RACE

Rail Supply Chain Optimisation Software

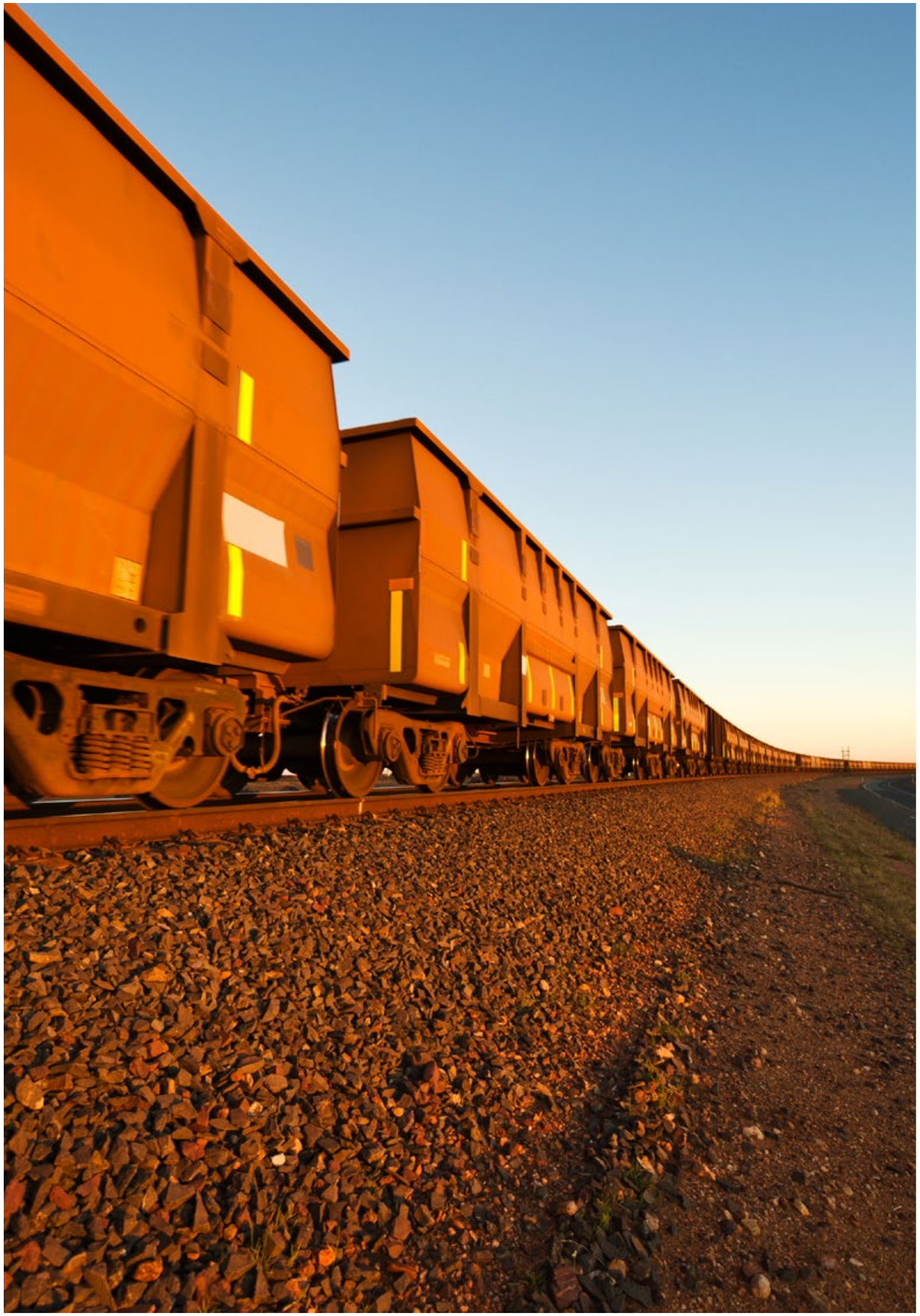
RACE maximises throughput and asset utilisation using industrial mathematics.

RA 1

Planner Module / Integrated Producers

Polymathian
Industrial Mathematics

RACE



Bringing innovation to Rail Supply Chain Planning

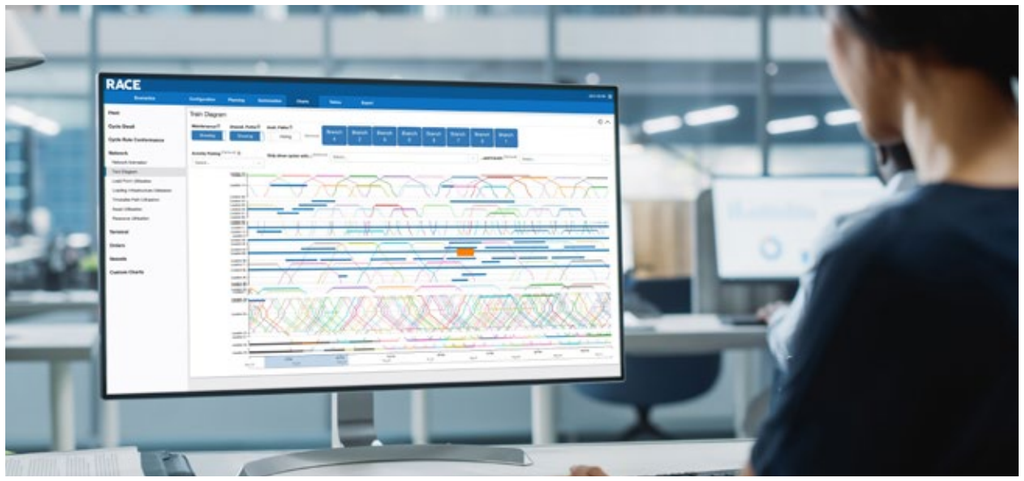
RACE is a rail supply chain planning optimisation software product that uses industrial mathematics to maximise system throughput and asset utilisation. It is a cloud-based decision support tool that optimises different combinations of inbound rail, terminal stockpiling and outbound vessel operations.

RACE automatically produces optimal plans that can either focus on inbound operations only (railing from load point to dump station) or can integrate inbound with outbound operations (reclaiming and ship loading), ensuring that the right product is being railed at the right time to make the most efficient use of all assets within the supply chain.

RACE is proven to reduce vessel waiting times by 18% in periods of high demand and reduce rail fleet requirements by 12% when demand is less than system capacity, compared to solutions generated using software without mathematical optimisation capability.

With RACE, planning teams can move away from laboriously manually constructing solutions to evaluating a range of automatically produced and optimal scenarios to choose the best outcome.

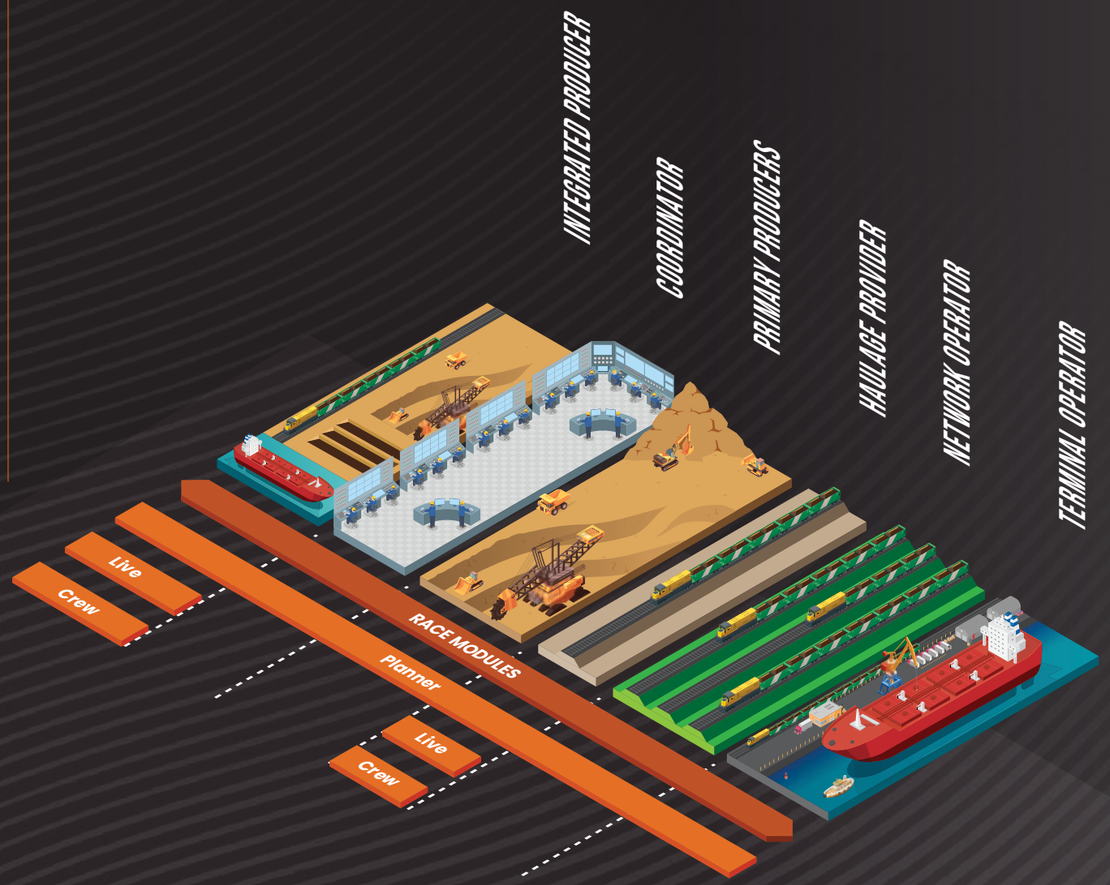
RACE systemises the planning function and reduces the risk of relying on key planning staff. It will elevate your planning functions' capability allowing them to easily conduct strategic studies to answer key questions often posed by management that just cannot be answered in a repeatable, auditable, and detailed fashion without software that both automates and optimises the planning process.



RACE Modules

RACE provides optimisation-based decision support for planning processes in bulk haulage value chains for all stakeholders.

It includes three modules to support the operational and planning needs of the value chain.



Integrated Producers

Producers who own and operate all supply chain assets from pit to port will value RACE for the optimisation and automation it brings to the planning and scheduling process. RACE ensures the efficient planning and scheduling of the entire value chain to maximise throughput whilst maintaining product integrity.

RACE Scenarios

Decision-based scenario planning

RACE's scenario-based planning capability enables planning teams to generate multiple "what-if" scenarios to produce the best possible outcome for the business. Using RACE's optimisation based decision support capabilities, planners can better understand how planning decisions impact the entire supply chain such as:

Decisions made for inbound operations might include:

- What services between which load point terminal combinations should each rail unit undertake over the planning horizon to ensure maximum efficiency of the supply chain?
- When should maintenance on track, load points, and dumpers be undertaken?
- When should maintenance on rail units be scheduled?
- How should the fleet be deployed?
- Which train crew should operate which legs in which train services?

Decisions made for outbound operations include:

- Which stockpile pads should be used to store which product?
- What days should vessels be loaded?
- When should stacker, conveyor, reclaimer and ship load maintenance be undertaken?

RACE can model rail networks with a range of complexities, from single line track with relatively few load and unload points, to large rail systems with many load and unload points, all serviced by a wide range of fleets.

RACE's crew module supports train crew allocation, which might occur 24-36 hours before services are planned to run and involve assigning rostered on crew to specific crew configurations (i.e., two drivers or single driver operations) at the same time as determining which crew should operate which legs in each different train service.

Plans aim to:

- Maximise supply chain throughput whilst making efficient use of assets
- Schedule network, terminal and rail fleet maintenance to minimise the impact on system throughput
- Maintain a safe work environment
- Ensure that the rolling stock plans respect rail crew deployment methods and scheduling considerations
- Use the train crew workforce as efficiently as possible

RACE Product Features

RACE solves complex optimisation problems using on-demand, high-performance cloud computing resources. It is configured to model complex rail-based supply chains whilst considering planning and customer demand data to produce optimal rail plans for your operations. These include modelling:

- Multiple haulage providers with multiple fleets
- Large and Complex Networks
- Inbound only Modelling
- Simultaneous Rail, Terminal and Vessel Operations
- Above and below rail contract modelling
- Rail crew modelling
- Fixed or flexible track maintenance
- Fixed or flexible train maintenance
- System shutdowns
- Master timetable design.

Platform features

RACE leverages the power of Tropofy, Polymathian's proprietary software platform.

- **Cloud-based**
- **Single Sign on role-based access**
- **Regular updates**
- **API based integrations**
- **Continuous backup**
- **Highly customisable**

How will I use RACE?

Inputs

Configuration Data

(semi permanent)

- Rail network modelling
- Terminal modelling
- Haulage provider modelling

Planning Data

(variable)

- Fixed infrastructure maintenance
- Above rail maintenance
- Rail orders
- Multi-parcel vessel demand

Solver

RACE

Output

Output

- Optimised rail plan
- Optimised terminal & vessel loading plan if solving for combined inbound and outbound operations

RACE Models

Stakeholder key

HP — **Haulage Provider**
Train operators providing haulage services to primary producers.

IP — **Integrated Producer**
Vertically integrated producers who own and operate the entire supply chain.

TO — **Terminal Operator**
Operators of bulk terminals servicing a range of products connected with large complex bulk haulage rail networks.

NO — **Network Operator**
Those who contract rail access to primary producers and haulage providers.

C — **Coordinator**
Independent entities that coordinate the combined operations of all rail participants in a common supply chain.

PP — **Primary Producer**
Primary producers who contract rail haulage providers, track owners and terminal operators to transport bulk commodities.

RACE's Input Data Model

RACE's Input data model is organised into "Configuration" and "Planning" Data.

Configuration Data defines the fixed infrastructure for a given value chain, and includes:

Rail network modelling information, including:

- Track network modelling
  - Track sections, gauges, passing bays, headway, loaded/empty run times
  - Rail fleet maintenance facilities with configurable capacities
  - Multiple "pathed" or access controlled and/or multiple "run when ready" geographies
- Load point modelling
  - Default load and recharge times with overrides per rail fleet
  - Load points shared by multiple producers
  - Max loads per day, time of day load restrictions, loop capacities, rail fleet compatibility, bin/silo recharge times etc.
  - Optional, access controlled load times (banned night time loading for example)
- Unload point modelling
  - Multiple dump stations with optional access controlled specific unload times and durations
  - Conveyor deconfliction modelling

Terminal modelling optionally including:

- Dump stations, conveyors, stackers (and stacking streams), pads, reclaimers, ship loaders (and reclaiming streams)

Haulage provider modelling including:

- Multiple haulage providers with multiple fleets
- Above rail contract modelling defined by compatible producer, load point, terminal, pad combinations
- Load point and unload point durations specified for particular fleets
- Modelling to the level of individual rail units (or consists) within fleets

RACE's Input Data Model

Planning Data is dynamic and varies for each plan, and includes:

Fixed infrastructure maintenance

- Load point loop and/or bin (i.e., hopper/silo) maintenance
- Dump station maintenance
- Fixed and flexible track maintenance
  - RACE can schedule track maintenance within any allowable flexible time windows to minimise throughput impact
- Pathing access control (paths not available or taken by other traffic)
- Conveyor maintenance
- Stacker maintenance
- Reclaimer maintenance
- Ship loader maintenance

Above rail maintenance

- Fixed rail unit (or consist) maintenance
- Flexible or floating rail unit (or consist) maintenance
  - Noting maintenance may happen at facilities with specific capacities
- Transition of rail units between fleets

System wide "shut down" modelling

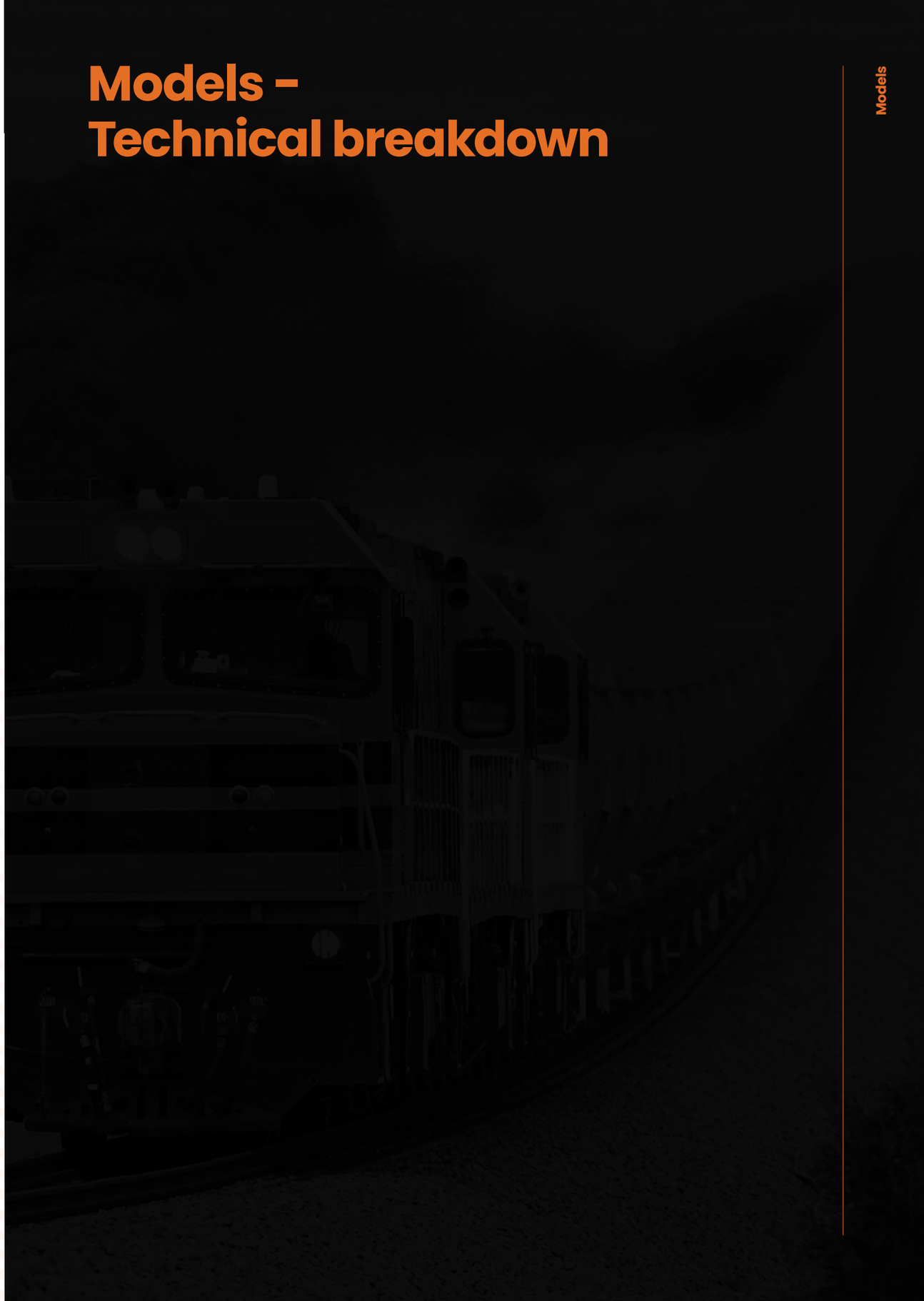
- Meaning rail units need to stow around the network whilst major maintenance activities are undertaken

Modelling demand specified in a range of ways:

- Modelling rail orders between specific producer, load point terminal, pad combinations against specific contracts
  - Placed direct by producers or by dedicated stockpile terminals on behalf of producers
- Modelling multi-parcel vessels, drawing product from multiple load points with specific product availability dates with vessel ETAs
  - Modelling vessels whose cargoes are already fully or partially assembled
  - Optionally modelling pre-assigned stockpile availability dates (these are generally an output of the optimisation process, but can be optionally specified as fixed inputs if required)

Models – Technical breakdown

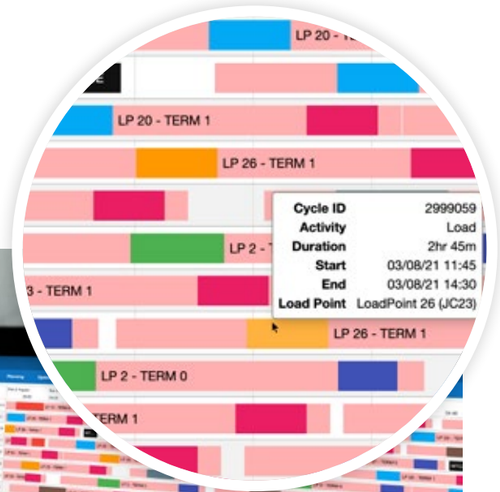
Models



Multiple Haulage Providers with Multiple Fleets

RACE models value chains involving rail units that:

- Have specific fixed or flexible (i.e., the timing is an output of the optimisation process) above rail maintenance requirements
- May move between fleets within the planning horizon
- Have specific times when they become available for scheduling purposes at the commencement of a planning period
- Have specific load and unload durations at load points and terminals
- May use a different gauge, meaning they can only run on a subset of the track geography
- Are compatible with only a subset of the load points and terminals within the network for contractual or infrastructural reasons
- May be dedicated to a given producer

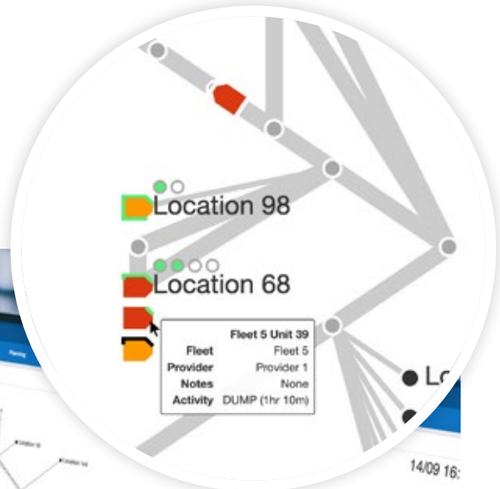


Number of cycles undertaken by each unit in the fleet

Large and Complex Networks

RACE can model supply chains that may:

- Deliver to many terminals: covering domestic delivery and/or dedicated stockpile or cargo assembly operations for export
- Service many load points that share operations among some producers
- Span multiple, separately access controlled track geographies, i.e., multiple zones with specific allowable pathing, or a trunk network that may also involve interaction with metropolitan rail networks



Visualisation of a complex rail network and the animated optimised rail plan

Inbound Only Modelling

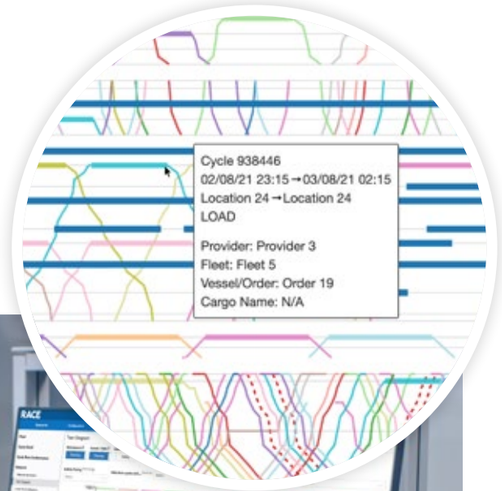
RACE can model value chains where terminal operations, beyond the ability to unload a train do not need to be considered.

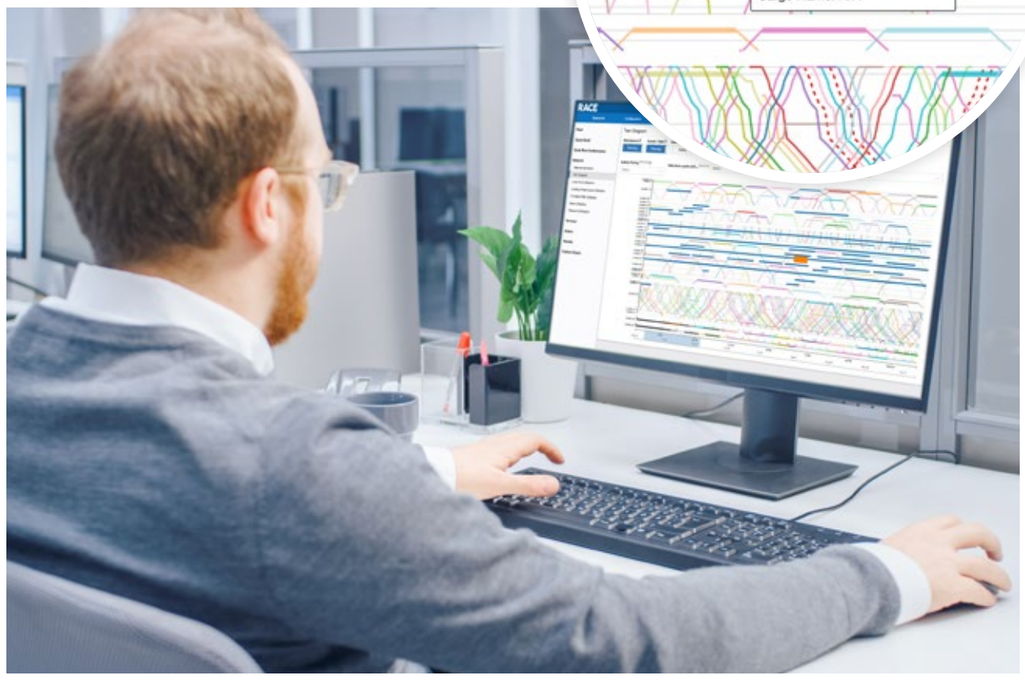
In such cases, usually for networks involving dedicated stockpile terminals, RACE models demand:

- Between specific producer, load point and terminal combinations
- Where contractual obligations might prioritise some demand over others
- That has specific time windows for delivery
- Might involve banned windows (to model day/night time only loading/unloading for example)

In such models, RACE is usually configured to optimise a hierarchical objective in the following order:

1. Maximise throughput, sometimes according to contractual priority
2. Use the fewest above rail assets to achieve this throughput
3. Make most efficient use of available train crew





Optimised train diagram for each cycle of the rail plan

Simultaneous Rail, Terminal and Vessel Operations

RACE can model value chains that involve cargo assembly terminal operations, noting the value chain may also include domestic or dedicated stockpile terminals.

In such cases, synchronising inbound and outbound operations is paramount to maximising system throughput to ensure the most efficient plan, for example:

- What train services should be run using which rail units to rail product for which cargoes?
  - What paths, empty and loaded, should such services use?
  - When do I run in a "run when ready" (i.e. unpathed) environment?
  - What load times, specific dump stations, conveyors and stacking streams should be used to stack product?
  - When should rail unit maintenance be planned to minimise impact on throughput?
  - How should train services dwell, where needed, to avoid maintenance on fixed infrastructure or to manage traffic when there is congestion?
- When should stockpile space for specific cargoes be made available to allow cargoes to be built, noting:
  - Train services cannot unload until cargo space is available
  - Stockpile space is precious and needs to be used intelligently
  - The duration required to assemble cargoes are a function of constraints on both inbound operations, available terminal assets, and the vessel queue and is a dynamic output of the optimisation process
- When should vessels load and depart, noting:
  - Vessels cannot load until all product for all cargoes has been assembled, and outbound capacity exists

In such models, RACE is usually configured to optimise with an objective designed to:

1. Minimise vessel turn-around time and rail dedicated stockpile orders on time
2. Use the fewest above rail assets to achieve this "system throughput velocity"
3. Make the most efficient use of terminal stockpile space

Above and Below Rail Contract Modelling

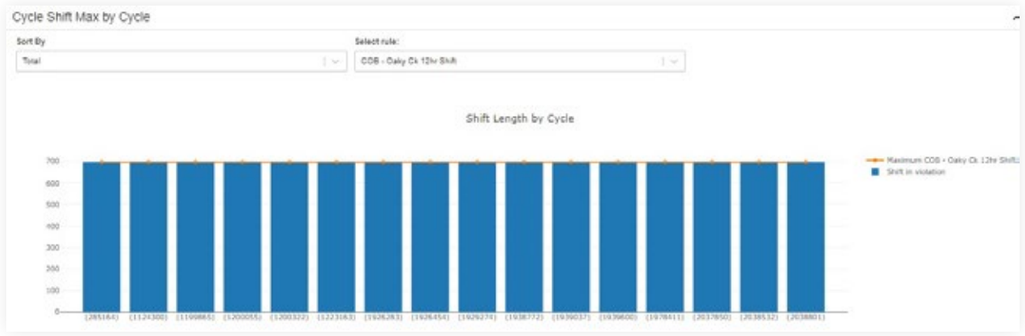
Producer load point terminal combinations may have specific below rail and above rail contracts that must be modelled. A key consideration when producing plans is ensuring, where appropriate, the long-run performance or short-term yield from these contracts is managed effectively.

RACE includes a configurable, hierarchical objective when solving that ensures contracts are modelled effectively. Contracts with the highest yield or require the most volume compared to others in a particular plan are prioritised over other contracts, with as many categories created as necessary. This ensures rail fleets are deployed optimally and track access is prioritised to manage contractual performance.

Rail Crew Modelling

RACE can model an extensive range of train crew considerations when generating a rolling stock plan, including:

- Roster constraints
  - Maximum number of departs within a time period to a certain geography or for the entire system to model constraints imposed by driver sign on profiles
- Crew deployment method constraints
  - Parts of rail journeys whose duration should not exceed crew maximum shift lengths, if possible, given the way crew are deployed to cover rail operations
- Crew overnighting in barracks
  - Crew operating one train in the first shift, spending the night at a remote location, and then operating a separate train back to their home depot
- Crew crosses
  - Where train crew from opposing trains swap trains within specific target geographies
- Dwells for crew changes
  - Include sufficient time within rail journeys at planned crew change locations for such relief to occur



Conformance to the shift hours allocated for crew to each cycle

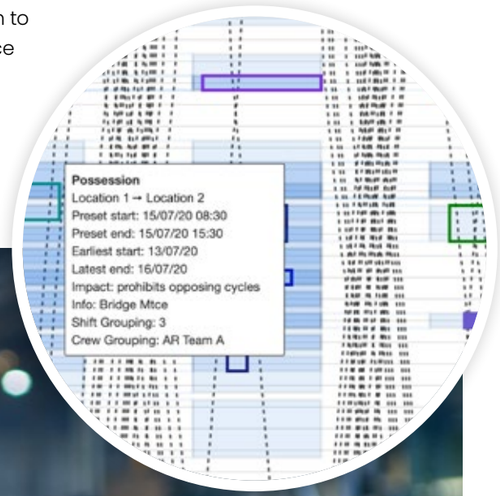
Heatmap of conformance to cycle activity rules

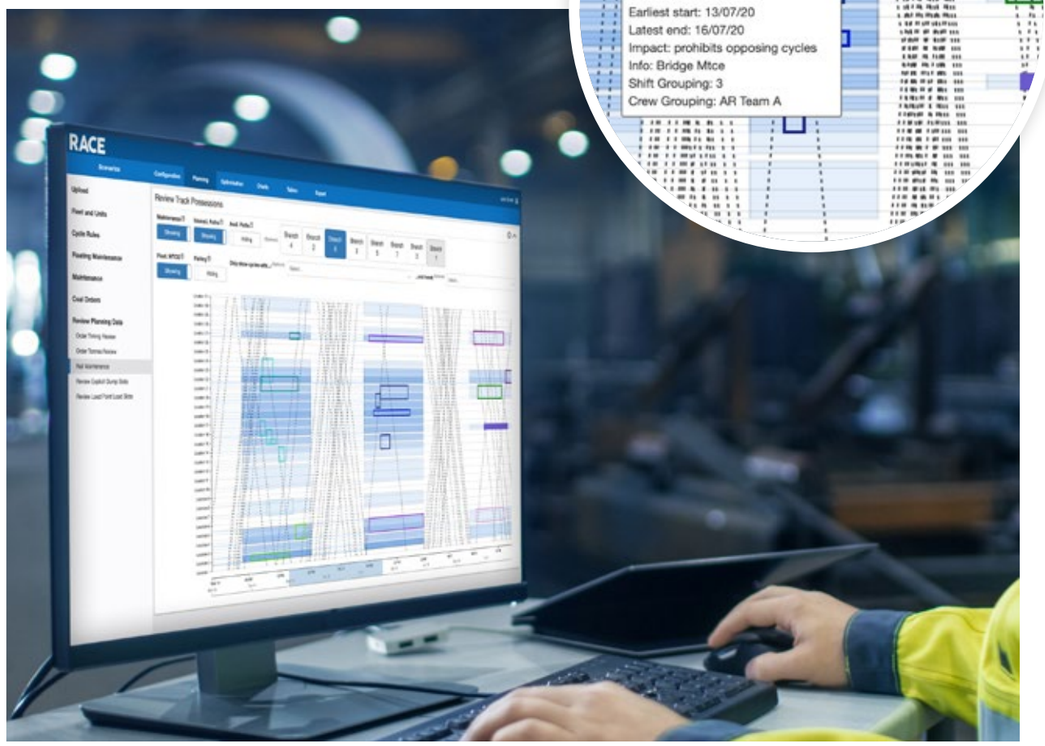
Fixed or Flexible Track Maintenance Modelling

RACE can model below rail (track maintenance), whose timing may be flexible. i.e. maintenance that is scheduled at the same time as train services are scheduled.

For example, maintenance might take four hours, block trains in both directions (or in dual track areas optionally allow trains to "wrong road" around the maintenance event meaning services in the plan are not allowed to cross whilst the maintenance is being undertaken in that geography), and be allowed to be undertaken at any time between 06:00 and 17:00 on the first three days of the week.

Determining when multiple track maintenance events should be timed, at the same time as planning the services that should run to rail dynamic demand (noting any other fixed maintenance on load points, dump stations, rail units and optionally on terminal infrastructure), is a very complex optimisation problem RACE is capable of solving.



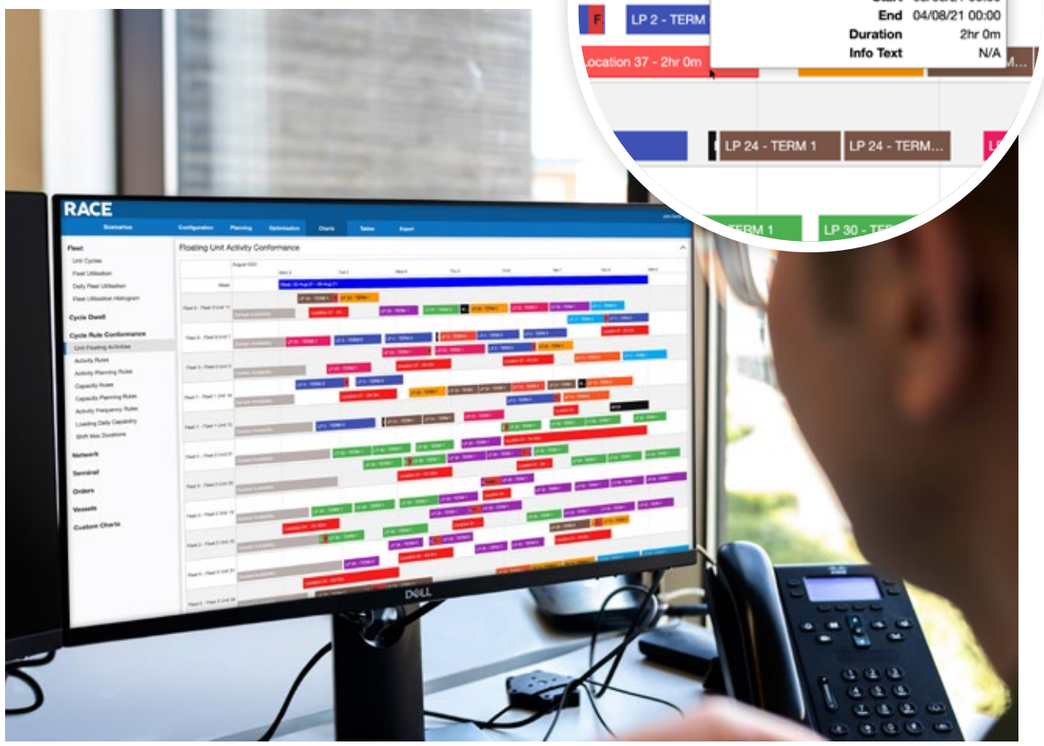


Cycles planned around floating track maintenance

Fixed or Flexible Train Maintenance

RACE can model "flexible" above rail maintenance, where an activity of some duration has to happen on a specific rail unit at one or more locations within a given time window in addition to maintenance whose timing is fixed in input data, noting maintenance facility capacity.

In such models, RACE decides when to schedule flexible maintenance events to minimise their impact on plan quality.

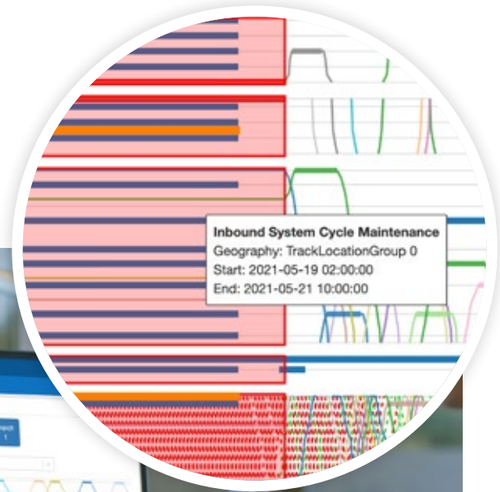


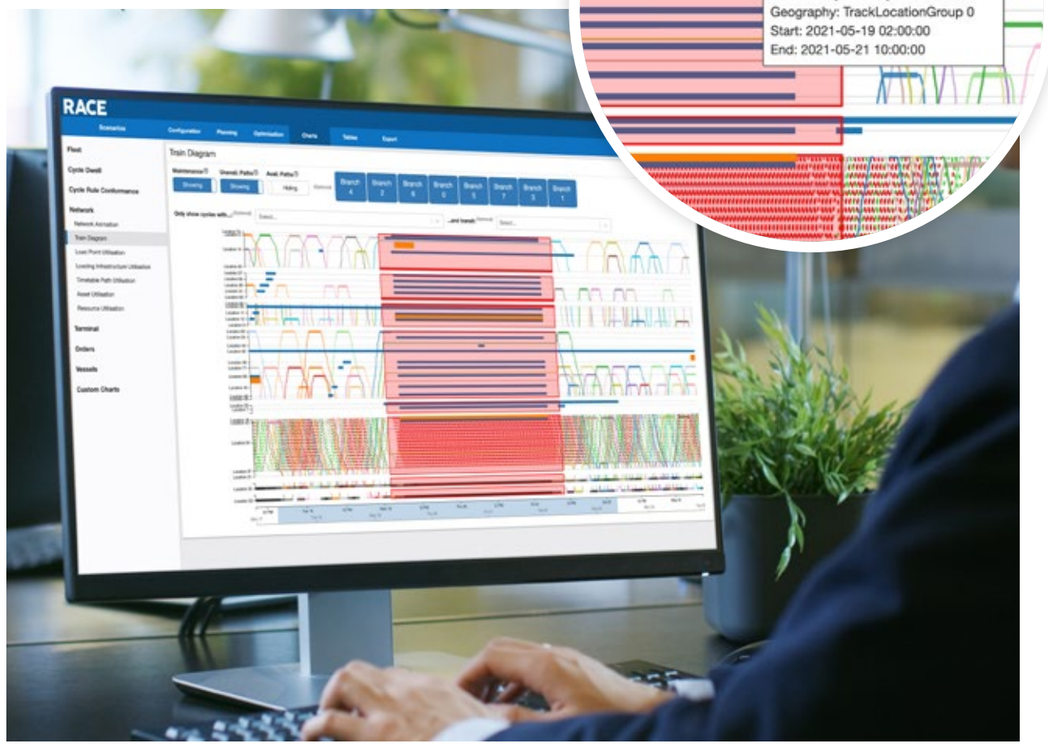
Unit cycles planned around floating/flexible rail maintenance

System Shutdowns

Rail networks often undergo periods of major maintenance activity where rail units need to be stowed during the maintenance event.

RACE is capable of modelling such “system shutdowns”, where rail units need to be stowed around the network, in allowable geographies, with sufficient shoulder time on either side of the maintenance events timings.





Overlay of a system shutdown on the train diagram

Master Timetable Design

RACE can be used to create master timetables where such timetables, which are often updated periodically, need to account for:

- Track infrastructure capacity: section run times, headway constraints, passing loop restrictions and passing bays, etc
- Complex track networks including parts with different or multiple gauges
- The operations of different haulage providers operating any number of different fleets hauling between any number of load point terminal combinations
- Load point load duration and time of day constraints
- Terminal unload durations and time of day constraints
- Forecast tonnages for a range of customers for multiple commodities
- The impact of timetabled passenger operations
- Contractual requirements on producer volumes, haulage provider access etc.
- Operations where the timetable covers only parts of the track network

Who is Polymathian?

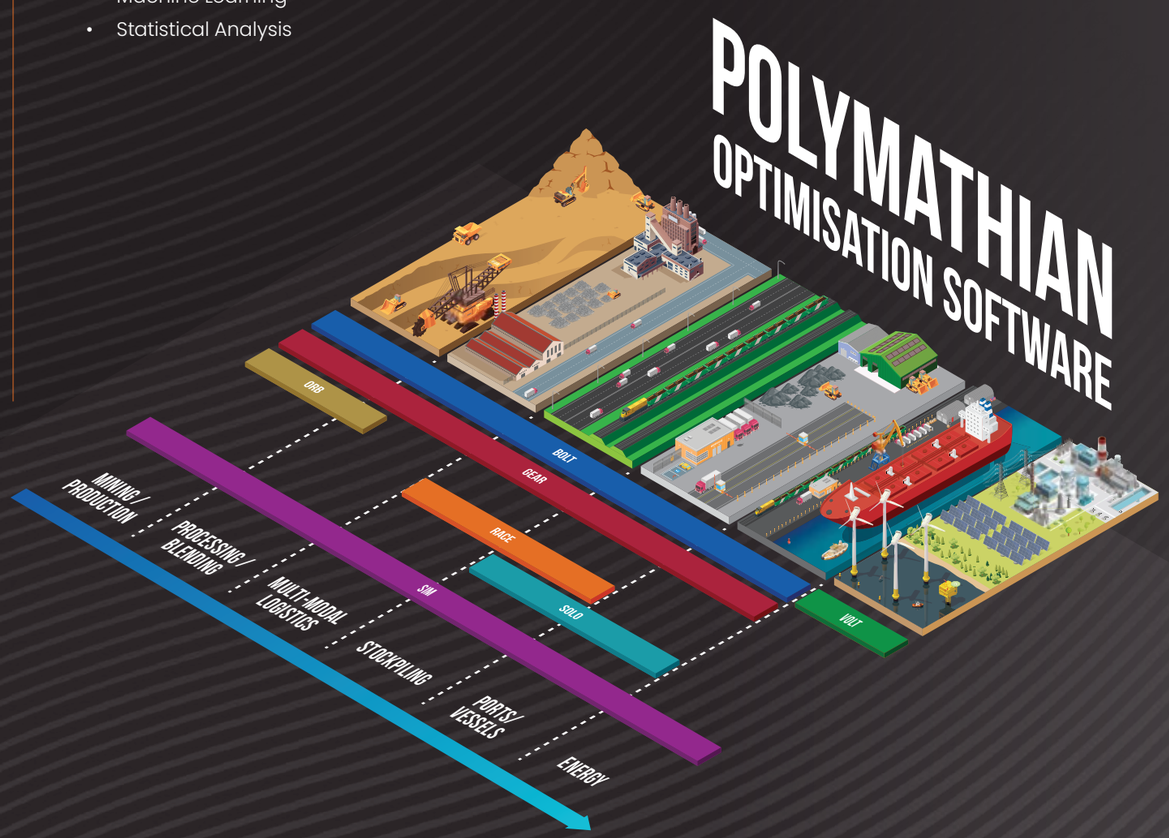
We are the industrial mathematics experts.

Polymathian adds significant value for our customers by solving complex planning and scheduling problems with software solutions that utilise advanced industrial mathematics. We are an Australian owned team of innovators, software engineers and mathematicians transforming the way industry makes complex planning and scheduling decisions.

Industrial Mathematical Capabilities

Polymathian develops industry leading decision-support software powered by the following industrial mathematics techniques:

- Mathematical Optimisation
- Simulation
- Machine Learning
- Statistical Analysis



Our Products

Polymathian's software is transforming the way industry makes complex business decisions.

RACE

Rail supply chain optimisation software that uses industrial mathematics to maximise throughput and asset utilisation.

BOLT

Bulk supply chain optimisation software that increases profit, reduces costs and maximises efficiency.

ORB

Mining planning and scheduling optimisation software to increase profit, reduce cost and maximise efficiency from strategic planning to real-time dispatch.

VOLT

Energy and utility dispatch software that uses digital twin capabilities to minimise operating costs and maximise revenue in real-time using industrial mathematics.

GEAR

Asset maintenance software that optimises maintenance strategies to improve safety, reduce costs and minimise downtime.

SOLO

Maritime operations software that increases throughput, minimises demurrage, reduces pilot fatigue and maximises efficiency.

Book a demo

Interested in learning more? Book a demo with us to learn how RACE will revolutionise how you plan and schedule your rail value chain.

RACE

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