Development of In-House logistics solvers

- TIMO management
- Costs / Revenues
- Management and Supply Chain Logistics

Nelson Operating Environment
Improving Transport Efficiency

Aims:
- Maximise day length
- Minimise lead distance to customer
- Minimise unloaded running distance

Describing a journey

<table>
<thead>
<tr>
<th>Unloaded Journey</th>
<th>Logger 1</th>
<th>Logger 2</th>
<th>Logger 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Destinations /Sources</td>
<td>Base</td>
<td>Coastal Milling</td>
<td>Local Port</td>
</tr>
<tr>
<td>Base</td>
<td>1</td>
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<tr>
<td>Coastal Milling</td>
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<td>Local Port</td>
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<tr>
<td>Paper plant</td>
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<tr>
<td>Golden Hills Sawmill</td>
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<th>Loaded Journey</th>
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<td>Golden Hills Sawmill</td>
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</tbody>
</table>

The building block for:
- a days operation for a single truck and
- describing a fleet of trucks
Describing the Delivery Plan

<table>
<thead>
<tr>
<th>Sources /Destinations</th>
<th>Logger 1</th>
<th>Logger 2</th>
<th>Logger 3</th>
<th>Logger 4</th>
<th>Logger 5</th>
<th>Total</th>
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<tbody>
<tr>
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<td>6</td>
<td>10</td>
<td>4</td>
<td>8</td>
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</tbody>
</table>

Other factors affecting a truck operating day

- Harvest Crew availability
- Mill yard capacity
- Individual truck up-time
Using a spreadsheet solver

- Set delivery plan (loads/destinations)
- Based on latest stock call
- Set constraints • Truck • Customer • Logger
- Set number of trucks
- Run model for first deliveries

Run model again later in the day as updated stocks are notified

<table>
<thead>
<tr>
<th>Trip 1</th>
<th>Trip 2</th>
<th>Trip 3</th>
</tr>
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<tbody>
<tr>
<td>Truck</td>
<td>Total delivered</td>
<td>Unloaded 1</td>
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<tr>
<td>a</td>
<td>275</td>
<td>5 Frasers</td>
</tr>
<tr>
<td>b</td>
<td>306</td>
<td>5 Frasers</td>
</tr>
</tbody>
</table>

MODEL TYPE: Mixed Integer / Linear
SOLUTION STATUS: GLOBALLY OPTIMAL
OBJECTIVE VALUE: 3807
DIRECTION: Minimize
SOLVER TYPE: Branch-and-Bound
TRIES: 27632
INFEASIBILITY: 0
BEST OBJECTIVE BOUND: 3807
STEPS: 42
ACTIVE: 0
SOLUTION TIME: 0 Hours 0 Minutes 52 Seconds

Outcomes

- An 14% potential improvement in truck utilisation was identified
- What the Dispatch learned...
- Not too many trucks were needed to capture the opportunity
- Used for benchmarking or day to day use?
- Moving toward an integrated system
- Contractual implications
But is truck scheduling the right starting point?

- Are logs being made for the right customer in the right location?

Building a weekly log allocation

The existing spreadsheet model had the basic components:

- Order schedule
- Production estimates for each logging crew
- Expected grade recovery for each crew
- A basis for comparing the supply/demand reconciliation

What was added to the existing tool:

- A stumpage calculation for every grade and location
- Conditional rules covering re-grading within and between log grade categories
- Tolerance limits around meeting customer orders
- Conditional limits on forest production to ensure crew production estimates are met.
- A reconciliation report showing the optimised solution compared to the indicated resource data
- An objective function to maximise net stumpage
What happened when we ran the model?

- The model captured the best value opportunity for the estate.
- Solution times were within 5 seconds
- An 8% opportunity to increase stumpage was identified
- Trials captured 90% of the opportunities
- Re-allocation of volume was partly grade swapping but mostly re-grading
- Ultimately we were able notify crews as to expected production by grade
- Some operational necessities – cut cards still had to make sense.

Scenario planning

What is the marginal value of increase supply to a given customer?
- A customer asks for more volume
Summary

• Spreadsheet solvers take this business function from the backroom to the front room
• If it's in a spreadsheet then it can be modelled and optimised
• Solvers are not expensive
• Specialist skills aren't really needed
• Management teams can fulfil their function get the best from the resources under their control
• Cost are removed and returns maximised with the supply chain with no impact to either customers or suppliers.