (*Please refer to the* Figure 86).

The way time is the time a worker needs to get back to the starting point of the workplace after having executed the process.

- In addition, the times of the value adding processes **((opr.timeVA(min))** and the non-value adding processes **((Opr. NVA (min))** are displayed along with the percent of their workload at the selected workplace.

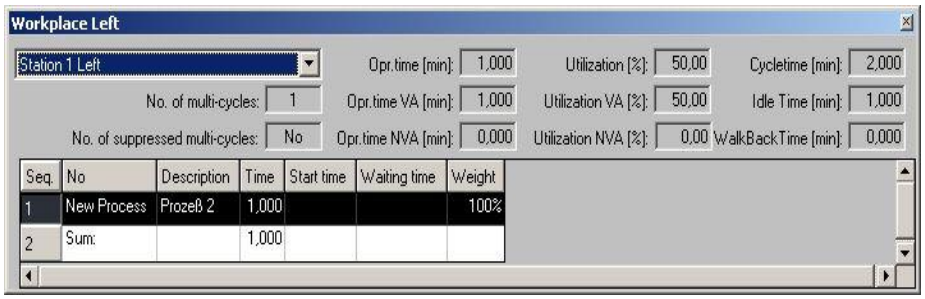


Figure 84: Example of a Workplace List

Editing Selection List

Figure 85: Workplace Selection List

1) Use the left mouse button to open the selection list.

2) Select the workplace from the selection list.

Editing Workplace List

Figure 86: Editing Workplace List – Reassigning Processes

3) To reassign a process, left click the line of the process to be reassigned.

4) Use the left mouse button to move this selected process to the new line of the workplace list.

Open Workplace View with the Info Button

Every workplace has been assigned an additional button in the Balancing view which can be used to open the Workplace view directly. All functions are available for editing.

5) Click **Info** button with the left mouse button to open the workplace view.

Figure 87: Info Button for Workplace – Balancing View

5.7.1 Moving Processes via the Context Menu

You can directly move processes via the context menu of a selected process in the workplace list and assign them to a new workplace. This function is useful, for example, if the process to be moved is assigned to a station which at the moment cannot be displayed on the screen. Moving via the context menu works exactly the same way as when a process is manually moved in the job coordination view.

1) Click **Info** button with the left mouse button to open the workplace view.

2) Select the process to be moved and click the right mouse button.

3) Select **Move to**….

Figure 88: Opening the Context Menu – Move to ...

4) In the dialog **Move Processes To** you can select the station and workplace to which processes are moved under **New workplace**.

5) Processes are always inserted in front of the selected process. If there are processes on the selected workplace already, you can select where the process is inserted. You have to select the process in order to do this.

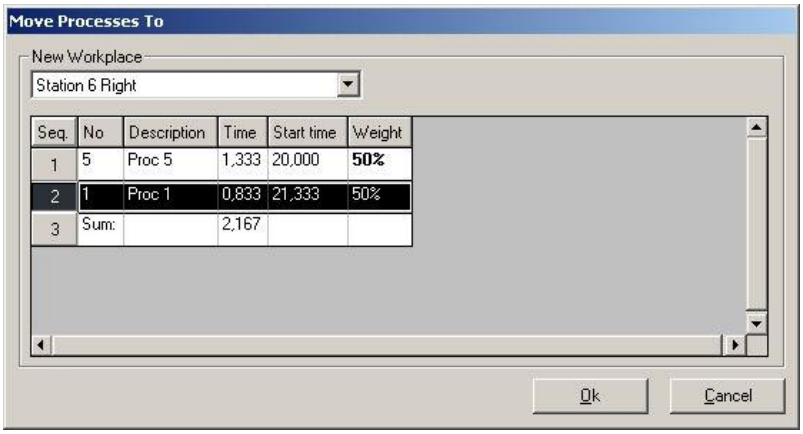
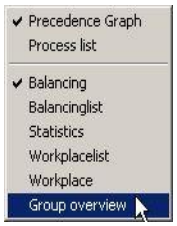


Figure 89: Dialog Move Processes to – Select Workplace

5.8 Group Overview View



In the Group overview view, either all of the workplaces are displayed or each workplace is displayed separately. The workstations are displayed in a bar chart. The utilization of the individual workplaces is highlighted according to the resulting needs. The display of shares is divided up into value-added, non-value added, and special equipment shares. In addition, the way time share will be displayed above each bar.

If a large amount of special equipment is needed at workstations, the actual variant station time will vary considerably. The group overview offers you quick access to the balancing process data. You can use the group overview in workshops as a valuable aid or use it for local new planning in order to compare this with the previous balancing process.

5.8.1 Starting Group Overview

Before starting the group view, you have to decide whether or not to summarize the Group overview.

1) Click **Yes** if you want to summarize the group overview.

2) Click **No** if you do not want to summarize the group overview.

Figure 90: Group Overview Selection Dialog

5.8.2 Summarized Group Overview

In the **summarized Group overview**, bars display the process shares of the respective workstations. Times are displayed on the Y-axis and workstations on the X-axis. The upper limit of the Y-axis represents the cycle time. The colored bars correspond to the time process shares of a work station. Time is displayed in minutes and corresponds to the sum of all process shares of a work station.

Example

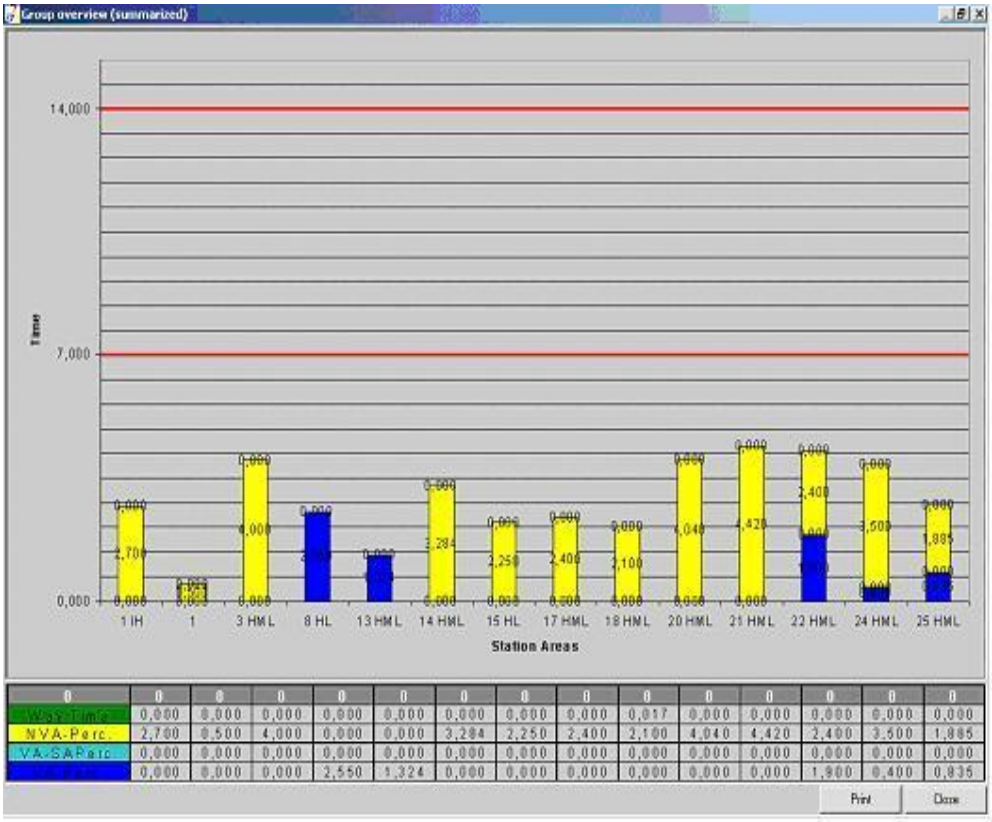


Figure 91: Example of a Diagram Summarized Group Overview

5.8.2.1 Process Shares of a Work Station

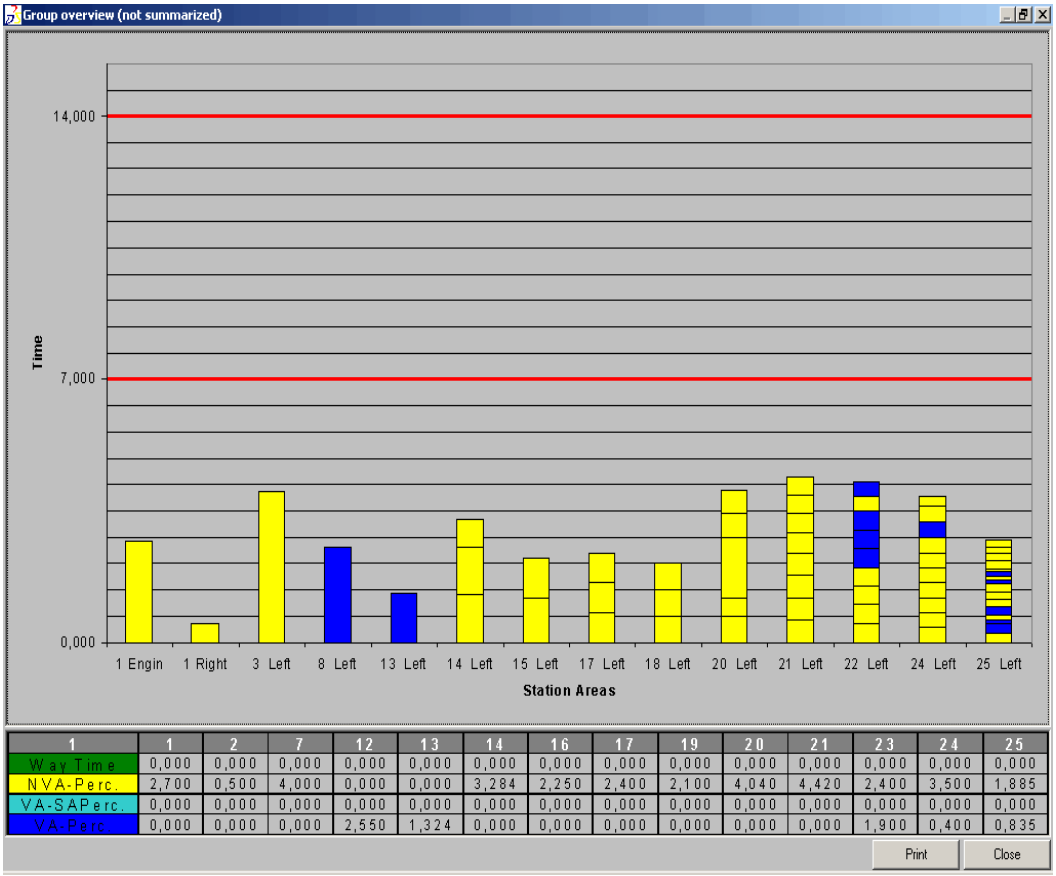
All times in the corresponding columns refer to the respective work station and the process share.

- The **way time** is the time needed for the return path.
- The **NVA share** corresponds to the non-value added process share time.
- The **VA-SA share** corresponds to special equipment process share time.
- The **VA share** corresponds to the value added process share time.

5.8.3 Non-Summarized Group Overview

In the **non-summarized Group overview**, bars display the process shares of the respective workstations. To print the result of the group overview in a station assignment table, use the **Print** button and the Automatic Line Balancing interface.

Example



1	1	2	7	12	13	14	16	17	19	20	21	23	24	25
Way Time	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
NVA-Perc.	2,700	0,500	4,000	0,000	0,000	3,284	2,250	2,400	2,100	4,040	4,420	2,400	3,500	1,885
VA-SAPerc.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
VA-Perc.	0,000	0,000	0,000	2,550	1,324	0,000	0,000	0,000	0,000	0,000	0,000	1,900	0,400	0,835

Figure 92: Example of a Diagram Non-Summarized Group Overview

5.9 User Defined Attributes

1) Open ALB in a New Line. *Please refer to the* Figure 1.

2) Go to **ALB Main Menu** > **View** > Click **Process List/ Balancing List/ Workplace**.
   The user defined attributes are displayed in different columns as Attribute1, Attribute_2.

Figure 93: User Defined Attributes

<u>To Create and Configure User Defined Attributes</u>

3) Open the ALB Configuration, Right-click DPE project > **Extra** > **Balncing ALB Configuration** > **ALB Customization**. The **ALB Customization** dialog box appears.

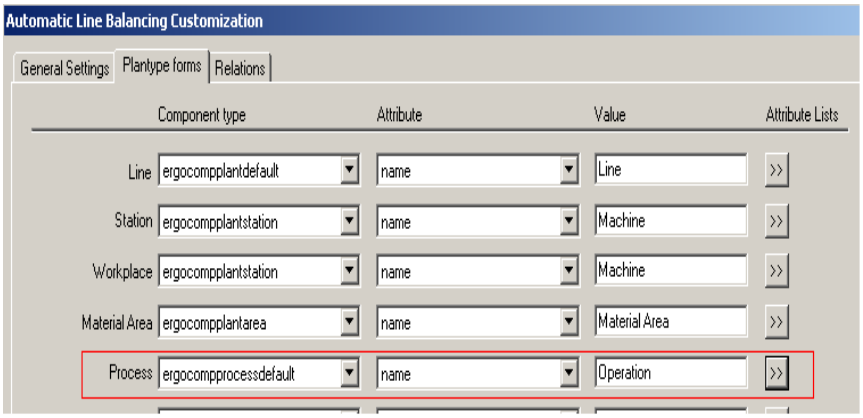


Figure 94: ALB Customization

4) Select tab **Plan type Forms** > **Process** > >> button.

5) The **Attributes Configuration** dialog box comes.

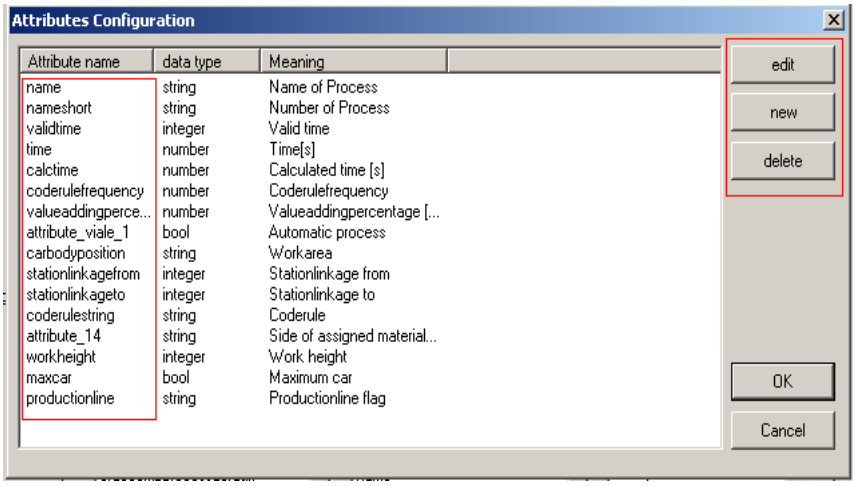


Figure 95: Attributes Configuration

6) Click **New/Edit** to create\edit your own attributes. All the existing attributes under the Column **Attribute Name** are by default for the process. The **Configure ALB Attribute** dialog box comes.

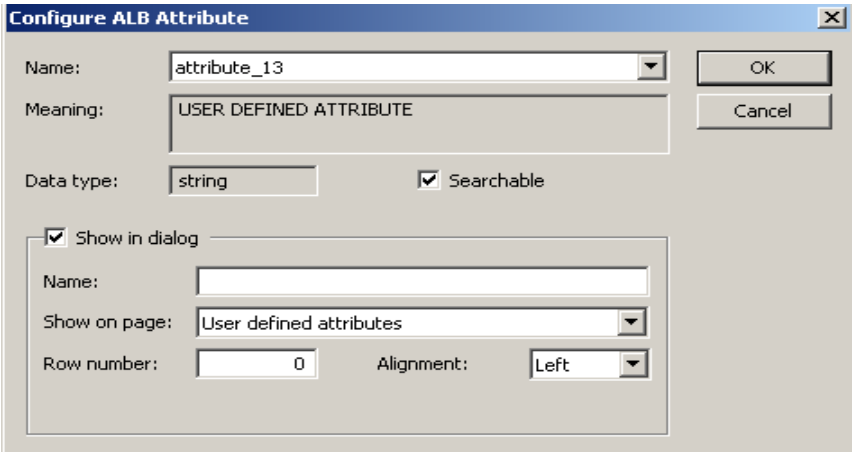


Figure 96: Configure ALB Attribute

7) Select attribute name from the drop-down list. Select the option **Show in Dialog** and enter other details.
The value of Name will be used as column name in list view.

8) Click **OK**.
   You can see the created attribute in the attribute list in the **Attributes Configuration** dialog box.

9) After creating user defined attributes, make sure that all created attributes created are visible in DPE Configuration (DPE browser and editor).

Figure 97: DPE Configuration

10) Enter the data for new attribute in all the processes under the work plan.

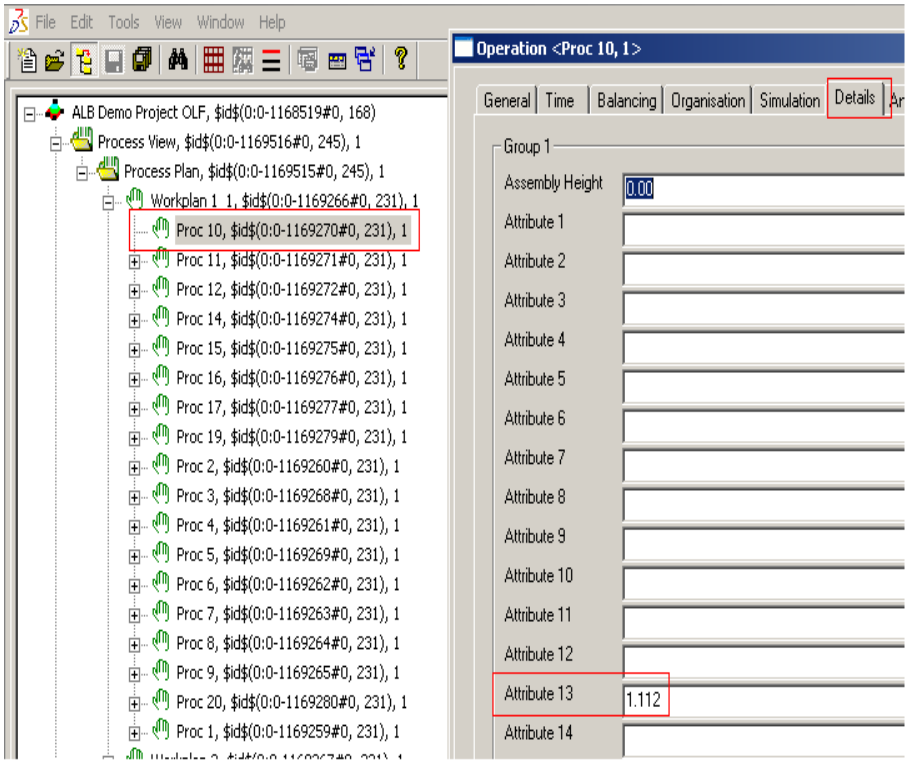


Figure 98: Entering Data for New Attribute

11) Similar configuration settings have to be made for all the user defined attributes created and data has to be entered in DPE before ALB is opened.

6. Computer-Assisted Automatic Balancing Procedures

The computer-assisted automatic balancing procedures can be divided into four main aspects. *Please refer to the* Figure 99.

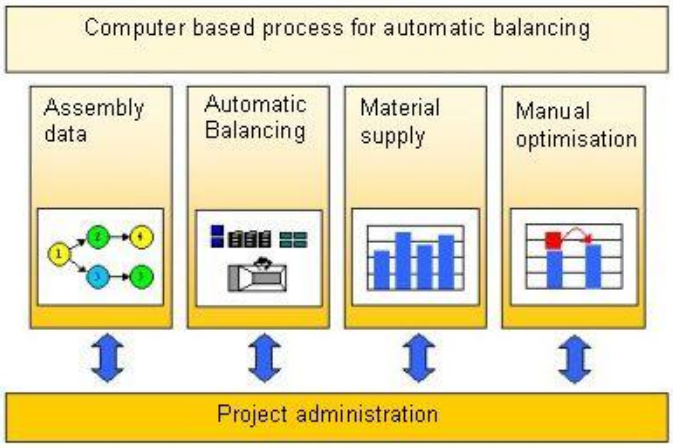


Figure 99: Program Structure

Assembly Data

The assembly data are entered in the PPR Navigator when generating the resource structure. The assembly data entry fields of the Process Engineer are specified by attributes. The Process Graph provides the balancing process with the processes used in Automatic Line Balancing. A Process Graph is generated in the PPR Navigator process structure.

Automatic Balancing

Automatic Balancing in Automatic Line Balancing will be executed according to a priority procedure. In addition, there are evaluation functions for automatic balancing.

Material Supply

After finishing the balancing process, you can arrange the carriers/bins individually in the material supply area and change the filling interval as well as the dimensions of the material supply area.

Manual Optimization

You can edit an existing balancing process manually. You can move processes and assign them to another station. Error messages will indicate restriction violations that might occur during the manual editing of a balancing process.

7. Working with Automatic Line Balancing

To work with fine balancing, you have to generate a process and resource structure in the Process Engineer PPR Navigator. Process and resource properties will be specified when these structures are generated. Use the **Process Properties** dialog to specify whether a process is to be linked to one or several stations. Moreover, you can use this **Process Properties** dialog (Body field) to specify where the processes will have to be executed on the vehicle. In Automatic Line Balancing only the workplace work areas are specified. In Automatic Line Balancing, you can specify a maximum of five workplaces. The work areas are assigned processes during the balancing process according to the definition in the Properties dialog. If the process body field is defined on the left, the process can also only be executed and assigned on the left side for the balancing.

7.1 Supplying Data for Automatic Line Balancing

Process Engineer structures and data described in the following section are needed for the work in Automatic Line Balancing. The structures are generated in the PPR Navigator.

For more information, *Please refer to the* PPR Navigator Manual.

7.1.1 Process Engineer Structures

The following structures will have to be generated in the PPR Navigator:

Resource Structure
The conveyor for which the stations are determined in Automatic Line Balancing is generated in the resource structure. The stations are determined and then displayed in the PPR Navigator.

Product Structure
Products processed at the conveyors and stations are produced in the product structure. Transport bins are assigned products.

Process Structure
Processes used to process products at conveyors and stations are generated in the product structure. A Process Graph, which is the basis for the Automatic Line Balancing Priority Graph, is created in the process structure.

7.1.2 Specifying Links

- Linking processes to products: according to process edited first product.
- Linking products to bins: Resource provides product.

7.1.3 Specifying Number of Pieces

- Specifying number of pieces per bin.
- Specifying number of pieces per process.

7.1.4 Showing the Balancing Process with Filtered Objects

You can use filters when opening projects. The structures of a project are displayed in accordance with the filters set. Filters also take effect on previously calculated or newly calculated balancing processes.

Use filters to show a certain planning status. Filters in this case refer to code numbers, line numbers, effectivity, or label. Filters can be assigned, for example, to processes and stations.

Potential Effects on a Balancing Process

- Processes which do not meet filter criteria are ignored in the balancing process, just as are stations which have an effectivity filter.
- A filtered balancing process can only be saved anew with the **Save As** function - this corresponds to a new balancing process with another name, one which can be edited independently. Normal saving is possible only if the balancing process is unfiltered.

7.1.5 Multi-Man Tasks in ALB

Normally, multi-man tasks are used for manual tasks that cannot be handled alone, such as lifting and carrying heavy loads.

A multi-man task is understood to mean a task needing at least two individuals to carry out. The relation for a multi-man task is planned in E5 by means of the Process Graph. A process is planned for each worker. All of the processes making up a multi-man task must start and end at the same time.

Example

An Example of a Multi-Man Task – Displayed in the Process Graph

The following example shows the process relation of a multi-man task. In this example, two activities can be observed – gluing and setting a windshield. Two workers are needed to set the windshield. This task will be assigned as a multi-man task.

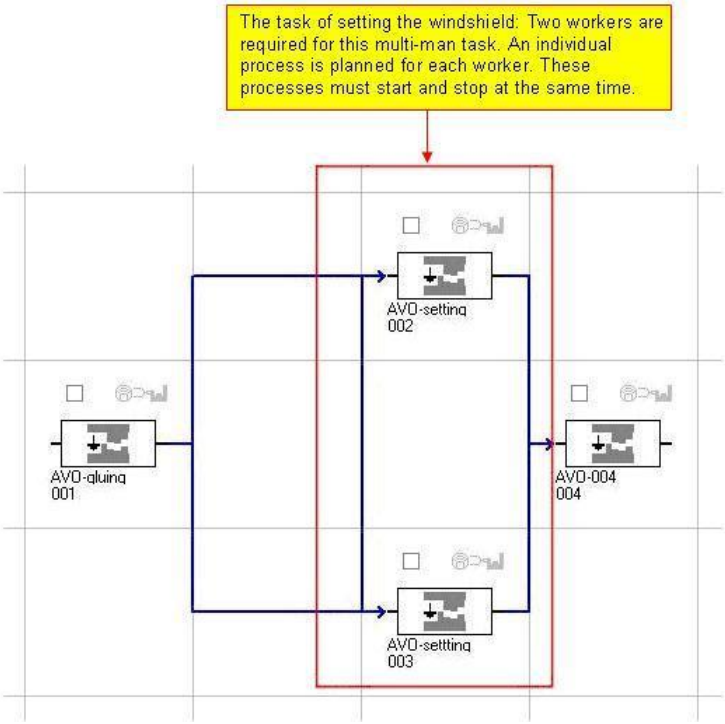


Figure 100: Multi-Man Task – Displayed in the Process Graph

7.1.6 Calculating the Start Time

The calculation of the starting time for processes has changed as of the PE 5.17 release. When changes were made to the process time in the old version, you were asked if the start time should be recalculated first. If recalculating was not carried out, a later recalculation was not possible.

Starting with the PE 5.17 release, the prompt for recalculating start times has been removed. For instance, as the ALB is opened, the start time is automatically calculated when changes have been made to the process or stand-by time. These new calculations are made exclusively for all processes that follow. The processes in the foregoing stations are logically disregarded – due to the fact that nothing has changed with regards to the start time for those processes.

7.1.7 Selecting Process Graph

To Select Process Graph

1) Once the **first** balancing process has been created, a process graph should be selected from the **Automatic Balancing - New** dialog. The balancing of processes in ALB for stations and work stations is now carried out through the selected process graph.

You can use the ALB-configurations to determine which process graphs should be displayed, so only the process graphs for a particular balancing process are displayed. The same applies for selecting a process graph, when adding product variants to an opened balancing process. *Please refer to the* Figure 101.

For more information, *Please refer to the* Administration Manual and Process Graph Manual.

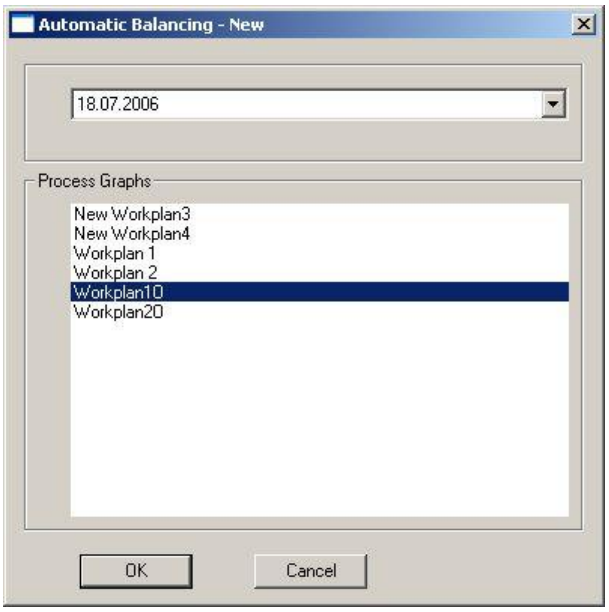


Figure 101: Select the Process Graph Dialog

2) Confirm the entries with **OK**.

7.2 Creating a New Balancing Process

Restriction violations with the balancing process

To generate a balancing process, you can either use: user-defined or default settings. You have already become familiarized with the description of the Automatic Balancing dialogs that you have to edit when generating a balancing process. *Please refer to the* Balancing Main Menu.

Note

All workplace entries refer to all of the workplaces and stations determined for the balancing process. In Automatic Line Balancing, a maximum of 50 workplaces per station can be generated.

7.2.1 Manually Balancing Processes

When creating the Automatic Line Balancing, you can decide whether the processes are to be balanced automatically, as previously, or if you wish to balance the processes manually. The following settings are not dependent on the procedure chosen – you can additionally determine whether the processes are to be balanced on the basis of user definitions or with the standard settings. *Please refer to the* Efficient use of the Process List for Automatic Line Balancing.

To Balance the Process

1) Click **No** if you wish to balance the processes manually.

2) Click **Yes** if you want to balance the processes automatically.

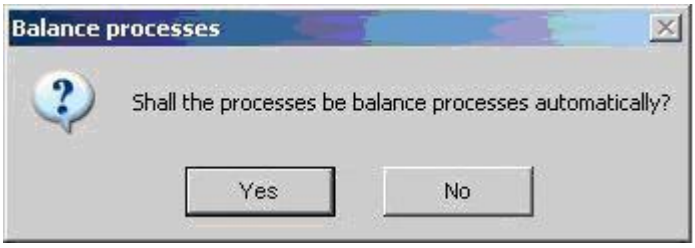


Figure 102: Message – Balance Processes Automatically or Manually

7.2.2 Generating Workplaces using the Default Setting

With the **Default setting** selection, you do not have to specify each workplace. In Automatic Line Balancing, workplaces and stations are determined automatically by the program. *Please refer to the* Balancing Main Menu.

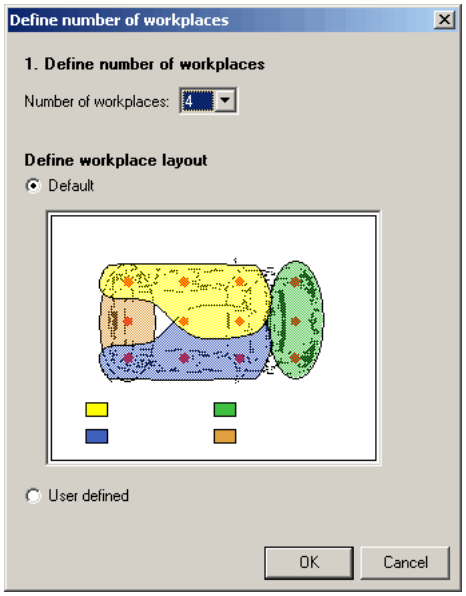


Figure 103: Selecting Standard Default Setting of Balancing Process

To Generate Workspace using the Default Setting

1) Click the **Default setting** field in the dialog.

2) Select the number of workplaces. Workplaces are highlighted. *Please refer to the* Figure 103.

Note

There are default configurations available for 1 to 5 and 1 to 50 workplaces. These standard configurations apply to general automotive and aerospace applications.

3) Enter the performance criteria and click **Run** in the dialog. *Please refer to the* Figure 25.

7.2.3 Generating User-Defined Workplaces

With a user-defined balancing process, each generated workplace specified in **Number of workplaces** in the dialog must be defined individually i.e. the workplace with all work positions must be specified exactly. In Fine Balancing, you can define a maximum of five workplaces. Each specified workplace is highlighted, too.

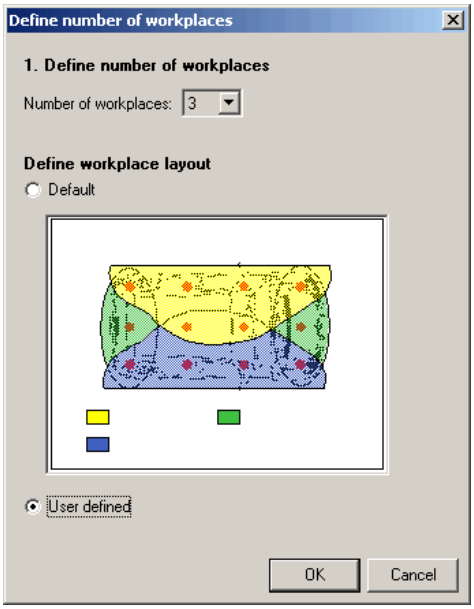


Figure 104: Example of a User-Defined Balancing Process

To Generate User Defined Workplaces

1) Specify the number of workplaces in the **Number of workplaces** dialog. There are three workplaces in the example. *Please refer to the* Figure 104.

2) Click **User-defined** field.

3) Confirm the entry with **OK**. After that you can specify the first workplace.

7.2.3.1 Specifying Workplaces one after Another

In the **Work areas** dialog, each workplace is defined. You have to specify work positions (there are three in the example) for each workplace. A balancing process cannot be calculated unless each work position offered (*Please refer to the* Figure 105) has been enabled at the last workplace at the latest.

Work positions of single workplaces may overlap. This means in practice that work positions on the vehicle can be executed from different workplaces.

The work area for the vehicle workplace is defined by the number of work positions.

Note

You do not necessarily have to select the "car body" example used in the dialog (picture of car body for specification of work positions). Thus, you can profit from the variety of products used in Automatic Line Balancing.

For more information on replacing pictures, *Please refer to the* Administration Manual.

Specifying First Workplace

Example

Use checkmarks to specify the work area. *Please refer to the* Figure 105.

Specifying the first user defined workstation

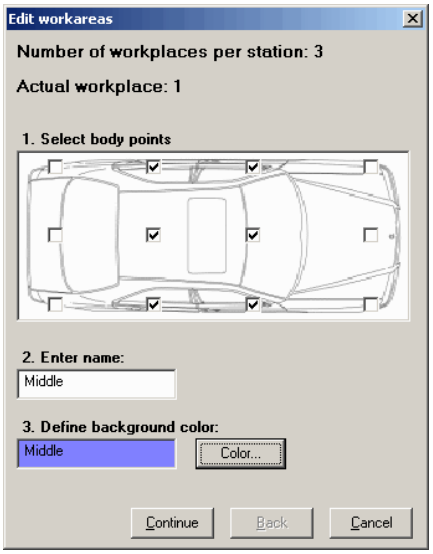


Figure 105: Example of First Workplace

Work positions are specified in the car body figure with the definition of a workplace.

1) To specify the work positions, checkmark the fields in **Select body points.** (*Please refer to the* Figure 105).

2) Enter a name for the workplace so that the workplace can be assigned in t he balancing process.

3) Each workplace will be highlighted in the Automatic Balancing view. Use the **Color** button to select the workplace color.

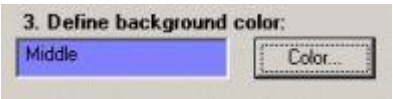


Figure 106: Selecting Workplace Color

4) Click **Continue** in the dialog to define the next workplace. *Please refer to the* Figure 105.

Example

Specifying Second Workplace

Proceed as with workplace 1.

5) After clicking **Continue**, you can make your entries for **Workplace 2**.

In the example, the rear area is defined as **Workplace 2** The initial work position specification view is empty and therefore does not contain the work positions specified for **workplace 1**.

This is due to potential overlapping of work positions. Continuing with this example, you could also now assign work positions to workplace 2 that had previously been assigned to workplace 1 (*Please refer to the* Figure 105). Workplaces that have not yet been assigned a work position will not be displayed until the last work position has been reached. *Please refer to the* Figure 108.

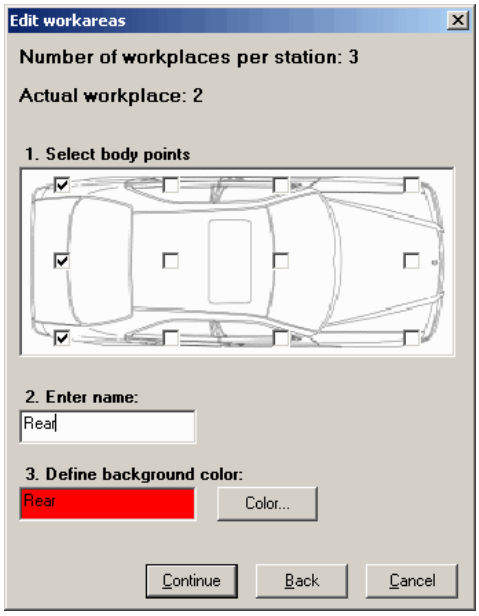


Figure 107: Example of Second Workplace

6) To make changes at this stage, click **Back** to return to the previous workplace.

Example

Specifying the Third Workplace

The three checkmarks indicate work positions not yet enabled.

7) You will have to assign these three unassigned **work positions**. **Workplace 3**, **Front** area, is assigned these positions. *Please refer to the* Figure 108.

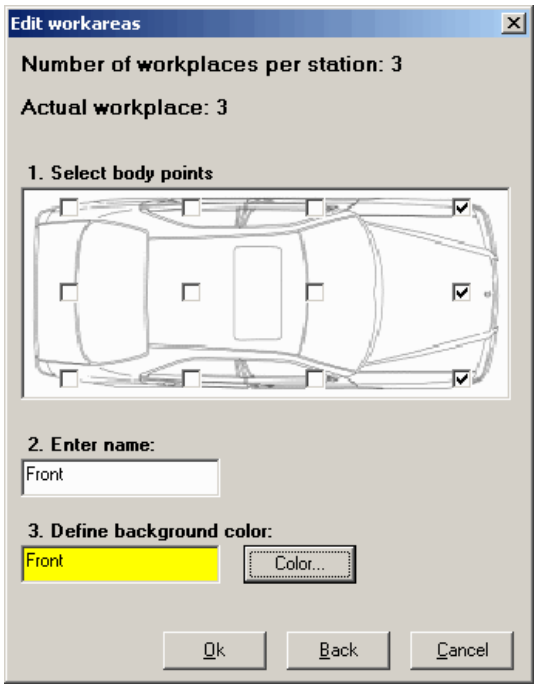


Figure 108: Example of Third Workplace

Third Workplace with Overlapping

This example shows an overlapping of work positions. Work positions marked in the red box can be executed at **workplace 1** and **workplace 3**. *Please refer to the* Figure 109.

Example

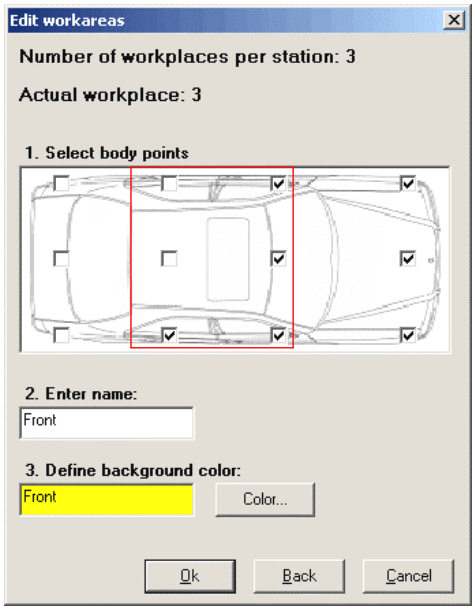


Figure 109: Example of Overlapping

7.2.4 Error Messages in Automatic Line Balancing

Restriction violations with the balancing process

When automatically calculating a balancing process, Automatic Line Balancing accesses process structure data stored in a database. During the calculation, data are checked for potential restriction violations.

Automatic Calculation Completed

This message appears whenever you calculate a balancing process.

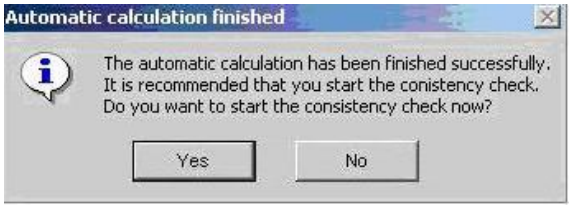


Figure 110: Execute Consistency Check after Calculation

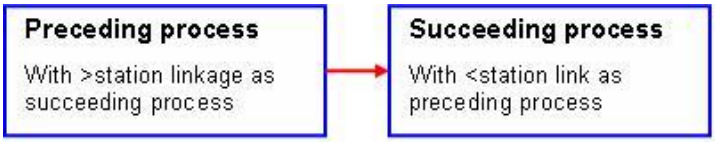
7.2.4.1 Three Restriction Violation Types

a) Errors in Station Linkage

This message only appears during an automatic balancing process and if there is a clear priority relation with an existing station linkage between the processes. This message will appear if the succeeding process has station linkage to a lower station number than the preceding process. Station linkage for this process will be temporarily deleted for the balancing process, but will continue to exist for the process.

Figure 111: Message – Error in Station Linkage

Example



Solving the Problem

During calculation, this message does not allow you to make any corrections.

- Close the balancing process without saving.
- Check the station linkage in the **Process Properties** dialog.
- Start the balancing process again.

Restriction violations with the balancing process

b) Missing Work Positions

This message will only appear with a user-defined balancing process if the last workplace is still to be assigned work positions – in other words before calculation is started.

Click **OK** button. The next step is to specify the missing workplaces.

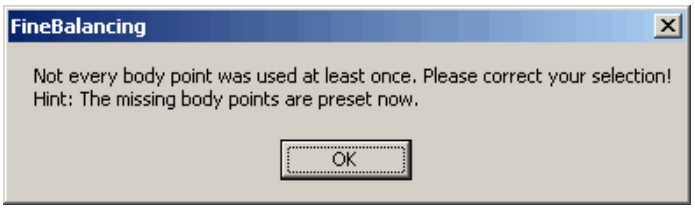


Figure 112: Restriction Violation when Generating a Balancing Process

c) Station Linkage is Larger than 500

Up to 500 stations can be generated in Automatic Line Balancing. This message will appear if a station linkage larger than 500 is entered in a process in the Properties dialog.

During the calculation process, station linkage will automatically be deleted.

Solving the Problem

- Close the balancing process without saving.
- Check the station linkage in the Process Properties dialog.
- Start the balancing process again.

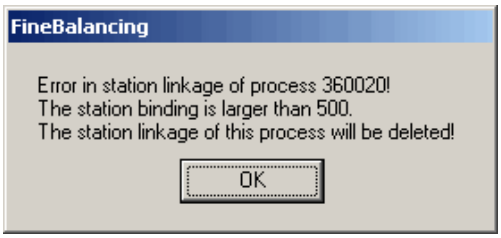


Figure 113: Restriction Violation due to too Large a Station Linkage

7.3 Displaying Processes

In Automatic Line Balancing, processes are displayed in the Automatic Balancing view according to their significance in relation to the planning. As a basic rule, the following applies to all types of display: A process is always marked by the process number.

7.3.1 Understanding the Display of Processes and their Meanings

In Automatic Line Balancing, processes are classified according to their usage. The different process usage types are as follows:

Process for Two Workplaces

If a process is displayed in a grey rectangle with a designation in black, this process can be executed at two workplaces at least.

Figure 114: Process Display – for at Least 2 Workplaces

Displaying Processes for Special Equipment Parts

If the weighting of a process is less than 100%, ALB automatically assumes that this process is to be used for special equipment parts. These processes are marked by a red box in the job view.

Figure 115: Process Display – Processes for SA Codes

Process with Station Linkage

Processes that can only be executed at one or at specific stations, are marked by a rhomb.

Figure 116: Process Display – Processes with Station Linkage

Process for a Workplace

Processes which have to be executed at one workplace only are displayed in the workplace color. Hence, you will already see whether a workplace can be assigned this process as soon as you move a process.

Figure 117: Process Display – for one Workplace only

Processes for Automatic Stations

Processes for automatic stations are displayed in a rounded rectangle.

Figure 118: Process Display for Automatic Station

7.4 Restriction Violations during Manual Editing

Restriction violations when manually editing the balancing process

You can edit a balancing process manually in the Automatic Balancing view. In manual editing, this generally means that you manually assign the processes to other stations or workplaces subsequently in the Automatic Balancing view after the balancing process has already been calculated. In Automatic Line

Balancing, these actions are automatically checked. A message will appear if restriction violations appear during manual editing.

7.4.1 Coping with Restriction Violations

Replanning of stations

After moving a process, Automatic Line Balancing checks whether a restriction violation occurs in the new assignment.

If no violations are detected, Automatic Line Balancing will newly plan the stations concerned. The new station assignments and the associated changes in utilization will immediately be calculated and displayed graphically. In addition, Automatic Line Balancing ensures that the material is always directly assigned to the workplace where the corresponding process is to be executed. Material can be supplied either to the right or to the left of the station for processes executed in the central area of the station. A change of the process station assignment can thus lead to changes in material supply.

7.4.1.1 Potential Restriction Violation Types

An error message containing a description on the cause of error will appear if there are restriction violations during manual editing of the balancing process. There are several different restriction violation types in Automatic Line Balancing.

Editing restriction violations

Read these messages carefully and use this information for your work. An error message may indicate several restriction violations simultaneously. If you confirm a message by clicking **Yes**, the process will be moved. *Please refer to the* Figure 119.

Figure 119: Overview – Four Restriction Violations

Editing restriction violations.

Wrong Area Message

This message will appear if a process has been determined for another work area in the Properties dialog.

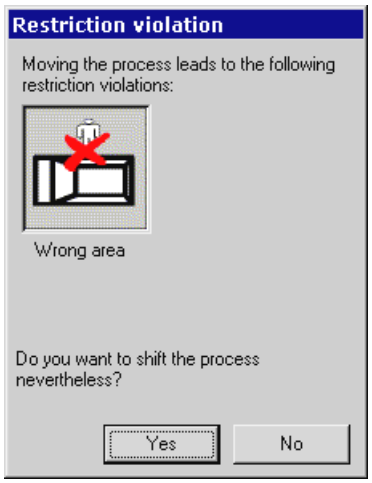


Figure 120: Restriction – Wrong Area Message

Editing restriction violations

Priority Relation Corrupted Message

This message will appear if, during movement of a process, a priority relation is violated. In the Process Graph, the process priority relations are generated by the process structure.

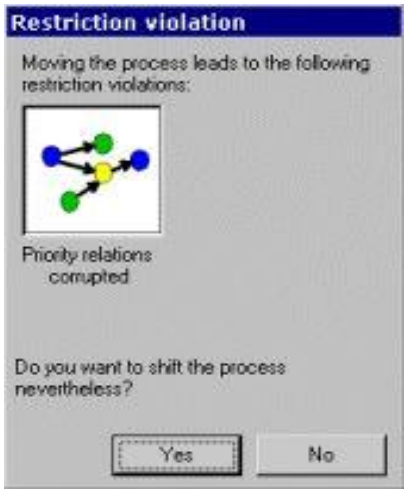


Figure 121: Restriction – Priority Graph Relation Violated Message

Corrupted Priority Relation in a Workplace Message

This message will appear if a priority relation to a further process within a workplace is violated while moving a process within the same workplace.

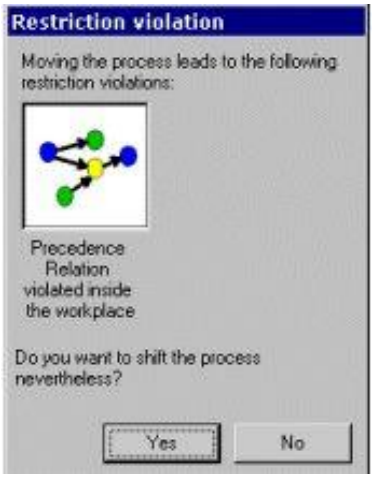


Figure 122: Restriction - Priority Relation within a Workplace Violated – Message

Station Linkage Violated Message

This message will appear if a station linkage is violated during the movement of a process. The process station linkages are specified in the **Properties** dialog.

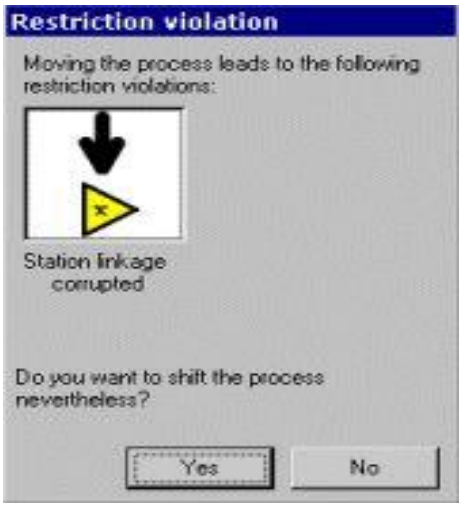


Figure 123: Restriction – Station Linkage Violated Message

Wrong Station Type Message

This message will appear if a station is to be assigned a process that cannot be executed at the corresponding station during movement of a process; for example, if an automatic station is assigned a manual process.

Figure 124: Restriction – Wrong Station Type Message

Material cannot be Placed Message

This message will appear if there is not enough space for material supply after movement of a process.

Figure 125: Restriction – Material cannot be Placed

Station Height is not Observed Message

This message will appear if the station height defined in the process Properties dialog is not observed while moving the process. *Please refer to the* Moving Processes – when Station Height is defined Differently.

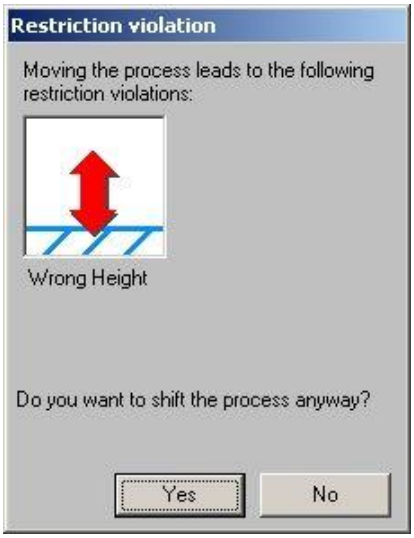


Figure 126: Restrictions - the Process is Assigned to a Wrong Station Height

7.5 Manual Editing of Automatic Balancing

New workplaces can be assigned processes in the Automatic Balancing view. The aim of this procedure is to optimize the calculated balancing process. Processes are always moved by drag and drop in Automatic Line Balancing.

Note

If the material supply area of a station is blocked during manual editing, this station will not be deleted automatically.

The same applies if the following option is enabled: Empty stations will automatically be deleted if the **automatically manage unassigned stations** function *is enabled in the settings dialog (*Please refer to the Figure 43.) Optimising the balancing process.

To manually edit the Automatic Balancing view, you can also use the Windows technique in the **Window** menu in Automatic Line Balancing.

1) Select **side by side** in the Window menu to display the Priority Graph and Automatic Balancing view side by side on the screen.

2) If you select a process in automatic balancing, this process will also be selected in the Priority Graph view.

3) You can maximize or minimize the Priority Graph and Automatic Balancing views.

Process Performance Data

4) In one of the two views, move the left mouse button to a process to display the most important process performance data for a process.

Figure 127: Displaying Performance Data for Process

Material Supply Performance Data

5) Move the left mouse button to a bin on the material supply area and double-click it to view the performance data. *Please refer to the* Figure 128.

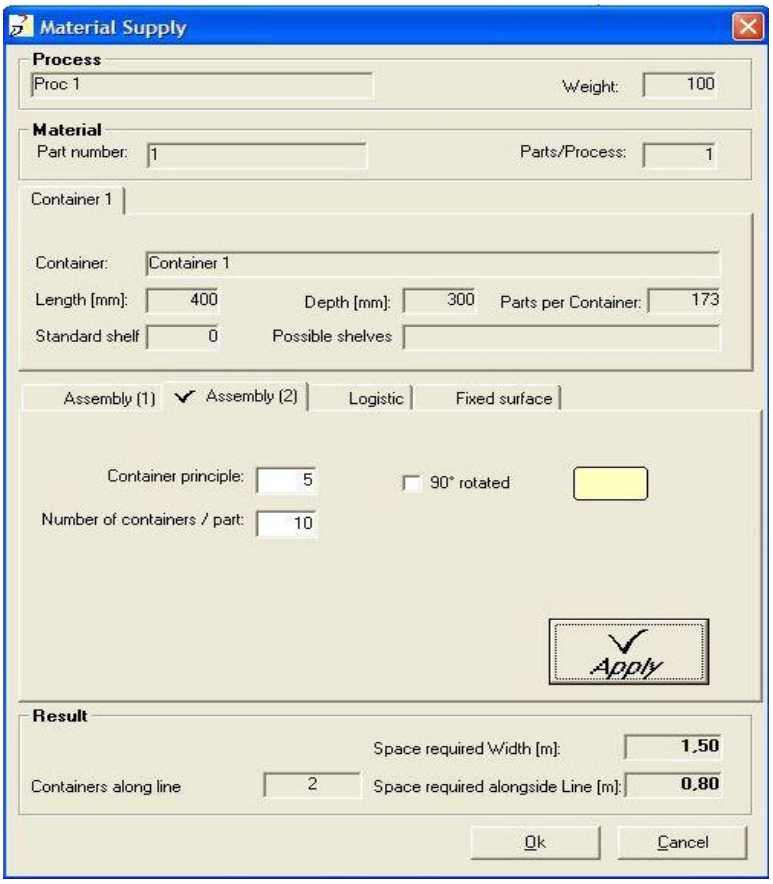


Figure 128: Displaying Material for a Process

7.5.1 Process Properties Dialog

Data are entered in the Properties dialog while generating the process structure in the Process Engineer.

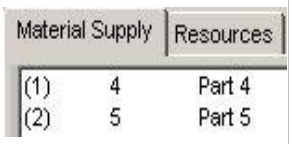
This dialog will specify the following criteria:

- The body field will specify where the process is to be executed on the vehicle.
- The value-added field will specify the valued-added share of a process.
- The station linkage field specifies whether or not a process is to be permanently linked to one station or several stations.

Process properties cannot be edited in the Automatic Balancing view.

1) To open the process **Properties** menu, double-click a process in the Automatic Balancing view.
2) Operating equipment as well as bins for material supply can be assigned processes. You can edit these in the corresponding dialogs.

Material Supply – Operating Equipment



3) Click one of the two tabs – Material supply/operating equipment to open a properties dialog (Material supply/Operating equipment) to open a Properties dialog. If material or operating equipment is already assigned, double-click the window line displayed. *Please refer to the* Figure 129.

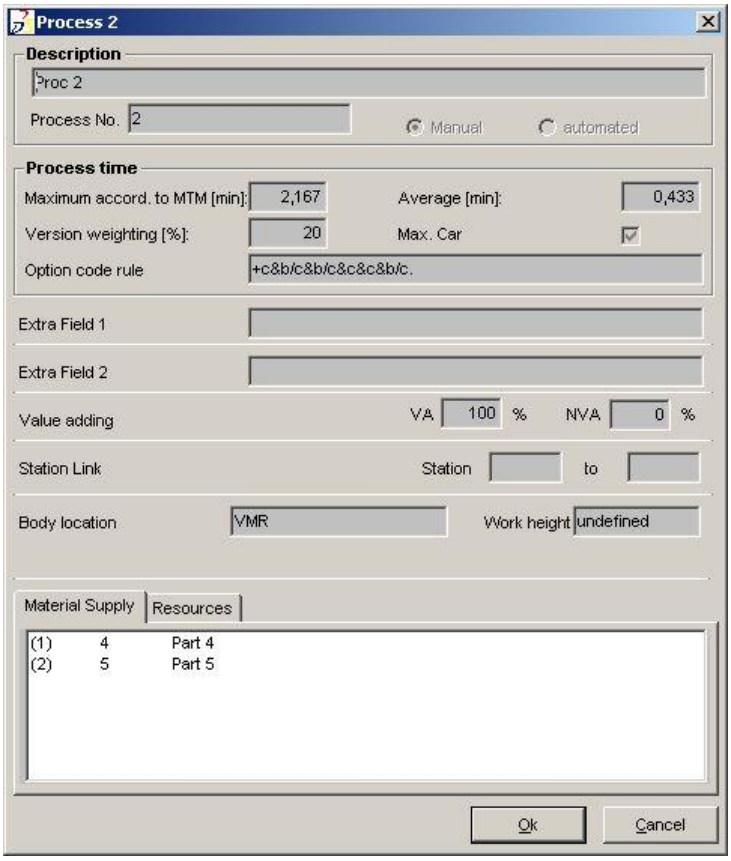


Figure 129: Process Properties Dialog

Displaying User Defined Attributes in the Properties Dialog

With the aid of user defined attributes, the user can display additional useful attributes in the properties dialog of the process. These attributes can contain additional information for the process, in this example for instance, the base time, Author, and classification attributes are visible. These attributes are for information purposes only.

For more information about the configuration attributes, *please refer to the* Administration Manual.

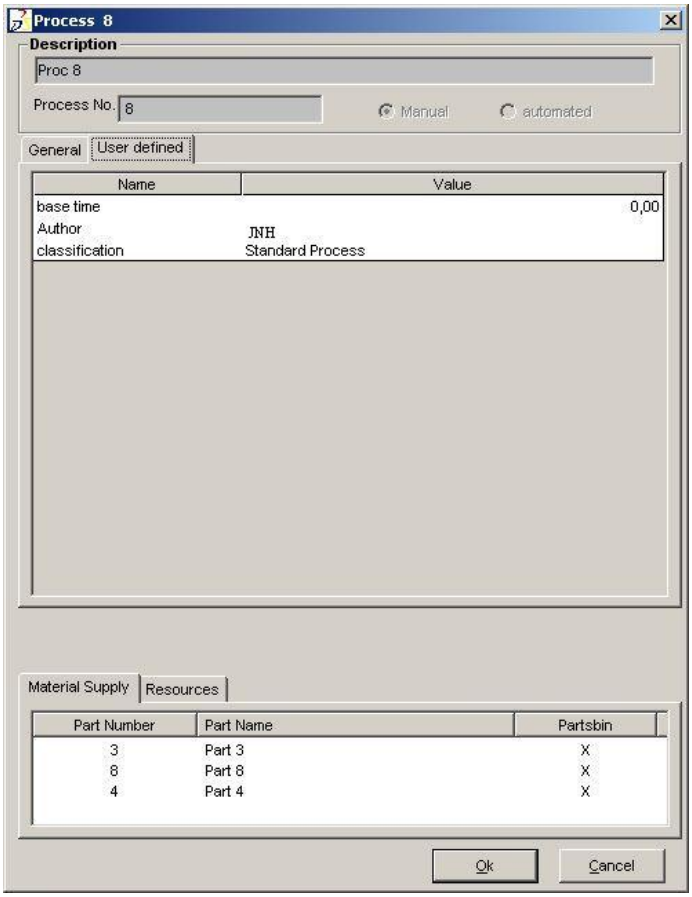


Figure 130: User Defined Attributes

7.5.2 Showing Station Properties

The properties of a station can be shown. In the **Properties** dialog the station type can be re-determined as well. In addition, there is the possibility to change the working height (station height) of the body in the station from low to high. The working height of the body determines in which position the processes are executed at the body.

7.5.2.1 Opening the Station Properties Dialog

1) Double-click station field to open the **Properties** dialog. *Please refer to the* Figure 132.

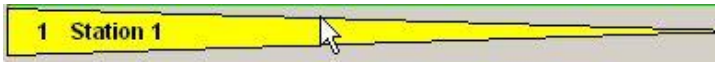


Figure 131: Open the Properties Dialog by Double-Clicking

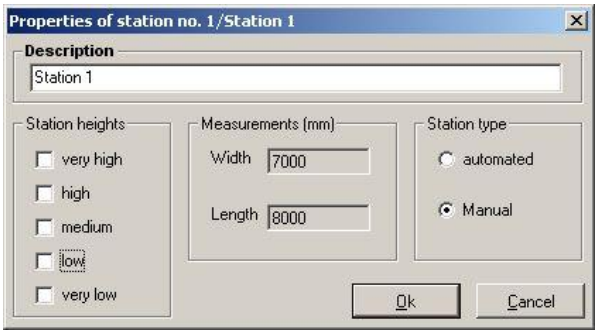


Figure 132: Properties Dialog for a Station

2) Define the Station Type and Height.

During Automatic Line Balancing each station is assigned the **Station type** and **Station height** of the first process assigned to the station. For instance, if the first process assigned is performed manually and the station height is set to high, the station is assigned to the **Station type manual** and the **Station height high**. Both attributes, station type and station height are defined in the properties dialog of a process.

The same applies to manual editing of stations. For instance, if you manually add a station and assign the first process manually to the new station, the station will likewise be assigned the two attributes of the process assigned.

The attributes defined in the properties dialog of a process are not changed when the **Station height** or **Station type** are altered. The attributes of a process remain unchanged, even if a manual process should be assigned to an automatic station.

3) To change the station type, click one of the two fields – **automatic/manual**. Upon opening of the properties dialog, the station type assigned to this station during line balancing is displayed.

4) To change the station height of the vehicle, click one of the fields. Upon opening of the properties dialog, the station height assigned to this station during line balancing is displayed. *Please refer to the* Figure 132 and Table 2.

7.5.2.2 Violation of Restriction - Assigning Processes Manually to a Station

If you try to assign a process to a station that has different attributes than the process, a warning message will be displayed that a violation of restrictions will occur. You may then decide if you wish to assign the process to the station anyway. Such violations are also displayed upon a consistency check. Again the following applies: the attributes of a process are not changed.

7.5.3 Moving Processes

Processes are manually moved by drag and drop. The **left upper corner** of the process plays an important role in moving a process.

When moving a process which is to be inserted directly in front of another process, the left upper corner of the process you want to move must be placed on the other process.

The Automatic Line Balancing plans the processes according to the relations set in the priority graph and distributes these processes to stations and workplaces. The sequence thus determined always results in the processes being created in a sequence set in the balancing process.

If you now move a process, for example one of from a previous station to a subsequent station, this process is inserted into the station at the beginning of the already present processes. This principle is also used in the other way around; if a process from a subsequent station is moved to a previous station this process is inserted at the end of the already present processes of the station.

The directions in which the processes are moved therefore play an important role. This principle is nullified if you place a process which is to be moved on another process with the left upper corner.

How to Ensure that you do it Correctly

You want to insert the process in front of the other:

1) Select the process you want to move.

2) Ensure that the left upper corner is placed on the process before which this process is to be inserted.

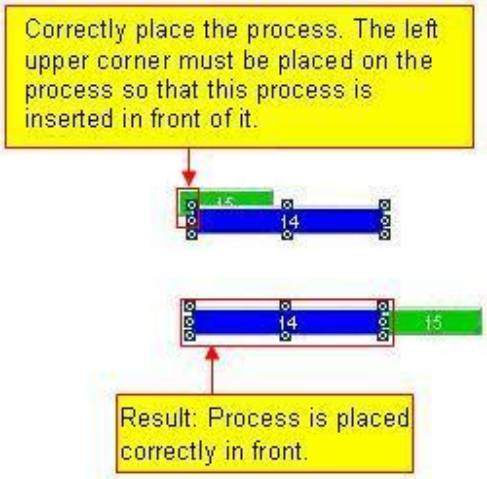


Figure 133: Moving Processes Manually – Placing in Front

7.5.3.1 Moving Processes – when Station Height is defined Differently

When the following preconditions are met, you can move processes without receiving the message **wrong height**: *Please refer to the* Station Height is not Observed.

The station height for the respective processes and stations are defined in the **Properties** dialog. Processes with defined station heights can easily be moved according to the schematic shown in the Table 2.

Table 2 shows the possible assignments of processes to stations with working heights that you can assign to the stations without a violation of restriction occurring.

- You can, for example, move processes of which the working height is defined as *low* to stations of which the working height is defined as very low, low, and medium.
- However processes of which the working height is very low can be moved only to stations of which the working height is defined as low or very low.

Assignment of Processes with Defined Working Heights to Stations

Table 2: Schematic – Assigning Processes to Stations

Stations	Very Low	Low	Medium	High	Very High
Processes					
Very low	X	X			
Low	X	X	X		
Medium		X	X	X	
High			X	X	X
Very high				X	X

7.5.4 Showing Processes

In the Automatic Balancing view, you can highlight the dependencies between processes and assigned bins graphically.

7.5.4.1 Graphically Highlighting Processes

1) Move the mouse pointer slightly over the bin. The assigned process will be selected and highlighted. *Please refer to the* Figure 134.

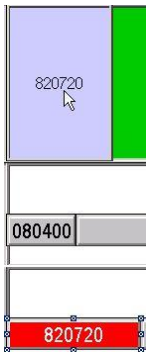


Figure 134: Highlighting Processes

7.5.4.2 Highlighting Bins

Move the mouse pointer slightly over the process. The assigned bin will be highlighted. *Please refer to the* Figure 135.

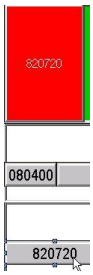


Figure 135: Highlighting Bins by Colors

7.6 PMS Features

7.6.1 Parallel Stations

Parallel Stations are indicated using the nameshort (or any other attribute mapped to that meaning in the ALB configuration). The same value list stored in the sortindex attribute of the PC relation to the line. A non-parallel station has an whole-numbered value, whereas a parallel station has a fractional portion. Examples: Station 1 is non-parallel, Station 2.1 has parallel stations. Station 2.2 is the first parallel station of station 2.1.

The first of parallel stations is positioned as usual in the line. The next parallel stations are positioned in the 3D space right to the first parallel station. Processes, shelves, and part bins are linked to each one of parallel stations as with normal stations. When saving, ALB keeps the positions of the existing part bins and shelves. When saving a new parallel station for the first time, the relative positions of part bins and shelves are taken from the first station. When part bins are assigned during work in ALB, ALB position these resources at an initial position in the material are.

The takt time is calculated by multiplying the takt time by the number of parallel stations.

To create parallel stations, first duplicate a station in the manufacturing concept.

To Create Duplicate Stations:

1) Open context menu by right-clicking the New Test Station and select **Split**. The **Split Symbol** dialog appears.
2) Enter the number of duplicate stations to be created in **Quantity.**
3) Press **OK**, connect the stations and move to appropriate places, the result looks like this in MC.

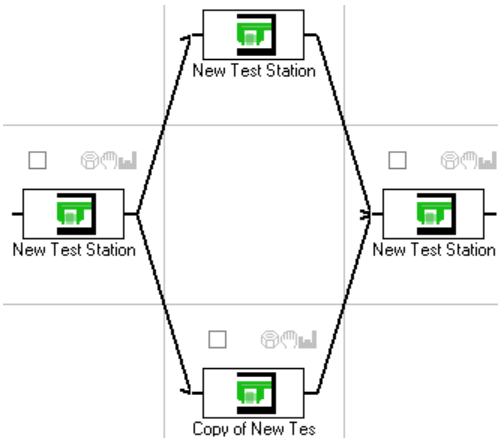


Figure 136: Duplicate Stations

To Create Parallel Stations:

1) Create a new ALB line and name it as Parallel Station.
2) Right-click new created station and select **Application** < **Create Children on ALB Line**.
3) Enter station number to be created in **Quantity** field in **Create Multiple Children** dialog.
4) Right-click new created station and start ALB via **Balancing** < **Open ALB Balancing.**
5) Select a workplan which should be balanced.
6) Enter takt time and balance the processes automatically in **Product Variant Properties** dialog.
7) Right-click station in ALB and use command **Parallel stations** from the context menu, or use **Station** properties dialog. Enter **number of parallel stations** in **Parallel Stations** dialog.
   The yellow station triangle in the 2D view becomes orange and number of parallel stations created is written as [ ] in the triangle.

When the dialog creates parallel stations, the name of the original station is used as base name and a number is appended with a dot to the base name.

View Duplicate Stations

- **Balancing 2D**: When the corresponding line is opened in ALB, parallel stations are marked by an orange triangle (normally the triangle below each station is yellow) in the Balancing 2D View. When moving a process from one station to the other, ALB needs to care for the length of the process, as this is changing dependant on the takt time of the station.

- **Bar Chart**: The respective takt time is shown in the bar chart. The scale (on the left) is used for each station and each PV. There is separate line for the takt limit in each station.
- **Balancing List**: The entry for the Workplace displays the actual takt time of the station.
- **Workplace View**: The header shows the actual takt time of the station.

7.6.2 Layout Planning: Takt Time per Variant

You can balance the same variant with different takt times and see the result in one view. You can also find the best fitting takt time. Two variants can be balanced at the same time, each with a different takt time.

1) Create a new line.
2) Right click on the new line and select **Application** < **Create Children on ALB Line**
3) Enter station number to be created in **Quantity** field in **Create Multiple Children** dialog.
4) Open the balancing on this line; choose process graph. The **Product Variant Properties** dialog appear, via **Balancing** < **Product Variants** < **Properties**.

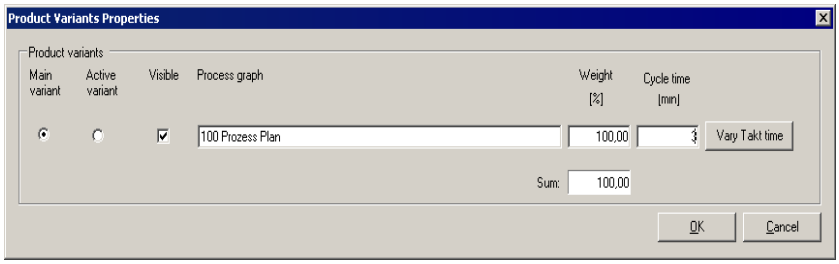


Figure 137: Product Variant Properties Dialog

5) Enter takt time for the loaded product variant.
6) Click **vary takt time** to enter a new takt time.
7) Click **Balancing** < **Base Data** to show the parameters. The **Parameters for Automatic Balancing** dialog appears (two fields are disabled in PMS mode: max. capacity and drift bound are not applicable in the PMS context). The takt (cycle time) is same as entered in **Parameters for Automatic Balancing** dialog.
8) Run the automatic algorithm
9) Save the balancing

Display of Takt time

- **2D View**: The length of the station represents the takt time. The lengths of the processes have to be scaled correctly to the takt time of the according product variant.
- **Resource Bar Graph and Bar Graph**: The takt line (red for active variant, grey for inactive variants) must be according to the given takt time.
- **Balancing List View**: Check the utilization of work contents and the working units.

To Add Product Variant

1) Open the balancing
2) Clcik **Balancing** < **Product Variant** < **Add Product Variant**.
3) Choose product variant in **Load Product Variant** dialog
4) In the **Product Variants Properties** dialog, check that the takt time is set to the takt time of the main variant by default. Distribute the weight evenly (sum 100%) and click **OK**. The dialog asking for automatic balancing the new PV appears.
5) Click **Yes** to continue with automatic balancing the new PV.
6) The added variant is balanced automatically: all identical processes known by ALB from the first PV aree balanced at the respective position (identical to the first PV). All newly introduced processes stay in the list of unbalanced processes. The following dialog shows the result.

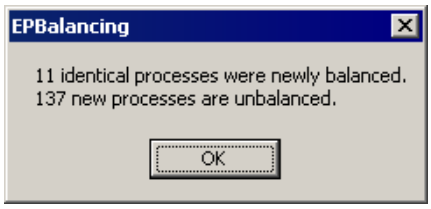


Figure 138: Result Dialog

7) Check if the processes of the added product variant are balanced correctly. That means, that the identical processes have to be balanced to the same workplaces, and all other processes have to be put to the unbalanced processes pool.
8) Assign all other processes to workplaces of your choice.
9) Save the balancing.

7.6.3 Layout Planning: Use Template Processes

You can create non-value adding process inside ALB. You can select processes from a process standard library, where some basic process types are defined. For example, these basic types could be Walking or Cleaning.

When you want to create a non-value adding process in ALB, select a process from the library. Then insert the process with drag and drop in the workplace. A new process is created inside ALB as a copy of the Standard Process. The Standard Process remains in the Process Library and can be instantiated another time. To check the process properties, open the properties dialog by double clicking the process in the library view.

Structure of the standard process library

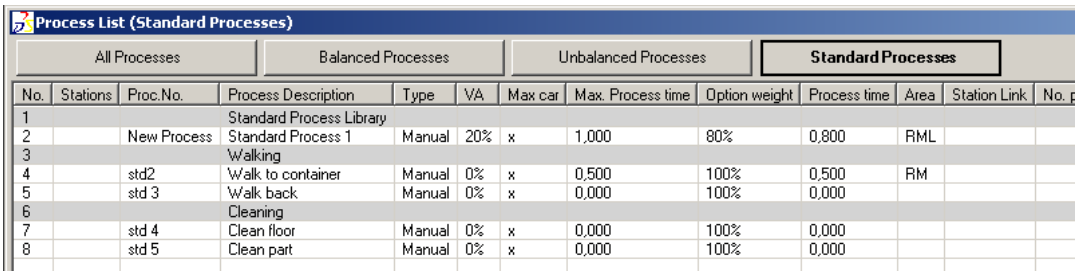
In this library, there can be stucture elements, for example to have all walking processes below a main node “Walking”.

There are some rules how the standard library must be build:

- All elements beyond the main library node, which have the same plantype as defined for Standard Processes, are read.
- Elements, which have children, are recognized as structure elements.
- Elements, which have no children, are recognized as Standard Processes.

To Insert a Standard Process from the Standard Process Library

In ALB, you can access the Standard Process Library, after pressing the button **Standard Processes** in the Process List:



No.	Stations	Proc.No.	Process Description	Type	VA	Max car	Max. Process time	Option weight	Process time	Area	Station Link	No. p
1			Standard Process Library									
2		New Process	Standard Process 1	Manual	20%	x	1,000	80%	0,800	RML		
3			Walking									
4		std2	Walk to container	Manual	0%	x	0,500	100%	0,500	RM		
5		std 3	Walk back	Manual	0%	x	0,000	100%	0,000			
6			Cleaning									
7		std 4	Clean floor	Manual	0%	x	0,000	100%	0,000			
8		std 5	Clean part	Manual	0%	x	0,000	100%	0,000			

Figure 139: Standard Process Library

If you needs additional information you can double-click the process to see the properties dialog. You can select a Standard Process from this list and insert it with drag and drop into a workplace in the Balancing List.

Note

The process is not removed from the Library, a copy of the process is created in ALB. When storing the balancing to the Hub, a link is created from the Process in the Library to the respective resource.

The standard processes that are inserted into a balancing from the process library must be copied into the project and linked to the according workplace (like all other processes are). TSAs are also created for these processes. The standard processes get a special flag, so that ALB can detect these processes as standard processes when a balancing is loaded. This is the identifier “PS” on the attribute “internalbalancingdata”.

There is a check box in ALB configuration dialog to enable or disable Standard Processes feature. *Please refer to* Figure 43.

CUSTOMIZATION

The plantypes for the Standard Processes and the Standard Process Library must be defined in the E5 library in the ALB plantypeset.

1) A new plantype for the Standard Process Library must be created (i.e Standard Process Library derived from OrgProcess).

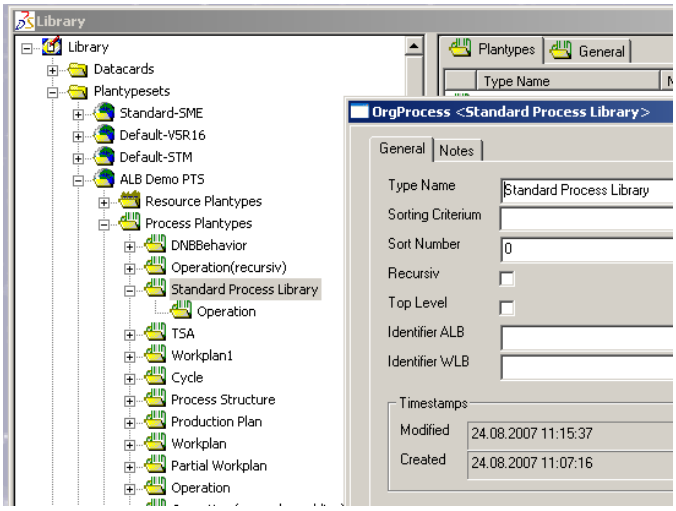


Figure 140: Plantype for the Standard Process Library

2) The child process is specified.

In the ALB Customization dialogue there is a new entry for the Standard Process Library. The behaviour of this entry is identical to the already existing entries.

7.6.4 Multiple Activity Chart: One Worker Working in different Workplaces

Earlier there was a 1:1 relation between workplace and worker (In the exceptional case of a multicycle workplace this was n:1). Now a worker can work on two different workplaces/stations. You can assign active resources to the stations inside ALB and can also create and delete active resources inside ALB.

If ALB is used in the context of the Standardization Scripts, then the PMS mode of ALB should only be set, e.g. the script to create valid station structures for ALB is mandatory for the workflow in PMS mode.

If the PMS mode is not set, then ALB is automatically in FAL mode.

To Create a New Balancing

1) Right-click the resource structure and create a new line.

2) Right click new created ALB line and click **Application** < **Create Children on ALB Line**. Enter details in **Create Multiple Children** dialog box.

3) The script creates the stations together with one worker and one machine. The created structure below the line looks like this:

Figure 141: New Created Stations

3) Open ALB on the line. Check in the 2D Balancing View, all work contents are shown. The active resource type (Machine or Worker), time, and name of the active resource are displayed in each work contents. For all stations there is one worker and one machine.
The usage of the script to create the resource structure is mandatory. If you create a faulty resource structure then ALB provides necessary information and informs what was wrong when you started.

Assignment of Active Resources to Stations

1) Click **Balancing** < **Worker/Macine Assignment**.
The **Working Unit Assignment** dialog box appears.

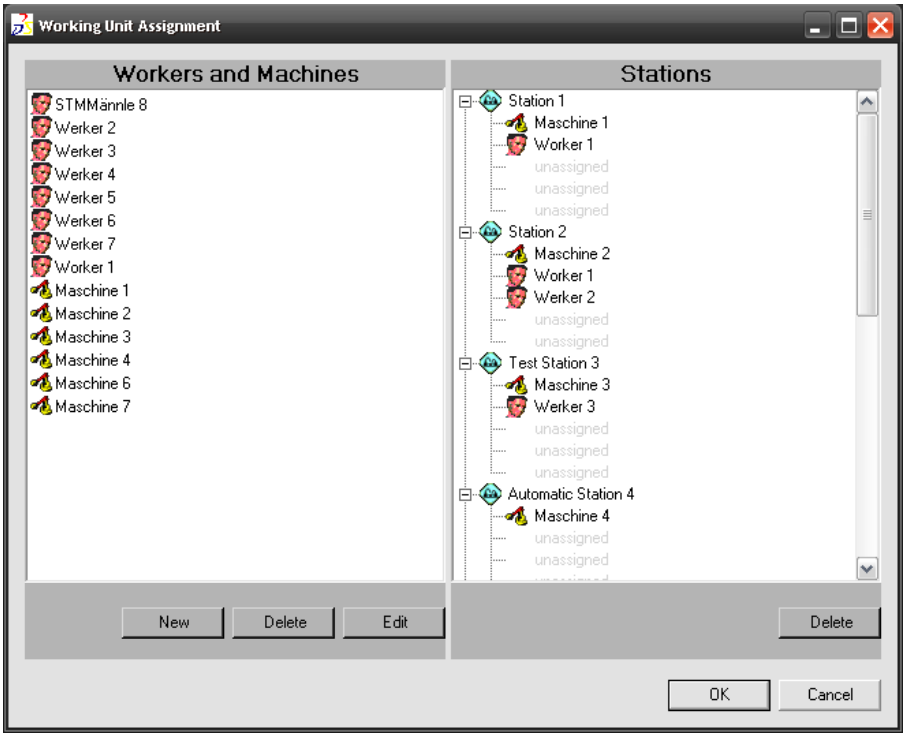


Figure 142: Working Unit Assignment Dialog

When the dialog is opened on the left side there are the active resources available, on the right side there are the stations with the current assignments listed. You can use drag and drop to connect active resources to stations.

2) Select the active resource and click **Delete** button to delete an active resource.
   If the selected active resource is still assigned to a station then the active resource is not deleted. You would get a message to remove the assignments first.

3) Click **New** to create new active resource. In the opening dialog you can select, which kind of active resources should be created as well as its name.
   It is not possible to create an active resource with a name, which is already used for another active resource.

Connect/Disconnect active resource to station: An active resource can be connected to a station via drag and drop. The active resource can be dropped on a station or on a place within a station:

- Select an active resource and drag it to the desired place in the station. If there is already an active resource, it is replaced without further notice.

- Select one active resource and drag it to the desired station on the right area. The active resource is added to the first unassigned place. If there are no unassigned places, there is a message that the assignment would not take place.

To disconnect an active resource, select it and click **Delete** in the station's button area. When the dialog is left with **Ok**, active resources which are not connected to any station are deleted.

4) Select an active resource in the Workers and Machines List and click **Edit** to rename the selected active resource.
   You cannot change the **Type**. You cannot choose a name, which is already used for another active resource.

In the resource bar graph view and see multiple assignment of active resources to stations. The worker 1 is assigned to 2 Stations (Station 1 left and Station 2 left).

If you delete a worker and machine from station, the work content and machine assigned to the deleted worker, is not present anymore. The process from that work content has been moved to the unbalanced processes list.

Parallel Stations

Parallel stations require the same number of active resources. The dialog cannot be left with **OK**, if there are parallel stations which differ in the number or the places of assignment of active resources.

ALB Customization

The Plantype “Machine” is added to the ALB Customization. Remove the ispms attribute from the balancing. Now you are in FAL mode. Start the balancing from a line or create a line yourself and start ALB from there. The menu entry for the assignment of active resources to stations is not there.

Note

Each of the two modes in which ALB can be run - mode FAL and mode PMS - is based on a specific DPE data model. As a consequence, a balancing which was created for PMS mode cannot be loaded in FAL mode and vice versa.

DPE Datamodel for PMS

The resource structure for the work content located under the Stations is changed for the DPE Data Model for PMS. In the new model, machine is introduced as a working Unit like a Worker. Worker and Machine are direct children of the Station. A Station can have machines and/or workers as children. Operations (Processes) are assigned to the Worker/Machine by Relations of type “proc_runningon_plant”. Additionally, all Processes which are assigned to a Worker or a Machine in a Station, have to be linked to the Station by “proc-runningon_plant” relations.

The names of the workers and machines used for one balancing have to be unique. This is verified when loading the balancing: If this restriction is broken, the load would not succeed.

Machine and Worker have a red frame and are managed by ALB.

The Behavior for a Worker as well as TSA’s are not part of the Data Model any more. Data structures for material area, shelves, and part bins are identical in both PMS and FAL model.

DPE data models comparison for the FAL and PMS modes:

- In PMS mode no need to load/save Workplaces (they are created internally in ALB). As children of a Station you have to load its Working Units, Workers, and/or Machines.
  Additionally we need to load the Relations of type “proc_runningon_plant” which link the Working Units with the related Operations.
- In FAL mode this would represent a Station with Worplaces and Workers with the related Relations. So in this case we have to load/save extra entities of type Workplace.
- In PMS mode, additionally we have to load the Relations of type “proc_runningon_plant” which link the Operations to the Station to which they are assigned.

There is minor degradation in performance for loading/saving of the data which are organized under Stations

Limitations

- It is not to assign a worker or a machine twice to the same station.
- When the balancing is started on a line in PMS mode, the resource structure must have been created by the CS script. Changes to the resource structure must be made from within ALB. If external changes are made, ALB is not guaranteed to start.
- In PMS mode the feature *multicycle* in ALB is deactivated.
- The names of the active resources must be unique within one balancing – that means all active resources below the line, on which ALB is opened.
- In parallel stations the **Working Unit Assignment** dialog box can only be left with **OK**, if corresponding parallel stations have the same number of active resources assigned to the same places.

7.6.5 Multiple Activity Chart: Worker Bar Chart View

This helps to assign the worker or machine to several workplaces. The Resource View provides information on active resources. It presents the processes according to resources assigned to work contents. Thus it give quick information how the process are shared on different resources and their utilization.

To View the Resource View

You can open the Resource View by selecting the Resource View entry from the balancing menu **View** < **Bar Chart**. The Resource View opens and shows the processes according to the active resources.The view is a read-only view.

The Resource View provide information on workers and machines, called active resources. It present the processes according to resources assigned to work contents. Thus it give quick information how the process are shared on different resources and their utilization.

The labels below the Bar chart show useful information like utilization for the active resource.

- Active Resource Grouping: Resources are interacting, if they are assigned to the same station (they are working together in the same station). If one active resource is assigned to more than one station, all resources of all these stations are interacting. Resources, that do have interaction, are shown directly side by side. Between those groups of resources there is be a bold separating vertical line.
- Takt Time: Takt time is shown for each active resource and for each product variant. If an active resource is assigned to two stations of different takt time (e.g. to one single station and one of two parallel stations) the minimum takt time is taken into account for the active resource.

Cross Highlighting in the Resource View

When you selects a process in any view of the application, that process (if balanced) is highlighted in the Resource View. When you selects a process in balancing 2D view, active the context menu and select entry “Highlight

Process In All Windows, that process (if balanced) is highlighted in the Resource View and balancing 2D view.

Note

The cross highlight functionality is triggered in different ways in views that support drag and drop and views that do not support it. That is because of the automated scrolling in other windows that is done when cross highlight is triggered. In the Resource View and BarChart drag and drop is not possible. Due to this cross highlight is triggered by clicking on a process. In other views cross highlighting has to be triggered over the context menu entry "Highlight Process In All Windows".

7.6.6 Variant Matrix: Load Processes for Product Variants

1) The planning mode can be set over a variable named "isvm" of type *balancing* in E5-Configuration. There are two planning modes available:

- *isvm* = false or not defined: Represents the old planning mode with workplans. (Default)
- *isvm* = true: Represents the new planning mode with variant matrices.

2) Open project library with calculation models defined or create new calculation models with unique Model Numbers/Identifiers.

3) Assign calculation models to workplan.

4) Open variant matrix and on the workplan and select processes that should be weighted by the calculation models.

5) Create a new line and start ALB on it.

6) Select workplan with assigned calculation models.

7) Configure balancing. Save generated balancing and click **View** < **precedence graph**.

8) Select the calculation models. All calculation models that are shown in variant matrix are loaded as product variants.

To Add a Product Variant

1) Open the ALB

2) Create calculation models.

3) Assign calculation models to workplan.

4) Open variant matrix and on the workplan and select processes that should be weighted by the calculation models.

5) Open saved balancing and Click **Balancing** < **Product Variant** < **Add Product Variant**. The **Load product Variant** dialog appears.

6) Select a product variant and click **OK.**

7) Click **OK** in the **Product Variant Properties** dialog. The product variant is loaded in the existing balancing.

To Remove a Product Variant

1) Open Balanicng and click **View** < **precedence graph**.

2) Select the product variant and click **Balancing** < **Product Variant** < **Remove Product Variant**.

3) Click **Remove** in the **Remove Product Variant** dialog.
The product variant is removed from the existing balancing.

To switch from variant matrix planning mode to work plan planning mode

1) Set planning mode to Workplans (delete **isvm** attribute from Balancing Type).

2) Open existing balancing (planning mode “Use variant matrix”).

3) Create a new balancing based on a work plan.
The existing balancing could not be opened because no product variant is available.

7.6.7 Variant Matrix: Honor Process Sequence

The order of processes (sorted process also) is correctly transferred to ALB from DPE. The processes can be sorted according to their order in the variant matrix. The attribute for the sorting order can be configured in the **ALB Customization** dialog. The default attribute is *sortindex*.

When selecting processes (single selection or multiple selection) the sum of the process times is displayed in the status bar of that view. By selecting the first process and the using Shift+Cursor-Down keys, you can select processes that fit into the takt time. You can do a drag and drop of the selected processes in the first workplace. You can repeat the selection procedure and balance the processes to the second workplace. You can continue until all processes are balanced.

The process behaviour applies to all three modes of the process list: All Processes, Balanced Processes, Unbalanced Processes. However, the intended workflow only makes use of the list of unbalanced processes.

- When no process is selected in the process list, the overall sums are shown in the status bar of that view.
- When at least one process is selected in the process list, the sum of the selected processes is shown in the status bar of that view.
- A double click on any of the column headers in the process list sorts the respective column.
- A second double click on the same column sort the list in the reverse order.

7.7 Planning of Material Supply Area

A process can be assigned assembly parts. During the balancing process, the material planning module calculates the required space for the material supply area.

Automatic Line Balancing first checks which charge carrier has been assigned the part. The second step is to check the number of parts contained in that

charge carrier. In the third step, the bin size, the maximum stack and line up heights are then determined and transferred to the **Material Supply Area** dialog. *Please refer to the* Figure 143.

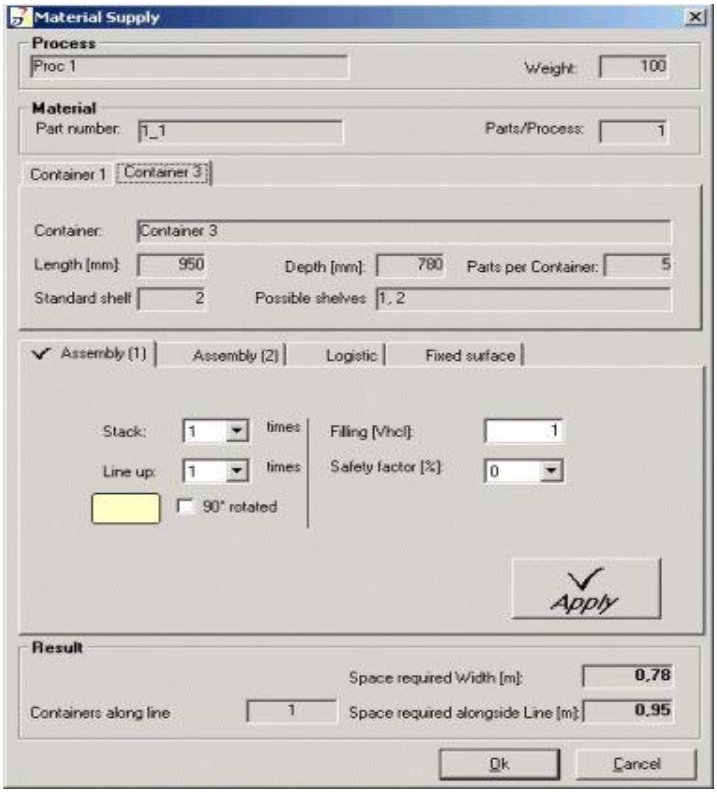


Figure 143: Material Supply Dialog

7.7.1 Determining Required Space

After specification of the arrangement and number of bins in the **Material Supply** dialog, Automatic Line Balancing determines the required space along the assembly line. Only values not exceeding the length of a station are accepted. The required space represents the return value of the material planning module as an attribute of the assembly process.

7.7.2 Creating Logistics Data

Every customer should be able to get a customized product. The variety of colors from which customers can choose for the variants, however, makes it necessary for logistics planning to focus on actual needs.

Identical parts for the same product can be used and planned in various colors, for example, if one customer wants a black steering wheel, and another customer wants a gray steering wheel in the vehicle.

This requirement is planned in the logistics data. The parts and bins are supplied on the line according to the planned color variants. Using the logistics data Automatic Line Balancing determines the number of bins and the space required on the material supply area. The bins marked using the logistics data are displayed in yellow in the balancing process.

The logistics data can be enabled only if both attributes for the **color code** and the **bin principle** are enabled in the configuration. Both attributes are generated on relations:

- **Attribute color code**: color code
- **Attribute bin principle**: bin principle

Set the logistics data for material planning in the properties dialog of the relation that links the part to the bin. To enter logistics data, the part must have first been linked with a parts bin, only then are the attributes for logistics data available.

After linking the part with a parts bin, open the dialog to the relation. Enter the logistics data on the appropriate page, in Figure 144 it is the **ALB Logistics** page. *Please refer to the* Figure 144.

The standard relations are generated according to the following schema. *Please refer to the* Figure 190.

1) Select a process from the PPR Navigator Process View. All linked part bins are displayed in the list view under the tab **Product is supplied by resource**.

2) Open the properties dialog by double clicking on the line for the part bins (in the example, the line for bins).

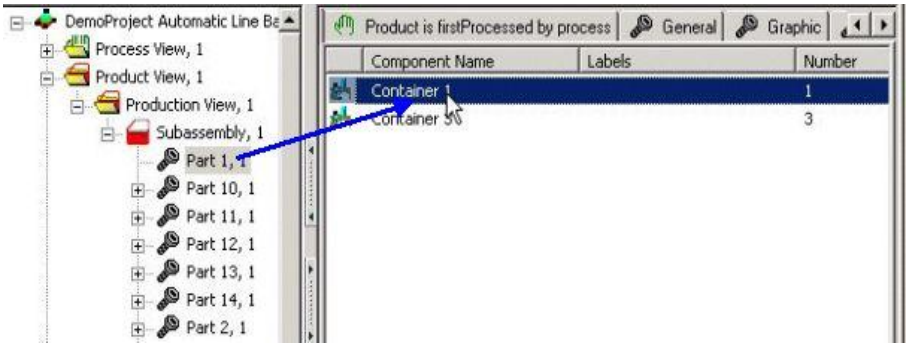


Figure 144: Open the Properties Dialog via Relation - Logistics Data

3) Enter the logistics data accessed in material planning in the properties dialog.

4) The tab which contains the fields for logistics planning can be freely configured. We consider it sensible to set up a separate page for the logistics data in order to ensure a unique allocation of data.

For more information *please refer to the* Administration Manual.

5) Click tab for logistics data, in the example the tab **logistics planning** and enter the data in the fields.

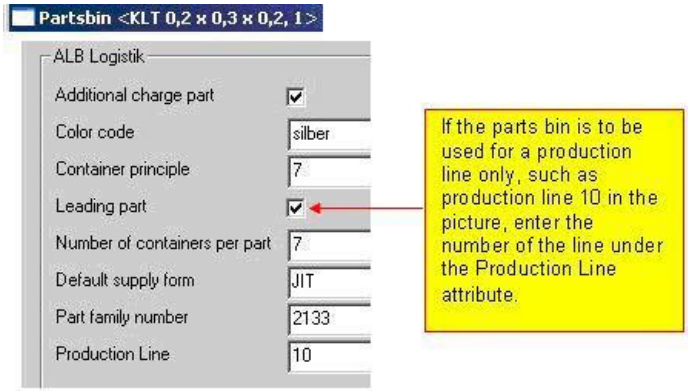


Figure 145: Properties Dialog of the Relation – Logistics Data

7.7.3 Planning the Logistics Data

The relation **Part-part bins** determines the demand for parts and part bins. *Please refer to the* Figure 145.

Note

The logistics data must always be supplied for the balancing product, i.e. these data are then processed in the balancing process itself.

If you make changes to the logistics data, you will always be asked whether the material planning should be executed according to the changed logitics data when opening the balancing process.

To Plan the Logistics Data

1) If you confirm the message with **Yes**, the material planning will be executed according to the changed logistics data.

2) If you confirm the message with **No**, the material planning will be executed according to the calculation mode previously set in the material supply dialog.

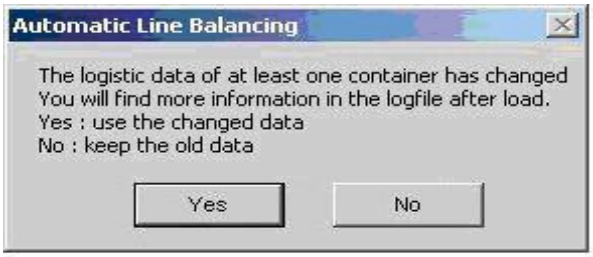


Figure 146: Execute Calculation according to the Changed Logistics Data

3) Enable **Additional Charge Part** field only if product variants for this relation (process, part, and bins) are already in the plan.

Planning Additional Parts

A part is called an additional part if variants of this part are not unlocked in the plan or material requirements planning.

By activating **Additional Charge Part** field you can supply the currently planned additional part with the information that variants are available for this part in the planning. The prospective demand for parts bins for the additional parts is taken into account and planned in the balancing process via the part labeled as an additional part.

These additional parts are considered product variants (in the Figure 147, **Variants A to D**); they are available as constructive variants, but they have not been unlocked for requirements planning.

This marking as an additional part is used exclusively for information purposes, indicating that the currently planned part can be replaced by the variants at a later point in time.

The number of parts bins unlocked for the part in the properties dialog of the relation is planned in the balancing process. When the variants marked as additional parts are unlocked for planning, the parts bins are planned using the defaults of the individual variants, which as a rule replace the currently planned parts bin requirement via the additional part.

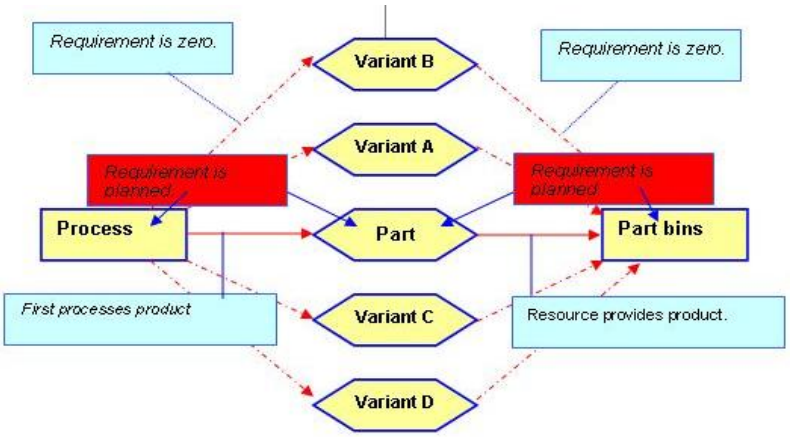


Figure 147: Requirements Planning for Allowance Parts Schema

4) Enable Leading Part field to mark this product variant as the lead part.

Leading part ☑

Planning the Lead Part

If you enable **Leading Part** field, this product variant is marked as the lead part. The number of part bins and the required space is determined for this product variant.

Enable this field only if the part bins are to be supplied on the line according to the type of delivery **just in sequence (JIS)**. Several product variants are supplied in **one** part bin on the line in this type of delivery (JIS).

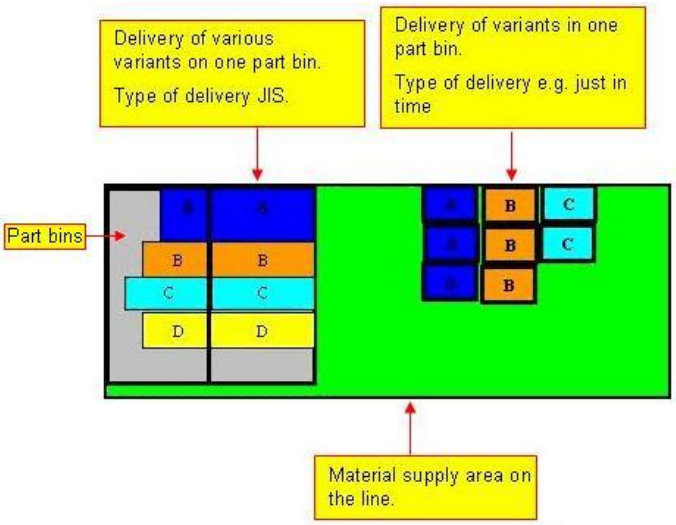


Figure 148: Schema for Type of Delivery Just in Sequence

5) Enter the type of delivery in **Default supply form**.

Default supply form JIT

Standard Type of Delivery

This field is used for information about the principle guiding the supply of parts (product variants) on the line. Input in this field is not necessarily required, and you can spell the delivery type. For example, **JIT** could stand for the type of delivery just in time.

Part family number 2133

6) Enter the planning part families in **Part family number**.

Planning Parts Families

Set the parts family for the part in this field.

7) Enter the planning color code in **Color Code**.

Color code silber

Planning Color Code

Set the color for the part in this field.

8) Enter the number of bins for parts in **Number of containers per part**.

Planning the Number of Bins for Parts

Set the number of part bins required for this color variant of the part in this field.

Number of containers per part 7

Container principle 7

9) Enter the part bins in **Container principle**.

Planning the Bin Principle

Set how many part bins are sequentially supplied for a product variant on the material supply area with the bin principle. When the required surface area is being determined, started sequences of a product variant are not filled with other part bins of a different product variant. *Please refer to the* Figure 145.

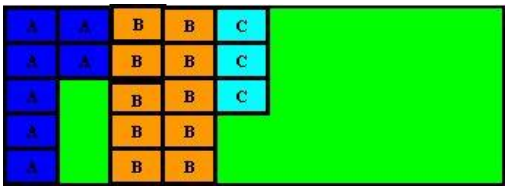


Figure 149: Planning Bin Principle Schema

7.7.4 Editing the Material Supply Dialog

As an alternative to the material supply area determined as previously described, the material supply area can be edited manually in the material supply area dialog in the balancing process.

You can further optimize the material supply by varying the physical arrangement of bins. Variation is achieved by stacking, lining up or rotating.

The required surface area is determined on the basis of the available data in the first calculation of the balancing process:

- The required space for part bins for which **no** logistics data are available is determined on the basis of a fixed defined area.
- The required space for part bins for which logistics data are available is determined on the basis of the defined logistics data.

The Four Calculation Modes:

Four calculation modes for calculating the required surface area in the balancing process are available in the material supply dialog. Only one of the four calculation modes can be used at any one time.

Assembly (1)

- The procedures for stacking and lining up bins can be found in the chapter: Executing Calculation according to Assembly (1)

- Planning the required surface area according to the bin principle: *Please refer to the*: Executing Calculation according to Assembly (2)

- Planning the required surface area with logistics data: *Please refer to the*: Execute Calculation according to Logistics Data

- Planning the required surface area for a fixed surface: *Please refer to the* Executing Calculation according to a Fixed Surface

7.7.4.1 Opening the Material Supply Dialog

There are several ways to open the material supply dialog:

Double Clicking on the Part Bin

- The quickest way to open the dialog is directly via the part bin.

1) Either double click or use the context menu.

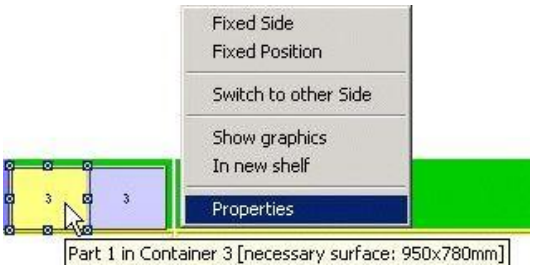


Figure 150: Opening the Material Supply Dialog – Directly on the Part Bin

Via the Shelf Properties Dialog

- It is somewhat more difficult if the part bins have been placed in a shelf.

2) First open the properties dialog of the respective shelf. Either double click in the shelf or use the context menu.

Figure 151: Opening the Dialog for Shelf

3) All part bins placed in the shelf are displayed in the dialog.

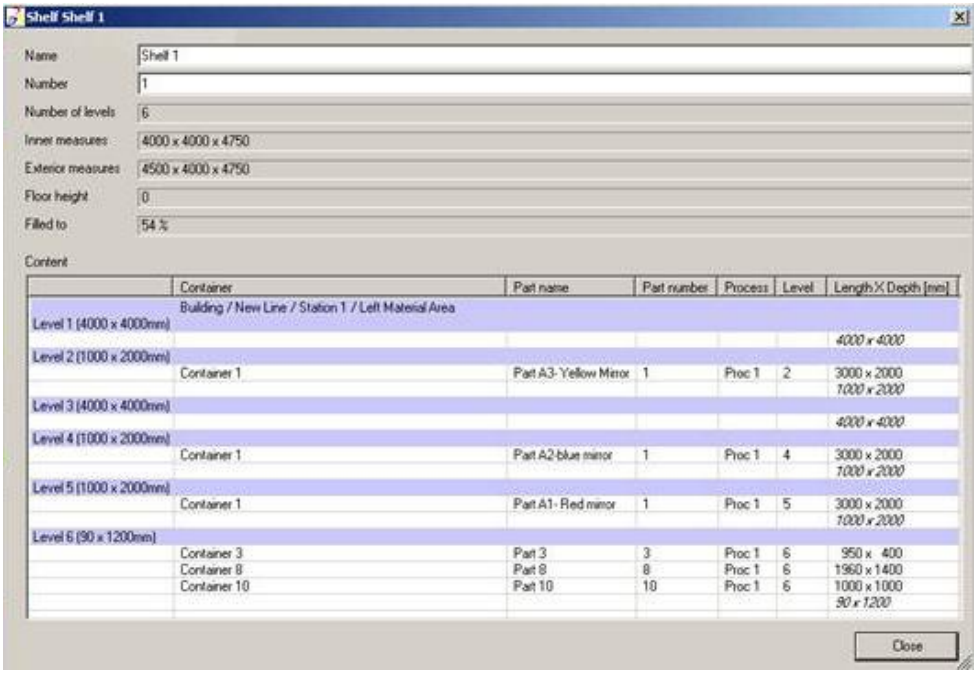


Figure 152: Shelf Properties Dialog

4) Open the material supply dialog either by double clicking or by using the context menu (properties) of the selected part. *Part 1* in the example.

Via the Shelf Properties Process

5) Double-click the process in the Automatic Balancing view. The Properties dialog will be opened.

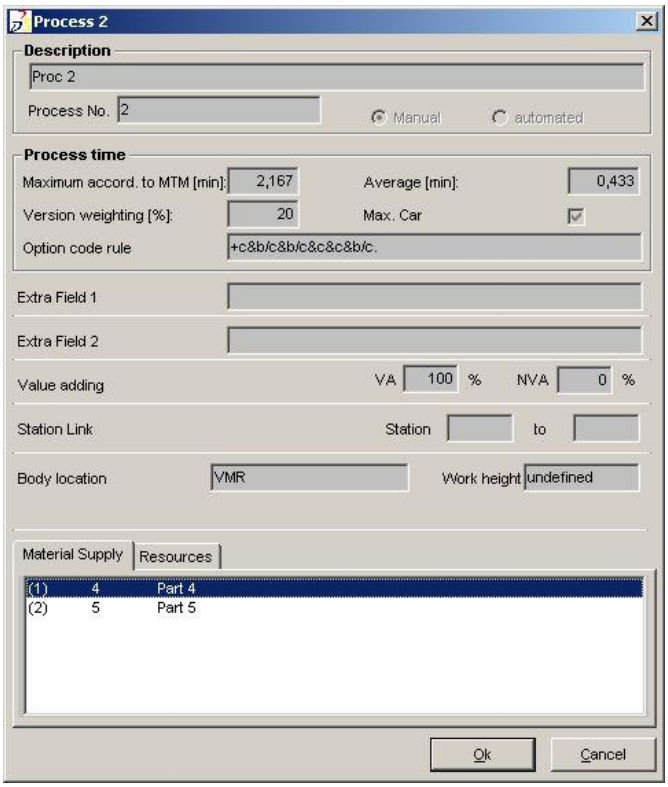


Figure 153: Opening Material Supply - Process Dialog

1) Then click Material supply in the dialog.

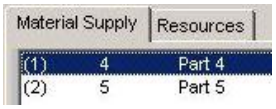


Figure 154: Material Supply Button

2) Double-click the material line in the window. The Material Supply dialog will be opened for editing. *Please refer to the* Figure 154.

7.7.4.2 Material Supply Dialog

The properties dialog is divided into two main areas:

- In the display area showing the data of the relation (process, part, part bins).
- In the calculation mode with the results display, in which the four calculation modes can be selected, to optimize the required surface area manually.

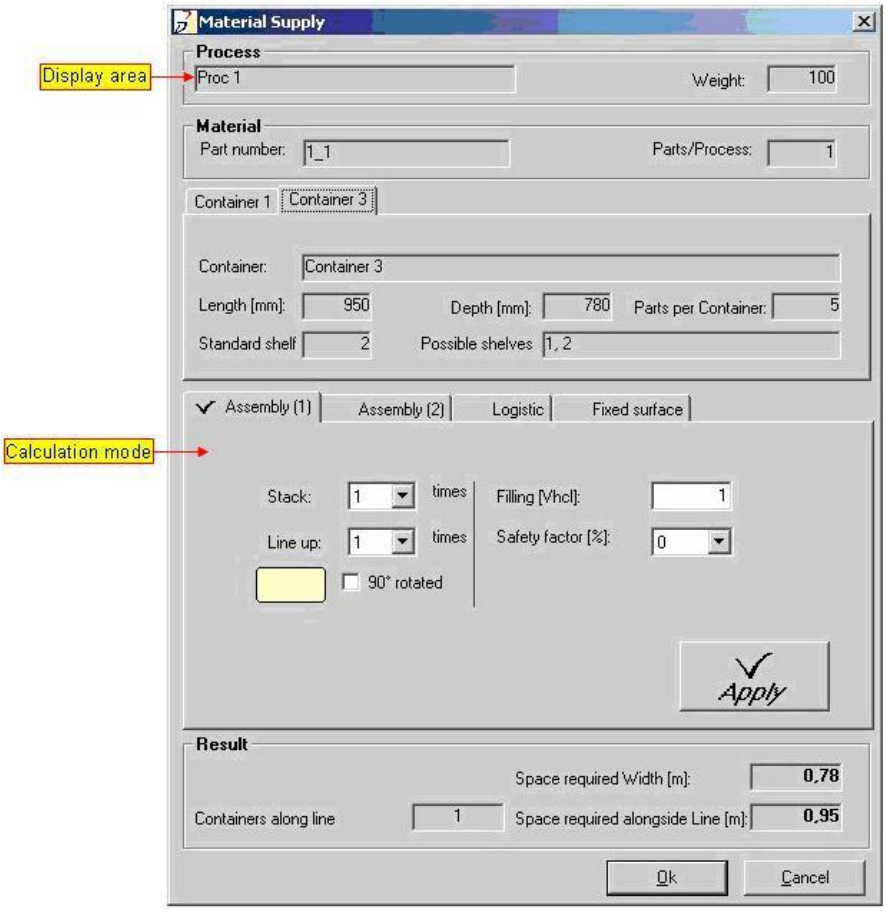


Figure 155: Material Supply Properties Dialog

Display Area in the Material Supply Dialog

The essential data of the relation are always shown in the display area of the dialog.

- The line for the **process** contains the process number and the weight with which the process is planned.
- The line for the **material** contains the part number of the respective part as well as **how many** parts of a variant are to be produced in the process. *Please refer to the* Planning the Parts Demand for Processes.

- The part bins are displayed if logistics data are planned. The data for the standard shelf and the possible shelves in which the part bins can be placed are displayed along with the dimensions.

1) Click button for the part bins to see the display for the part bins.
2) If several part bins are assigned, you have to press this button for every one of the four possible calculation modes to display the result for the respective part bin.

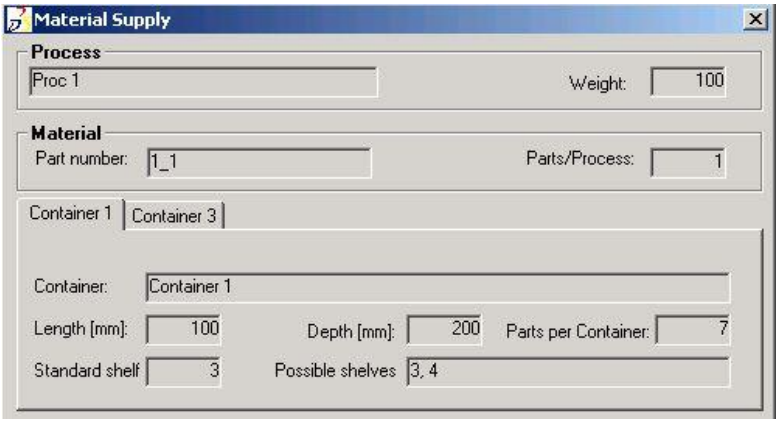


Figure 156: Display Area of Material Supply Properties Dialog

The Calculation Mode in the Material Supply Dialog

The four possible calculation types with which the surface area required in the balancing process can be determined are available in calculation mode.

Note

*You can only use **one** of the four calculation modes for calculating the material supply area.*

1) Set a calculation mode by clicking on one of the four tabs.
2) Click **Apply to** enable the calculation mode.
3) The ascertained values displayed in the results area.
4) Click **OK**, to enable the settings, and the required surface area is updated in the 2D view.

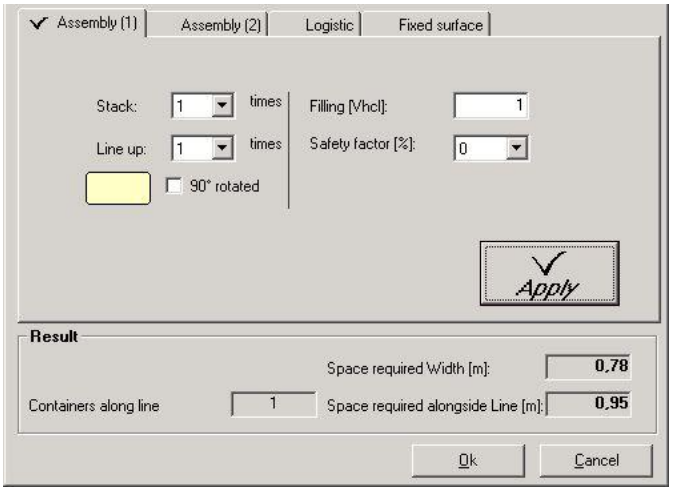
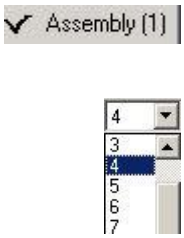


Figure 157: Calculation Mode in the Material Supply Properties Dialog

- The four calculation modes are described in the following chapters.

7.7.4.3 Executing Calculation according to Assembly (1)



With the calculation mode marked *Assembly (1)* you can set whether the part bins are:

Stacked, Lined up, Rotated by 90°, Placed with filling level and safety factor. *Please refer to the* Figure 157.

Stacking and Lining Up Part Bins

- Set the respective number via the selection list.

Figure 158: Stacking and Lining Up Part Bins

Stacking

Set whether the bins are to be stacked on the material supply area, i.e. how many bins should be placed on top of each other, with **Stack**.

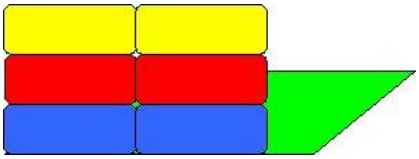


Figure 159: Stack Bins Schema

Lining Up

With **line up** you can set how many part bins can be lined up behind one another in a row.

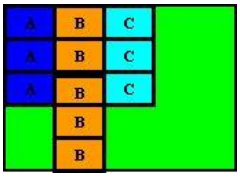


Figure 160: Line-Up of Bins Schema

Rotated by 90°

Enable this field to rotate the part bin by 90°.

Figure 161: Rotate Part Bin by 90°

Filling and Safety Factor

Filling Interval

In the Filling field (Vhcl) you specify the number of assembly cycles that need to be completed before bringing a new bin to the line. Using this interval (delivery and pickup of bins) the number of parts to be supplied is also optimized in the bins. The safety factor can be said to have a buffer function for problems that might occur during the delivery of parts. These parameters for the safety factor are normally set by the logistics department of a company per default and checked permanently.

Figure 162: Setting Filling

In the Filling field, enter the number of vehicles for which the material supply is to be calculated. The **Automatic Line Balancing** then calculates the number of bins on this basis. The safety factor is an allowance. Experience may be considered here.

7.7.4.4 Planning the Parts Demand for Processes

In ALB, there are two possible ways to enter the parts required for a process:

- Enter an amount in the properties dialog (reference model) of a part, by opening the relation between a process and a product,
- Or just link the same part, according to the amount needed, individually with a process **(structural model**). A further demand entry is not required. ALB determines the demand for parts (piece count of one per part) according to the amount of parts that are linked with a process.

Please set up the method you have chosen for planning in the demand, in the Settings dialog which can be found under the menu *Extra* < *Options*.

2) If you activate the **Calculate the number of parts by the number of part relations at a process** option, all identical parts must be linked individually with a process - structural model.

3) By deactivating the **Calculate the number of parts by the number of part relations at a process** option, all parts can be linked with a process at the same time – reference model.

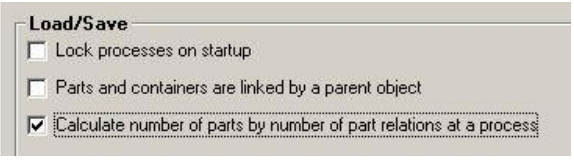


Figure 163: Choosing the Type of Link

7.7.4.5 Planning the Parts Demand in the Properties Dialog - Reference Model

If you base your planning of parts on the reference model, the same part will only have to be linked with the process once. The required parts needed for a process, can be entered in the properties dialog.

1) To enter the parts needed for a process, you must always open the properties dialog of the process on the relation. This is the only method that will enable you to enter the parts demand in the properties dialog.

Figure 164: Opening the Properties Dialog at the Relation

2) In the properties dialog, under the *ALB* tab, enter the demand in the field **quantity** – in the example 10 parts are to be used in this process.

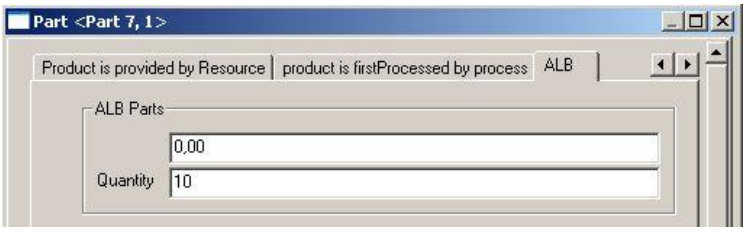


Figure 165: Entering the Parts Demand

3) Open the Material Supply dialog in the job view of the process. The demand is displayed in **Parts/Process** and is used in the balancing process.

Figure 166: Parts Demand in the Material Supply Dialog

7.7.4.6 Executing Calculation according to Assembly (2)

With the calculation mode marked **Assembly** *(2)* you can set whether the part bins are placed according to

- The bin principle
- Number of bins per part
- Rotation by 90 Grad

For a description of the bin principle and number of bins per part, *Please refer to the* Figure 149. For a description of rotated by 90° *Please refer to the* Figure 161.

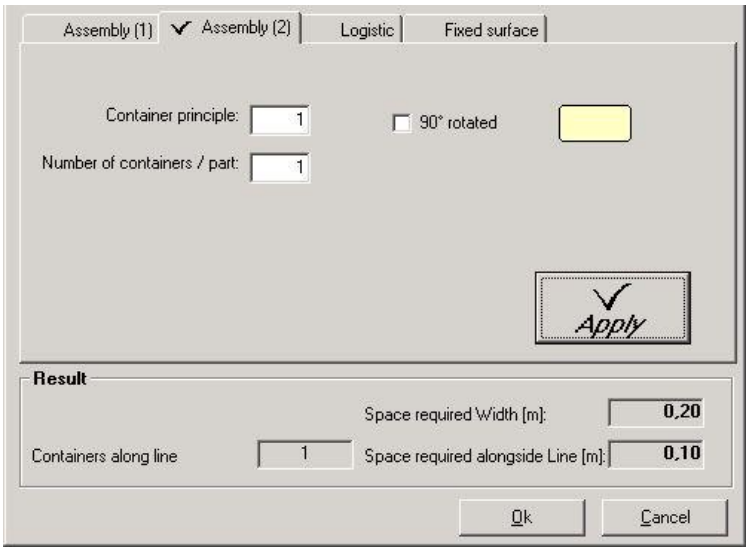


Figure 167: Assembly Calculation Type (2)

7.7.4.7 Execute Calculation according to Logistics Data

The calculation mode according to logistics data can be executed only if you have generated the relation logistics data in the properties dialog. *Please refer to the* Creating Logistics Data.

1) The result is always displayed for the selected part bins.

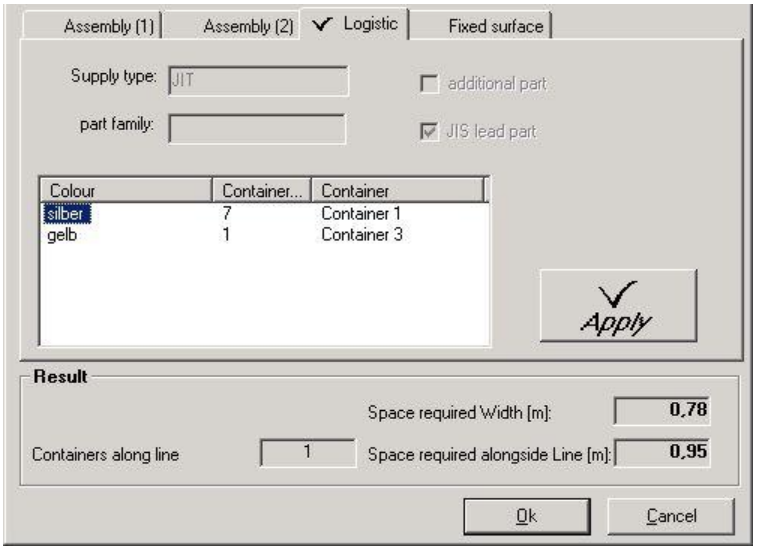


Figure 168: Logistics Calculation Mode

7.7.4.8 Executing Calculation according to a Fixed Surface

The calculation mode for a fixed surface can be determined, for example, to display the required surface area for a special conveyor device or a pre-assembly set up in the material supply area. If charge carrier data are not yet known in particular parts or if it seems too complex to enter them exactly, you can also make use of this generalization to reserve space in the material supply area. *Please refer to the* Figure 251.

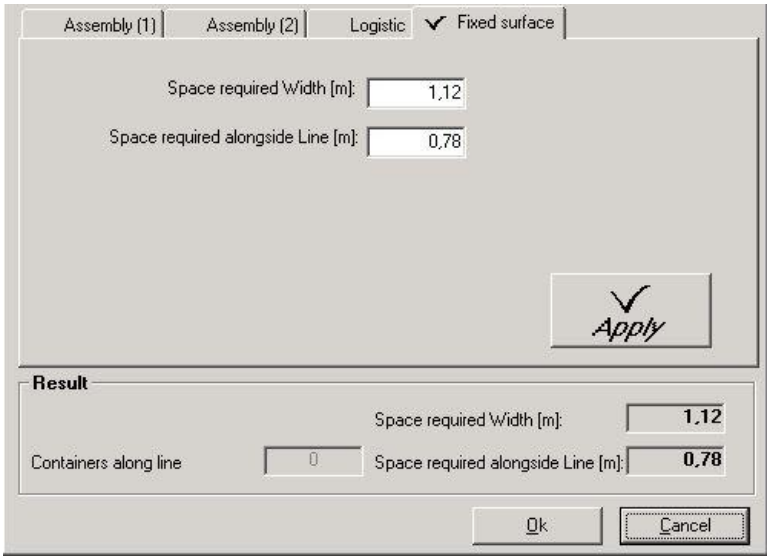


Figure 169: Calculation Mode for Fixed Surfaces

7.7.5 Displaying Operating Equipment

1) Click the **Operating Equipment** button in the Process Properties dialog to display assigned operating equipment. *Please refer to the* Figure 170.

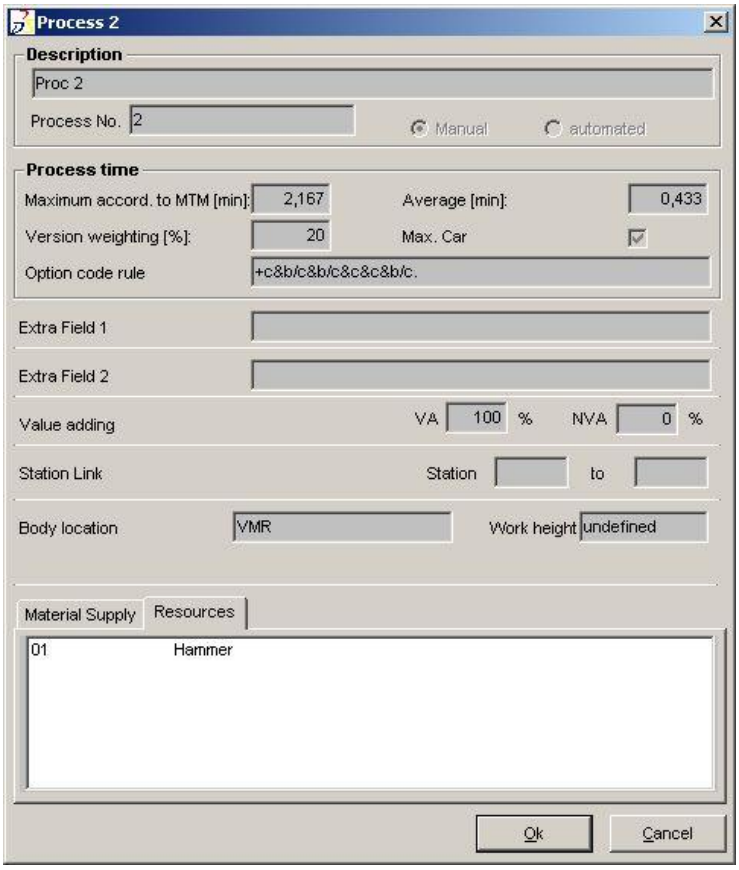


Figure 170: Displaying Operating Equipment

7.8 Planning the Parts bins and Processes for Production Lines

If processes and parts bins should be planned in for use with particular production lines exclusively, each should be marked accordingly. A process graph (which is the basis for the balancing of processes) must be created for each production line, in order to makes the planning of the material supply possible.

This requires that the relevant preparatory measures be taken in the Process Engineer, before the balancing of a production line in ALB.

Preparatory Measures in the Process Engineer

The planning of a process is made possible with the aid of a process graph. This graph includes the full sum of processes and variants needed to produce the final product. So these process graphs can include processes that are used exclusively for a single production line, as well as processes that are independent of any particular production line and can be used with a variety of different production lines.

The planning for the parts bin, which is also used for particular production lines, runs parallel to this planning method.

The planning process for the parts bin is carried out by linking processes with products, and the products in turn with the appropriate parts bin.

The processes and parts bin are marked using the **Production line** attribute.

The **Production Line** attribute in the properties dialog must be displayed according to the parts bin and processes.

For more information on how to create user defined attributes, *please refer to the* Administration Manual.

The creating of process graphs, the linking between process, products and parts bins and finally, marking via the **Production Line** attribute, are all measures to be taken before the balancing process.

7.8.1 Production Line Attributes in Processes

The attribute for the production line (*Production Line*) must be displayed in the properties dialog of a process:

If you enter the production line in the properties dialog of a process, this process will only be used in that production line (only be planned in this process graph). The string value of your choice can be selected as the value for the production line - for example the value 10 in the example.

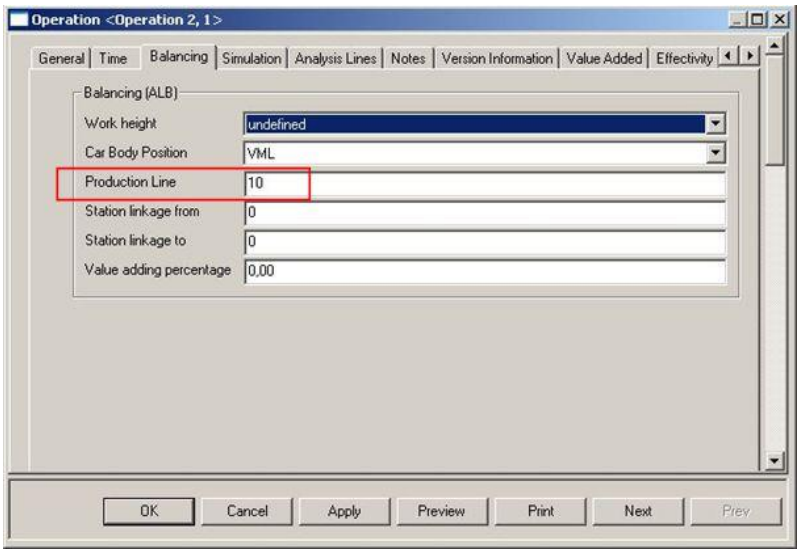


Figure 171: Production Line Attributes in Processes

7.8.2 Production Line Attributes in Part Bins

To enter logistics data for a parts bin, one must open the properties dialog by way of the relation between the Part and Parts bin.

In other words, the part must be linked with a parts bin in order to enter logistics data. The logistics data page is only available when for one, the link has been made, and second the properties dialog is opened by way of the relation. Just as with processes, you are free to choose the string value for the production line – in the example the value 10.

After linking, open the properties dialog by way of the relation. Enter the logistics data on the appropriate page, in the picture it is the **ALB Logistic** page. *Please refer to the* Creating Logistics Data.

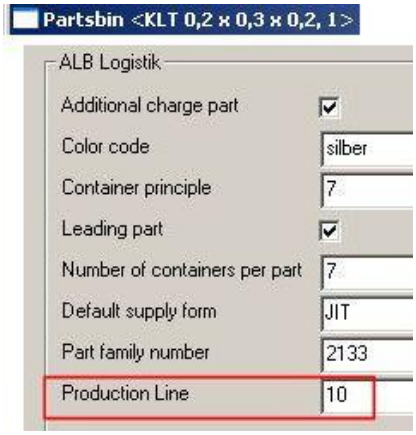


Figure 172: Production Line Attribute for a Parts Bin

7.8.3 Material Supply for a Marked Parts Bin

Once again, the making of process graphs, the marking of processes and parts bins with the aid of the **Production Line** attribute, and the linking of the process with the parts bin and parts, are all preparatory measures for the balancing process.

To plan a product line with all variants included, it is advisable to develop a process graph which is valid for the entire product line. This will enable you to create a second process graph which is only valid for a single production line from the first. This production line is only used for balancing processes which are used in specific variants.

The following scheme shows the planning for parts delivery, using a process graph for a specific production line. *Please refer to the* Determining the Material Supply.

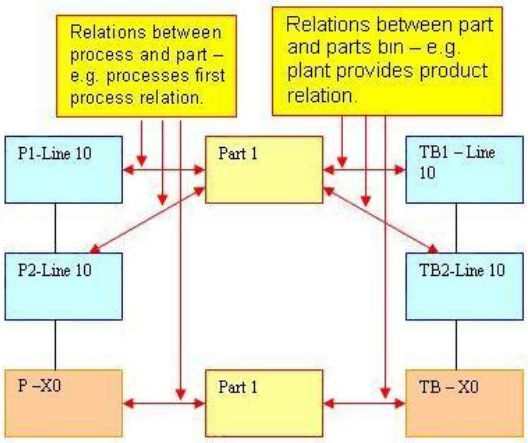


Figure 173: Scheme – Material Supply for a Production Line

7.8.3.1 Legend

P = process

Line = process and parts bin which are marked with the Production Line attribute – e. g. P1- Line 10 or TB1 – Line 10

Part = supply of parts that are in parts bins on the production line – e. g. Part 1

TB = parts bins carrying the parts to be delivered to the production line – e. g. TB1

X0= these are unmarked processes and parts bins, which are not fixed to a particular production line – e. g. P – X0 and TB – X0

7.8.4 Determining the Material Supply

The scheme shows how the material supply is to be planned, for the production line 10 in the example. The process graph that is laid down as a basis for the balancing process of the production line 10 can only contain processes which are unmarked or have been marked for line 10, using the **Production Line attribute**. All other processes, to put it simple, are not welcome in these process graphs.

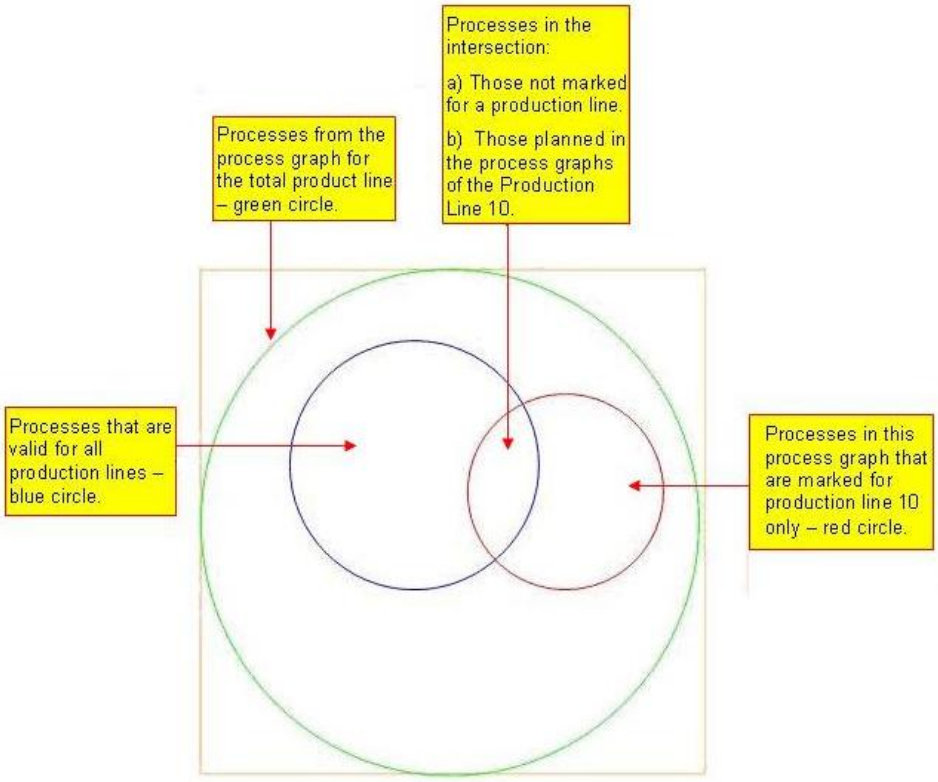


Figure 174: Intersection Scheme

7.8.4.1 Calculating the Part Bins

The parts bins are calculated using a simple mathematical method, as the Intersection scheme shows on the following page:

The basis for the calculation is created by the links between processes, parts and parts bins.

- All of the processes that are marked for line 10, and those found in the intersection are used for the calculation: Intersection based processes must be present in the process graph of the production line.
- The parts bins are determined via the links for processes to products. The parts bins being calculated are the ones marked for the production line 10 using the **Production Line** attribute. In addition to these, parts bins that have not been marked for a production line, but are still linked with processes that are planned in the process graph of the production line 10 are recognized – these processes are made up from the Intersection.
- The parts bins without markings are calculated out of the intersection. The intersection only contains processes which are not assigned to a

production line, but are still planned in the process graph of production line 10.

Note

Processes without markings can only be used with parts bins which are also unmarked.

From a practical standpoint this means: that when planning in processes which are valid for all production lines, you make sure that when the link is made between parts bins and products, that also parts bins without markings are planned in.

7.8.5 Rotate Part Bins by 90°

You can rotate the part bins by 90° in the Material Area and Station.

To Rotate part bins by 90° in the Material Area

1. Open ALB in a Line.
2. Right click left material area of station 1 in the ALB Balancing view.
3. Click **Rotate Part Bins by 90°** in the contextual menu.

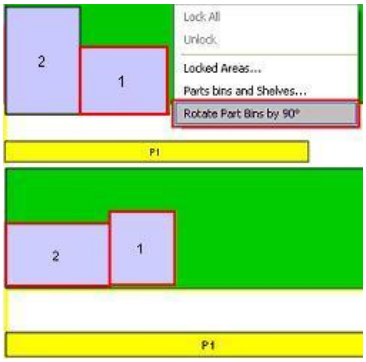


Figure 175: Rotate all the Part Bins in Material Area by 90°

To Rotate part bins by 90° in Station

4. Double click Station 1 to view the **Properties** dialog box.
5. Select option **Rotate all Part Bins by 90°**.

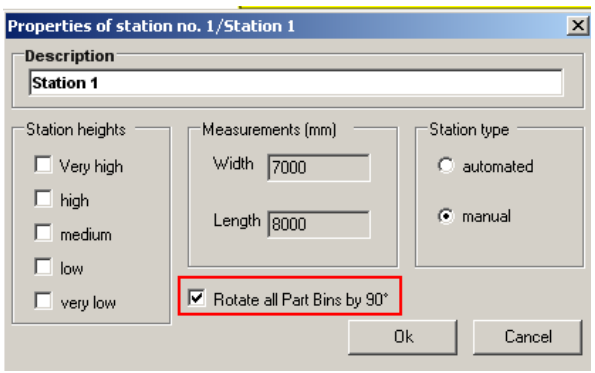


Figure 176: Rotate all the Part Bins in Station by 90°

7.9 Planning Shelves for Material Supply

Small parts which, for example, are processed on assembly lines are usually kept on the lines directly in the bins on the shelves. This reduces transit

distances between for example, central storage areas or suppliers. The small parts can, for example, be supplied for the individual work places on the shelves, sorted according to their variants, and the amount can be adapted to the demand.

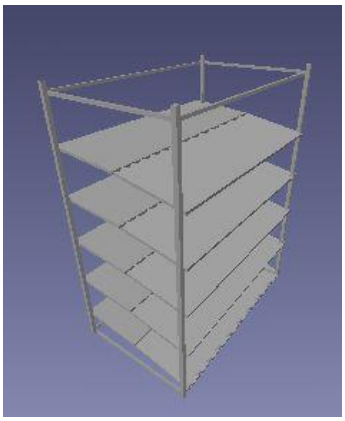


Figure 177: Planning Shelves

What is the objective of this? What goals are pursued in the balancing process?

- One of the many possible answers could be: to increase transparency and reduce false requirements.

In version PE 5.13 the shelf and loading unit requirement (for example. bins, boxes) for parts can be calculated in the balancing process.

7.9.1 Prerequisites for Planning Shelves and Loading Units

7.9.1.1 Creating Templates

The shelves are created in templates. You may be familiar with templates from word processing, for example. Templates are created in the plantype set you are using for the project in the system library. The template itself contains so-called shelf libraries to which the shelves are assigned. There is no limit to the number of shelf libraries which can be generated in a template.

The number of shelves is unlimited, and it should always be set to the respective number needed. The number of templates you can use is also unlimited.

Note

Self libraries are thus used to plan the corresponding shelves for the balancing process. If you generate only one shelf library, these shelves will automatically be used for the balancing process. If there are further shelf libraries available, you can select the corresponding shelf library in a dialog.

Example

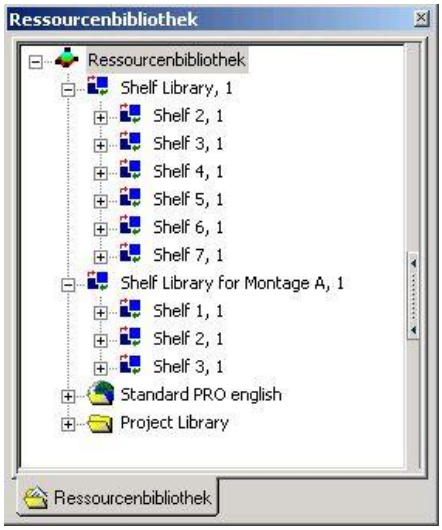


Figure 178: Example of a Template with Two Shelf Libraries

For more information *please refer to the* chapter *Generating templates* in the System Library Manual.

The dialog Load shelves is opened

- **Only** if you have generated **several** shelf libraries for shelves,
- Otherwise **always** in the first calculation of a balancing process,
- When opening a previously calculated balancing process, if you either execute a **new calculation** or manually place a **bin** into a new shelf.

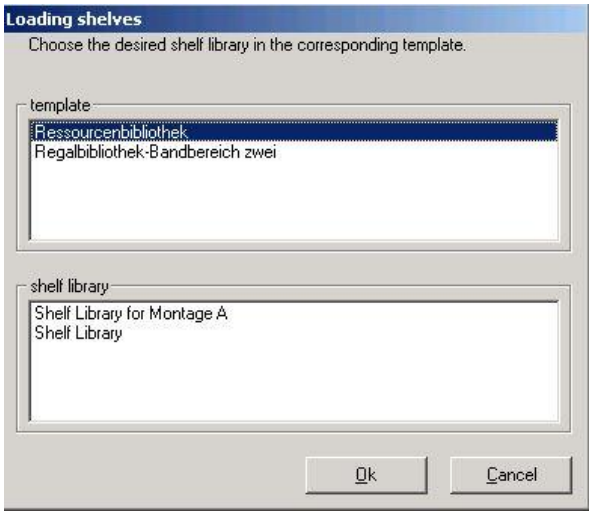


Figure 179: Select Shelf Library Dialog

Setting Properties

The shelf is specified in the properties dialog of the shelf. Apart from the data such as the name of the shelf, length, width and height, the shelf type is uniquely defined by two figures (number of shelf levels and standard shelf):

Number of Shelf Levels

Planning Number of Shelf Levels

Set the number of levels for the shelf in this field. You can freely select the number of levels. You must **always enter a number in this field**; otherwise the shelf cannot be planned.

Default Shelf

Setting the Standard Shelf

Set whether the shelf is defined as the standard shelf in this field. If you **do not enable** this field, the shelf is not taken into account in the automatic

calculation, and it can then be planned only in manual processing of the balancing process.

Note

*You can define only **one shelf** as the standard shelf per shelf level. If for example you generate several shelves with the same number of levels, the shelf which is required most often for material supply is defined as the standard shelf.*

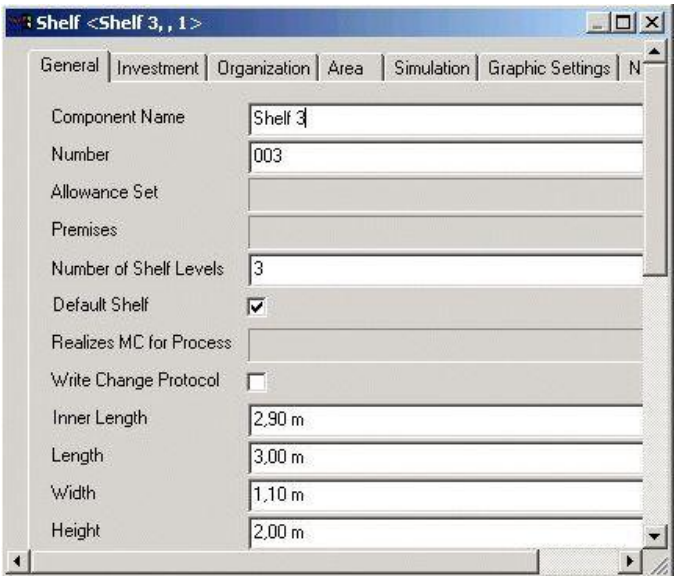


Figure 180: Example of Shelf Properties Dialog

7.9.2 Planning the Attributes for the Level Angle and Protrude

Starting with the PE 5.17 release the calculation for the shelf geometry has been extended by three attributes:

- Shelf level angle attribute
- Shelf level height attribute
- Shelf level protrude attribute

In earlier versions of DPE the shelf geometry was calculated using the outside measurements. The calculation was based on the values entered into the properties dialog of each shelf, namely length, width, height and interior length.

With the aid of a simple calculation method, the position for each individual shelf level could be determined: the shelf height divided by the amount of shelf levels equals the position of a shelf level. As long as zero is entered at the value for the new attributes, this method can continue to be used.

The three new attributes enable you to optimize the utilization of a shelf, by adjusting the shelf level to the geometry of different loading units.

- A shelf in ALB can have a maximum of six shelf levels. The shelf level angle, shelf level height, and shelf level protrude can be calculated for each shelf level.
- These attributes are configured by default. The value set for all 18 attributes is zero.

- To plan the level angle, shelf level height and the shelf protrude, at least one attribute is needed for each shelf.
- A maximum of 18 attributes are available for planning.
- The new attributes are only needed for calculations in which a value other than zero is entered. If only zero values are entered for the attributes, the shelf position is calculated using the original method.

7.9.2.1 Using Attributes for the Planning

You can enter the attribute values in the Shelf Library found in the properties dialog of the shelf.

To open the properties dialog of a shelf, you must first open the template that holds the Shelf Library, for example the picture shows, the **ALB Shelf Template**.

1) Open the Template directory via the System Library in the plantype set.
2) Select the **ALB Shelf Template** directory and open the context menu by right-clicking the mouse.
3) Select **Open Template As Project** in the context menu.

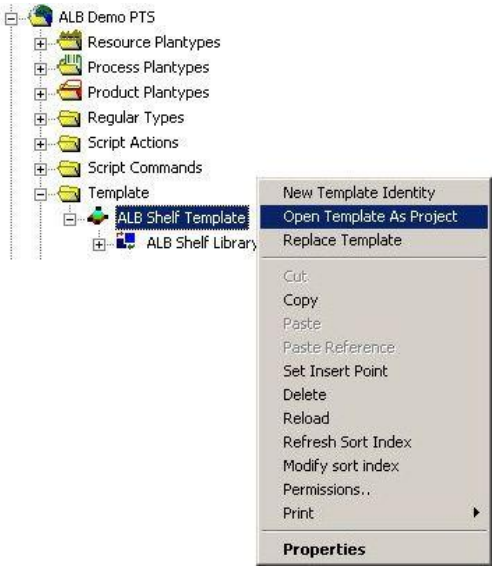


Figure 181: Open the Properties Dialog for the Shelf

4) Select the shelf from the shelf library in the open **ALB Shelf Template**.
5) Open the context menu by right-clicking the mouse and select Properties. You can enter the values for the attributes in the properties dialog.
6) Once you have saved the values, the shelf can now be used with these values in ALB.

Shelf Level Angle

The shelf level angle is always entered in degree. This angle enables you to plan the positioning for a shelf level – the angle can be entered as plus or minus values. *Please refer to the* Figure 182.

Shelf Level Height

The shelf level height can be entered in meters, centimeters or millimeters. The shelf level height is where the shelf level bottom edge and the inside wall of the shelf intersect, and is measured from the base of the bottom shelf level (zero level). *Please refer to the* Figure 182.

Shelf Level Protrude

The shelf level protrude can be entered in meters, centimeters or millimeters. The shelf level protrude enables the measuring of the distance of the end of the protruding shelf level to the shelf front. *Please refer to the* Figure 182.

The Geometrical Scheme for Attributes

The following scheme shows the geometrical position for measuring and calculation of the shelf level angle, level height, shelf level protrude, and width attributes.

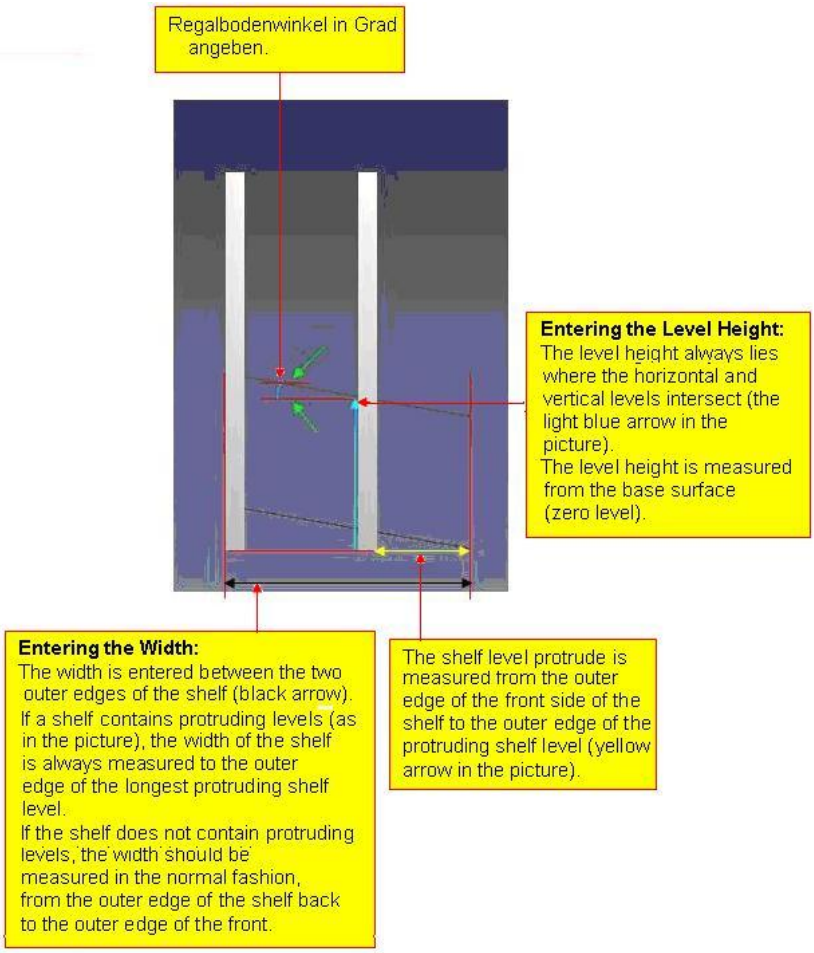


Figure 182: Scheme – New Attributes for the Dimensions of a Shelf

Shelf Length

The following scheme shows the dimensions for the length and inner length of a shelf. These values are added to the calculation and are entered in the properties dialog. *Please refer to the* Figure 180.

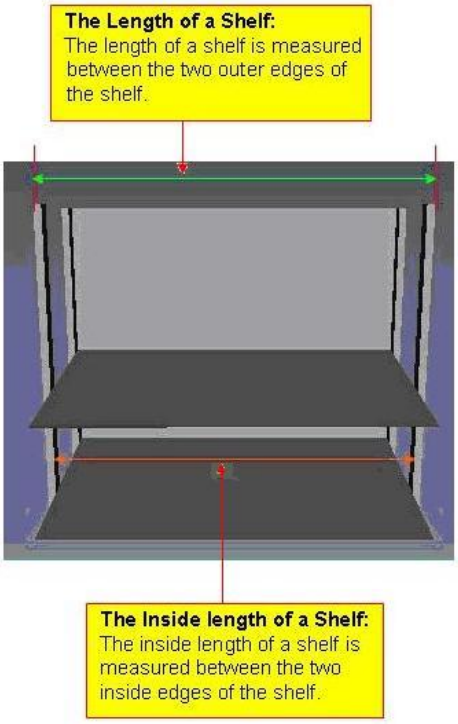


Figure 183: Scheme - Length and Inside length of a Shelf

7.9.2.2 Entering Values for Attributes

As was mentioned earlier, the values are entered via the properties dialog in to the shelf library of the shelf. The default setting zero is given for the values. The following examples show the possibilities for shelves. *Please refer to the* Figure 181.

Examples Using the Value Zero

The example shown here is a shelf with two shelf levels. The positioning for this shelf has been carried out using the old calculation method. All of the attributes hold the zero value.

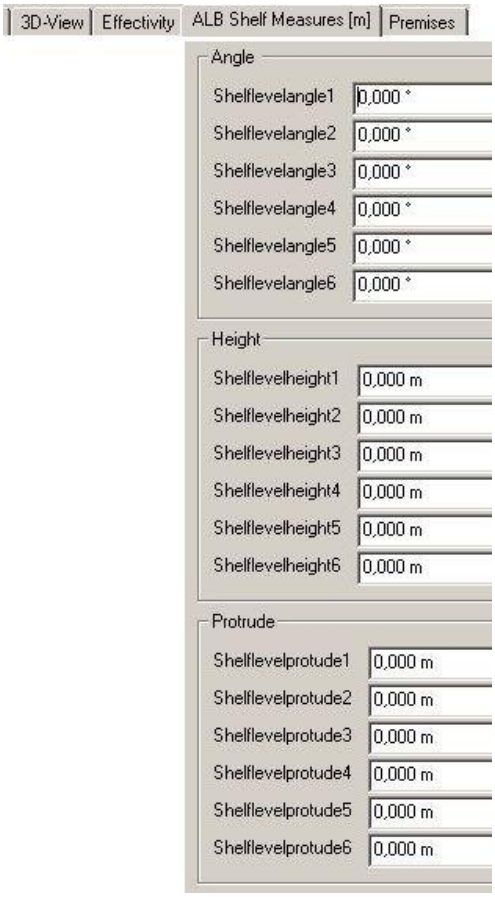


Figure 184: Values with a Zero Setting

The shelf level position is calculated using the old method: the shelf height divided by the number of shelf levels (two shelf levels in the example) equals the position for a shelf level.

The picture shows the result:

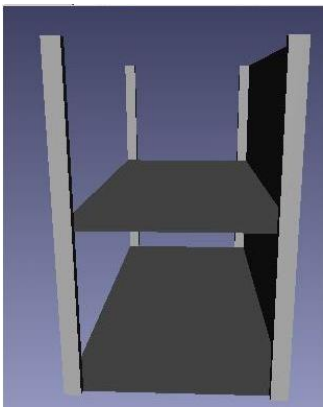


Figure 185: Calculating the Position of the Shelf Levels using the Zero Value

Example Using Attribute Values

In this example of a shelf with six shelf levels the values for the shelf level angle, shelf level height and shelf overhang are already set. The amount of attributes needed can be increased or decreased, depending on the amount of shelf levels.

The positioning for the shelf level in this example is calculated with the aid of the attribute values.

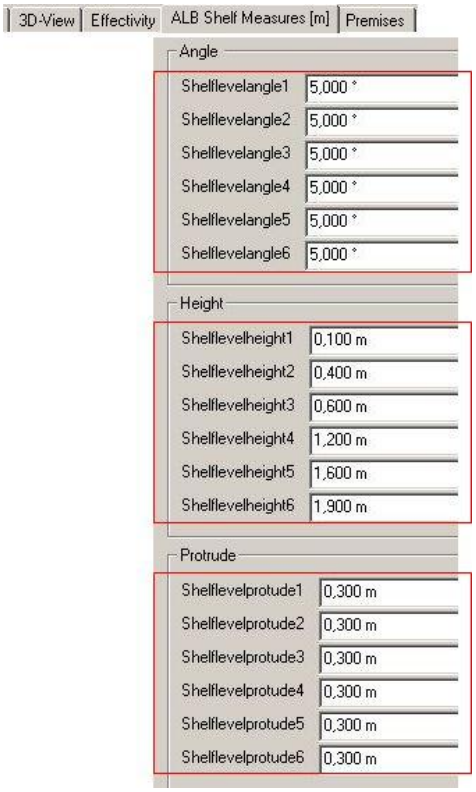


Figure 186: Values for the Attributes are Preset

The picture shows the result:

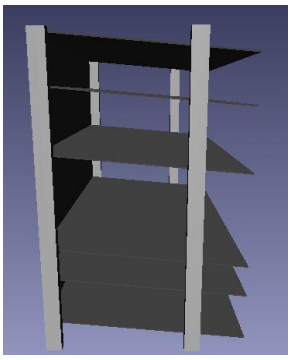


Figure 187: Shelf Levels that have been Calculated with the aid of Attribute Values

Example of a Negative Shelf Level Angle

To plan the shelf level with a negative shelf level angle, the planned angular measure of 360° must be reduced: In the example, a negative angle of five degrees has been planned for the **shelf level six**.

In the example **355°** is entered for the **Shelflevelangle 6** attribute. Depending on the planned negative angular measure, the value is reduced or increased – for minus ten degrees for example, 350° etc.

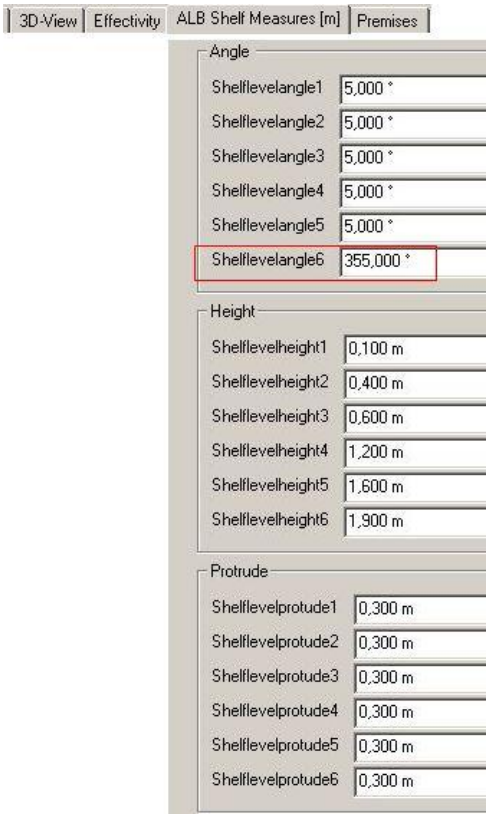


Figure 188: A Negative Shelf Level Angle

The picture shows the result:

Shelf level six – in the example the shelf level on top – has a negative angle.

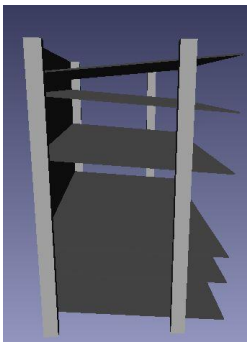


Figure 189: Picture containing a Negative Shelf Level

7.9.2.3 Planning Loading Units (bins) for Parts

Structures (process, resource and product structures) for the balancing process are shown in the PPR Navigator. The structure for the loading units is generated in the PPR Navigator in the resource structure.

In order to make it possible for the loading units (bins) to be planned in the balancing process, the loading units are linked to parts (**relation resource supplies product**). The parts are also linked to the processes (**relation first processes product**) which are supplied in the loading units on the line.

In this way it comes full circle:

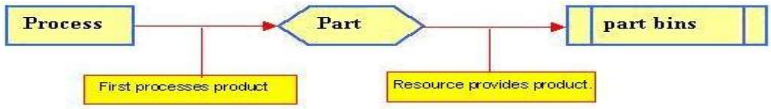


Figure 190: Linking Process, Part, and Loading Unit Schema

- The stations are determined via the process structure in the balancing process.
- All data for optimally planning shelves and loading units for the parts supply are available via the link between the processes and products (parts), which in turn are linked to the resource structure of the loading unit.

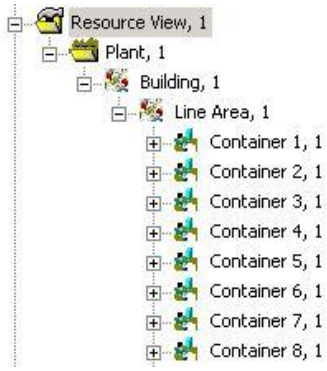


Figure 191: Example of a Resource Structure for Loading Units

For more information, *please refer to the* PPR Navigator Manual.

Setting Properties

The loading unit is specified in the properties dialog of a loading unit. Apart from the data such as the name of the loading unit, length, width and height, the type of loading unit is uniquely defined by two figures (possible shelves and standard shelf).

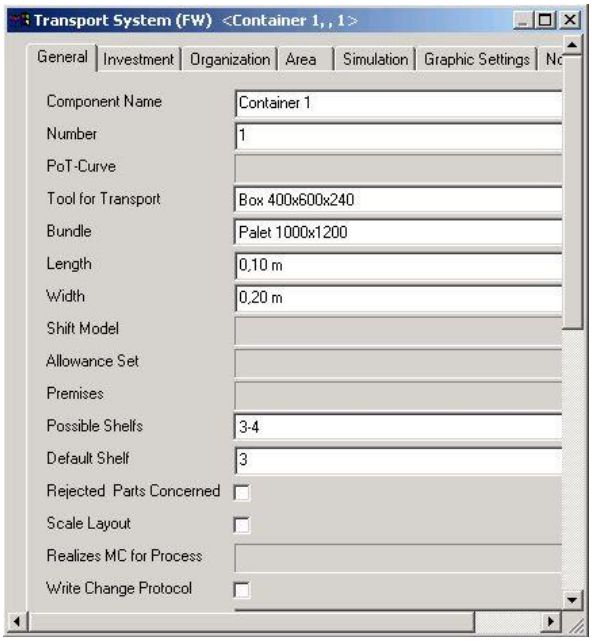


Figure 192: Example of Loading Unit Properties Dialog (bin)

Possible Shelfs

Setting Possible Shelves

Note

The selection of the possible shelf levels must be set in advance in the configuration.

In order to configure the possible shelf levels, Please refer to the chapter Configuring Automatic Line Balancing in the Administration Manual.

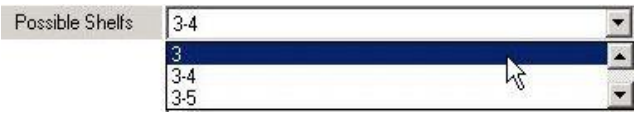


Figure 193: Possible Shelf Levels

Set the possible shelf types in this field (shelves with set number of levels). In manual balancing process editing you can you can place additional loading units with this entry – apart from the standard shelf there are also defined shelf levels available for planning. You must **always enter a value** in this field.

A loading unit can be placed in a shelf if the dimensions of the loading unit and shelf correspond.

- If, for example, you select **3**, this means that the loading unit can be manually placed only on shelves with three levels.
- If you select **3-4**, this means that the loading unit can be manually placed on shelves with three or four levels, etc.

Setting the Standard Shelf

Default Shelf

Set the shelf type in which the loading unit is to be placed in this field. The loading unit is placed in this set shelf type with an automatic calculation of the balancing process.

You must **always make an entry** in this field.

- This entry must be unique; you cannot specify more than one level.
- If, for example, you enter **3**, the loading unit is placed in a shelf with three levels in the automatic calculation.

7.9.3 Editing Shelves and Loading Units in the Balancing Process

In the first calculation of a balancing process, the shelves and loading units are allocated to the workplaces according to the determined demand and are displayed in the job coordination view.

The shelf libraries are not automatically loaded when a previously calculated balancing process is opened. The shelf libraries are available only when they are needed, i.e. if you start a new calculation after opening the balancing process, replace a shelf, or manually place a bin in a shelf.

Shelves and Loading Units (part bins) can be Manually Edited in the Balancing Process:

- You can remove shelves
- Replace one shelf with another
- Place a loading unit on a new shelf
- Open the properties dialog of loading units
- For a description of further functions: See the chapter on
- You can execute the corresponding functions via either of the context menus, shelf or loading unit. *Please refer to the* Figure 195 and Figure 198.

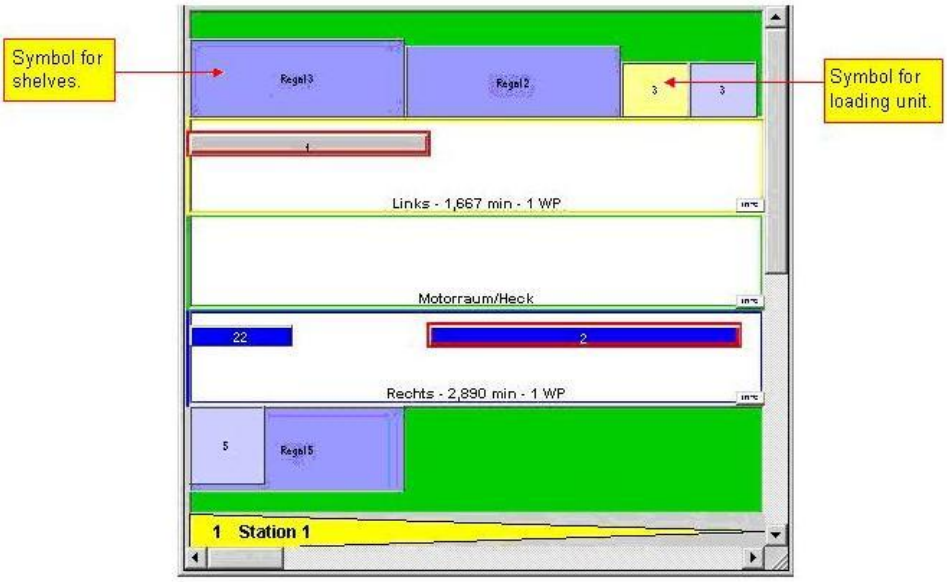


Figure 194: Job Coordination View – Shelves, Loading Units in the Station

7.9.3.1 Executing Context Functions for Shelves

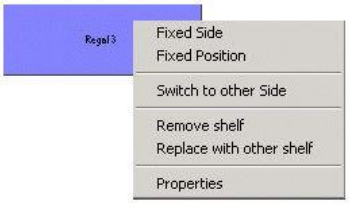


Figure 195: Shelf Context Menu

Replacing Shelves

When replacing a shelf it is important to note whether the shelf is **empty** or already **full** of bins. You can simply replace an empty bin with another. If there are bins in the shelf, check first to see on which shelf type the bins are to be stored before replacing the shelf.

Figure 196: Replacing Shelves

- You can obtain this information either in the properties dialog of the part bin or via the Material supply dialog.

1) Select the shelf to be replaced and open the context menu. All part bins of this shelf are displayed in the properties dialog. The Material supply dialog can be opened by double clicking on a part bin.
2) in order to replace the shelf with another, click on *Replace with other shelf.*
3) All shelves are displayed with data on the size and shelf levels in the dialog **Replace shelf**.
4) Select the shelf and click the **OK** button to confirm.

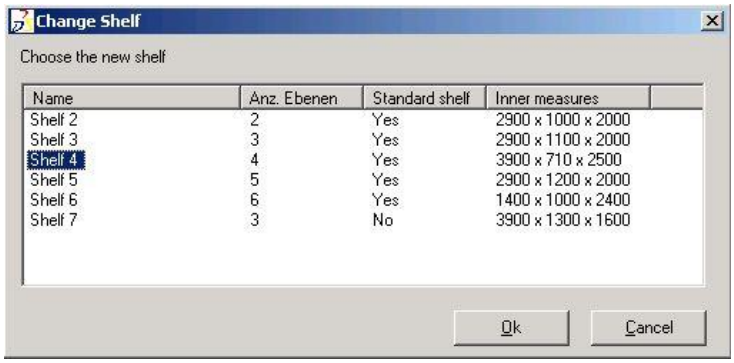


Figure 197: Exchange Shelf Dialog

Removing Shelves

You can easily remove shelves from the Material supply area. Shelves with part bins on them are removed and the bins are placed in the space cleared on the floor.

5) Select **Remove shelf** in the context menu of the selected shelf. *Please refer to the* Figure 195.

7.9.3.2 Executing Context Functions for Loading Units (bins)

Displaying Graphics

A graphic of a certain part can be displayed only if it was generated with other software; CATIA, for example.

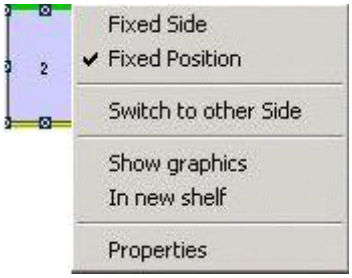


Figure 198: Loading Unit Context Menu

Placing Free Bin into a New Shelf

1) Select the bin and open the context menu.

2) Click on **On new shelf** to place a free bin in a shelf. This context function is available for bins only if levels for the **standard shelf** and the **possible shelf levels** have been defined in the properties dialog.

3) All shelves are displayed with data on the size and shelf levels in the **New shelf** dialog. In addition, the possible shelf types for this bin are displayed.

4) Select the shelf and confirm with the **OK** button. *Please refer to the* Figure 204.

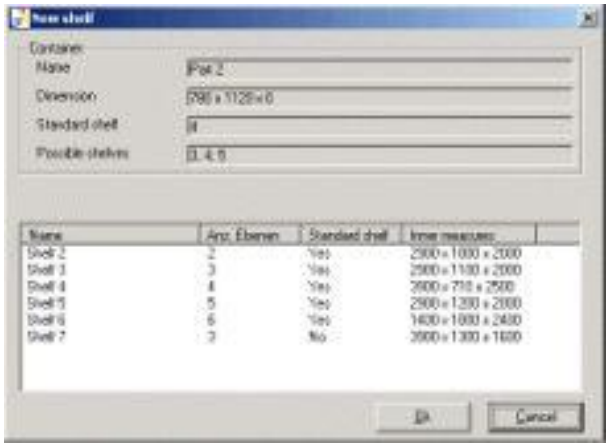


Figure 199: New Shelf Dialog

Removing bins from Shelves

The context Menu for bins placed in a shelf can be called by

1) Opening the properties dialog of the respective shelf. Either double-click or use the context menu to open the Properties dialog.

2) All bins in the shelf are shown in the dialog. Select the bin to be removed from the shelf and open the context menu.

3) Click on **Remove from shelf**. The bin is removed from the shelf and placed on the floor of the material supply area, depending on the process it has been assigned.

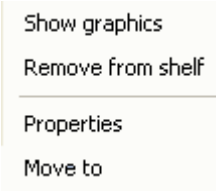


Figure 200: Shelf Properties Dialog - Context Menu for Bin

7.9.4 Manually Placing Part Bins in the Shelf

You can place part bins in the shelf by mouse click.

1) Select the part bin on the material supply area and move it to the shelf.

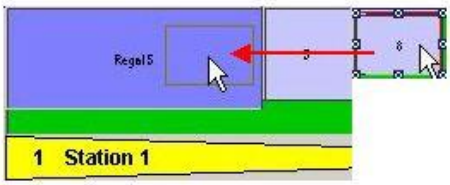


Figure 201: Placing Bins in the Shelf by Mouse Click

2) Release the mouse button in the shelf, in the **Move bin** dialog click **In shelf**. The bin is only placed in the shelf of the shelf levels correspond. *Please refer to the* Figure 204.

Figure 202: Placing Bins in the Shelf

3) You can place the bin in a new place with **Move**; i.e. the bin is placed on the floor and the shelf is moved to the right.

7.9.5 Messages in Shelf Planning

New Shelf is too Small

This message appears, if you replace a shelf with another and there are bins in the shelf which **cannot** be placed on the new shelf.

You can replace the shelf manually by confirming the message with **Yes**; the shelf is then replaced.

Figure 203: Bin does not fit on the New Shelf

Bin does not fit on shelf

This message appears if you try to place a bin in a shelf and the shelf levels **do not** correspond.

Figure 204: Shelf Levels do not Correspond

Shelf Settings are Inconsistent with Bin

This message appears if the shelf settings are not clearly defined for the bin – for example. if no values have been entered for *Possible shelves*. The message is displayed when the balancing process is opened.

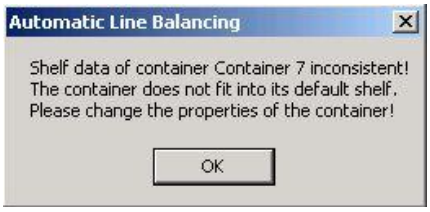


Figure 205: Shelf Data Incomplete

7.9.6 Editing Name of Shelf

1) Open ALB on a Line.

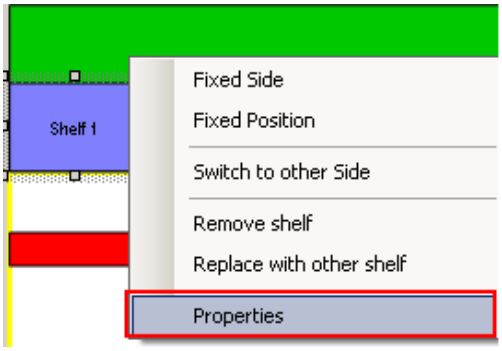


Figure 206: Edit Shelf Name

2) Right click shelf and select **Properties** in the ALB Balancing View.

3) Edit name and number of shelf.
   Give unique name for shelf.

4) Click **OK**.
   Changed name and number are retained in 2D View, **Properties** dialog box and as tool tip.

The name and number attribute of shelf can be configured in E5. The maximum character length for Name and Number permitted is 1000. There is also length attribute and by default this is set to 64.

7.9.7 Reordering of Part Bins in Shelf

1) Open balancing, and launch the shelf properties dialog box.

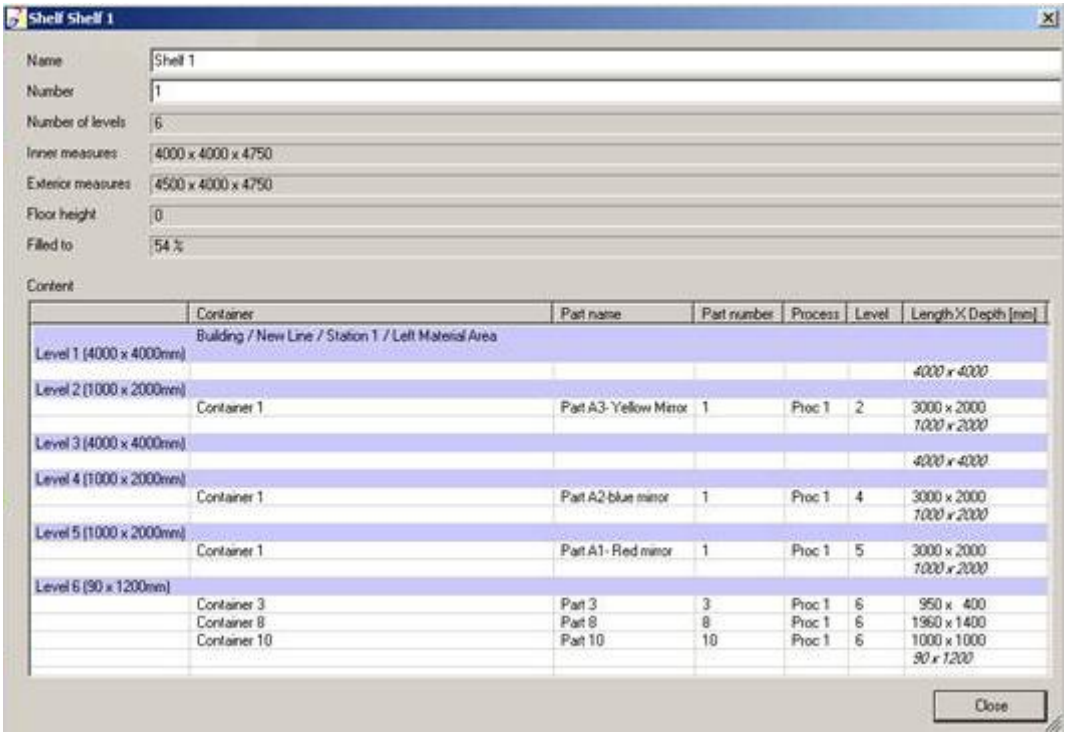


Figure 207: Shelf Properties Dialog Box

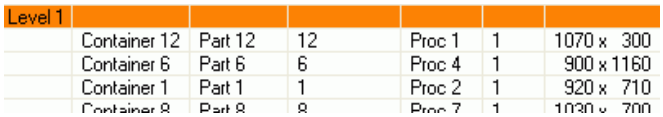
The dialog box include headers with Levels (Level 2, Level 3...) to distinguish between the available levels and to categorize the containers accordingly. The number of levels shown in this list view is the number of levels in Shelf as defined in Shelf Library. The available space for a Level is shown in the *Italics*

format in the “Length X Depth” column to have an idea whether a particular container can fit into this level.

2) Drag a container from any one level to another level where enough space is not available.

The container is moved from source level to target level with its level now changed to that of target level. The available spaces for both the source and target levels are updated accordingly.

The target level header is turned orange.



Level 1						
	Container 12	Part 12	12	Proc 1	1	1070 x 300
	Container 6	Part 6	6	Proc 4	1	900 x 1160
	Container 1	Part 1	1	Proc 2	1	920 x 710
	Container 8	Part 8	8	Proc 7	1	1030 x 700

Figure 208: Target Level Color Changes

These are the levels where part bins are added beyond a levels capacity to hold them.

The dialog cannot be closed until there remains even a single inconsistent level (header in orange color). If you close the dialog that has inconsistent level t then the following message comes.

Figure 209: Inconsistent Level Message

3) Right-click a part bin from any of the level and from its contextual menu select **Move to <Level>**.

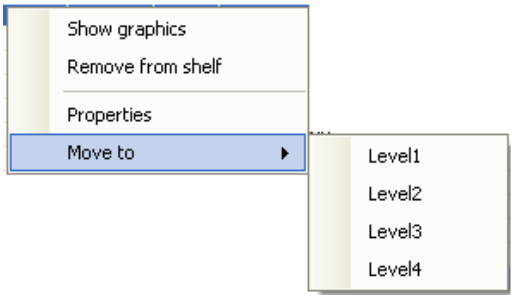


Figure 210: Context Menu “Move To”

The container is moved from source level to target level with its level now changed to that of target level. The available spaces for both the source and target levels are updated accordingly. The following behaviors are possible:

- If space is available then the container will be placed in the level and the header color of that level will remain intact.
- If space is not available, then also the container will be moved to the level and the header color will change from light grey to Orange making it an inconsistent level.

4) Click **Close** to save the changes and close the dialog box.

Persistency

The containers would be stored with their changed levels and their sequence inside levels would be persistent too. The sequence is stored on an attribute

"internalbalancing" of the default relation "albspec_partsbin_positioned_in_shelf" between part bin and shelf.

The window is resizable which automatically resizes list view too. The properties window size, list view window size, and the columns width inside list view will be persistent.

Running the Automatic Balancing Algorithm for the whole Balancing

When automatic balancing algorithm runs, the part bin sequence inside shelf would be according to this algorithm. Shelves would be filled automatically as with the existing ALB functionality. The appearance however include headers and available spaces to clearly distinguish the part bins of different levels.

Running the Automatic Balancing Algorithm for a Product Variant just added to Balancing

When a new product variant is added to the existing balancing, the part bins of this new PV are added inside shelves according to the automatic balancing algorithm. Shelves would be filled with these new part bins automatically. However, the new part bins would be added at the end of each level if space is available so as not to destroy any existing manually created sequence.

Manual Re-balancing of Processes

A process moved to another station would take away its part bins from shelves too. The following changes take place:

- The remaining part bins from the level from which the part bins are removed would be moved left to cover the space available in that level. However there would be no change amongst the sequence of these remaining part bins within the level.

This automatic re-arrangement of part bins is restricted within levels and there would be no adjustments across levels.

- The part bins would be moved to outside corner of the station where the processes are moved.

Removal of part bin group from Shelf

When a part bin group is removed from shelf, it would not be moved in the respective container area but is placed in outside corner of this container area with regard to "Free Placement of Part Bins in Material Area", otherwise it get placed according to the default behavior. Removing part bin groups from shelf would have the following impacts:

- Available space in the particular level from which it is removed would be updated.
- No automatic adjustments of other part bins across levels or sequentially within a level takes place.
- If the removed part bin groups level is inconsistent and if there is some available space after removal, the level header color changes from orange to default light grey.

Moving a Container inside Shelf

A container dragged and dropped on a shelf is placed inside shelf at a valid position in a level where space is available. This newly added container is placed in the level in last position so as not to destroy any existing manually created sequence. Filling shall be executed from bottom level to top most level.

Re-Arranging Material Area

There is no impact on part bin planning inside a shelf.

Replacing with a New Shelf
During replace with a new shelf, part bin planning inside the shelf is copied from target to source only if they have same levels. Otherwise, part bin planning would be destroyed and recalculated.

Limitation
During replacment with a new shelf, part bin planning inside the shelf is copied from target to source only if they have same levels. Otherwise, part bin planning would be recalculated.

7.10 Planning and Displaying Product Variants

Product variants of a type series are largely manufactured with the same parts at the same workplaces on an assembly line. Product variants of ALB planning include limousines, convertibles and coupes. This series of examples could go on forever.

What does the balancing process of product variants, which is available in version 5.13 of Process Engineer, do?

The same parts for several product variants are manufactured with the same processes. In the balancing process it is assumed that the processes for the same parts will be executed by the same employee. One process graph is generated for every product variant; all processes required for the manufacture of product variants are planned in this process graph. An unlimited number of product variants can be calculated in the balancing process.

It is furthermore assumed that a high number of processes of the same type are used for the manufacture of product variants in all process graphs, thus forming dependencies between the process graphs.

In order to show these dependencies, you can mark the same-type processes:

- either via relations
- or via BOM entries

Marking processes of the same type forms the basis of the balancing process of several product variants, which are calculated and displayed according to weight accordingly. The processes of the same type must first be marked in the PPR-Navigator between the individual process structures of the respective process graphs of the product variants. Processes marked as the same type are marked by the **blue** line link.

Blue line link marks processes of the same type in the precedence graph.

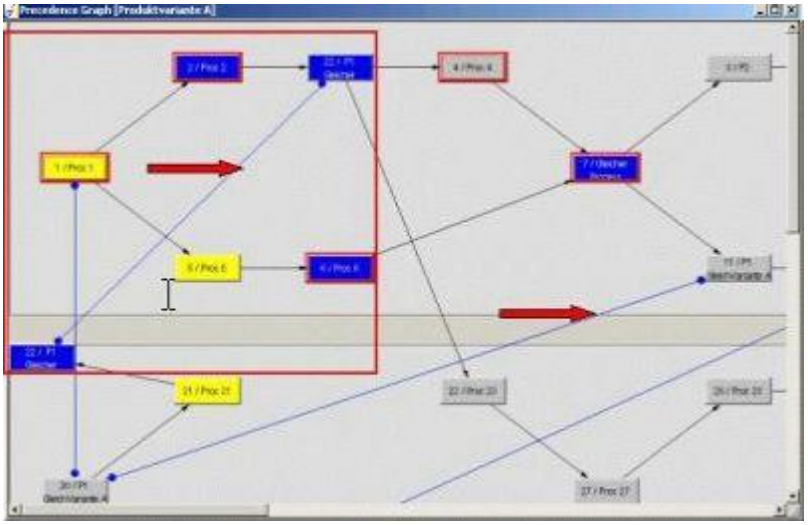


Figure 211: Processes of the Same Type in the Precedence Graph

7.10.1 Marking Processes of the Same Type via Relations

Processes of the same type are marked in the process graphs of the individual product variants via the relation *Same process*. These processes can be further edited independently in the respective process graphs – a change in a process (for example. the process time) is **not** automatically implemented in the process linked via this relation. Proceed as follows:

1) Select the process from the PPR Navigator process structure. In example, a process of **product variant B** is selected (process structure for the process graph of product variant B).

2) Drag this process to a process in the process graphs of another product variant. In example, a process of **product variant A** is selected (process structure for the process graph of product variant A).

3) Release the mouse at this process. In the *Linked operation...* dialog select the relation **Same process**.

4) Click **OK** button to confirm. Both processes are marked as processes of the same type. *Please refer to the* Figure 212.

Marking processes of the same type via relation.

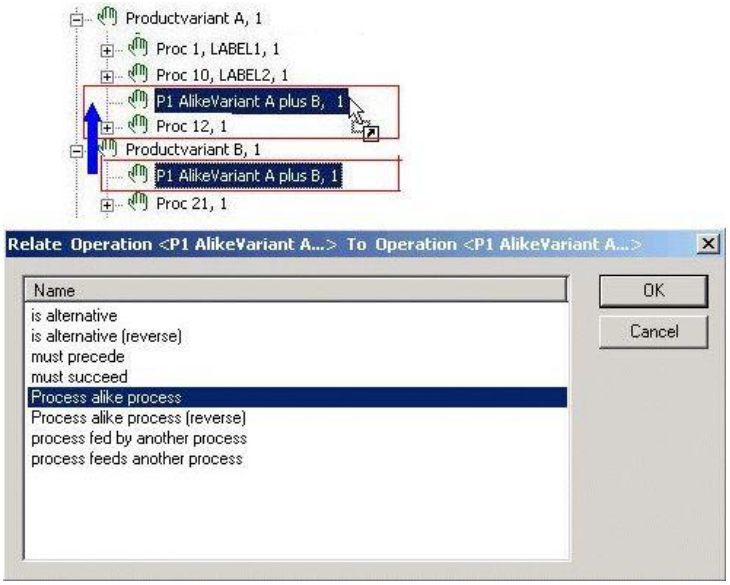


Figure 212: Marking Processes of the same Type via Relation

7.10.2 Marking Processes of the same Type via BOM Entries

Processes of the same type marked via BOM entries are real references of the processes. Any change to a process (for example. the process time) is **automatically** made in the process linked via the BOM entry. Proceed as follows:

1) Select a process from the PPR Navigator process structure. In example, a process of **product variant B** is selected (process structure for the process graph of product variant B).
2) **Always** drag this process to the hierarchy level of the process graph. In the example **product variant A** is selected.
3) Release the mouse button. In the **Relate Workplan To Operation** dialog select the **BOM entry**.
4) Click the **OK** button to confirm. The process is added to this process graph as a reference. *Please refer to the* Figure 213.

Example

Marking processes of the same type via BOM entry.

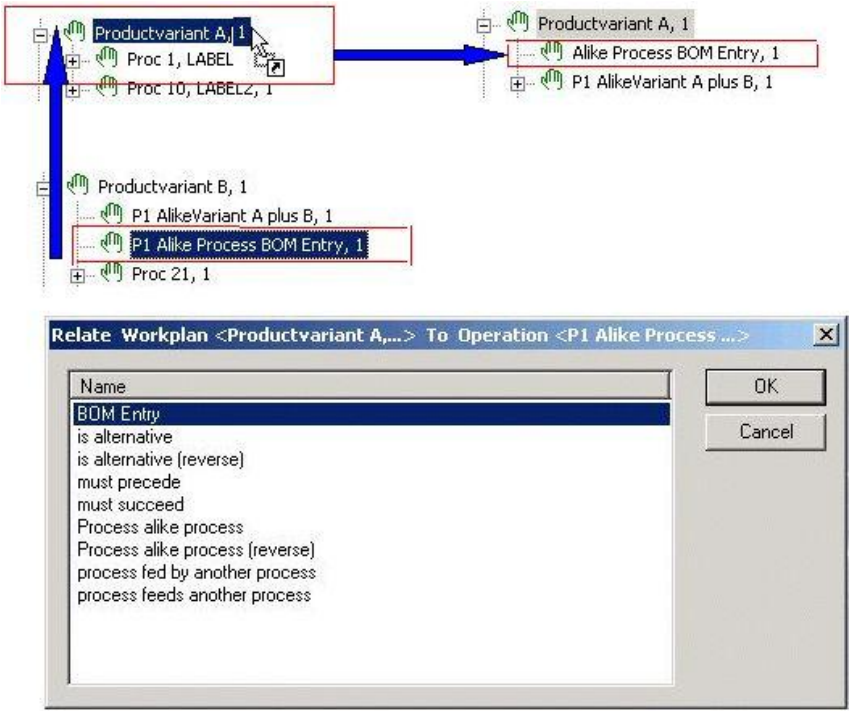


Figure 213: Marking Processes of the same Type via BOM Entry

7.10.3 Editing Product Variants in the Balancing Process

Optimization, transparent display and flexible editing of product variants.

A fundamental principle for making product variant planning as transparent as possible is followed in the balancing process display of several product variants of a type series. You can balance as many variants as you wish. Whenever doing this, however, you must always keep one thing in mind; an optimal balancing process is possible only for the main variants ascertained in the initial creation or recalculation of a balancing process.

The additional stations and workplaces are determined for all added product variants, but the stations are always added as the end of a line.

The "main variant" as a rule refers to the variant manufactured most frequently. Main variants and additional variants can be balanced according to weight and scheduling. The variants you want to view can be displayed

together or separately in the job coordination view – viewing one variant corresponds to the balancing process for a product.

You can edit only the processes and stations of active variants. Processes for inactive variants are displayed in gray. All menu functions, however, are available for editing. Added variants in this way can later be manually optimized.

Product variants can be removed from the balancing process if, for example, the process graph of the product variant has to be revised or the product variant is to be replaced by another. You can as previously for example, print out the results of this balancing process or display them in a group view.

Product variants for the balancing process schema.

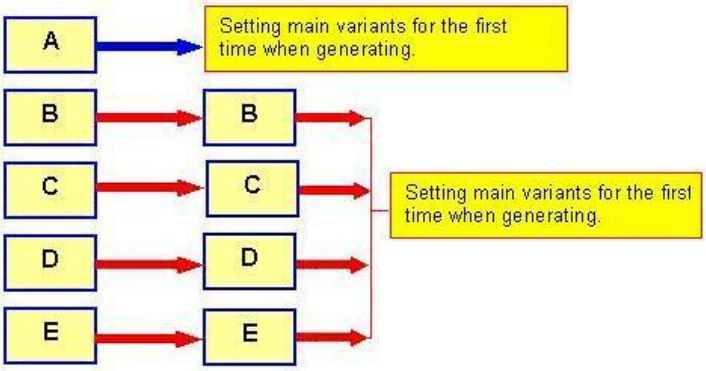


Figure 214: Supply Product Variants for the Balancing Process Schema

7.10.4 Product Variants Menu

The basic settings for the balancing process of the product variants are made in the menu Product variants. You can set which variants are to be calculated and displayed in the balancing process using three menu points.

The process graph of the main variant is planned for the first calculation of a balancing process. This variant is available in the balancing process after the calculation is complete. Of course this variant is simultaneously the main and active variant. All other variants are subsequently added to the balancing process.

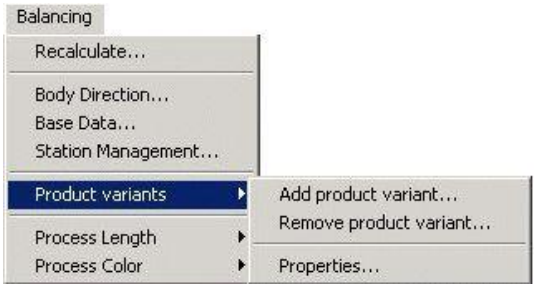


Figure 215: Product Variants Menu

7.10.4.1 Adding and Weighing Variants

The variants for which the balancing process was generated is displayed in the Properties dialog. The weight is of course one hundred percent on the first balancing process.

Initial situation after the first balancing process – planned variant is the same as the main and active variant.

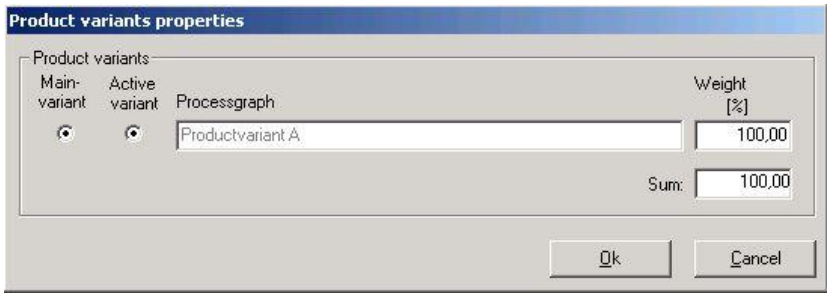


Figure 216: Properties Dialog with a Variant

1) In the Product variant menu select the menu item **Add product variants** in order to add variants. The process graphs of the possible product variants are displayed in the upper window of the dialog. *Please refer to the* Figure 215 and Figure 217.

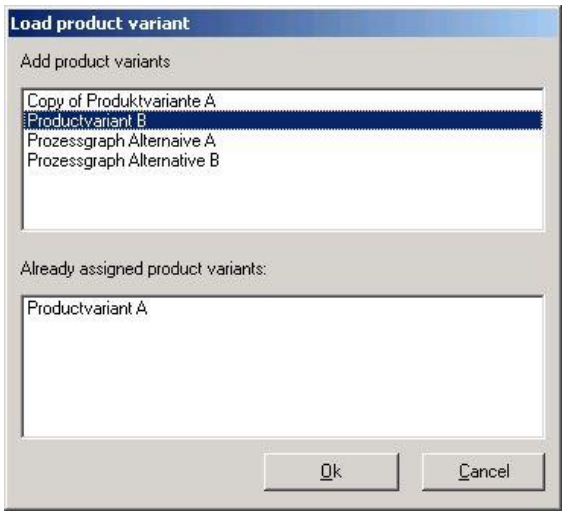


Figure 217: Add Product Variants Dialog

2) Select the variant in the upper window. The variants must be added individually. Confirm the selection by clicking **OK**.

3) The **Product variant settings** dialog is then opened. The added variant is displayed. The main and active variant are also displayed.

4) Specify the weight. The weight of all variants must always add up to one hundred percent. Tip the corresponding percent values into the fields under Weight.

5) You can set the main variant only in this dialog. You can set the active variant in this dialog as well as in the selection menu of the job coordination view. The active variant is always the variant you can edit.

6) To edit the variant, click in the corresponding fields under **Main / active variant**.

7) Confirm the entries with **OK**. The calculation is executed.

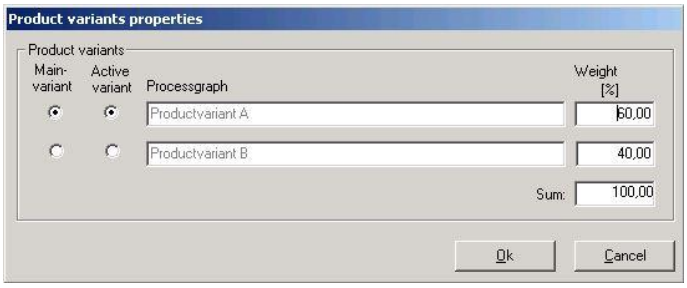


Figure 218: Weighing in the Dialog

3) After the calculation the Consistency Check dialog opens; it shows you possible errors which you can then correct. *Please refer to the* Figure 219.

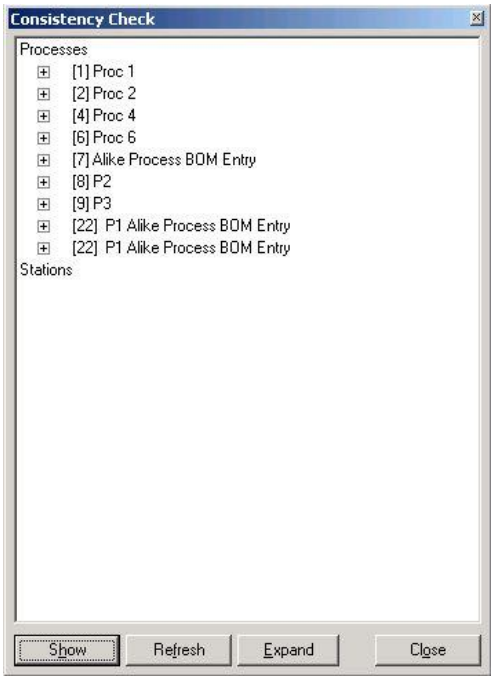


Figure 219: Planning Errors are Immediately Displayed in the Dialog

4) Close the dialog by clicking **Close**.

7.11 Planning the Logistics for Parts Delivery

As of the DPE 5.17 release the calculation for parts delivery has been extended by two options, which can be used when planning several product variants. This makes a total of three options that aid in making the planning of logistics possible.

Up till now, the number of parts bins needed for each process was calculated and the common result was too high. This in turn meant a considerable amount of space would be needed for these parts bins on the line.

To prevent the calculating of duplicate parts bins from identical processes and parts, into the number of parts bins needed for the planning of product variants, you have the possibility of directing the calculation by way of processes or identical parts using the new options.

This chapter will provide you with a general overview of how this works:

- Using the Using Options option
- Using the **Do not handle Duplicate Partbins** option.

- Using the **No duplicate Partbins for Same Processes** option.
- Using the **No duplicate Partbins for Same Parts** option.

7.11.1 Using Options

The options for calculating the number of parts bins can be set in the ALB-configuration. As long as you do not change and save the option for a balancing process, the option setting made in the ALB-configuration is valid for all newly created balancing processes.

Also see the corresponding chapter in the Administration Manual.

After starting the ALB, the configuration setting can be changed for a user via the **Parameter** *for* **Automatic Balancing** dialog.

1) To open this dialog, select the **Station data** menu item in the Automatic Balancing menu.
2) Under **Logistics Planning** select the option that you want to use for calculating the number of parts bins.
3) Once you have confirmed your selection with **OK**, the calculation will automatically be carried out. To make the option setting permanently valid for the balancing process, save the option settings for this balancing process.

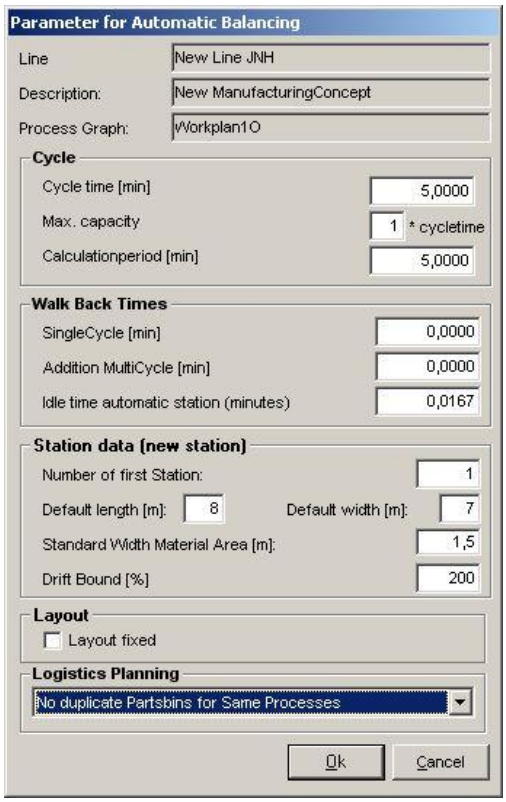


Figure 220: Options for the Number of Parts Bins

7.11.1.1 Using the Options for Parts Delivery

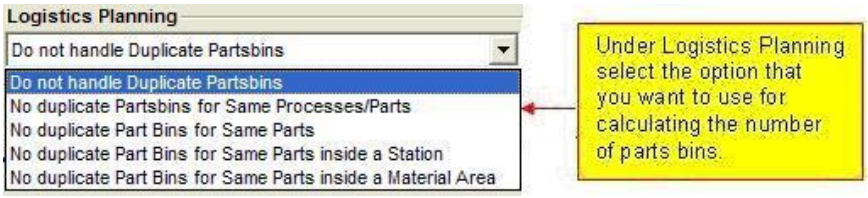


Figure 221: Logistics Planning

- Option one, the same planning as before:

Duplicate bins are not handled – Planning the same way as before for parts delivery means, an appropriate parts bin is made available and calculated in for each and every process of a product variant. *Please refer to the* Creating Logistics Data. *Please refer to the* Figure 220.

- Option two, **no duplicate parts bins for the same processes**

With the help of this option, the number of parts bins for the process of the main variant is first calculated. Next, depending on the supply turnover ratio of a process on line, they are made available for the planning of identical processes, which are in turn used for different product variants.

- Option three, **no duplicate parts bins for the same parts**

The third option enables you to calculate the number of parts bins for the planning of identical parts on the basis of a unique parts number. Use this option when planning identical parts that are used in different product variants, or occur repeatedly in a single variant. In this case a different parts number is given for the same part, depending on the usage.

The calculating of the number of parts bins takes place when, parts are linked with a process by way of a relation, over which the parts for delivery are calculated and depending on the material supply, made available on the line.

Example

Planning for Identical Parts.

Example

Two identical parts are used for the assembly of product **C**, the parts **W1** and **W2**. Every identical part should receive a different parts number.

Product C is to be balanced:

- W1 is linked via relation 1 with process 1
- W2 is linked via relation 2 with process 2

Process 1 and process 2 are both linked with product C.

- Both processes, which are linked with the product C via relations 1 and 2, are recognized during the balancing process for product **C**. If you activate the **no duplicate parts bins for the same parts** option, the parts are supplied for the process first used in the balancing process. All other processes linked with this part, are to be **disregarded** for the material supply planning.

When the **disregard** option is activated, the supplying of materials happens separately for all identical parts linked with processes – such as both of the processes 1 and 2 in the example.

Open the balancing, set the planning mode. The Enhanced logistics planning mode is set in the base data of ALB:

No duplicate Part Bins for Same Parts inside a Station: Same as “No duplicate Part Bins for Same Parts”, but the scope of the parts is only inside

the station. If this option is selected the algorithm does not search for same parts in the complete line, but only inside a station instead.

No duplicate Part Bins for Same Parts inside a Material Area: In this mode, the scope of the same parts is only inside the material area. That means, if there are two same parts inside a material area, they share one part bin together.

In the following examples, only the two new modes are considered.

Situation 1: Moving a container from one material area to another

Mode: No duplicate part bins for same parts inside a station

- **The container is moved to another station**: If the moved part has a same part in the origin station, a new part bin is placed for the left same part(s). The same is valid for the destination station: If there is a same part for the moved part in the destination station, the moved part bin is not visible in the destination station, because the already existing part bin is used for this part.
- **The container is moved inside the station**: The number of part bins cannot be updated.

Mode: No duplicate part bins for same parts inside a material area

- **The container is moved to another material area:** If the moved part has a same part in the origin material area, a new part bin is placed for the left same part(s). The same is valid for the destination material area: If there is a same part for the moved part in the destination material area, the moved part bin is not visible in the destination material area, because the already existing part bin is used for this part. It does not matter if the destination material is in the same
- **The container is moved inside the material area**: The number of part bins cannot be updated.

Situation 2: Moving a process from one workplace to another (within a station)

Mode: No duplicate part bins for same parts inside a station:

The number of part bins cannot be updated.

Mode: No duplicate part bins for same parts inside a material area

If the process is moved to a workplace that uses the same material area, the number of part bins cannot be updated. If the process is moved to a workplace that uses another material area, these checks are done:

- A new part bin is placed in the original material area, if the moved part bins contain any parts that have a same part in the original container area.
- The moved parts use the already existing part bin, if moved part bins contain any parts that have a same part in the destination material area.

Situation 3: Moving a process from one station to another

Mode: No duplicate part bins for same parts inside a station

- A new part bin is placed in the original station, if the moved part bins contain any parts that have a same part in the original station.
- The moved parts use the already existing part bin, if moved part bins contain any parts that have a same part in the destination station.

Mode: No duplicate part bins for same parts inside a material area

- A new part bin is placed in the original container area, if the moved part bins contain any parts that have a same part in the original container area.
- The moved parts use the already existing part bin, if moved part bins contain any parts that have a same part in the destination container area.

7.11.2 Using the No duplicate Part bins for Same Processes Option

The same part can be used in different product variants. To plan the same part for product variants (for the assembling of a part, for example), a process must be planned for each product variant in order to edit the part. So in other words, this means identical processes for each product variant.

These processes can be marked as identical in ALB. The marking can be carried out over relations or bill of materials entries as well. *Please refer to the* Marking Processes of the same Type via BOM Entries.

- The number of parts bins can be planned on the basis of a process exclusively for processes that are marked as identical processes with the aid of **the No duplicate Part Bins for Same Process** option.

The principle behind calculating the number of parts bins is based on simple arithmetic:

- During the planning of identical processes for main and active variants of a product, the calculating of the number of parts bins for the process (the product variant marked as the main variant) generally takes place with the first use in the balancing process.
- The space required and number of bins will be calculated accordingly. If you change the main variant, the calculation is carried out based on the same scheme. The only difference of course is that it is for the identical process, which is the newly marked main variant for the planned product variants.

The Exception Often Proves the Rule
A possible exception to this principle is, when an identical process is **not** planned in to balancing process using the main variant – for example with three possible product variants, process P1 only appears in the second and third variant of the balancing process.

The first variant is marked as the main variant, and is not used in the process P1. In cases such as this, the number of parts bins for process P1 is planned more or less on the principle of contingency. Normally, the number of parts bins for the process, that was planned in first is calculated (process P1 in the example).

7.11.3 Planning the Number of Part Bins in the Job View

To edit the delivery of parts in the job view, use the *Parameter for Automatic Balancing* dialog and the properties dialog of an identical process.

7.11.3.1 Using Dialogs

The following sections will inform you of the possible ways to use dialogs.

Think of a balancing process in which two product variants are to be planned. The basis for the product variants are the process graphs (priority graph) Workplan 10 and Workplan 1. The product variant that is to be planned on the basis of Workplan 10 is also the main variant and active variant.

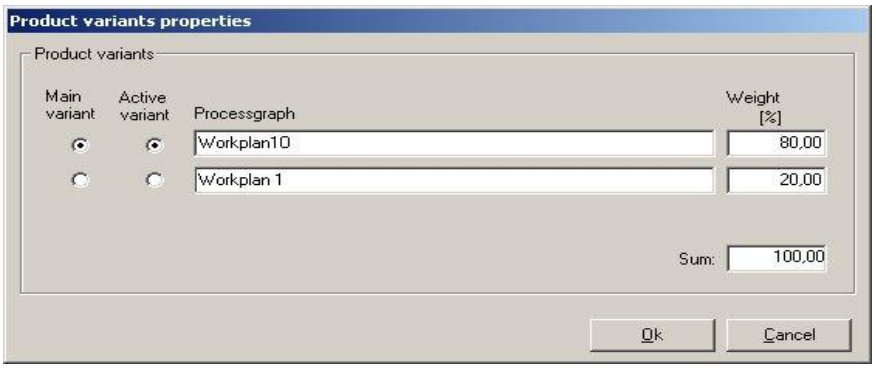


Figure 222: Examples of Product Variants

To provide more of a vivid display of the results, the first step should be to adjust **the Do not handle Duplicate Part Bins** option in the station data. You'll recall that the parts bins for each process are planned using this setting – this is basically the same as the only possible method used in earlier versions in ALB, for planning the number of parts bins.

Process 12 is marked as the identical process in both variants.

In review: Processes for the active variant are always displayed in the color of the workspace; all other processes are displayed in grey.

In the example the process 12 is pictured twice: The process shown in yellow is the process for the active variant and, at the same time the process for the main variant.

The following picture shows that with this option parts bins are calculated for both processes (main- and active variant).

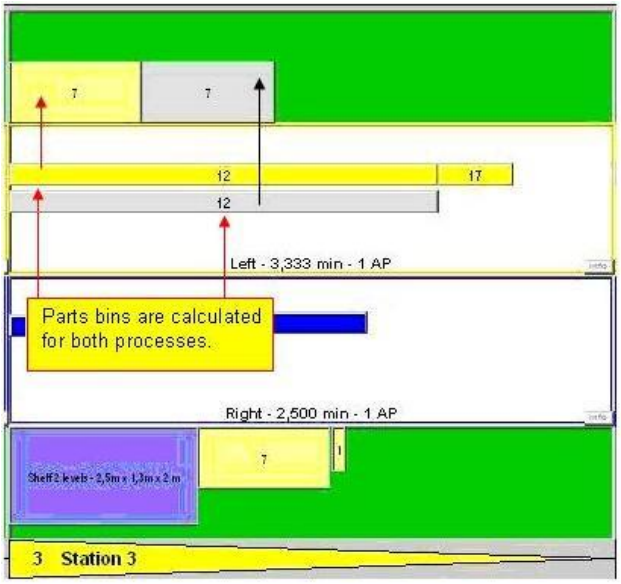


Figure 223: Parts Bins are Supplied for both Processes

For the next step, change the option for calculating the number of parts bins to **No duplicate Part Bins for Same Processes**. *Please refer to the* Using Options.

1) Open the Parameter for Automatic Balancing dialog.

2) Then select the No duplicate Part Bins for Same Processes option.

3) Confirm your selection by pressing **OK** and then close the dialog.

The calculation for the number of parts bins is carried out immediately, as the following picture shows:

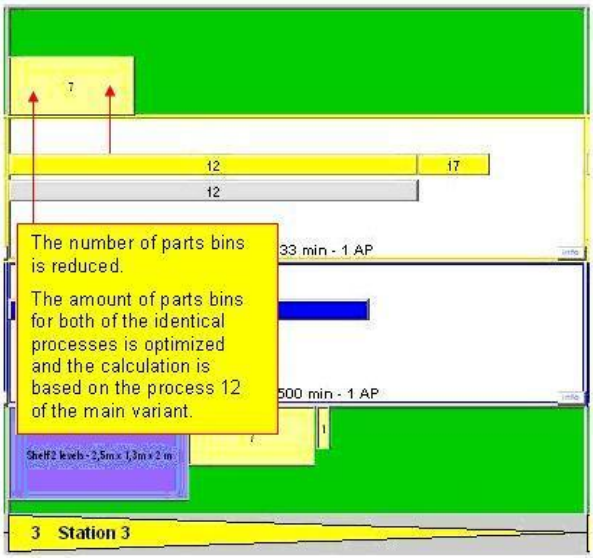


Figure 224: Calculate the Number of Parts Bins according to the Process of the Main Variant

7.11.3.2 Changing the Parts Delivery for an Identical Process

The foregoing example showed how, the number of parts bins can be calculated by changing the option in the station data. Changing the option in the station data always affects the entire balancing process, for all identical processes.

This next step will explain how to change the delivery of parts for a single process.

For some parts it makes sense to have the parts available in different areas for individual delivery to each process, even when this process is marked as identical.

So that you do not rearrange the option for parts delivery of the entire balancing process, you can change the parts delivery for single processes via the properties dialog.

In our example the parts delivery for the **Process 12** is to be changed again. The change is always made using the process of the active variant and never the main variant in the case of identical processes.

To free the parts delivery from the process of the main variant, deactivate the **Use material planning from main process** field. The **Main process for material planning field** cannot be edited.

When this field is activated, the parts delivery is carried out according to the option settings in the station data.

Neither of the two fields can be edited in the case of an identical process for the main variant.

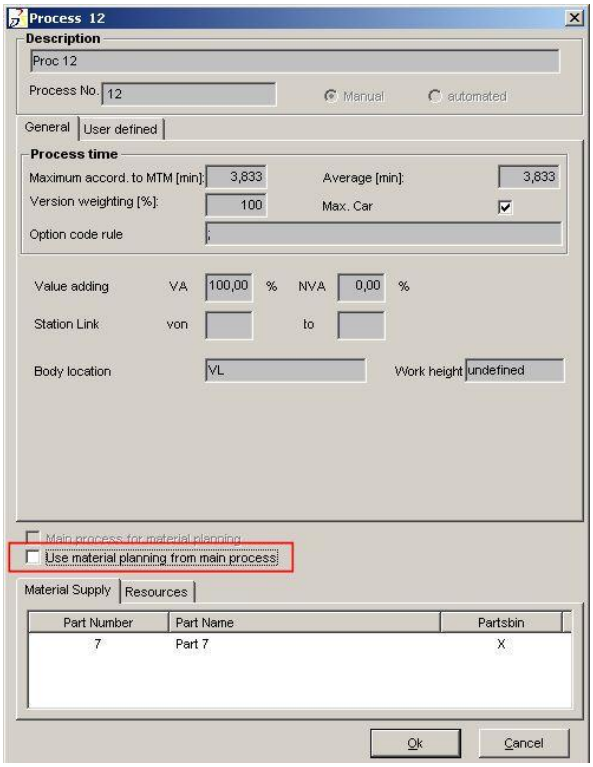


Figure 225: Process Properties Dialog for the Active Variant

The result is that the number of parts bins is planned in for both processes (main- and active variant).

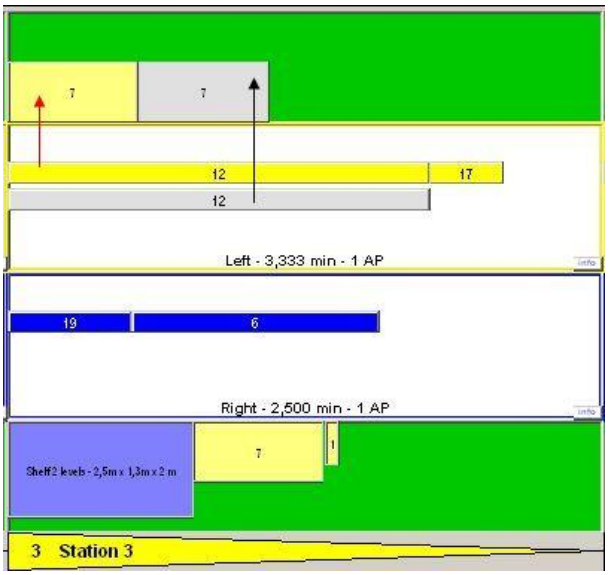


Figure 226: Planning for an Identical Process is Changed

7.11.4 Using the No duplicate Part bins for Same Parts Option

A second way to avoid identical parts bins that belong to the same part from appearing in duplicate on the line, is by identifying each part with a unique parts number. The same part can be used in different product variants or several times in a single product variant, for example.

The only stipulation for using the **No duplicate Partbins for Same Parts** option for planning is, is that you give the same part a different parts number, according to its usage.

The balancing process for the product variant is carried out as usual, via the process planning of the process graph being used. To calculate the number of parts bins, link the parts to a process by way of a relation.

7.11.4.1 Result of the Planning

The result of planning with the assistance of this option is shown in both of the following pictures:

Initial Situation

The first picture shows planning with the **Do not handle Duplicate Part Bins** option. The parts bins for the same part are supplied for the station, according to the link with a process.

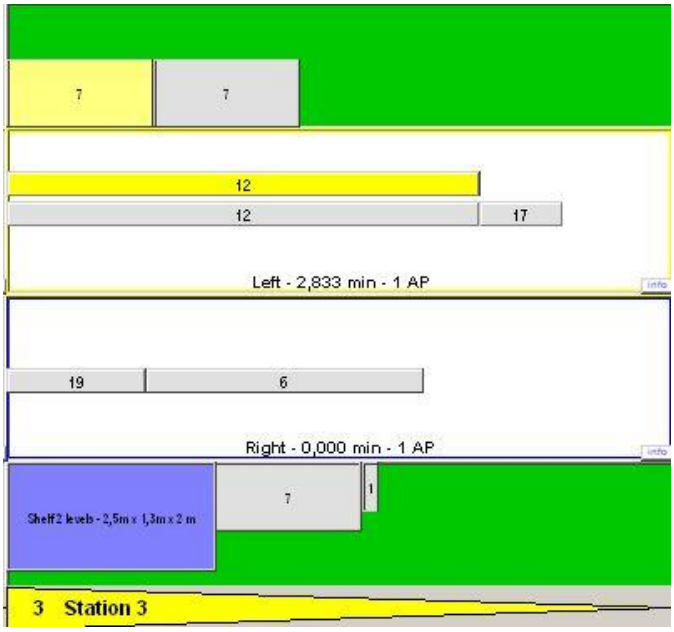


Figure 227: All of the Parts Bins are Planned in

The Option is Used

1) Once again, open the **Parameter for Automatic Balancing** dialog to plan the number of parts bins using the **No duplicate Part Bins for Same Parts** option.

2) Then select the No duplicate Part Bins for Same Parts option.

3) Confirm your selection by pressing **OK** and then close the dialog. *Please refer to the* Using Options.

The calculation for the number of parts bins is carried out immediately, as the following picture shows. *Please refer to the* Figure 227.

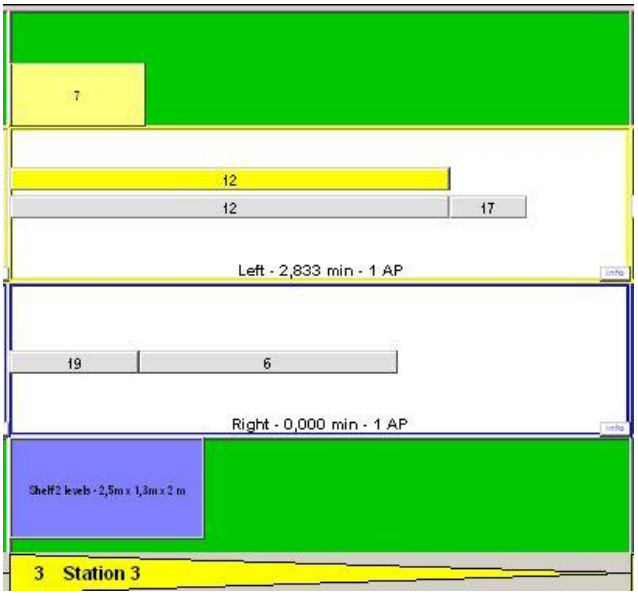


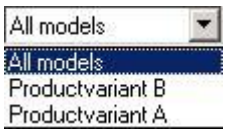
Figure 228:The Option has Optimized the Number of Parts Bins

7.11.5 Editing Product Variants in Job Coordination

You can edit the enabled product variants in the Job coordination view. You can also have a variety of options for displaying the ascertained results. The following examples follow the most common case in practice - all processes are displayed according to weight. For more information on displaying processes.

There are two further selection menus for editing the product variants:

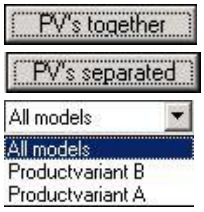
- You can set which balancing process of a product variant is displayed using the buttons ***PV's together*** and ***PV's separated***. When viewed together, all variants are shown.



- All added variants are displayed in the selection window **All models** – all variants (active and inactive processes) are shown in the Job coordination window if **All models** is set. In this selection window you can also select a product variant to be individually displayed. This variant is then the active product variant.

- The active variant is always displayed in the status line. The job data are displayed according to the selection.
- The job data of all added variants (active and inactive variants) are ascertained and displayed if **All models** is set.
- Only these job data are displayed for a **select variant**. (*Please refer to the* Figure 54).

7.11.5.1 Showing Balancing Process Results

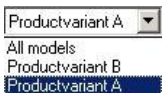


The following settings, for example ***PV's together*** or ***PV's separated***, *Please refer to the* Balancing view in ALB.

In order to display the results of only **one variant**, set *PV's separated*.

1) In order to display the results of **all variants**, set *PV's together*. In this mode always all processes will be displayed, independent on which product variant is chosen.

2) In order to display the processes of **all variants** (active and inactive variants), set **All models**. The active variant remains unchanged with this setting.



3) In order to display the processes of only **one variant**, set the variant. If you want to display only the processes of one product variant, the mode **PV's separated** must be set.

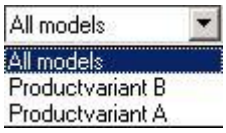
- This variant is the **active variant**, and you can edit its processes.

7.11.5.2 Displaying a Variant (Product Variant Separated)

Example

In the example, the active product variant is **product variant A.**

- Button *PV's separated* is enabled.
- **All models** is enabled.



- The processes of the inactive **product variant B** are **displayed in light gray** – for example, **process 21**. The processes of the active variant **A** are displayed in the colors set at the workplace.

What results are yielded with this setting?

- The calculated time (processes per workplace) is calculated only for this variant.
- The job data of all variants are displayed (in the example, of variants **A** and **B**).

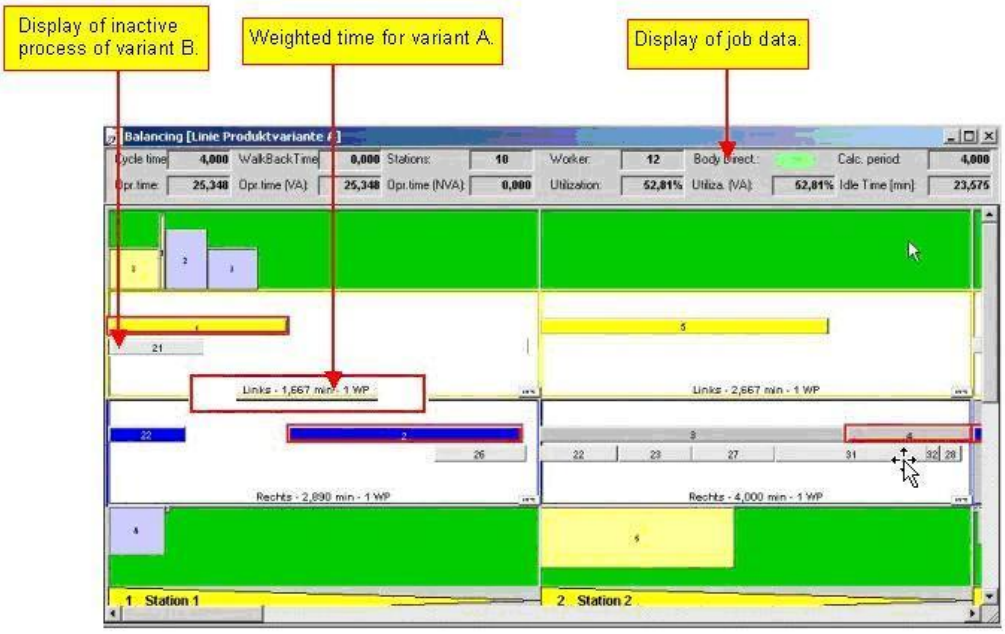
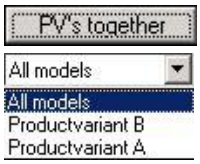


Figure 229: Job View for a Product Variant

7.11.5.3 Displaying all Variants (Product Variants Together)

In the example, the product variant **A** is active and **B** is inactive.



- Button PV's together is enabled.
- All models is enabled.

What results are yielded with this setting?

- The calculated time (processes per workplace) is calculated for both variants.

- The job data of all variants are displayed (in the example, of variants **A** and **B**).
- The display of the processes for both variants corresponds to the weight of the variants and processes as well as the existing precedence relations.
- Inactive processes are displayed in light gray.

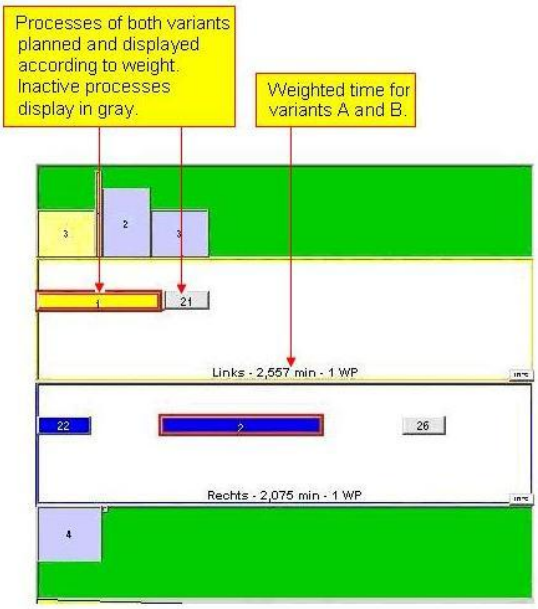


Figure 230: Job View for Two Product Variants

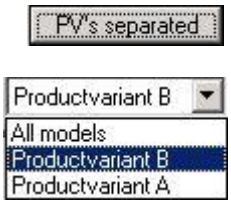
7.11.5.4 Display for One Variant (Two Displays)

Example

The display of **variant B** is shown in both of the following examples.

Example One:

Only the processes of **variant B** are displayed in the job view.



- Button PV's separated is enabled.
- Product variant B is enabled.

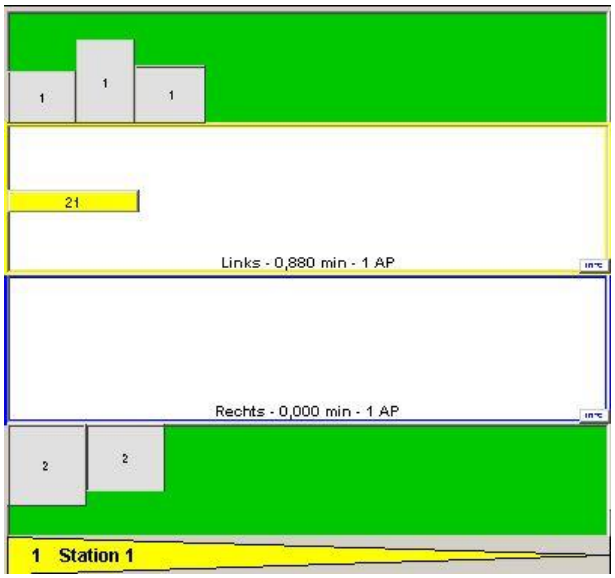


Figure 231: Display of the Processes for One Variant

Example

Example Two:

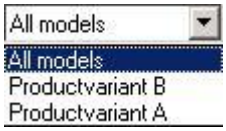
The processes of **variant B and variant A** are displayed in the job view. Calculated values always refer to the active variant (in the example, variant B), such as the activity period or utilization.

Variant B stays the active variant in this example.

Note

*If you want to set a different variant as the **active variant**, you have to directly select this variant. Switching to **All models** affects only the display of the variants in the job coordination view.*

Button PV's separated is enabled.



- All models is enabled.
- Inactive processes are displayed in light gray.

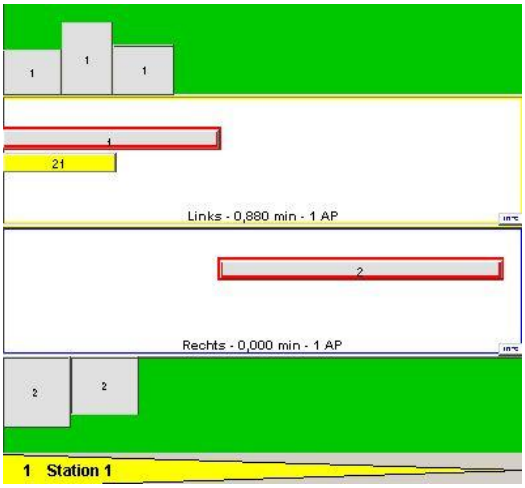


Figure 232: Display of the Processes with Inactive Variants

7.11.6 Removing Product Variants, Opening the Properties Dialog

You can remove product variants from the balancing process and replace them with new variants.

As the word **remove** indicates these variants are only removed from the balancing process and not deleted. You can use these variants for another balancing process at any time. Variants are usually deleted in the PPR-Navigator.

1) To do this, click on *Remove product variants* in the Product variants menu. *Please refer to the* Figure 215.

2) In the *Remove product variant* dialog, select the variant (in the example, **product variant B**).

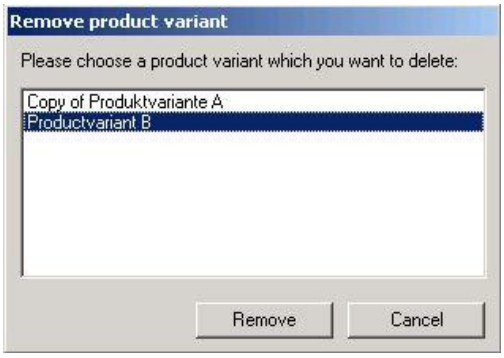


Figure 233: Remove Product Variant Dialog

3) Then click **Remove**. Messages corresponding to the balancing process setting (for example. the variant to be removed is the active variant) are displayed. *Please refer to the* Messages for Product Variant Planning.

7.11.6.1 Opening the Properties Dialog

The variant that was removed is no longer displayed in the Properties dialog or in the selection window under **All models**.

Click **Properties**... in the Product variants menu, *Please refer to the* Figure 215, to open the **Product Variant Properties** dialog box.

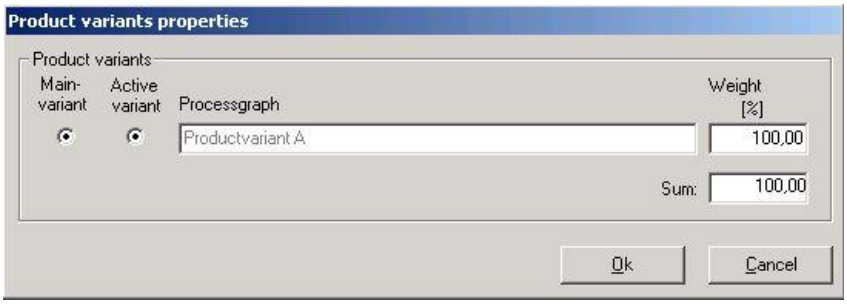


Figure 234: Product Variant Properties dialog box

7.11.7 Messages for Product Variant Planning

Balancing process messages have a variety of purposes and they suggest a sensible action on your part. Just as is the case with other processes in the editing of a balancing process, you can be informed of a certain circumstance when planning several product variants.

The basic messages are explained briefly below:

Product Variant Enabled

Whenever product variants are removed this message appears if the variant to be removed was previously set as the active variant.

Figure 235: Variant Enabled Message

Weight 100 Percent

This message appears when the sum of the weight in the Properties dialog of the product variants is larger or smaller than one hundred percent. The weight values must be corrected so that they add up to one hundred percent.

Figure 236: Sum of the Weight is one Hundred Percent

Moving Processes of the Same Type

This message appears whenever you want to move a process of the same type to another workplace in manual balancing process editing.

Figure 237: Moving Processes of the same Type

7.12 Using Graphic Layout for ALB

The stations, material provision areas and loading units of a workload balancing are shown graphically in the layout with the help of the layout display. The layout is created automatically if you create a new workload balancing for a line. You can then edit a layout.

The setup of the performance view in the Automatic Line Balancing is divided into graphic and logistic elements:

- Graphic elements of the performance view are stations, material provision areas, and loading units such as parts bins, shelves, and palettes.
- Logistic elements of the performance views are processes and workplaces.

The graphic elements of the performance view can be displayed and edited in the layout. One possible way of editing in the layout is to reposition graphic elements: moving material provision areas and stations takes effect only in the layout. If, however, loading units are repositioned, this also takes effect on the performance view in the **ALB**.

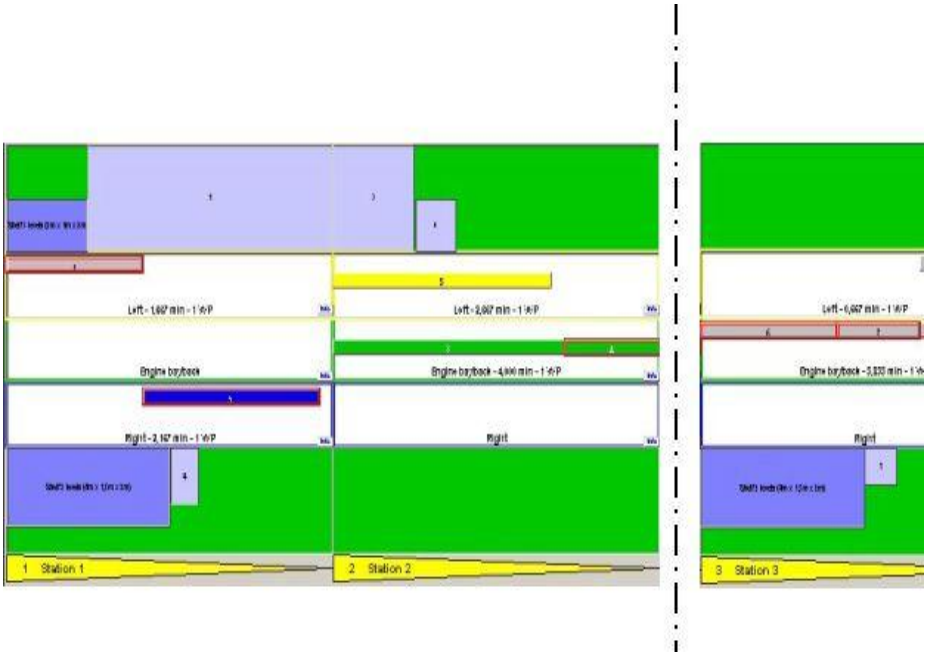


Figure 238: Display of the Performance View in the ALB

Set Layout for Parts Bin and Shelves

The system elements for the parts bins and shelves are created in the system library. In order to correctly position the graphic of parts bins or shelves in the layout of the workload balancing, the zero point must be set for the graphic as follows:

- The X and Y axes must be positioned in the middle of the parts bin and the base of the parts bin must be on the zero point of the Z axis.

For more information, *please refer to the* System Library Manual.

7.12.1 Fixing the Layout

You can fix a layout if the graphic elements of the performance view are no longer to be changed in the ALB. Once you have fixed a layout, the graphic elements positioned in the layout are one hundred percent identical to the planned stations and loading units of the performance view: layout and performance view therefore have the same status.

- If the field is activated, the graphic elements of the performance view such as parts bins, shelves, or stations can no longer be changed in the performance view in the ALB.
- Whenever a process with a fixed layout is moved, the bin is not moved along with the process.

1) The field can be activated in the properties dialog of the line.

Figure 239: ALB Layout Fixed Field

2) The field is also available in the Basic Data dialog when a workload balancing is open.

Figure 240: Layout

If you have opened the workload balancing and deactivate the field, all stations are again available for editing. After saving the changes you can again fix the basic data in the Basic Data dialog. The saved changes of the workload balancing are executed in the layout.

7.12.2 Editing Graphics in the Layout

The graphic elements of the performance view are shown in the layout. Loading units are displayed as graphic elements only if they were planned concretely with a set number of loading units. A loading unit identified as a fixed area in the ALB is not recognized or displayed as a graphic element. The loading unit that has been reserved as a fixed surface in the ALB, can be identified and displayed using a so-called dummy-bin as a graphic element.

Open Edit Graphic

1) In order to open the layout for editing, switch to the resource view.
2) Select **Edit Graphic** in the context menu.

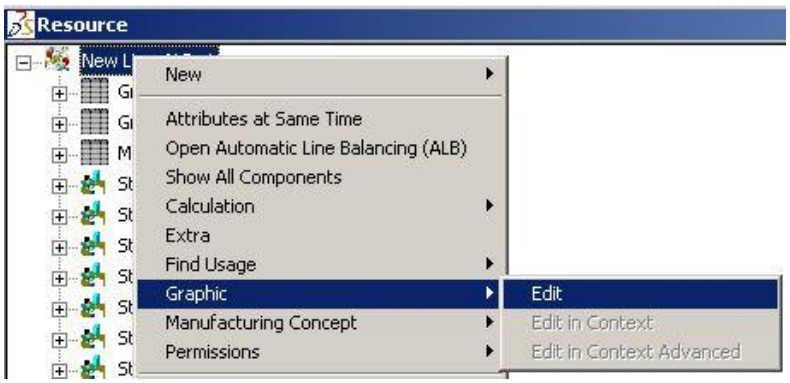


Figure 241: Open Edit Graphic

For more information on the editing of graphic layouts, *please refer to the* Graphic Tools Manual.

7.12.2.1 Views in the Layout

The layout can be displayed in various ways. Three important views for the display are described below.

The views can be set via the tool bar whenever a graphic is open.

Figure 242: Toolbar

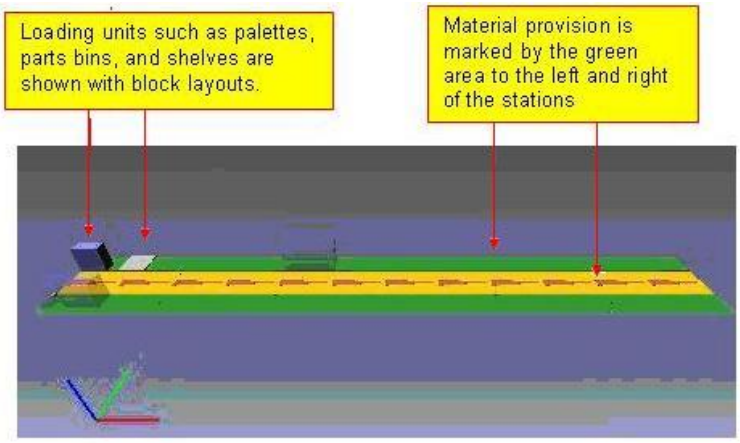


Figure 243: Example of a Layout with Graphic Display – Volume Display

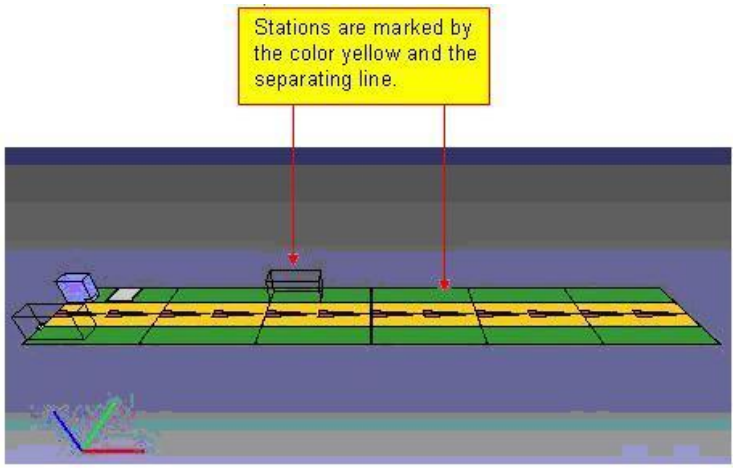


Figure 244: Example of a Layout with a Graphic Display – Wire Model

Display in the top view. The top view is very well suited for the re-positioning of loading units.

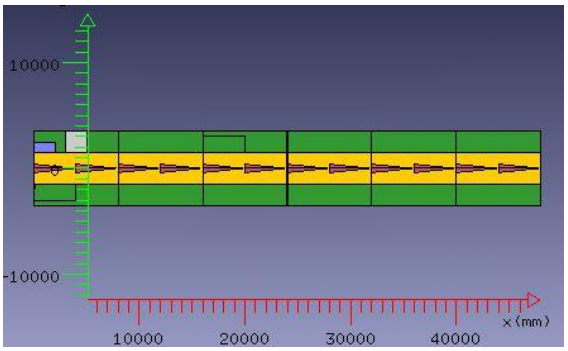


Figure 245: Example of a Layout with a Graphic Display – Top View

7.12.2.2 Edit Loading Units

You can move and delete loading units in the material provision area.

For example, in order to move or delete a loading unit, select the loading unit in the graphic. In order to move a loading unit, keep the control key pressed while moving.

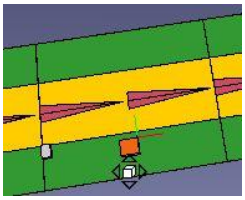


Figure 246: Example of a Select Loading Unit that is being Moved

Note

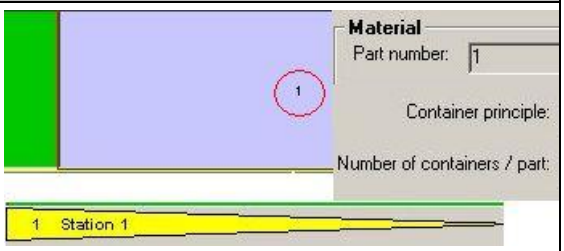
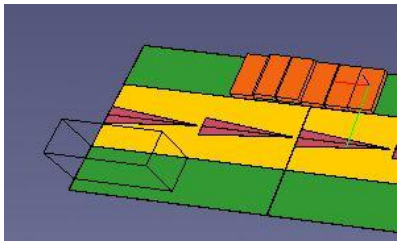
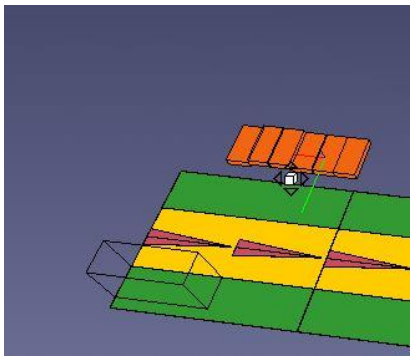
When deleting shelves, the parts bins are not deleted along with them. The parts bins are set to the position of the shelf after the shelf is deleted.

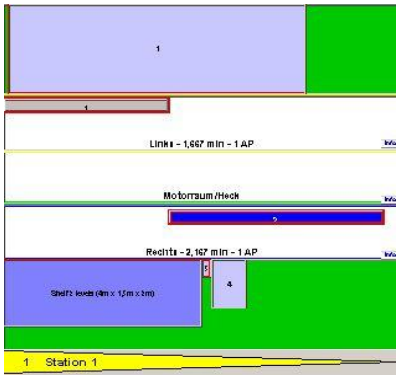
Rules for Moving Loading Units

- Loading units and shelves should be moved only within a material provision area.
- If several loading units are defined for the supply of a part on the line, the complete group must always be moved (**Container bunch**).

If several bins are defined for the delivery of a product *(***Container bunch**), all the part bins must be moved as a group. This process is shown in the table.

Table 3: Example of Moving Several Bins for a Product

Description	Parts bins re-positioning a product via the layout
The six parts bins for the material provision of a product on the line are shown in the performance view as a block.	
After saving the layout and re-opening the ALB, the six parts bins are re-positioned in the performance view.	
If a product is provided in several bins on the line, all of the bins must be moved as a group -- in the example, the six selected orange parts bins. You should move bins only in the station with which the parts bins are linked in a **fixed** manner via the relation. Wire model display mode	

Description	Parts bins re-positioning a product via the layout
After saving the layout and re-opening the ALB, the six parts bins are re-positioned in the performance view.	

7.12.2.3 Editing Stations and Material Provision Areas

Stations and left and right material provision areas can be re-arranged in the layout. These changes are not executed in the layout in the performance view in the ALB.

Note

Stations should not be deleted in the layout.

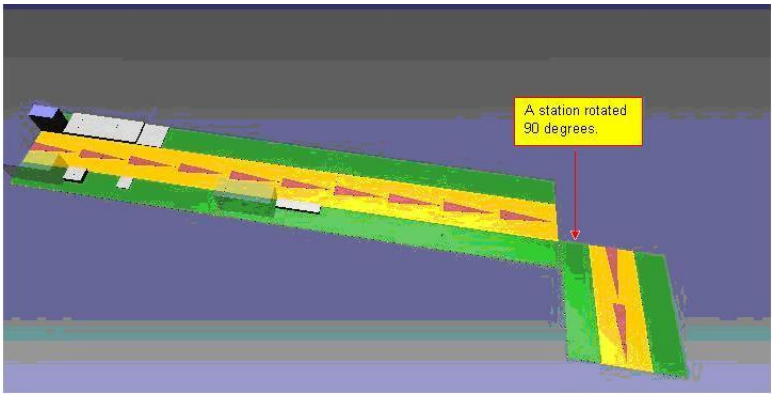


Figure 247: Moving Entire Stations with Material Provision Areas

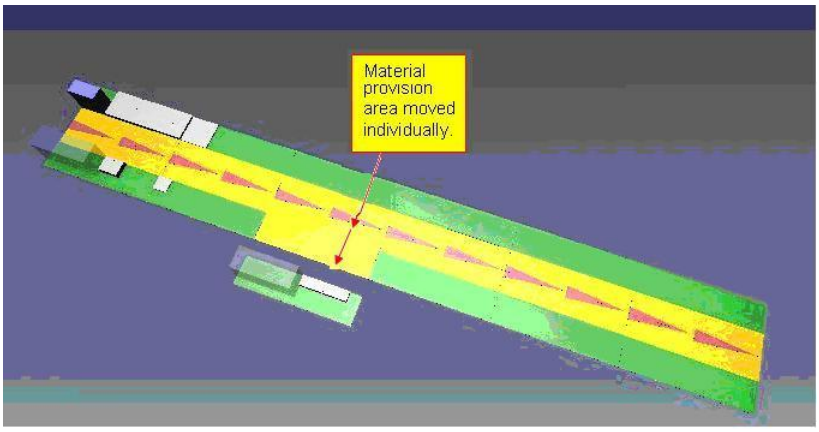


Figure 248: Moving a Material Area

7.12.2.4 Typical Messages after Editing in the Layout

The messages refer to editing steps taken in the layout upon opening the Automatic Line Balancing.

This message appears whenever you move loading units such as parts bins and shelves in the layout.

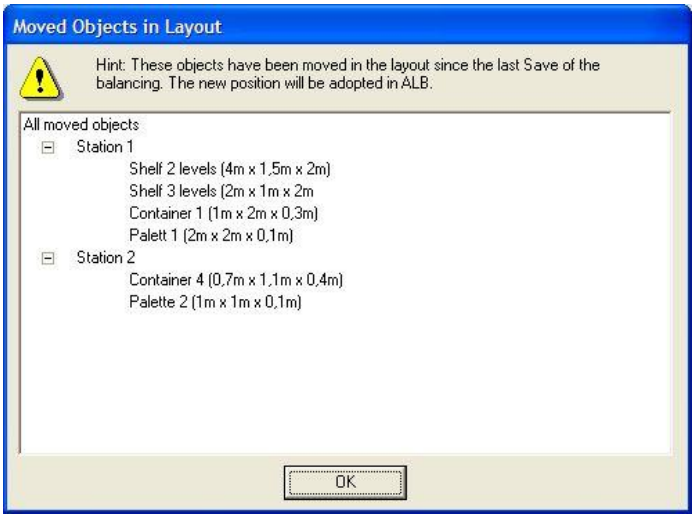


Figure 249: Message Loading units Moved

This message appears whenever you move a parts bin with which a product is provided from a group of parts bins in the layout. *Please refer to the* Table 3.

Figure 250: Message Parts Bin Moved from a Group

7.12.2.5 Show the Fixed Surface in the Graphic

To show the fixed surface in Layout, the **ALB Dummy Partsbin** attribute must be configured for the **Dummy Container** plantype in ALB-configuration.

For more information on ALB-configuration, *Please refer to the* Administration Manual.

The fixed surface is displayed as a two-dimensional box in the layout, according to the planned dimensions for the fixed surface in the material supply dialog – the fixed surface in our example amounts to one square meter. *Please refer to the* Executing Calculation according to a Fixed Surface.

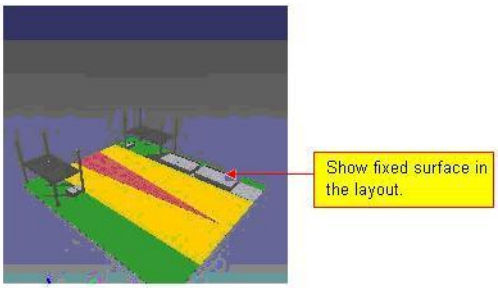


Figure 251: The Fixed Surface in the Layout

7.13 Show Graphic of Parts

From Release PE 5.17 on you can view graphics of parts. This function is only available if you have installed a script.

For further information concerning this script, *please refer to the* Scripting Manual.

1) In order to view the graphic of a part, in the performance view open the properties dialog of a process by double-clicking.
2) Under the Material Supply tab, open the context menu on a part.
3) Then select the menu item **Show Graphic**.

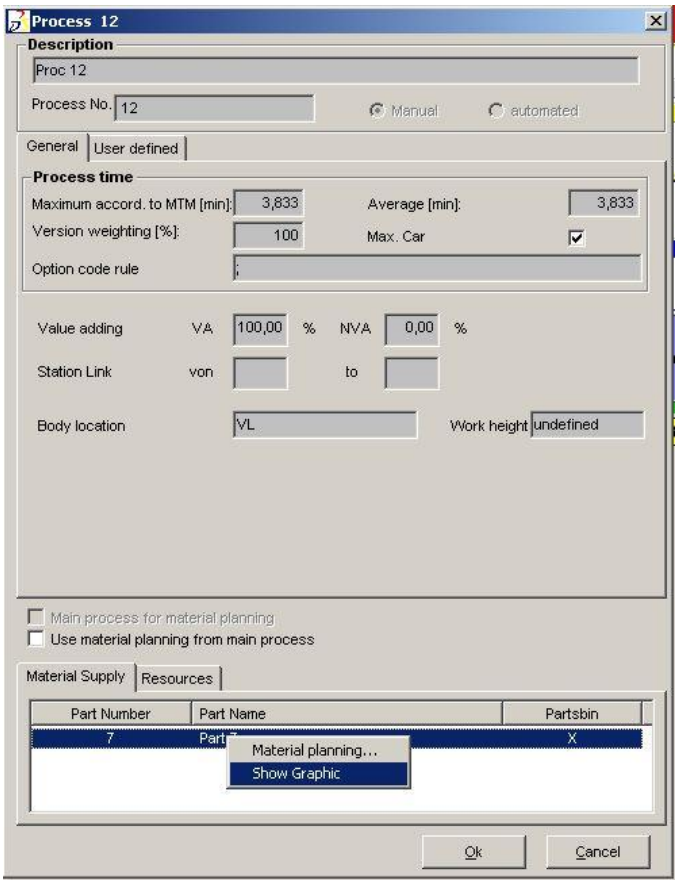


Figure 252: Show Graphic for Parts

Process Engineer opens with the graphic window.

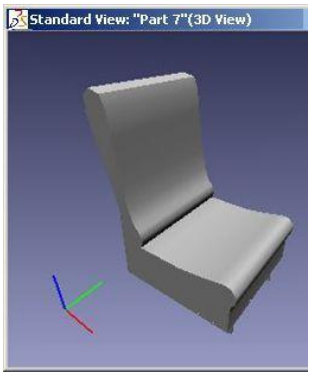


Figure 253: Graphic Window with Part

7.13.1 Planning Alternative Processes in the Process Graph

Identical products are planned on the basis of the same process graph. The customer can choose the equipment for example. for a vehicle. The same vehicle with glass sliding roof is delivered for a customer, and for another customer the sliding roof is made of metal. The processes for this production are as a rule the same. The alternative processes are marked with the relation **Is alternative** in the process graph. Depending on the equipment the product

is supposed to have, the respective alternative process is planned in the balancing process.

- The processes marked as alternative processes mutually exclude each other. Thus only the respective process for the particular equipment feature is planned.

Max. Car ☑

- Alternative processes are displayed in the **hundred-percent display** only if the process is marked as Max. Car in the properties dialog of the alternative process. *Please refer to the* Figure 35.

The following prerequisites apply to the 100% display of alternative processes:

- If several alternative processes are marked as Max. Car, the alternative process that has the greatest process time is displayed in the 100% display.
- The point in time at which the respective processes are planned is determined using frequency.

7.13.1.1 Generating Alternative Processes in the Process Graph

You can generate alternative processes for the same process graph either directly in the process structure of the variants in the PPR-Navigator or in the open process graph. The procedure is the same for both possibilities.

Example of Link in the PPR-Navigator

1) Select the process in the process structure of the variant.
2) Drag the process to the alternative process. Then select the relation **is alternative** in the dialog. Select the same relation in the selection window of the relations in the process graph before linking.
3) Confirm the selection in the dialog with **OK**.

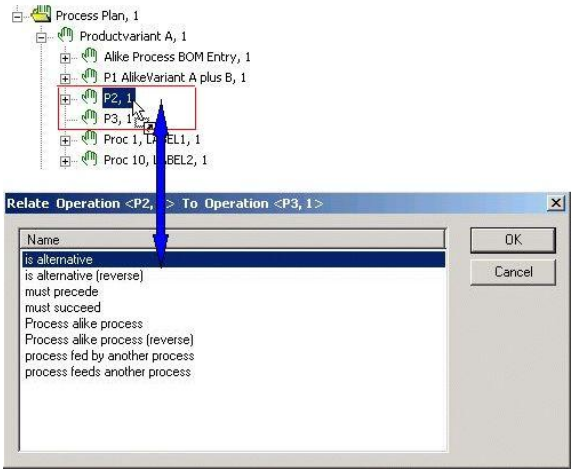


Figure 254: Alternative Processes in the PPR-Navigator

7.14 Context Functions in Automatic Balancing

The context menu functions for automatic balancing are available corresponding to the design. In the context menu, you can add new stations and delete them or edit a workplace.

This chapter will provide you with an overview of the context functions in the Automatic Balancing view.

7.14.1 Opening Context Menu

Context menus are accessed using the right mouse button. There are always two different context menus in Automatic Line Balancing: the Material Supply and the Workplace menu.

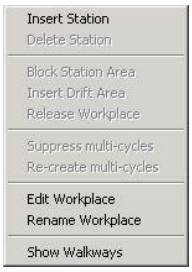


Figure 255: Workplace Context Menu

Example

Example of opening a context menu.

1) Move the left mouse button to the workplace. Then press the right mouse button.

2) The context menu will be opened with the enabled functions. Whether or not a function is enabled in the context menu depends on the function you want to execute and the function you have already executed.

7.14.2 Context Menu for the Workplace

The table (*Please refer to the* Table 4) provides an overview of the procedures during which the *Functions* of the Workplace context menu are active. *Please refer to the* Figure 255.

Table 4: Overview - Table for Active Context Functions - Workplace

Active Context Functions	Descriptions
Add station	This function is always active.
Delete station	This function is active only when no processes are assigned to the station.
Lock station range	This function is active only when no processes are assigned to this workplace.
Set up drift range	This function is active only when no processes are assigned to this workplace.
Release workplace	This function is active only when a workplace is either locked (Lock station range) or a drift range is set up. This function is used to reset the locking of a workplace.
Suppress multi-sequence	This function is active only when a workplace is a multi-cycle machine . This function allows you to suppress a multi-cycle machine.
Restore multi-sequence	This function is active only when a workplace is a multi-cycle machine. This function allows you to restore a multi-sequence.
Edit workplace	This function is always active.
Show process paths	This function is active only when processes are assigned to this workplace.
Rename Workplace	This function is always active, except there are workplaces for which identical body position have been defined.

d

ding, deleting stations

The function **Add station** allows you to add a new station in the Performance Management display adaptation.

A station is always added before the station from which you opened the context menu.

1) Click on the station before which you wish to add the new station.

The function **Delete station** allows you to delete only stations with no processes or containers assigned to. Please refer to the Figure 255.

Locking station range, releasing workplace

The function **Lock station range** allows locking exclusively vacant workplaces. It is not possible to lock an entire station in one go.

The function **Release workplace** allows releasing locked workplaces. Please refer to the Figure 255.

Setting up drift range, releasing workplace

The function **Release drift range** allows to lock work areas from other workplaces.

This function is used when the computed processes to be handled by a workplace for some product variants cannot be completed in the allocated cycle time and the processes thus must be processed in at least two stations for these product variants. This function ensures that no other process can be worked on during this phase at the workplace identified as a drift range.

The function **Release workplace** allows re-releasing the drift range. Please refer to the Figure 255.

Rename workplace

You can name every workplace individually with the Rename workplace function, for example, instead of the car body position; you can select a name for the activity of the workplace.

1) Click on the workplace you want to rename. Then open the context menu and select **Rename workplace**.

- The old name will be shown in the dialog. Type in the new name and confirm the entry by clicking **OK**. The new name is immediately displayed at the workplace.

The functions listed below are described in the following chapters:

- *Please refer to the* Workplace View.
- *Please refer to the* Editing MultiCycles and Suppressing MultiCycles, Restoring MultiCycles.
- *Please refer to the* Show Process Path.

7.14.3 Show Process Path

Two options for material supply need to be considered when simulating the process path between workplace and parts bin:

- An employee fetches the needed parts for each process in work from the parts bin separately. *Please refer to the* Figure 259.
- An employee fetches
  the parts for processes in work from the marked parts bin. *Please refer to the* Figure 258.

Configure the setting in the properties dialog of a parts bin.

In the Automatic Line Balancing walkways are simulated and shown only for one workplace.

- Walkways can only be simulated if a workplace has been assigned processes as well.
- The process of a simulation can be interrupted at any time (press Stop or Break). *Please refer to the* Simulating Process Paths.

7.14.3.1 Marking the Process Path in the Properties Dialog for Material Supply

In properties dialog of a parts bin, mark the parts delivery to the workplace:

- If the option **Part must be fetched from container** is active, the parts for each process from the linked container are marked separately by an individual process path, as before. Therefore, the parts for these processes need to be fetched separately.
- If this option is **not** activated, the process paths of the employee are considered and parts will only be supplied from marked parts bins.

You can open properties dialog also directly in the simulation window Process Paths and modify the marking.

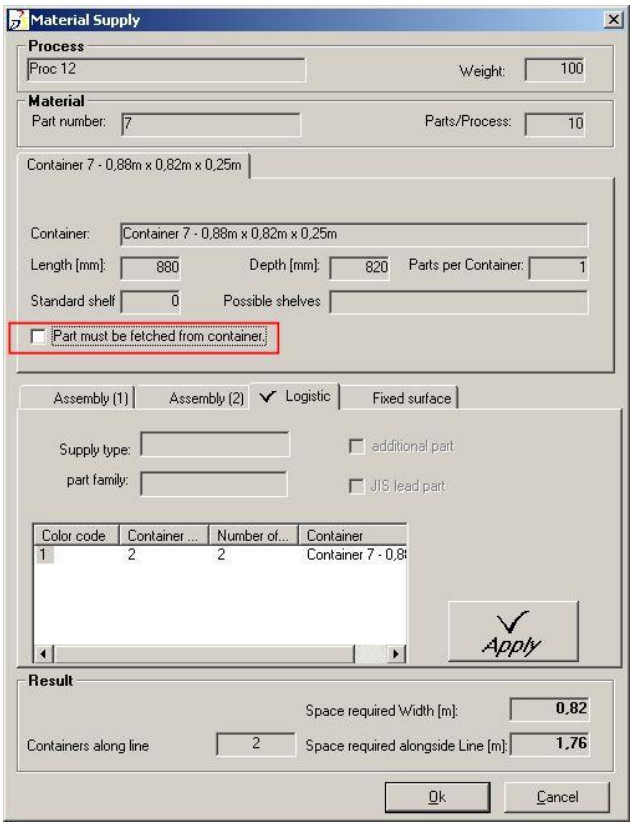


Figure 256: Option – Supply Needed Material

Two examples for determining the process paths will point out the two different options for parts supply. *Please refer to the* Simulating Process Paths.

The first picture mirrors the situation, where a worker fetches parts for each process separately.

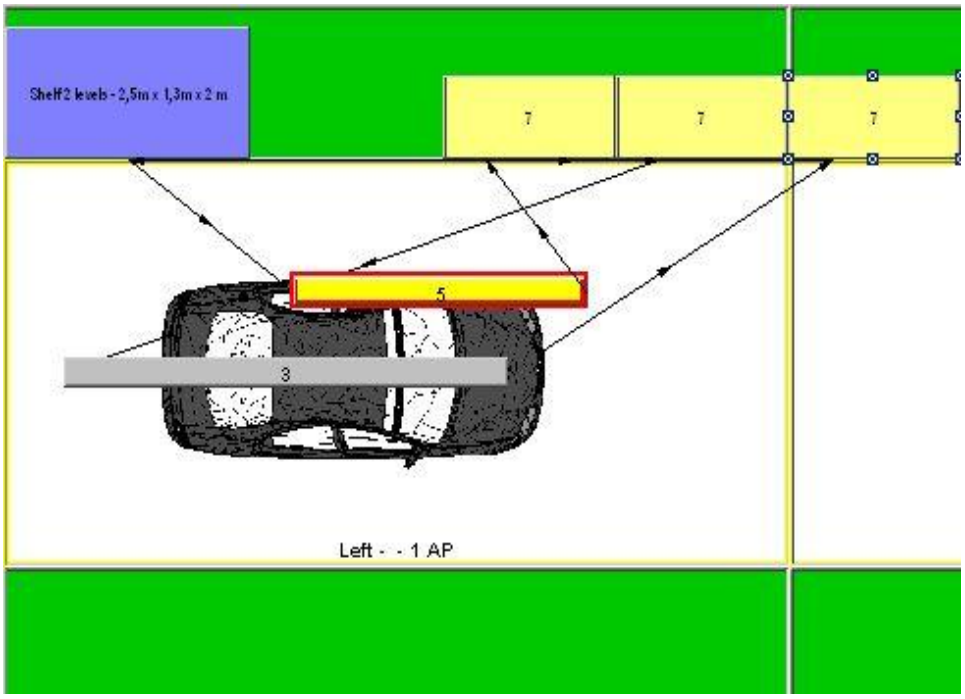


Figure 257: Option is Activated for all Parts Bins

The second picture mirrors the situation, where the option is activated only for particular parts bins. This option allows cutting down on process paths.

The sequence of process paths is marked in the picture. In this example, parts are first supplied for process 3, then for process 5.

After process 5 has been completed, our worker returns to container 7 (position 3) and brings the parts to the starting point of process 3.

The material supply for parts from **parts bin seven** comes mainly from the parts bin, which offers the shortest process path to the workplace. The other two parts bins numbered 7 could contain parts, which are not regularly required for process 3, but only for specific versions. By putting a mark in the properties dialog for Material Supply, you can optimize the process paths.

Note

Using this option you can for example, fetch a number of parts in one process path.

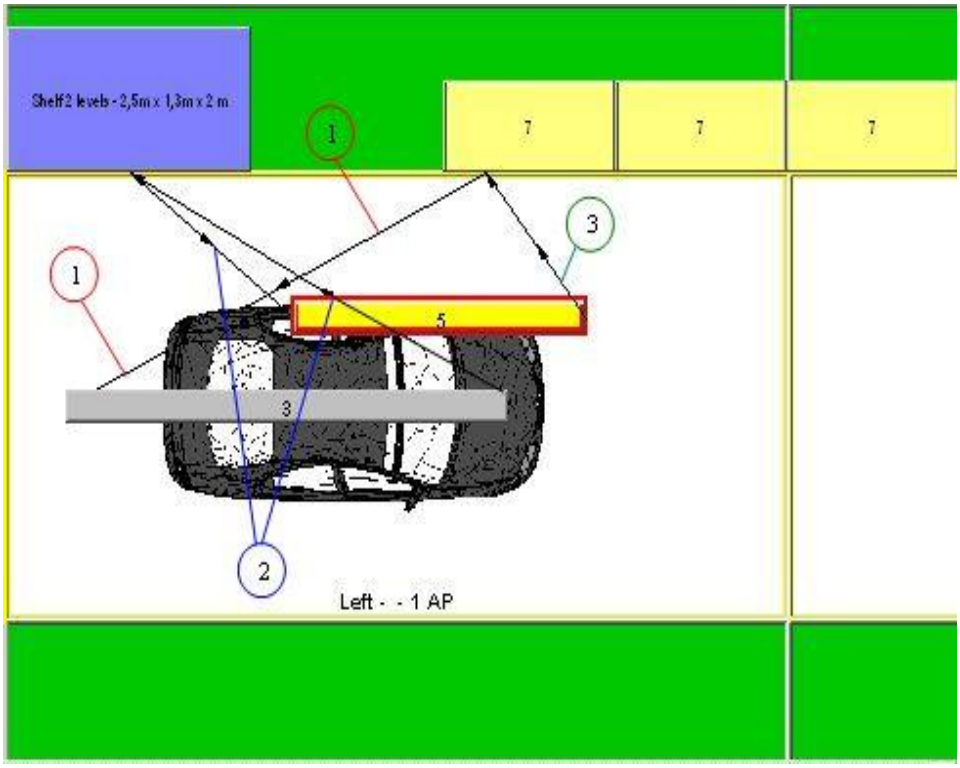


Figure 258: Option is not Activated in all Parts Bins

7.14.3.2 Process Paths of Employee – Parts Bin

The walkways of an employee for the parts transport are calculated as follows:

- The position of a container is fixed for the calculation between the route of a container and the body point. Whereby the centre of the side of the container that is turned towards the conveyor is always used for calculation.

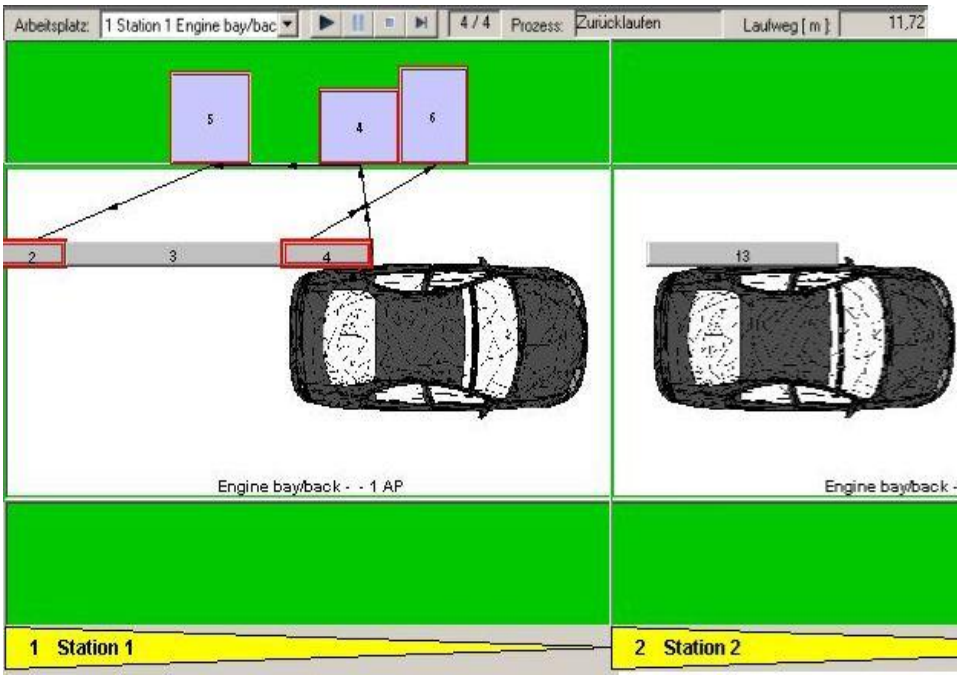


Figure 259: Example for Simulating or Showing Walkways

- The containers are viewed individually and the walkways between the containers are also taken into consideration when calculating.

- The sum of the walkways is shown in meters. The actual walkways are displayed with arrows. The arrowhead shows the direction of the walkways: between the processes and away from or towards the material containers.

- This display shows the current information on the simulation of the process paths and the process to be executed at that point in time. In the example, the last process has been executed and the return to the material container is shown in order to be able to start the work process at this workplace again.

7.14.3.3 Starting Show Walkways

Before you show the walkways of a workplace, make sure once again whether processes have also been assigned to this workplace.

Example

1) Left-click on the workplace for which you want to show and simulate the walkways.
2) Right-click to open the context menu.
3) Click **Show properties** in the context menu to open the simulation window.

All work places will be displayed in the simulation window. In the *Workplace* entry only the workplace is shown where the simulation window has been opened.

In the selection list all workplaces of a station are displayed, including the workplaces to which no processes are assigned. Using the selection list you can select another workplace of this station for the simulation. *Please refer to the* Figure 260.

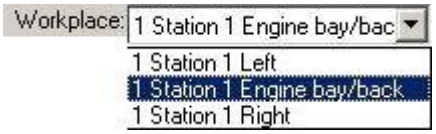


Figure 260: Selection List – Workplaces of a Station

7.14.3.4 Simulating Process Paths

In order to simulate the process paths, use the four icons in the simulation bar. You can run the simulation for the selected workplace all at once or in single steps.

Figure 261: Icons for the Simulation - Simulation Bar

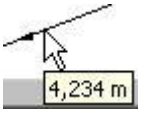
1) In order to run the simulation all at once, click on the icon on the left in the in the simulation bar.

2) In order to run the simulation in single steps, click on the icon on the right in the simulation bar.

- The Break and Stop functions, for example, can be used to get a precise overview of the current situation of the simulation. Using these two functions you can interrupt or restart the simulation at any time without closing the simulation window.

3) In order to interrupt the running of a simulation and then to continue at the same point again, click on the **Pause** icon. Then click on one of the two icons for **Start** in order to run the simulation again.

4) In order to interrupt the running of a simulation and to start the simulation at the beginning again, click **Stop** icon. Then click on one of the two icons



for **Start**, in order to start the simulation again. You can use the Stop function, for example, to select another workplace of the station for the simulation.

5) You can use a tool tip to show the process path in meters. To do this, click on one of the lines of the process paths displayed.

7.14.4 Context Menus for Material Supply

Automatic Line Balancing provides two context menus for material supply:

- The context menu for the material supply area, allowing to lock and release the material supply area of a station.
- For processing of the material containers, such as pallets, shelves or crates.

7.14.4.1 Unlock or Lock Material Supply Area

To lock the material supply area you have two options:

- For free material supply areas
- For occupied material supply areas

There are four menu items in the context menu for locking/unlocking of material supply areas:

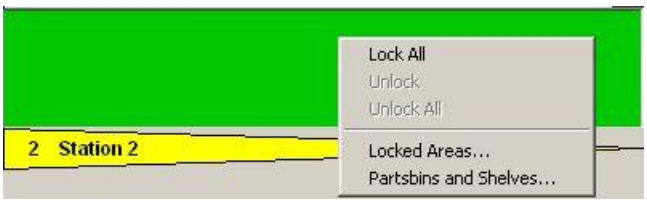


Figure 262: Menu Items in the Context Menu for Locking/Unlocking of Material Supply Areas

- Lock all
- Unlock
- Unlock all
- Locked areas

Context Menu for Free Material Supply Areas

If you open the context menu on a free material supply area, you can initially choose from two menu items: **Lock all** and **Locked areas**…:

- Using the menu item **Lock all**, locks the complete material supply area. This menu item is only active on a free material supply area.
- Using the menu item **Locked Areas**…, locks single areas of a material supply area. *Please refer to the* Figure 263.

1) In order to lock a material supply area, open the context menu on the material supply area.
2) Select the menu item **Lock all**. This locks the complete material supply area.

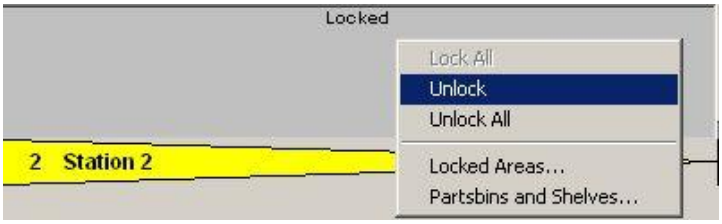


Figure 263: Context Menu for Material Supply Area

3) In order to unlock the locked material supply area, either select the menu item **unlock** or **unlock all.**

Context Menu for Occupied Material Supply Areas

If you open the context menu on an occupied material supply area, only the menu item **locked areas**… will initially be available. As mentioned earlier, using this menu item, locks individual areas of a material supply area – for both occupied and free material supply areas. *Please refer to the* Station Management Dialog.

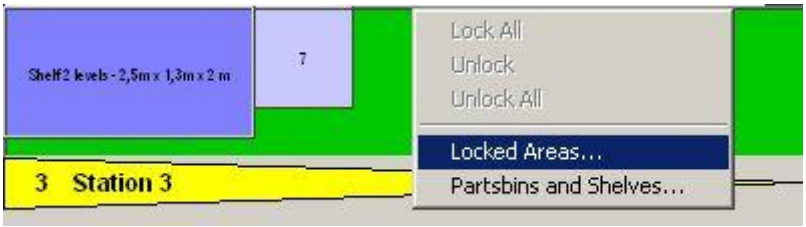


Figure 264: Context Menu for Occupied Areas

You can define areas you want to lock in the dialog Locked Areas for Station.

4) Open the context menu and select the menu item **Locked areas**….

By using **Lock all**, the complete material supply area of a station is locked.

Click **Unlock all;** all locked areas will unlock.

5) Confirm the selection with **OK**.

These areas are marked as locked in the material supply area.

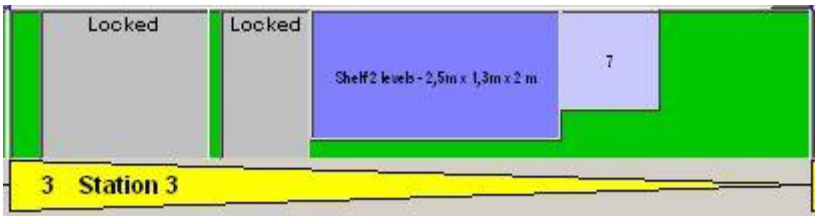


Figure 265: Individual Areas Locked

Unlock Locked Areas Separately

6) To unlock locked areas separately, select the locked area and open the context menu.

7) Select the menu item **Unlock**. If all locked areas are to be unlocked, select the menu item **Unlock all**.

Figure 266: Unlock Individual Locked Areas

7.14.4.2 Creating and Managing Locked Areas

1) Open the ALB Configuration, Right-click DPE project > **Extra** > **Balncing ALB Configuration** > **ALB Customization**. The **ALB Customization** dialog box appears.

2) Specify plantype for the Locked area.

This newly created plan-type would have a parent-child relation with the container area. Once locked areas are created on ALB and saved, these objects should appear in PPR tree as children of container area just like part bins and shelves.

Figure 267: Plantype for the Locked Area

If the resource plan-type is not defined with the plan type-set, then a message comes informing that the Locked area must have a proper plan type defined.

3) Open context menu on the material supply area and select **Locked Areas**. The following dialog box comes.

Figure 268: Dialog Locked Areas

StartX is the start X position in the container area. 100 in above figure indicate that the locked area start from the 100 on X axis.

StartY is the start Y position in the container area. 100 in above figure indicate that the locked area start from 100 in Y axis.

Length indicates how long the locked area is going to be. 4000 indicates it start at (100,100) coordinate in container area and will have a length of 4000.

Width indicates how wide the locked area is going to be.7000 indicates it start at (100,100) coordinate in container area and will have a width of 7000.

Name column takes the name to be given to a locked area. The maximum character length for Name is 1000. There is also length attribute and by default this is set to 64. If the length more than 64 is required, then it needs to be configured using “length” attribute.

With the above settings, the result in the 2D view of balancing looks as shown below:

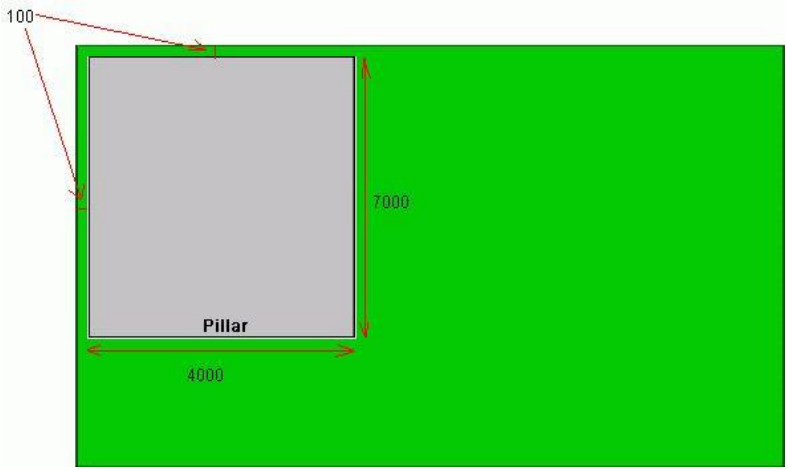


Figure 269: Result in the 2D View of Balancing

4) Save this balancing with above settings, then in PPR tree the locked area object (“Pillar”) appears as a child of container area.

Figure 270: Locked Area Object in PPR Tree

Behavior of Locked Area in Container Area

The locked area is not moveable in balancing 2D view and cannot be placed or moved to outside corner with regard to the Free Placement of Part Bins.

New locked areas can be created by filling more entries in the list view in the locked area dialog box. The positions and dimensions can be changed for a locked area from the respective locked area dialog box. Remove the coordinates in locked area dialog box that would remove the locked area in that container area. For editing a locked area, you can go to locked area dialog box and change the dimensions or location to see the change.

The Snap functionality with regard to “Free placement of part bins” works with Locked areas. The part bins and shelves could be snapped with locked areas.

Collision Detection while Creating Locked Area

There should be check for collision on creation of locked area. Two scenarios exist:

If there is no collision with any of the existing objects in container area, the locked area should be created on the desired place and the locked area dialog box get closed.

If there is collision with any of the existing objects in the container area, then the locked area wouldnot be created and a message comes informing about the colliding object. In this case, the locked area dialog remains open. Information about colliding object contains the name and number of part bin/shelf/locked area and name/ number of parts/shelf if it collides with part bin or shelf or locked area.

Persistency of Locked Area

The locked area object should be persisted in PPR tree as a child of container area just like a part bin or a shelf with a parent-child relation. The information about the length and width is stored on “Length” and “Width” attributes of locked area object .The positioning of locked area with respect to container area is stored on the graphic info object on the parent-child relation of container area and locked area. The “name” attribute on locked area object stores the name of the locked area. While loading, this locked area object below container area in PPR tree is loaded to recreate locked area.

Macros for Container Area and Locked Area

The already existing macro “alb_materialarea_default.makro_es” takes care for both container area and the locked area graphical representation inside DPE. Two new macros, “alb_materialarea_default_new.makro_es” for container area and “alb_lockedarea_default.makro_es” for Locked area, are available and used by ALB for graphic representation of these objects in DPE by default.

These new macro’s are assigned to all newly created locked areas by ALB. The existing locked area macros should not be altered. There is also the possibility to change these macro’s from DPE.

Deletion and Creation of Locked Areas outside of ALB

Creation of locked area objects in PPR tree manually outside of ALB is possible and ALB consider those objects on load routine and display them in 2D view. On loading, there is no check whether a locked area was created manually or by ALB. There is a check whether the locked area fits into this particular container area. If it does not fits or is exceeding the container area bounds, then this locked area should not be considered / created inside ALB.

Deleting the locked area outside of ALB from PPR tree does not have any impact on re-load of balancing. The load does not check for locked area objects which are deleted outside of ALB. Whatever locked area objects are found under the container area object are considered and shown.

Limitation

Previous locked area information is converted and saved according to the new storage model. All reports which take into account the old storage format of locked area’s for displaying their results are affected as the data in old format would be deleted. These reports need to be adapted according to the new model of storage.

7.14.5 Positioning Material Containers

Material containers are always linked to a process. The processes are executed at a body point. To optimize the walkways that an employee has to cover between the material containers and the body point, you can exactly position the containers on the material supply area in the Automatic Line Balancing. The material supply areas are always located on the right and left hand side of the stations.

- Containers can directly be moved and positioned per mouse click or using the context menu functions.

During balancing the Automatic Line Balancing places the containers in the same process sequence as they are assigned to the workplaces.

Containers placed in such a way are not fixed to the material supply area of the corresponding station. This means, for example, that if you move a process to another workplace on the other side of the conveyor or to another

station, the container is automatically moved as well and is placed according to the process sequence at the new workplace.

Using this method, for example, you cannot control whether the containers have been placed in an optimal way compared to the process. Using the context functions you can exactly determine the placement of containers.

Figure 271: Context Menu - Positioning Material Containers

- **Fixed Side means:** You have fixed a container to one side of the two material supply areas of a station.
- **Fixed Position means:** You have fixed a container to one side of the two material supply areas of a station and you have positioned it at exactly one place.
- If you now move a container process with a fixed assignment to another workplace, you can determine beforehand whether this container should be placed at a new workplace of the process or whether it should remain at the old place. *Please refer to the* Figure 278.

7.14.5.1 Fixed Containers are Highlighted

Containers with either a fixed position or a fixed side on the material supply area are highlighted.

- Containers **without fixation** are not highlighted with a colored frame. *Please refer to the* Figure 272.
- Containers that have a **fixed side** are highlighted with a yellow frame. *Please refer to the* Figure 273.
- Containers that have a **fixed position** are highlighted with a red frame. *Please refer to the* Figure 274.

Figure 272: Container with no Fixation – not Highlighted

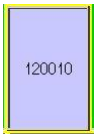


Figure 273: Container with a Fixed Side – Yellow Frame

Figure 274: Container with a Fixed Position – Red Frame

7.14.5.2 Placement of Containers by Mouse-Click

If you place a container by mouse-click, the container is always assigned a fixed position on the material supply area. While doing so it is not important whether a container is repositioned by mouse-click on the same material

supply area or on another material supply area. The container can be positioned directly by mouse-click between two containers, for example.

Note

When moving a container always remember that the process assigned to the container is still executed on the same body point.

Example

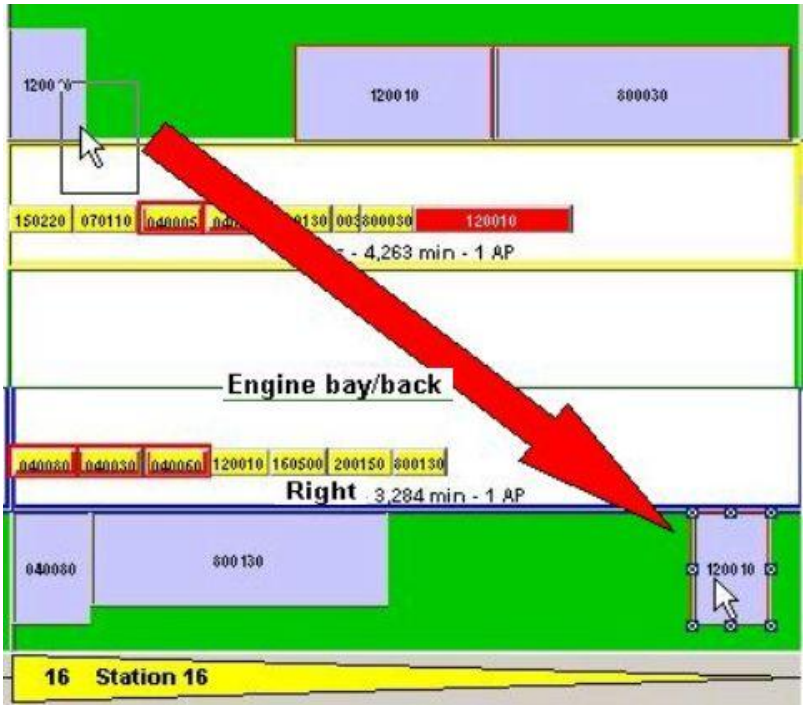


Figure 275: Positioning a Container by Mouse-Click on the Other Side

Proceed as follows:

1) Left-click on the container that you want to move.

2) Drag the container with the mouse to the new position. Release the mouse button. The container is positioned and is always marked with a red frame. In the example the container has been positioned on the other side.

3) Right-click the repositioned container once again; a checkmark is set next to the **Fixed Position** function to show the fixed position.

4) If you disable the **Fixed Position** context function, the fixed position is disabled and the container is moved from the Automatic Line Balancing to the old place again.

7.14.5.3 Context Functions for the Placement of Containers

During the planning process of the material supply for a conveyor you should take the following aspects into consideration:

- Parts that are used for multiple processes and have to be supplied to almost all stations of a conveyor. For these parts it is recommended not to fix the containers to a material supply area. When moving a process, only then do you have the guarantee that a container is also supplied for this process.

- Parts that are only used for certain processes and only have to be supplied to these stations, as in the case of frequently changing product variants, for example. For these parts it is recommended to fix the containers to a

material supply area. Only then are you able to control whether the container is to be replaced while moving the process and whether, for example, the walkways are still optimally specified for the employee when executing the process. *Please refer to the* Figure 277.

Using the context functions you can determine whether a container is to be fixed to a side or only to one side of the conveyor. With the **Switch to other Side** function you can move the container to one of the two sides. Using the **Properties** function you can view the properties of a container, but you cannot edit them.

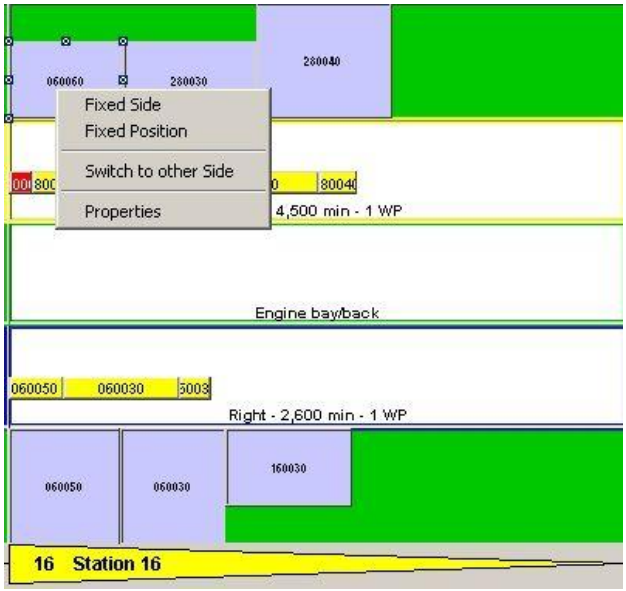


Figure 276: Open Container Context Menu

Proceed as follows

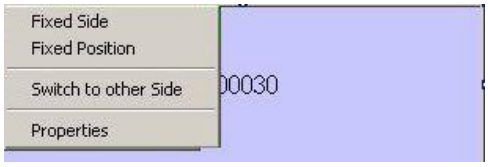


Figure 277: Overview Context Functions – Container

- **Opening context menu:** Left-click on a container and then right-click to open the context menu.
- **Determining Fixed Side:** Click **Fixed Side**. The container is fixed on this side of the material supply area. When moving the corresponding process, the fixation is taken into consideration and the user is asked whether he wants to maintain the fixation.
- **Determining Fixed Position:** Click **Fixed Position**. The container is fixed on this side of the material supply area and is positioned exactly at this place. When moving the corresponding process, the fixation is taken into consideration and the user is asked whether he wants to maintain the fixation.
- **Switching to other Side**: Click **Switch to other Side**. The container is positioned on the other corresponding side of the conveyor. The container is thereby fixed on this side of the material supply area.
- **Opening Properties:** Click **Properties**. The container **Properties** dialog will be opened. The Properties dialog cannot be edited in this mode.

- When moving a process you can decide whether a container with a fixed assignment to a material supply area should be repositioned. An existing fixed assignment for containers is disabled after moving. The containers are placed according to the process sequence at the new place on the material supply area.

Figure 278: Prompt when Moving a Process

7.14.6 Changing Side for Containers using the Process Context Menu

Using the context menu of an assigned process, containers can also be directly placed on the other side. As a rule only one of the two context functions is enabled: The case when containers are assigned to a process that has been placed on both sides of the station on the material supply area is considered an exception.

Figure 279: Overview of Process Context Functions

For containers that are fixed to a material supply area, the same criteria are to be considered as for the container context menu functions (Fixed Side, Fixed Position). *Please refer to the* Positioning Material Containers.

For containers with a fixed assignment (Fixed Side/Fixed Position) you have to first confirm the change of sides of a container. Using the following prompt you can confirm whether a fixed container should really be moved to the other side.

Figure 280: Prompt – Move Fixed Container to the other siDe

Proceed as follows

Containers that have been placed to another side using this function are then fixed to this side. A fixed position occupied beforehand is deactivated.

If you additionally want to assign a fixed position to the container, use the mouse to position the container at this specific place after the change.

If the container should remain in a fixed position at the same place after the change, use the context menu to position the container.

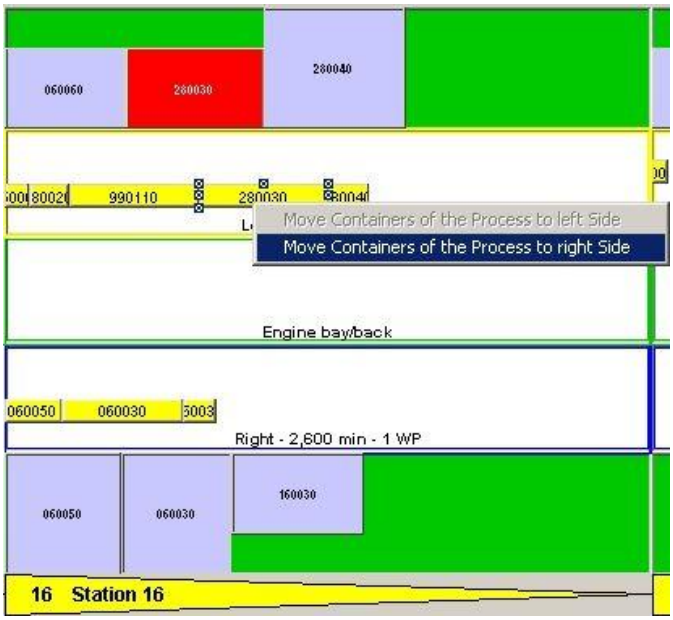


Figure 281: Open Process Context Menu

1) Left-click the process to open the context menu and then right-click.
2) Click one of the two possible entries. *Please refer to the* Figure 281.

7.14.7 Editing MultiCycles

The calculated balancing process will only include MultiCycles, however, if the average default time of one or several processes exceeds the difference between cycle time and way time.

You can generate MultiCycles manually by moving processes using Drag and Drop until the sum of default times and all idle times exceeds the cycle time.

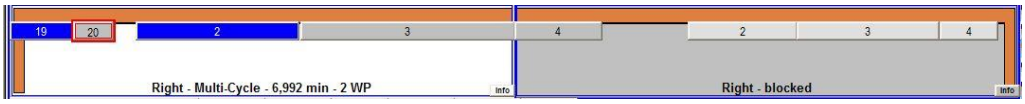


Figure 282: Display of a MultiCycle

7.14.7.1 MultiCycle Options

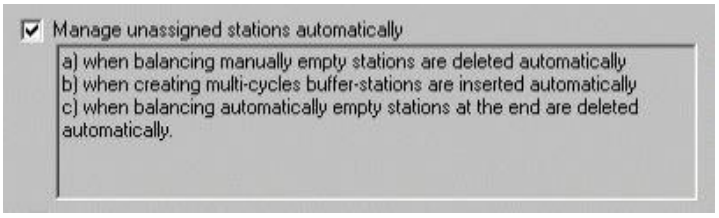


Figure 283: MultiCycle Options

MultiCycles can only be generated with an unassigned successor station.

- MultiCycles will automatically be generated by the program if the *Manage Unassigned Stations* function **is enabled** in the Extras/Options menu. This means that if a succeeding station is assigned in Automatic Line Balancing, the program will automatically generate an unassigned station.
- If the **Manage Unassigned Stations Automatically** function is **not enabled**, MultiCycles can only be generated if succeeding workplaces are not assigned and the station type (automatic/manual) is suitable.

- You can quickly solve this problem, however, by manually inserting an extra unassigned station.

7.14.7.2 Suppressing MultiCycles, Restoring MultiCycles

Using these two context functions, you can suppress and restore a MultiCycle. *Please refer to the* Figure 255.

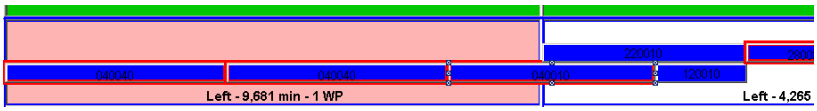


Figure 284: Display of Suppressed MultiCycle

8. Advanced Features of Automatic Line Balancing

The result of Automatic line balancing is saved in the database. The database thus incorporates a function for provision of data. **V5** and **E5** applications may access the data saved in the database and process further the results of Automatic line balancing.

8.1 Planning Resource-Related Processes

TSA processes are resource-related processes. In V5 only processes of this type can be displayed and used for resources.

What is the purpose of TSA processes?

During Automatic line balancing, the stations and workplaces for processes are found on the basis of a process plan (precedence graph). In V5 the results found can be represented by means of Behavior processes and TSA processes. TSA processes created by the Automatic line balancing are copies of actual processes which are automatically generated during balancing. Behavior processes are needed in V5 for representation of TSA processes for resources with workplaces.

ALB is a workflow-based balancing module: stations and workplaces are found on the basis of a process plan (precedence graph), which is set up in E5. The process plan thus determines the planning of processes.

To guarantee the consistency of the balancing results, changes in the process data of processes belonging to a process plan that has been used for balancing can only be made in E5. Such changes only are considered for balancing.

Note

If you change the TSA data, such as times, in V5, the changed data will not be considered in the Automatic line balancing. Such changes are irreversibly lost in the next Automatic line balancing for the process plan.

Initial Situation: Process Plan with Processes

The basis for Automatic line balancing is the processes of a process plan; the stations and workplaces for it are found.

Note

TSA processes are copies of the actual processes; they are created during Automatic line balancing to allow display of these processes in V5 for the resources (stations) with workplaces found. ALB links these TSAs to behaviors, according to the BiW data model.

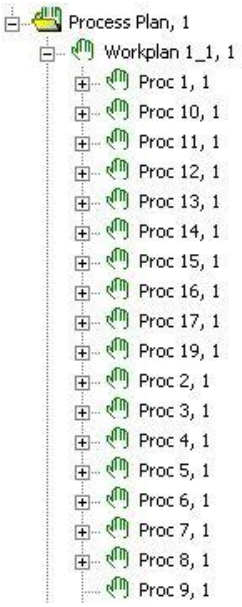


Figure 285: Process Plan with Processes

Automatic Line Balancing Result Displayed in E5 PPR Navigator:

The respective workplaces and stations for line 007, as shown in the tree structure in the PPR Navigator, have been created in this example. The TSA processes are displayed at the individual workplaces in the tree structure, under the Behavior processes (New DNBBehavior), such as the TSA processes **Proc 19, Proc 2**, and **Proc 20** for **Workplace 2, right**.

Processes are performed by machines and workers. ALB determines the required number of workers and assigns these workers to the workplaces of the stations. The workers found are linked to the workplace and all TSA processes of this workplace, as is evident from the tree structure here shown. Workers are found only for workplaces to which processes have been assigned.

In PPR Navigator, the result of the Automatic line balancing is shown with the Behavior processes and the TSA processes.

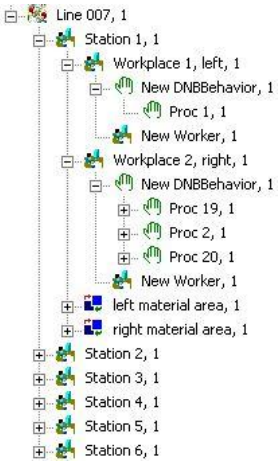


Figure 286: Result of Automatic Line Balancing in PPR Navigator

Results of Automatic Line Balancing in V5 are Displayed in the PPR Tree

As in the PPR Navigator, after opening of the project in V5, you can display the results in the PPR tree. The structure corresponds to the tree structure in PPR Navigator.

The result of Automatic line balancing for **Line 007** is displayed in the PPR tree in V5:

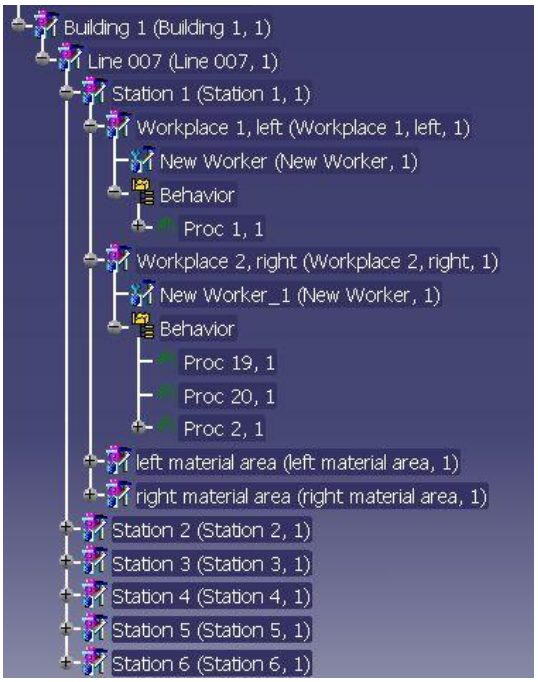


Figure 287: Displaying the Result of Automatic Line Balancing in V5

Note

If you change the position of load carriers in the layout of the V5 application, such changes are considered during Automatic line balancing.

8.1.1 Supplying Data for Provision of Part Bins

Suppose, for instance, that you want to know which parts are in part bins at which workplace. To get this information, ALB creates a logical part bin. Logical part bins are placeholders used to get data concerning part bin usage.

With the aid of logical part bins data concerning part bin usage is saved during Automatic line balancing and can then be displayed in **E5** and **V5** in the properties dialog of the logical part bin.

Having created a Balancing in ALB, the stations, workplaces and material areas with part bins and logical part bins are shown in the PPR Navigator.

The figure shows a Balancing created in ALB including stations, workplaces and material areas. As is seen in the picture, the logical part bins and the load carriers (e. g. a palette) are linked to the tree structure of the material area by means of a **parent child** relation.

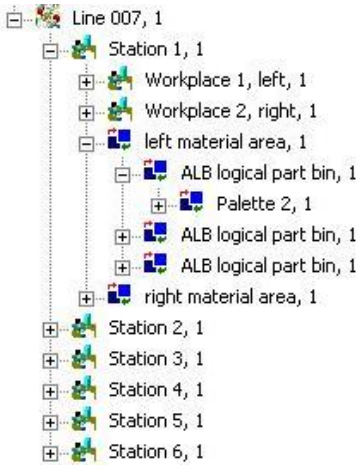


Figure 288: Tree Structure of a Work Load Balancing in the PPR Navigator

Load carriers as well as part bins are linked to the material area by means of a logical part bin. Logical part bin contains textual information about the part that is hold in the part bin and the processes that are using this part bin.

The following R18 Data model shows the relationships **Station < Workplace < Material Area < Shelf < Logical part bin < Part bin.**

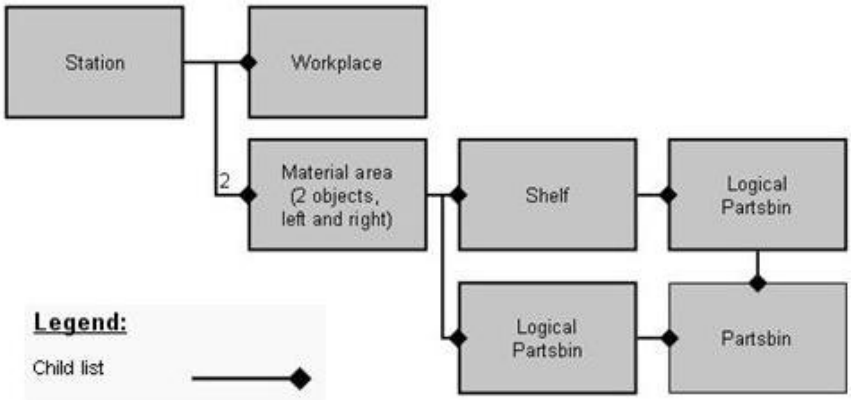


Figure 289: R18 Data Model, Section Station – Part Bin

8.1.2 Showing Part Bins in V5 DPM

ALB link the part bins under the material area objects of a station and to the shelves. by a parent child relation. This helps to show the layout of the line correctly in Process Engineer and in V5 DPM.

Part bins are linked as children to the material area and to the shelves. The layout of the line is displayed correctly in V5 DPM

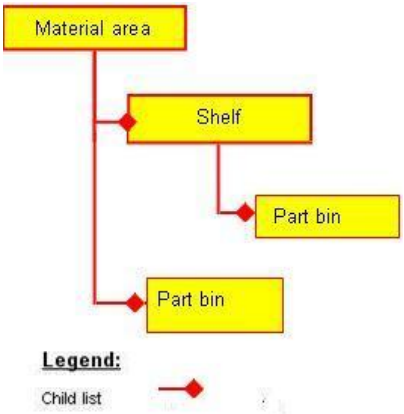


Figure 290: Data Model with Parent Child Relations between Material Area/Shelves and Part Bins

8.1.2.1 Displaying Part Bin Usage in E5 and V5

In **E5** as well as in **V5**, part bin usage is displayed by means of the properties dialog of the logical part bin.

The data for part bin usage must be determined beforehand in the ALB configuration. In the present example, the usage data is displayed under the part bin usage tab.

For more information on configuration of the part bin usage data *please refer to the* Administration Manual.

In addition to the usage data shown in the present example, you may configure further attributes:

- For example, the list of part bin identification numbers

Displaying Data

The Part Name and Part Number fields display the name and the number of the part that is provided in this part bin. In the List of Processes field, all processes are displayed which are linked to this part and the part bin.

1) To display the part bin usage data, open the context menu on the logical part bin.
2) Select the respective tab; in the present example it is “Part Bin Usage” in the properties dialog.
3) The usage data is displayed depending on the attributes configured.

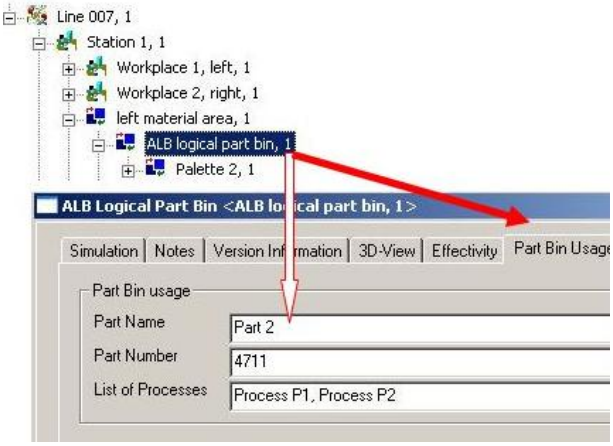


Figure 291: Displaying Part bin Usage Data

8.1.3 Free Placement of Part Bins

Now, ALB supports placing of part bins in several rows and you can do the following:

1) Place Part Bins in second and subsequent rows or outside corner
2) Rearrange Part Bins of a material when too many changes are done.
3) Mark in consistent material areas for clear reporting
4) Snap of Part bins for easy placement

8.1.3.1 Place Part Bins in Outside Corner or Second Row

You can place the part bins in outside corner or second and subsequent rows when opening a new or old balancing, when moving processes within and across stations, and when moving part bins within and across stations and it does not destroy the previous planning. Shelves can be placed similarly. There is one outside corner for every material area which mean a total of two outside corners for every station. This holds all the un-positioned part bins and shelves.

The following settings in **Parameter for Automatic Balancing** (Figure 22) dialog to enable to place the part bins in outside corner or second or more rows. The following settings are applicable for a line i.e. each line can have different values for these options.

- **Free Placement of Part Bins**: Select this checkbox to enable free placement of part bins. By default this is unchecked.

If a saved balancing with new material planning is opened and if this option is unchecked, the new planning done in all the material areas will be destroyed and material planning according to old approach will take place.

- **No. of Rows per Material Area**

You can mention number of rows in this field. The least would be one row. ALB can create as many rows as possible but if no more space is available in the container area then it will place them in outside corner.

- **Walkway between Rows**

You can enters the desired space here between any of the two rows.

Note

*If setting for **No. of Rows per Material Area** and **Walkway between Rows** is changed for an existing balancing, the planning in all the material areas will not be destroyed. These settings will be used when you manually start the rearrangement of material area using command **Rearrange Material Area** or does an automatic balancing using **Recalculate**.*

- **Snap part bins when at distance [m]**

A container say *A* when dragged close to another container say *B*, such that the distance between them is below the mentioned distance in this setting, then the container *A* will be snapped to container *B*.

- **Mark Inconsistent Material Area**

Select this checkbox to mark the inconsistent material areas of the balancing with selected color.

Example

Figure 292 shows the part bins when you select mode **Subsequent rows** and opens a new balancing and chooses automatic balancing algorithm.

Let the selected rows be 2. So there will be two rows maximum per container area.

While Automatic balancing runs (opening a new balancing), if there is no space in the first row after part bin 3 in the right side material area, the part bins are placed in second row in this case. After second row is exhausted and since the settings had only two rows specified, there will be no more rows whether or not there is availability of space in container area and the rest of the part bins will be placed in outside corner.

Outside Corner holds excess part bin groups of a container areas of a station and every container area will have one of its own as shown above. This scenario only show the excess part bins from the right container area. So basically a particular outside corner holds un-positioned part bins of this container area.

When **No. of rows per material area** selected is 1, there would be no second or more rows and all the subsequent part bin groups which cannot be placed in the first row will be directly placed in outside corner as shown in Figure 293.

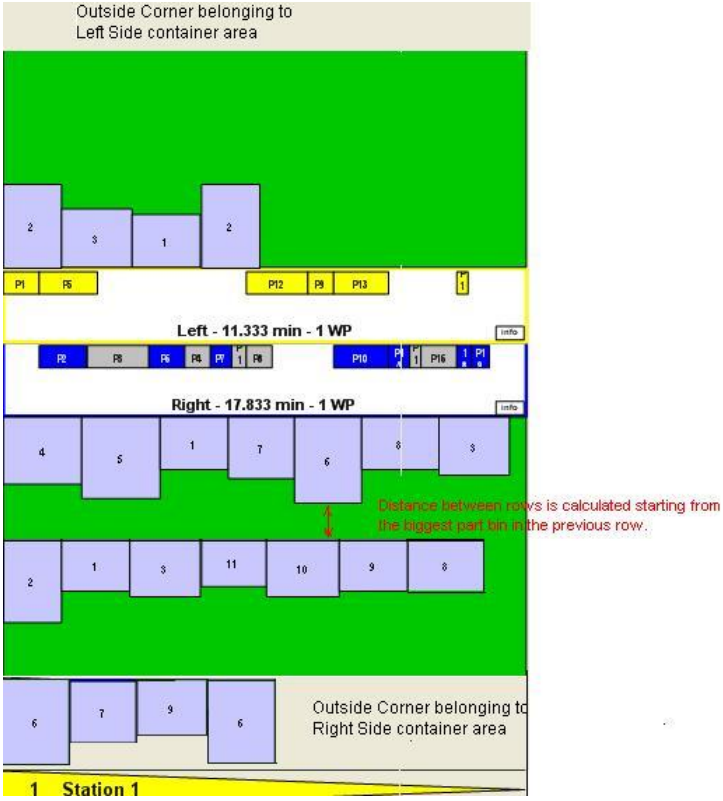


Figure 292: Part Bins with Subsequent rows mode

When **No. of rows per material area** selected is 2, the part bins will be placed in first row and then in second row if second row is possible and those which cannot be accommodated in both rows will go to outside corner.

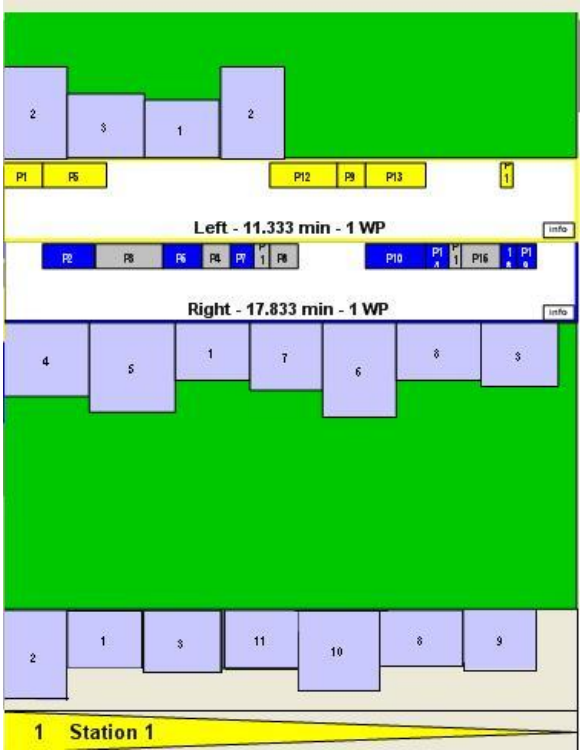


Figure 293: Part Bins in Outside Corner

The above figures, display part bins only in outside corner of right side container area. Similarly there is outside corner for left side container area.

Outside Corner

This is a mere place holder to keep un-positioned part bins of a material area.

The width and length of outside corner on the screen will not exceed width and length of material area and will be same as that of material area.

There will be direction arrows in the outside corner when all the part bins or shelves cannot be shown in the outside corner due to space constraint.

Twelve part bins are to be shown in the outside corner but the space is only for the first 9 as shown:

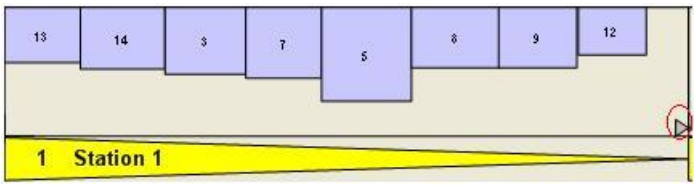


Figure 294: Direction Arrows in the Outside Corner

There will be one right side arrow in outside corner to see the ones that are not visible. When clicked the result is like this: there will be a left side arrow to go to see the previous part bins.

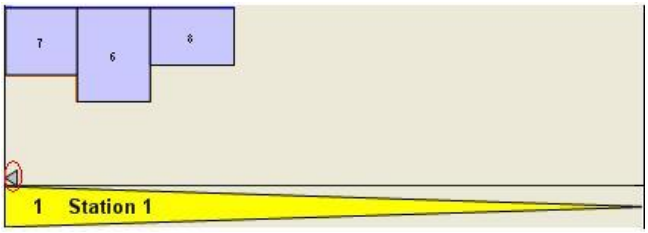


Figure 295: Right Side Arrow in Outside Corner

The arrows in the outside corner serve the purpose of showing the part bins or shelves which cannot be accommodated all at the same time and are not visible. When clicked on arrows the part bins and shelves which are not shown will be shown in respective directions.

If a part bin or a shelf is removed from outside corner, then remaining right side part bins or shelves will automatically be shifted left thus filling its space.

Drag and drop functionality willl not work as was working in container area. When a container is dragged and dropped from one location to outside corner , then the container is placed in the last.

Position in outside corner and all the part bins will be shifted to fill the empty space. Outside corner will have the same depth and width as that of its material area and there is no user interface to change the length and width of outside corner.

Outside cornert will be created with the same width and length of its container area and shall only hold the excess containers. On close of balancing, all outside corners will be destroyed and on reopening will be again created to hold the containers.

Changes in Contextual menu's:

- **Part bin Contextual Menu**: The options **Fixed Side**, **Fixed Position**, and **Switch to other side** are removed in the event of free placement of part bins (Figure 150).
- **Shelf Contextual Menu**: The options **Fixed Side**, **Fixed Position**, and **Switch to other side** are removed in the event of free placement of part bins (Figure 151).

Note

*There will be no red border any more for a displaced part bins as there is free placement and there is no **Fixed position**.*

Placing of part bins in outside corner takes into account the following scenarios:

Moving a process from one workplace to another (within a station)

If the process is moved to a workplace that uses the same material area, the associated part bin groups will not be updated.

For destination material area: If the process is moved to a workplace that uses another material area belonging to the same station, then the part bins will be placed in the outside corner of destination material area.

Regarding Shelf's creation or usage in outside corner in this moving process, depending upon the **Manage Shelves Automatically** settings (Right click on Project in DPE >**Extra** > **Balancing ALB Configuration** > **General Settings** > **Balancing** > **Manage Shelves Automatically**), there will be two different behaviors:

- If **Manage Shelves Automatically** is unchecked, the part bins will not be moved into any shelf automatically nor will there be a new shelf created automatically.
- If **Manage Shelves Automatically** is checked, a fitting new shelf will be created in outside corner of destination material area or an existing shelf in the outside corner of destination material area will be used and the part bins will be placed inside automatically.

For source material area: If the part bins are moved from material area, then empty space will get created and there will be no automatic adjustments of part bins. If part bins are removed from the outside corner, then the remaining part bins will automatically adjust themselves thus filling the space left by the moved part bins.

Regarding Shelf's deletion or usage in this moving process, depending upon the settings **Manage Shelves Automatically** there will be two different behaviours:

- If **Manage Shelves Automatically** is checked, the empty shelves will be deleted automatically from the material area.
- If **Manage Shelves Automatically** is unchecked, then all existing shelves will remain in material area or outside corner and will not be removed automatically even if it is empty.

Moving a process from one station to another

If a process is moved from a station to another station then following effects take place:

For destination station: The part bins will be placed in the outside corner of destination material area.

For source station: The related part bins will follow the process and will be removed from the source station material area or outside corner. There will be no other action in the material area. After this part bins be moved, there will be a gap at their location and no other part bin/shelf will be adjusted automatically. If the part bins are moved from outside corner then the remaining part bins will automatically shift to left thus filling the space of the moved part bins.

Regarding Shelf's creation or usage in outside corner in this moving process, depending upon the settings **Manage Shelves Automatically** there will be two different behaviors for source/destination stationsas similar to Moving a process from one workplace to another.

Moving a part bin group inside a material area, at a valid position without collision

When a part bin is moved in same material area at a valid position, it will be placed inside at the target position if it is not colliding with other part bins or shelves or locked areas. There will be an empty space created at its original location. There will be no automatic adjustment or re-arrangement of other part bins.

Moving a part bin group inside a material area, colliding with another part bin group or shelf or locked area

When a part bin is moved in same material area at a position where it collides with other part bin groups (PBGs) or shelf or locked area, it pops back to its original position.

Moving a part bin group to another material area, at a valid position in same/another station

When a part bin is moved in another material area of the same station, it will be placed at the target position if it is not colliding with other part bins and shelves of that material area.

There will be an empty space created at its original location. There will be no automatic adjustment or re-arrangement of other part bins in both source material area and target material area.

Moving a part bin group to another material area, colliding with another part bin in same station/another station

When a part bin is moved in another material area of the same station at a position where it collides with other part bins, it pops into the OC of the target material area.

Moving a part bin group in a shelf inside same/another material area

If a part bin is moved inside a shelf in the same material area, it will be placed inside it if enough space is available in shelf to accommodate it. There will again be an empty space created at its previous location and there will be no automatic adjustment or re-arrangement of remaining part bins.

If there is not enough room for it in shelf, then it will pop into the OC of target material area.

Adding a product variant to a balancing

When a product variant is added to an existing balancing and the algorithm is chosen, then, the algorithm balances all the processes that already exist in balanced product variant. All the new part bins associated with newly added product variant will get automatically placed in the outside corner so as not to destroy any already planned material area.

Regarding shelves creation or usage in outside corner, there will be two behaviours:

- If **Manage Shelves Automatically** is not set, the part bins will not be moved into any shelf automatically nor will there be a new shelf created automatically.
- If **Manage Shelves Automatically** is set, a fitting new shelf will be created or an existing shelf will be used and the part bins will be placed inside automatically.

When you use filter to display the variants, part bins which are seen material area are filtered. When second variant is added, the part bins will be placed in outside corner. If you use filter option before planning these part bins, the material area will be shown as empty.

Loading of Balancing where part bins are added outside of ALB

When an existing balancing is loaded and one of the balanced processes has got a new part or an existing part has got a new part bin, a new part bin will be created by ALB and it will be positioned in outside corner of the particular material area belonging to process.

Regarding shelves creation or usage in outside corner, there will be two behaviors:

- If **Manage Shelves Automatically** is not set, the part bins will not be moved into any shelf automatically nor will there be a new shelf created automatically.
- If **Manage Shelves Automatically** is set, a fitting new shelf will be created or an existing shelf will be used and the part bins will be placed inside automatically.

Loading of Balancing where part bins are removed outside of ALB

When an existing balancing is loaded and one of the balanced processes has its associated part-bin group removed, ALB will remove this part bin from balancing (from material area or outside corner). If it is removed from material

area, there will be an empty space for its position and there will be no automatic adjustments or re-arrangement of other part bins. If it is removed from outside corner, other part bins will be realigned and re-arranged by ALB and there will be no empty spaces.

Regarding Shelf's deletion or usage in outside corner, there will be two different behaviours

- If **Manage Shelves Automatically** is set, the empty shelves will be deleted automatically from the material area.
- If **Manage Shelves Automatically** is not set, then all existing shelves will remain in material area and will not be removed automatically even if it is empty.

Recalculate of Balancing

On **Recalculate**, the base data dialog will pop up subsequently and according to the options selected the whole balancing will be automatically balanced by ALB. All the previous planning will be lost. All the material areas will be reset and re-arranged or re-calculated according to the selected options including the outside corners.

If **Free placement of part bins** option (Figure 22) is selected then the material areas will depict multiple rows planning with outside corner.

If **Free placement of part bins** is not selected then old planning will run and there will be no multiple rows planning and outside corner.

Behavior of part bins with Merging

Different Logistic modes now consider only the container area for material planning. With this new enhancement, the logistics mode will continue to run in the same way as was running before and the duplicate part bins will be merged and shown in the same way.

The part bins which are assigned to outside corner belong to its corresponding container area. The only information missing is the positioning of part bins placed in outside corner. For merging of part bins, ALB will see container area and outside corner as one entity and all the part bins belonging to either of them will be considered as belonging to only container area. Therefore, the merge shall take place in outside corner too as if part bins were standing in container area.

There is one change in the behaviour. Previously if a part bin A1 was moved in a container area having same part bin A2, one would get invisible (A2) while the other will still be shown (A1) depending on a particular merging mode. If again this duplicate part bin (A1) is removed from the container area, the invisible part bin (A2) gets visible again at the same place where it was before. Now with the new enhancement, the part bin A2 would be visible but will be moved to outside corner of that container area.

Save problem in ALB when part bin name includes more than 1000 characters

When the balancing is saved in ALB, the information about the parts which are merged is saved on the attributes of logical part bins as given below.

attribute_20 – Names of Merged Parts

attribute_21 – Part Number of all merged parts

attribute_22 – Names of Related Processes

attribute_23 – IDs of TSAs of Related Processes

attribute_24 – IDs of all Parts Merged

attribute_25 – ID of Part Bin

If the number of part bins which are merged is more, then some strings may exceed 1000 characters.

In this case, you would get the following error message when you try to save the balancing in ALB.

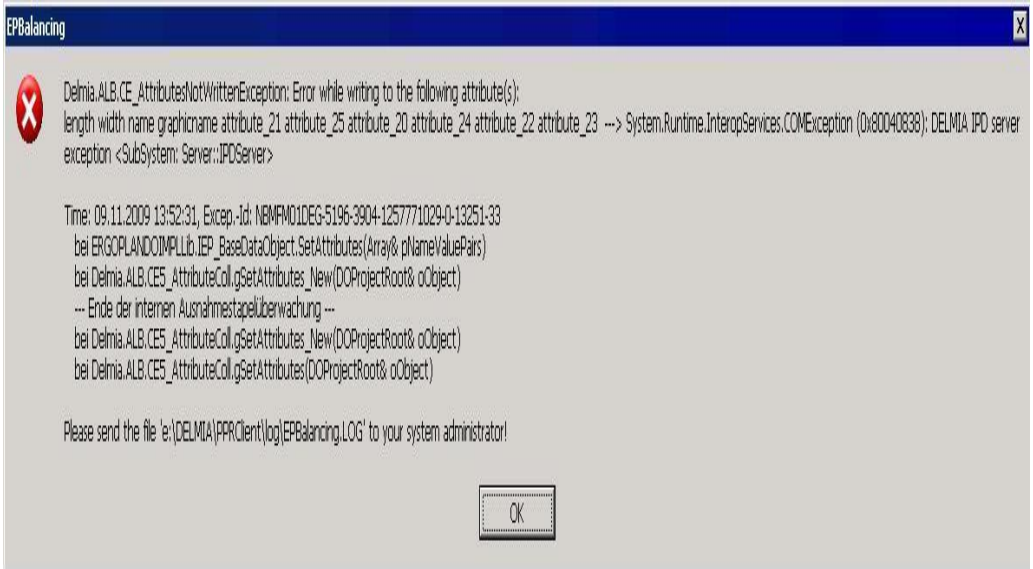


Figure 296: Error Message when String exceeds 1000 Characters

When you get this error message, please contact IT Oracle DB Administrator and request them to increase the Oracle attribute value size to be greater than 1000 (maximum possible value is 4000).

The Oracle DB Administrator might need to contact DELMIA Support to obtain the right procedure to make the change in setting.

Considerations regarding Persistency

Part bins in outside corner will be saved just like part bins in material area and there will be no difference apart from their different positioning. One possible option for this position might be 0/0/0.

Removing part bins from Shelf

When a part bin is removed from a shelf, it will go directly to the outside corner of the shelf's container area. In this process, if the shelf becomes empty, then according to the option **Manage Shelves Automatically**, the shelf will be removed or will be allowed to stay.

Creating Locked Areas in material area

The locked areas can only be created at the user defined place if there are no containers present there. In a planned material area, if the space is available then only the locked area will be created otherwise it will not be created which will be followed by a message box saying that it is not possible to create. There will be no automatic adjustments of positions of containers while creating locked area.

"Move Containers of the processes to left /right side" contextual menu of process

On selecting this option in the contextual menu of a process, all the part bins and shelves belonging to the process will move to the outside corner of destination container area.

For the source container area, if the containers are moved from container area, there will be empty space and no automatic adjustments of remaining containers whereas if containers are moved from outside corner, the remaining containers will be adjusted automatically by ALB.

For destination material area, the moved containers will move to outside corner.

Deleting a station

Deleting of a station require the outside corners belonging to its container areas to be empty.

There should be no element in the outside corner now for delete of station to work.

Part bins and Shelves" in contextual menu of Container area

Selecting this option pops up a dialog with listing of all the part bins and shelves for the container area.

It will continue to show the information of part bins and shelves from container area. Button **Outside Corner Information** in the dialog to show information of part bins and shelves from outside corner of that particular container area.

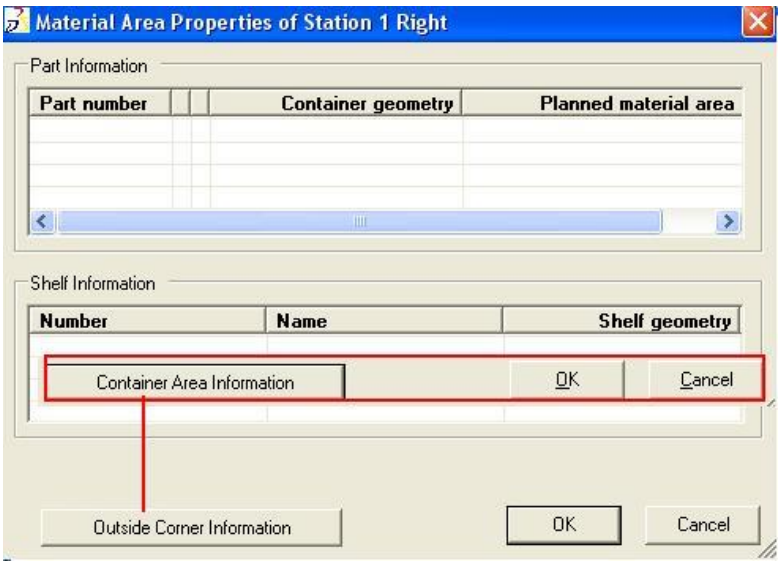


Figure 297: Listing of all the Part Bins and Shelves for the Container Area

Clicking button **Outside Corner Information** change the button text to **Container area Information**.

Now clicking again will display the part bins and shelves information of container area. The same button works for showing information for both container area and its outside corner.

The button **Outside Corner Information** appear disabled when there will be no containers in outside corner.

Change side of material supply to the right / left " in contextual menu of workplace

In the contextual menu of workplace, if "change side of material supply to right / left" option is selected, then all the part bins and shelves from the source container area and its outside corner associated to processes of the selected

workplace will be shifted to the outside corner of target container area. There will be no changes in target container area.

Cross highlighting of part bins and process

Cross highlighting will work as was before but with one exception:

Those part bins or shelves which are present in outside corner but are not shown due to space constraint will not be highlighted since they are not visible in outside corner for the moment. The part bins or shelf has to be visible either in container area or outside corner to be highlighted.

Opening a new balancing with the new settings

When opening a new balancing and choosing automatic algorithm with new advanced settings for free placement of part bins, ALB will start placing the part bins and shelves in the material area. Following are the different behaviours:

- If there is a shelf library selected, then ALB will start placing the shelves in material area. If a shelf is too big to be accommodated in the first or subsequent rows in material area, then it will be placed in outside corner and the planning will continue to place others.
- If a part bin is too large to fit into the first or subsequent rows in a material area, then ALB will place it in the outside corner and continue placing others.

“In new shelf” contextual menu of a part bin

Following are the behaviours of selecting this option for a part bin in outside corner and material area:

- If part bin is in material area, then selecting this option will create a selected shelf in outside corner of this material area and part bin will be moved inside this. This will create a empty space in the material area. There will be no automatic adjustments of any of the remaining containers in material area.
- If part bin is in outside corner, then the shelf will be created in the outside corner there itself at the location of part bin and the part bin will be placed inside it. Rest of the containers will be pushed to make space for this new shelf.

Logistic” Part bin group behaviour

Following are the behaviours possible with Logistic part bin groups:

- If a planned balancing without logistic part bin groups is reopened with the logistic part bin group settings, all the logistic part bin groups will be placed in the outside corner so as not to destroy the planning of other part bins.
- If in a balancing with “Logistic” part bin groups, when only the settings for a Logistic part bin is changed, this part bin group will be moved to outside corner. No other part bins will be automatically shifted.
- If a planned balancing is reopened removing the logistic part bin group settings, all these logistic part bin groups will be moved to the outside corner. No other part bins will be automatically shifted.

Assembly 1/2 Part bin group behaviour/ Fixed Surface” Part bin group behaviour

Following are the behaviours possible with “Assembly 1” part bin groups:

- When a part bin is configured as “Assembly 1” part bin, then this part bin group is placed in the outside corner after the changes whether or not it takes more space or less space. There will be no automatic adjustments for rest of the containers in material area.
- When only settings are changed of an existing “Assembly 1” part bin group, this part bin group will move to outside corner whether or not it takes more space or less space. There will be no automatic adjustments for rest of the containers in material area.

Change Length and width of material area

The planning in all the material areas will be destroyed and again automatic planning will take place according to the settings readjusting and realigning all the part bins if the material area is reduced. If it is enlarged, the planning will not be destroyed.

Rotate Part Bins by 90 degrees

When you selects the option Rotate Part Bins by 90 degrees, the planning in all the material areas will be destroyed and again automatic planning will take place according to the settings readjusting and realigning all the part bins if all the part bins are rotated by 90 degrees. If an individual part bin is rotated by 90 degree, it will be straight away moved to outside corner and it is your responsibility to place it in desired position. If you wants to go to previous state, use UNDO.

8.1.3.2 Re-arranging Material Area

Material area for the whole line can be Re-arranged from menu **Balancing** > **Re-arrange Material Area.**

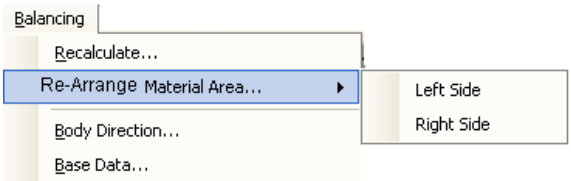


Figure 298: Re-arrange Material Area

The Left Side option re-arranges all the part bins and shelves in left side material areas of all the stations i.e. all the left side material areas of a Balancing. Right Side option re-arranges all the part bins and shelves in the right side material areas of all the stations.

This function executes an automatic execution of re-location of all the Part bins and shelves inside material area and all the planning inside material area will be lost. All the empty spaces in material areas will be adjusted. All the planned part bin positions will be lost and all the part bins will be placed according to Automatic algorithm. ALB places the PBGs station by station, material area by material area, and then one by one rearranges them meaning that PBGs remain in their material area. All the available part bins and shelves within a material area are arranged according to settings and if more free space is available, part bins and shelves from its outside corner are considered for placement.

Part bins from outside corner will also be taken into account and will be placed inside material area if place is found.

An individual material area can be re-arranged in a similar way by selecting **Re-Arrange Material** contextual menu option of material area.

8.1.3.3 Snap Part Bins

Snap functionality will make placement of part bins more comfortable and you have full control over its availability.

Snap can be enabled and disabled for the whole balancing by checking and un-checking this check box.

Snap for the whole balancing an also be switched on and off from an individual container area via its contextual menu:

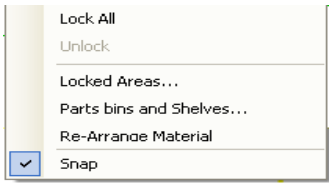


Figure 299: Snap Part Bins

Snap works only for container areas and not for outside corner.

Example

Consider the below scenario:

When moving a part bin, snap functionality will look for other part bins near one of the 4 corners of the moved element and the moved element will be positioned at the exact location - point to point. The moved element should be within the distance mentioned in the snap distance mentioned in base data.

Part bin 3 from right side container area is moved to left side container area and is dropped near to part bin 2 in left side container area. Let the distance between the 2 parts bins be 0.05 m as can be seen in the below figure. The snap distance mentioned in the base data is 0.06 m.

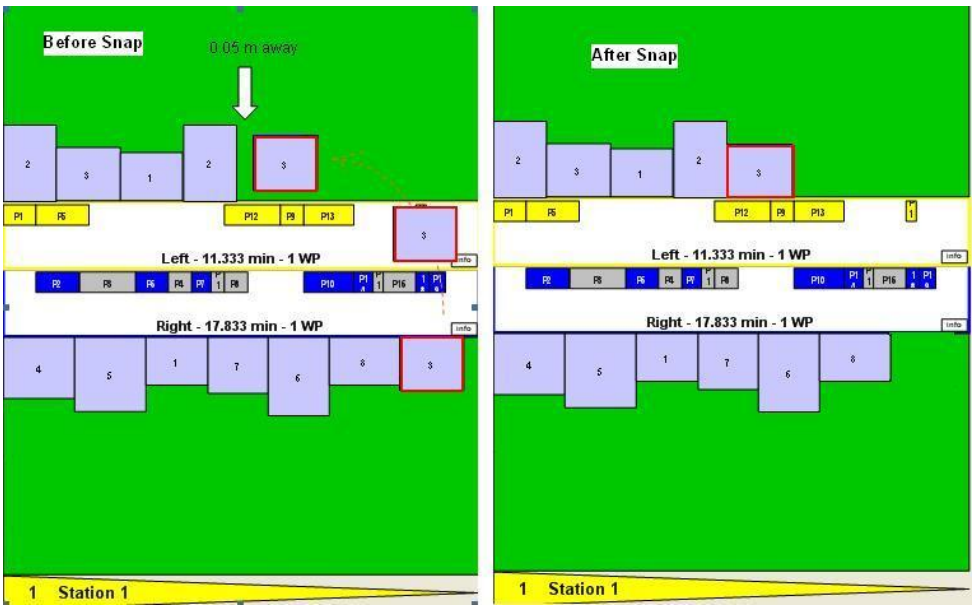


Figure 300: Before/After Snap

Since the distance is well within the mentioned snap distance, the part bin 3 will be automatically snapped to the side position of part bin 2 and the user can easily align up and down the part bin 3 without leaving the mouse. Snap shall work in all 4 directions.

Toggle for snap

The snap functionality can be toggled while dragging. When dragging a container, the simultaneous press of “SHIFT” button will toggle the snap functionality for this particular moment. So if snap is on in advanced planning

options, then for this drag operation with the “SHIFT” button pressed, the snap will be turned off. The moment the “SHIFT” button is released while on drag, the snap behaviour will turn on. So snap can be turned ON and OFF at the time of drag also. You can use this functionality to snap only in a target area and to avoid snaps at all positions.

Toggling will work only when the Snap functionality is on in advanced material planning. It can only be used to turn off the snap for a particular moment of drag.

8.1.3.4 Marking Inconsistent Material Areas

Inconsistent material areas are areas where there are part bins without location i.e. the particular outside corner of that material area is not empty.

These material areas can be marked with different color code than normal one and this can be done from base data dialog.

When you check the option **Mark Inconsistent Material Area**, a default orange color is set in color box. If again a different color selection has to be made, the color dialog can be launched by clicking the color box (Figure 22).

The color of inconsistent material area will change according to the availability of part bins in its outside corner.

Example

In the image below OC of Station 1 has some part bins and hence its material area is colored orange. (In this case user has selected Orange as color to mark inconsistent material areas.) Material areas whose OCs are empty are colored green the default color of material area.

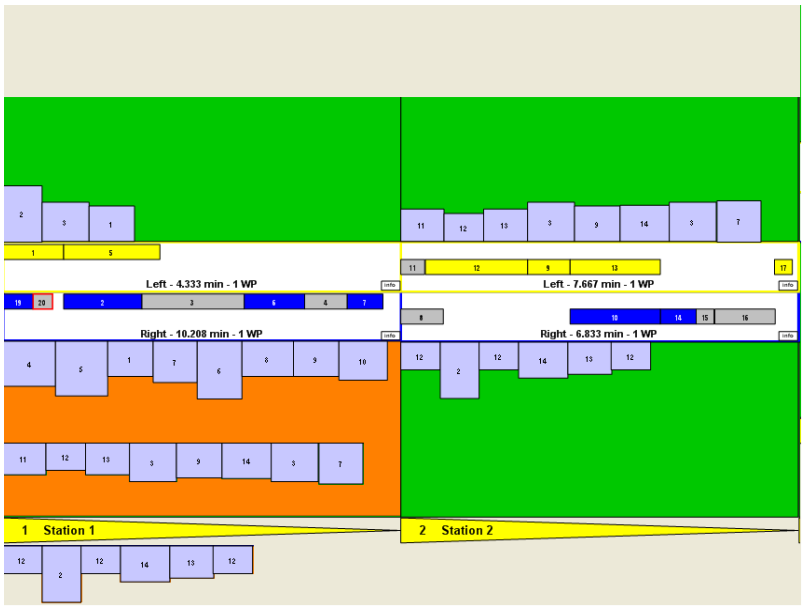


Figure 301: Marking Inconsistent Material Area

The default color available would be orange with this setting.

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