Scheduling Setups

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scheduling

Scheduling Setups

Setups represent changes in the configuration of a certain Resource, preparing it to process another range of Materials than what was initially possible. Since these changeovers in configurations can have long durations, they are an important constraint to a production line and must be considered.

Scheduling can implement setup times when these changes occur. In addition, these configurations can also reduce the total time of setups in a certain schedule:

- Optimization criterion Minimize Total Setup Time: This optimization criterion will determine a sequencing and scheduling solution focused on having a low percentage of the Resources' availability spent on setups.
- Untie Sort Rule Setup Time: This untie sort rule is used to ensure that, at a given resource, the next job to be scheduled is the one that will cause the least setup time
- Schedule Property Use Local Sorting for Setups: This property determines the behavior of the Minimize Setup Times criterion. If set to False, scheduling will determine a global sequence of Materials with low total setup time. If set to True, scheduling will locally (at each resource) determine the sequence that minimizes the setup time for that Resource, with the trade-off that there might be changes in the sequence from the one in the previous step.

In order for setups to be considered by the system, the user must provide two inputs:

- Setup Characteristics - how to recognize a change in configuration
- Setup Times - how long the change takes

Implementing Setup Characteristics

Firstly, in order for scheduling to implement setup times, it is necessary to identify which configuration/property must be monitored for changes.

This is done at the Step level, with the property Setup Characteristic. This can assume four values:

- Service - a change in the Service being offered by a Resource in consecutive operations is considered a setup.
- Product - a change in the Product being processed at a Resource in consecutive operations is considered a setup.
- Product Group - a change in the Product Group being processed at a Resource in consecutive operations is considered a setup.
- Recipe - a change in the Recipe being used at a Resource in consecutive operations is considered a setup.

> ⚠️ **Warning**
>
> When using Product Group for the Step Characteristic, all Materials which are included in the scheduling universe and whose Flow passes through that Step must have a Product which is associated with a Product Group.

> ⚠️ **Warning**
>
> When using Recipe for the Step Characteristic, for all Materials which are included in the scheduling universe and whose Flow passes through that Step, there must be a Recipe Context, which must not be specific to Resource.

Thus, whenever for two consecutive operations in the same Resource the chosen characteristic changes, it is considered that a setup has occurred. The times to be charged for these setups are explained below.

Implementing Setup Times

There are two ways of implementing setups in the system, as described below (the order in which the options are presented shows the precedence used in defining Setup Times):

1. Using Setup Matrixes

The Setup Matrix object details the changes between the different configurations of a Resource. These configurations are expressed in terms of what Service the Resource is providing at any moment. An example of a Setup Matrix is shown below:

	Service A	Service B
Service A	0	3
Service B	5	0

Table: Implementing setup times - using Setup Matrix

Assuming, for this example, that the Setup Matrix's Time Scale is is hours, this means that, for any Resource associated with this Setup Matrix, whenever that Resource is forced to change from providing Service A to Service B, the first operation executed with Service B after the change will suffer a setup time of 3 hours; if the change occurs in the other direction, the first operation executed with Service A after the change will suffer a setup time of 5 hours.

ℹ️ Since the diagonal of the Setup Matrix represents the situation when the Service provided by the Resource is not changed, and since this situation may not require a setup time, it is possible to activate the Setup Matrix property Use Zero in Diagonal in order to automatically zero these Matrix positions.

> ⚠️ **Warning**
>
> Setup Matrixes do not work for Resources of Schedule Type Batch, as a single batch of Materials may contain multiple (compatible) Services, not being possible to identify the transition between consecutive batches. Instead, the Default Setup Time is applied whenever a new batch is planned.

> ⚠️ **Warning**
>
> Setup Matrixes only work for a Setup Characteristic of Service.

2. Using Default Setup Times

An alternative to using Setup Matrixes is using Default Setup Times, defined at the Resource level. Comparing with Setup Matrixes, the Default Setup Times do not allow the user to give different times

according to the transition; however it does allow all the SetupCharacteristics (Service, Product, Product Group and Recipe). The Default Setup Time creates a virtual Setup Matrix, where all the positions have its value: assuming a case where the Default Setup Time equals 2 hours, and that the Setup Characteristic being used is Service, the virtual matrix would be:

	Service A	Service B	Service C	Service D
Service A	2	2	2	2
Service B	2	2	2	2
Service C	2	2	2	2
Service D	2	2	2	2

Table: Implementing setup times - using default setup times

This means that for any operation, even when the Setup Characteristic does not change, a 2-hour setup time is applied. However, as in many situations, a lack of a Setup Characteristic change means that there should not be a setup time, it is possible to use the Schedule property *Use Zero Setup Times* to consider these setups as 0. By activating this property, the virtual matrix changes to this:

	Service A	Service B	Service C	Service D
Service A	0	2	2	2
Service B	2	0	2	2
Service C	2	2	0	2
Service D	2	2	2	0

Table: Implementing setup times - Use Zero Setup Times

If the Setup Characteristic is Service, it is possible to combine both Setup Matrixes and Default Setup Times. Imagining a Resource that supplies many Services, with most of the transitions having the same value, but with a few being different, it is possible to define a Default Setup Time and to override the transitions which have different values with a Setup Matrix. An example of this can be the combination of the last scenario (Default Setup Time = 2), with the example given for the Setup Matrix, which would result in this:

	Service A	Service B	Service C	Service D
Service A	0	3	2	2
Service B	5	0	2	2
Service C	2	2	0	2
Service D	2	2	2	0

Table: Implementing setup times - mixed approach

> **ⓘ Info**
>
> The Schedule's property Use Zero Setup Time only works when there is no Setup Matrix associated with it; as such, when combining a Setup Matrix with the Default Setup Time, it is also necessary to zero the transitions where the Service doesn't change.

In this last matrix, the transitions given by the Setup Matrix are shown in green, and those given by the Default Setup Time are show in blue.

> **ⓘ Info**
>
> This last implementation may be particularly helpful when using Default Setup Times with Resources of Scheduling Type Tunnel that have compatible Services. Since, in principal, it would not be desirable to have a setup between these Services, it is possible to define a Setup Matrix which overrides these transitions to 0.

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