

# FINDING THE OPTIMAL SPARES STRATEGY FOR RAIL VEHICLES

Håkan Borgström  
September 2008

Systecon AB  
Box 5205  
S-102 45 Stockholm  
Sweden

**What assortment of components and spares will be needed for a train operation when the low-frequent maintenance starts?**

**How can the choice of maintenance strategy possibly impact on the size of this investment?**

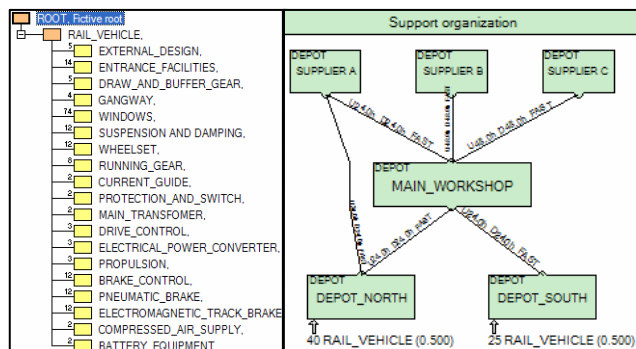
**These are questions that all fleet operators and owners face from time to time.**

This example, based on a real situation, describes how an operator is revising its current spares management practice with the ambition to develop a new spares strategy. A central part of the new strategy is to implement the leading spares optimization software OPUS10™ as the standard analysis tool throughout the organization. OPUS10 is not limited to calculating the optimal assortment and location of spares, it also offers extensive analysis functionality that provides key input to strategic decision makers. In addition to this OPUS10 will also be used to recommend a consignment stock for 15 new trains that are gradually entering service over the next two years.

The transit operator has a fleet of 65 trains and two depots; one to the North and the other to the South of the city, with the train fleet split 40/25 between these depots.

Major overhauls and repairs are performed at a central workshop in the same region and shipments between the depots and the workshop will arrive the following day. Consumable items are delivered from three different suppliers with lead-times varying from 1 to 4 weeks depending on the type of component. One of the suppliers is also responsible for repairing some hi-tech components.

The target for the analysis is a mean waiting time (MWT) for spares of 3 hours. This performance level is required in order to meet the exceptionally high demands on operational availability.

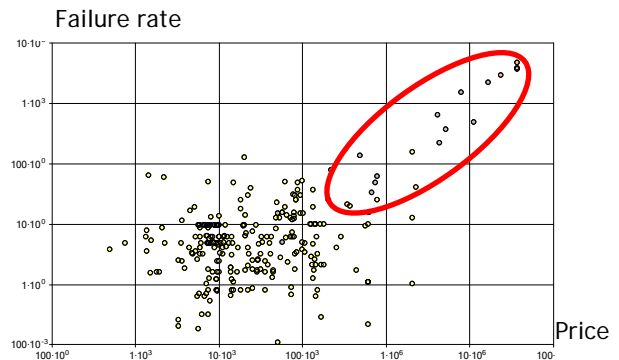


Vehicle breakdown structure and support organization in OPUS10.

## CRITICALITY AND COST DRIVER ANALYSIS

The optimization method used in OPUS10 relies on standard logistic data such as corrective and preventive maintenance activities, lead-times, and turnaround times (TAT) etc. This information is usually readily available within the organization. The model can also take into account if some components are considered to be extra critical to the operational performance.

With all data entered into the model, the analyze function in OPUS10 will give an initial overview of all the components and highlight potential cost drivers that need closer attention.



Analyze function in OPUS10. Components with high failure rate and high price are highlighted in the red area.

The cost driver analysis will in this early stage of the process raise questions on the current maintenance practice and possibly bring about immediate actions. This could for instance concern modularization, i.e. the, from a maintenance perspective, division of large systems into smaller subsystems.

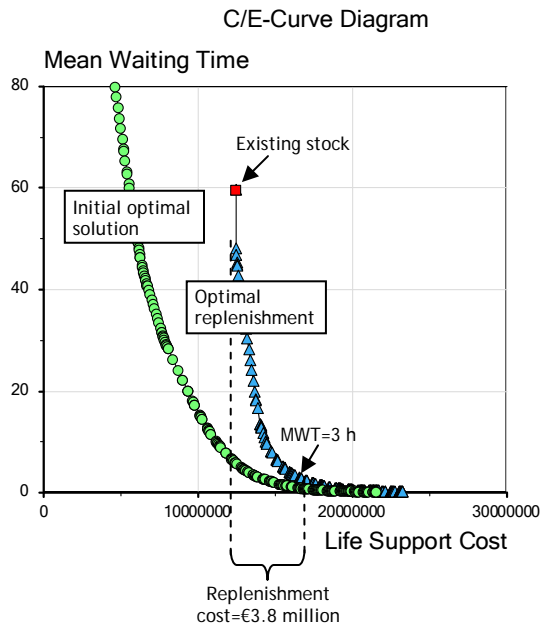


Modularization of motor and gear.

## FINDING THE OPTIMAL SPARES SOLUTION

OPUS10 is used to calculate the initial optimal spares assortment as well as the optimal replenishment strategy of an existing stock. When calculating the optimal replenishment strategy it is valuable to include the initial

optimal solution as a reference in order to have an idea of how well the organization should have performed if OPUS10 was used already during the initial spares provisioning.



OPUS10 graph showing the initial optimal solution, the existing stock and the optimal replenishment strategy.

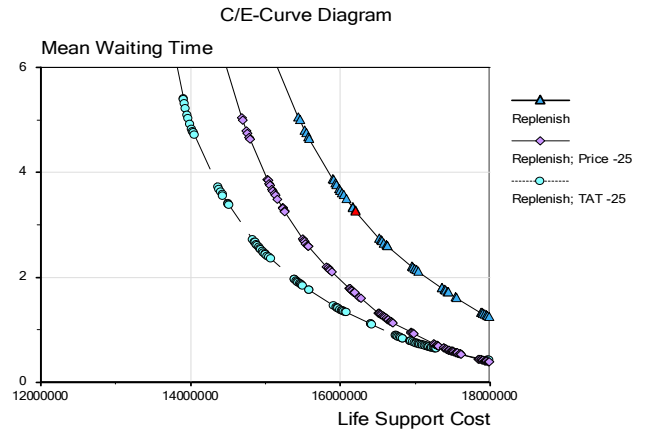
In this case the analysis shows that the €12.1 million invested in the existing stock will give an MWT for spares of 59 hours. Investing the same amount initially using OPUS10 would have provided a spares assortment with an MWT of 6 hours.

This emphasizes the importance of using OPUS10 early in the project. The analysis also shows that the suggested replenishment to meet the target MWT of 3 hours will require an additional investment in spares of €3.8 million.

**SENSITIVITY ANALYSIS**

OPUS10 offers extensive possibilities to perform sensitivity analysis on the input data. This could either involve all components or focus on a selected group of items. The sensitivity analysis will reveal which parameters have the largest influence on the final output. This in turn will pinpoint the most valuable improvements initiatives as well as areas to focus on in the negotiation with external suppliers.

In this case it was decided that the sensitivity analysis should evaluate a 25 percent reduction of price and TAT respectively, since this was assumed a realistic goal.



Sensitivity analysis on price and TAT.

The analysis shows that cutting the turnaround times with 25 percent is the most effective way to reduce the additional spares investment required to meet the target MWT. This is supposed to be realized through more efficient internal processes and renegotiation of the agreements with some external suppliers.

**IMPLEMENT NEW SPARES STRATEGY**

The recommended spares assortment at the given target MWT of 3 hours is presented in a table that for each unique component specifies the number of spares that should be stored at each location in the supply structure. Discardable components will also be associated with a reorder point and reorder size at each location.

STSZ / Station: Stock allocation		STSZ	STID: Station identifier		
Item identifier	Description	Total per item	QTY: Total number of each station		
			DEPOT_SOUTH	DEPOT_NORTH	MAIN_WORKSHOP
6	SUSPENSION AND DAMPING	8	1	1	1
7	WHEELSET	69	5	3	1
8	RUNNING_GEAR_AND_VEHICLE_BODY_CONNECTION	7	4	2	1
9	CURRENT_GUIDE	5	3	2	1
10	PROTECTION_AND_SWITCH	5	3	2	1
11	MAIN_TRANSFORMER	2	1	1	1
12	DRIVE_CONTROL	12	7	5	1
13	ELECTRICAL_POWER_CONVERTER	10	6	4	1
14	PROPULSION	8	5	3	1
15	BRAKE_CONTROL	7	4	3	1
16	PNEUMATIC_BRAKE	4	2	2	1

OPUS10 table with the optimal spares levels per location.

The final step is now to implement the new optimal spares strategy that was developed based on the outcome of the cost driver analysis, the recommended replenishment strategy, and the sensitivity analysis.

**CONCLUSIONS**

In conclusion with this analytical approach Systecon can assist spares managers with:

- Optimal assortment and location of spares for existing fleet and new deliveries
- Highlight cost drivers and possible improvements of current maintenance practices
- Sensitivity analysis and focus areas for negotiation with workshops and external suppliers