

# SUCCESSFUL RAILWAY MANAGEMENT USING ADVANCED SIMULATION

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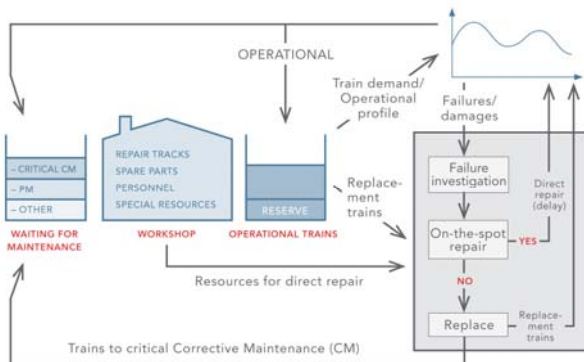


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Asset managers within the railway industry frequently face critical strategic decisions regarding the long-term development of the organisation. The complexity of a transport system makes it very difficult to analyse and understand the true implications of these decisions. To support asset managers in making complex decisions Systecon developed a method using the advanced optimisation and simulation techniques in OPUS10™ and Simlox.

The objective of the method is to provide asset managers with essential information in the development of an organisation that delivers operational excellence and long-term financial sustainability. The method involves the entire organisation and concerns decisions regarding investments, operation and maintenance. It embraces all central parts of a railway system, such as:

- Planned timetable
- Depot capacity
- Corrective and preventive maintenance
- Spares
- Maintenance staff



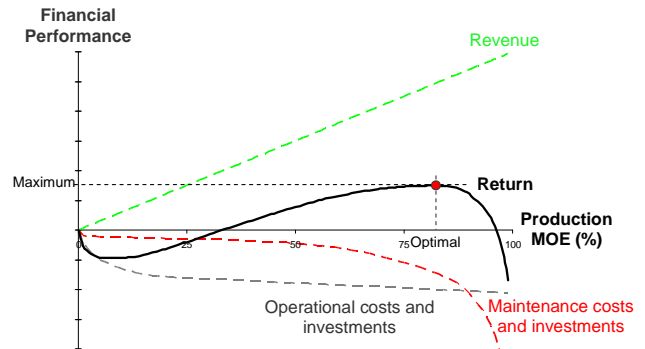
Layout of the transport system.

The model evaluates availability based on a planned timetable, available resources, reliability performance and the maintenance plan. The aim is to provide analysis of various alternatives and to find the solution that best complies with:

- Operational requirements

- Financial targets
- Long-term commitment

The operational requirements define the boundaries of the analysis. These could for instance be regulations regarding the license to operate. The aim is then to achieve the highest profitability within these boundaries.



The profit/effectiveness curve.

Another important aspect of the analysis is to ensure the organisation's long-term commitment and preparedness to handle future challenges.

## ESSENTIAL RESOURCE ALLOCATION ISSUES

There are a number of essential requirements that the analysis needs to address:

- When is availability of the trains critical, for instance is it during peak hours on weekdays?
- When should the maintenance resources be available, for instance off-peak hours such as nights and weekends?

Based on this a number of specific measures are used to assess the possible solutions:

- Availability both during peak hours and as a weekly average
- Resource utilisation during daytime, nights and weekends
- The loss of operation time expressed as hours per week

## THE CASE OUTLINE

A commuter train operator purchases 65 new trains that will enter service gradually. The operator has two depots; one to the North and the other to the South of the city, with the train fleet expected to be split 40/25 between these depots. The total existing depot capacity includes 5 repair tracks used for heavy maintenance and 2 service tracks used for inspections and lighter maintenance.

A key issue is to analyse whether or not the existing organisation will achieve the desired train availability and number of journeys. If not, is it possible to revise the spares assortment, maintenance plan and work schedule to achieve the desired availability, or is there a need for investment in additional resources? If investment is required which resource will add most economic value?

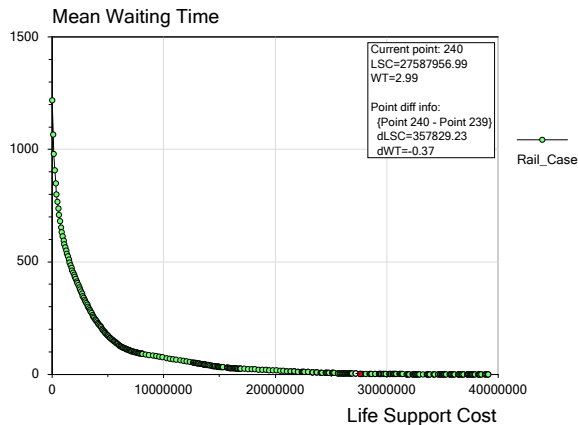
Finally, as the new trains are introduced over a three year period, when must the new resources be available?

## THE ECONOMIC VALUE OF OPERATION

It is central to estimate the economic value of operation in order to evaluate the expected financial outcome of various alternatives. In this case the previous year's results showed net sales of €140 million from 290 000 operational hours, i.e. an average revenue of €490 per operational hour.

## OPTIMAL SPARES ASSORTMENT

The spares assortment was analysed in the spares optimisation tool OPUS10™. Given an acceptable mean waiting time for spares of 2 hours the optimal spares assortment was calculated and exported into Simlox.



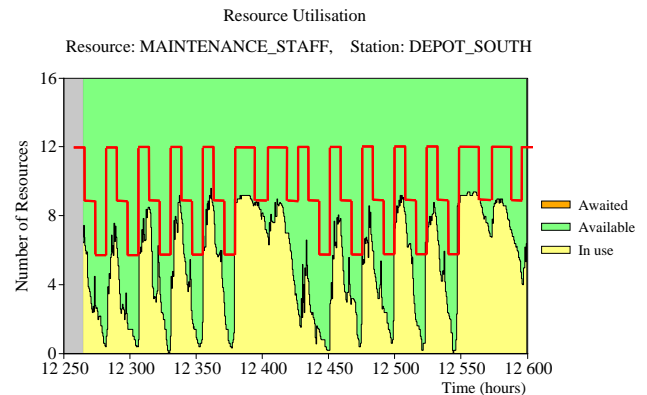
The optimal curve in OPUS10™.

## MAINTENANCE PLAN AND STAFF

The initial focus of the simulation study is to ensure that the maintenance activities and staff are scheduled in accordance with the planned timetable.

The maintenance plan should be arranged to enable high utilisation of the available maintenance time, meaning there should be maintenance activities of various lengths suited to be performed at either daytime, nights, or weekends.

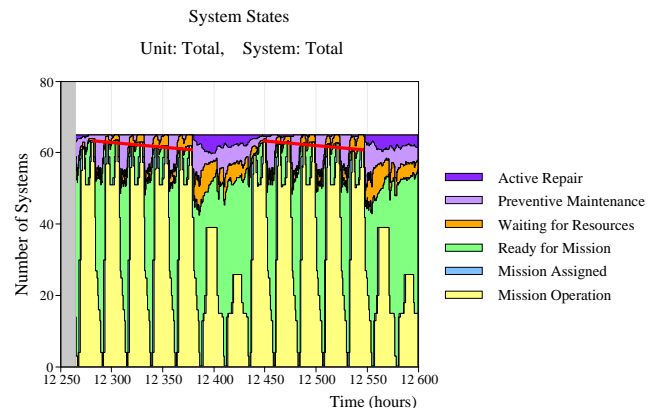
Maintenance staff should be available when the trains need maintenance. The simulation shows how the staff is utilised over the week which provides valuable input when designing the work schedule.



Staff utilisation over two weeks. The red line shows the recommended work schedule.

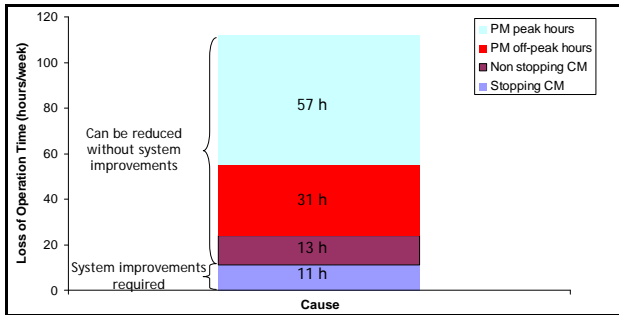
## INVESTMENT IN RESOURCES

Simulation of the existing depot capacity updated with the final revisions of the maintenance plan and work schedule shows difficulties to achieve the desired train availability.



Operational performance with existing depot capacity. The red line shows the increasing number of cancelled departures.

The difficulties are due to insufficient resources during nights and weekends to handle the maintenance workload, which in turn results in an increasing number of cancelled departures during the week. The average availability in a week is 98.0 %, which equals a loss of operation time of 112 hours per week. This is attributed to various causes in order to determine the most appropriate improvement.



The cause for loss of operation time.

The improvements to consider are either investment in additional depot capacity or investment in reserve trains. The first option will increase the maintenance capacity during nights and weekends and the latter will extend the possibility to perform maintenance during daytime since not all trains will be needed in traffic.

When investing in depot capacity it must be decided what type of maintenance track to invest in and at which depot it is needed. Simulation results on the utilisation of the existing resources provide the information necessary for this decision.

	Resource Utilisation (%)			
	40 vehicles at Depot North and 25 vehicles at Depot South			
	Service tracks at Depot North	Repair tracks at Depot North	Service tracks at Depot South	Repair tracks at Depot South
Daytime	3.2	6.9	17.9	16.1
Night	56.5	55.5	75.4	68.5
Weekend	91.2	97.2	97.8	97.8

Resource utilisation.

In this case the resource utilisation is very high during nights and weekends, which limits the ability to handle the random variations of maintenance workload. The key figures indicate that the most critical resources are repair tracks at the north depot and service tracks at the south depot.

Reserve trains should preferably be split between the depots in proportion to the scheduled timetable. In this case approximately 2/3 of the scheduled departures originate from the north depot and 1/3 from the south depot.

Based on the simulation results two investment alternatives are considered;

- Three new maintenance tracks; two repair tracks at Depot North and one service track at Depot South at a total investment of €25M
- Three additional trains providing a reserve of trains at peak hours at a total investment of €30M

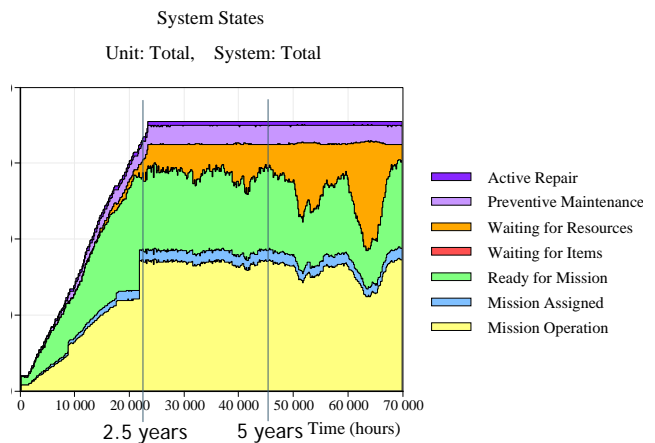
The two alternatives were analysed in Simlox. Both lead to considerable improvements in operational availability, and a comparison of relevant key figures favours an investment in maintenance tracks.

	Availability (Existing Capacity)	Availability (3 New Maintenance Tracks)	Availability (3 Additional trains)
Peak Hours Weekdays	95.6 %	99.1 %	98.4 %
Weekly Average	98.0 %	99.5 %	99.2 %
Availability Increase - Weekly Average		1.5 %	1.2 %
Total Investment		€25M	€30M
Availability Increase per Invested 1M EUR		0.06%/€1M	0.04%/€1M

Comparison of key figures before and after investments.

The simulation shows that investing €25M in three new maintenance tracks will significantly improve the operational performance. However, it remains to analyse whether the expected increase of future revenue is adequate to justify this investment. With three new maintenance tracks the loss of operation time for the entire train fleet is reduced from 112 to 26 hours per week. Assuming an operational life of 20 years and 52 weeks of operation per year, this amounts to 89440 hours. The value of an operational hour was estimated to be €490 which over 20 years gives a total increased revenue of €43.8M. Hence the added value from this investment is €18.8M.

The question of when it is critical for resources to be available has been addressed. A simulation also taking into account the delivery plan of the trains shows that the resources must be in place 2.5 years after the first delivery or else there are unacceptable delays due to waiting for resources.



Long-term performance based on a delivery plan of new trains.

## CONCLUSION

In conclusion with this analytical approach Systecon can:

- Determine to what extent the current operations can be met with existing resources
- Support investment appraisals
- Ensure long-term commitment