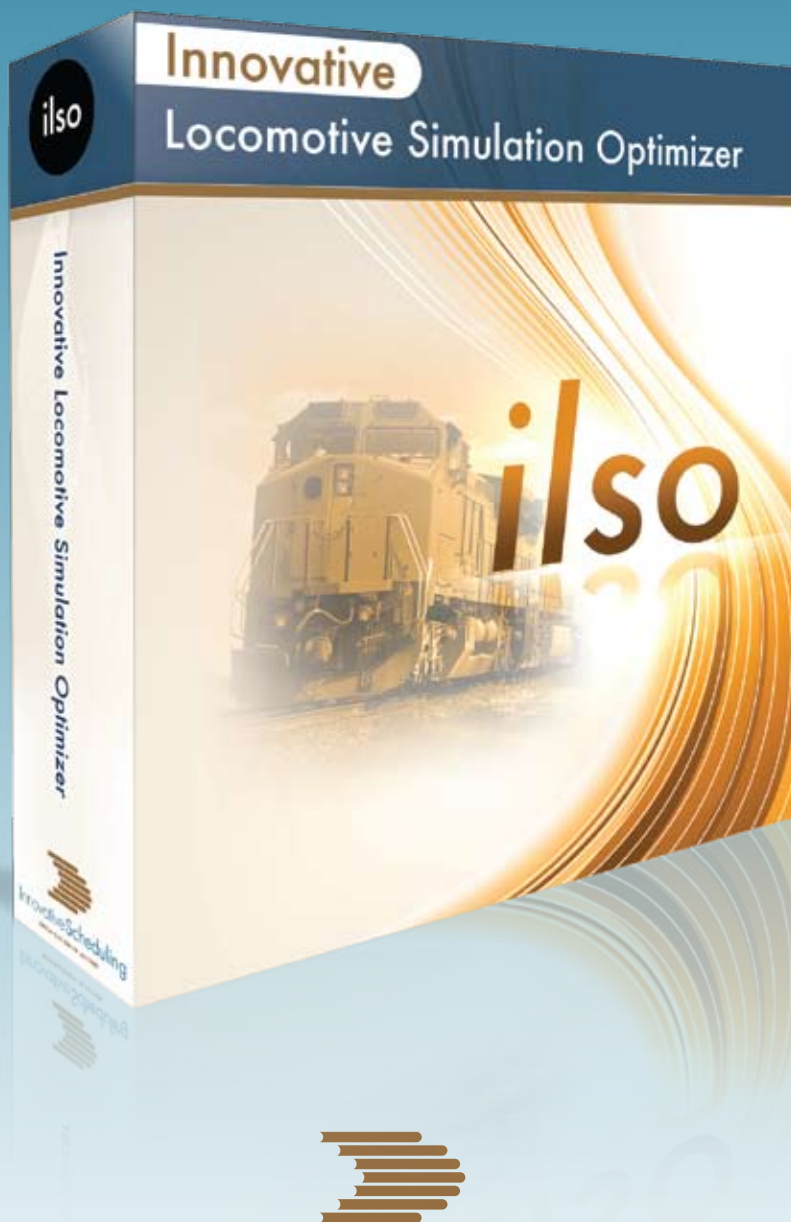


# SIMULATE LOCOMOTIVE OPERATIONS IN RAILROAD NETWORKS



Innovative Scheduling

OPTIMIZATION IN ACTION

Innovative Locomotive Simulation Optimizer (ILSO) is a decision support system that simulates locomotive movement across a rail network and keeps track of four major resources: locomotives, trains, terminals, and shops. It mimics a real-life environment in which:

- Train travel times are random variables
- Locomotives visit shops for quarterly and breakdown maintenances
- Shop repair and terminal processing times are random variables
- Locomotives tactically repositioned to meet demands

# INNOVATIVE LOCOMOTIVE SIMULATION OPTIMIZER



## INNOVATIVE LOCOMOTIVE SIMULATION OPTIMIZER HANDLES THE FOLLOWING:

- Assesses the impact of locomotive fleet size on the on-time train originations
- Determines the impact of shop locations and shop capacities on locomotive utilization
- Identifies terminals with frequent shortages of locomotives and determines potential solutions
- Determines the impact of strategy or policy changes on system performance

At each terminal, Innovative Locomotive Simulation Optimizer (ILSO) allocates available locomotives to outbound trains by considering horsepower and tonnage requirements of trains, locomotive power plan, and train priorities. Due to network imbalances or random disruptions caused by train delays and locomotive breakdowns, some terminals might have locomotive excesses or deficits. ILSO identifies surplus and deficit locations, finds locomotive repositioning to restore network balance, and routes locomotives to eliminate this imbalance. ILSO monitors the status, inventory, and detailed plans for individual trains, locomotives, terminals, and shops, and then uses this data to calculate key statistics and plot a variety of charts. ILSO can simulate six months of locomotive operations within a few minutes. The ILSO simulation engine is packaged in an Access-based decision support system. The user can change input data and parameters, run the ILSO engine, and view solution results. The user can then change inputs, re-simulate, and observe the impact of changes made on key statistics.

**MAJOR CONTRIBUTIONS.** ILSO is a discrete-event simulation system that realistically models locomotive operations in a railroad network. It is also an optimization-guided simulation system where some of the important operations perform a limited amount of optimization such as: assignment of locomotives to trains, routing of locomotives to shops, and repositioning moves to meet the demand of locomotives. To achieve computational efficiency and provide greater modeling freedom, the ILSO engine is implemented in the C++ programming language and does not use any commercially available simulation language. It employs sophisticated algorithms for locomotive assignments, and locomotive tactical repositioning that imitate real-life decision-making processes.

**CASE STUDIES.** ILSO has been built in development partnership with CSX Transportation. It has been tested extensively on the data provided by CSX, including train and locomotive plans. We computed key statistics such as: locomotive utilization, terminal dwell time, shop queues, power plan compliance, and locomotive out-of-service rates, and compared with the statistics observed in practice. These statistics showed that ILSO provides a good representation of reality and can be used for locomotive planning and strategic analysis. ILSO is currently in production at CSX and is being used for locomotive planning studies.



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