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Simulation of Coal-Barging on a River

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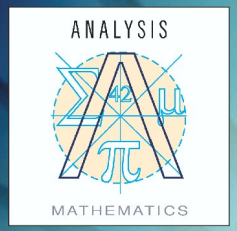
December 2010

Overview

- **Background**
  - Aims
  - Approach
- **The Problem**
- **Simulation Results**
  - Baseline Model
  - Sensitivity Analysis



Background

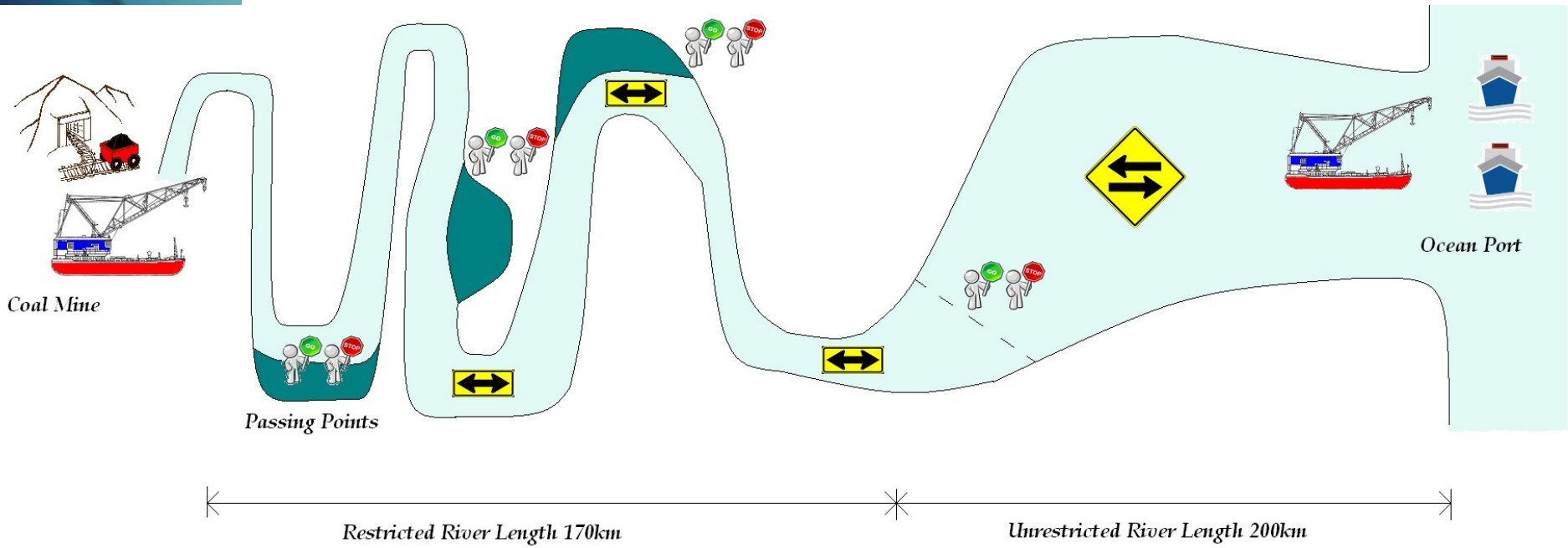
- **Investigate the feasibility of barging coal downriver to an ocean port**
  - River constraints
    - Possible issues with queuing for limited resources and congestion
- **Short-term solution while other infrastructure was built**

Project Aims

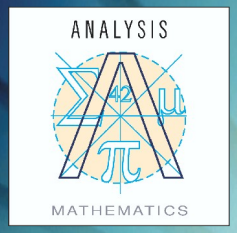
- **Client estimated that 2.5Mtpa could be transported**
  - Is this estimate feasible?

- **If so, investigate simple options for increasing annual tonnage**
  - E.g. increasing the number of barges

The Problem



- River Availability
  - 360 "working days" per year
  - Navigable 75% of working days



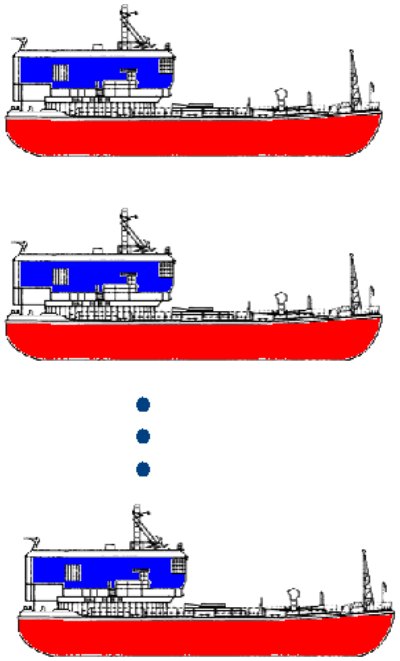
DAA Approach

- **Lots of sources of variability, complex system, queues…**
  - Simulation Approach
  - Extend Software Package
- **Results needed fast to aid decision making**
  - Quick, simple solution
  - Limited data – rough assumptions
  - Consider relative importance of system components

DAA Approach

- **Baseline model to check feasibility of 2.5Mtpa**
- **Sensitivity Analysis on key assumptions to see effect on annual tonnage**
- **Areas that may affect productivity:**
  - Number of barges
  - Passing Points
  - Variation in arrival time of the ships
  - Prioritisation of barges up and downstream

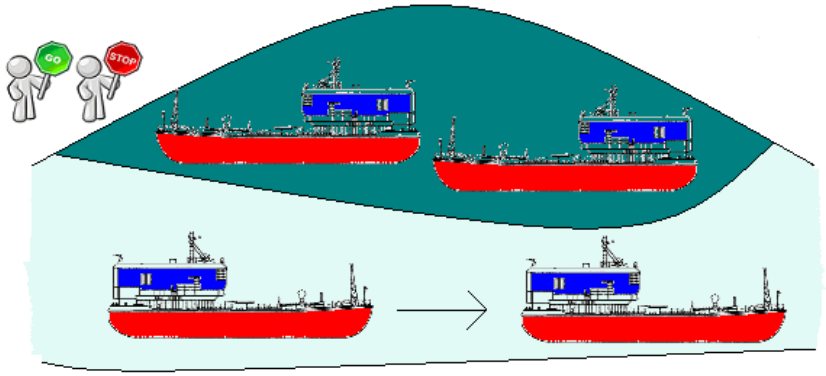
Barges



- Capacity of 5,000t
- 17 barges in baseline model
- Introduced at Coal Mine as crane becomes available
- Simulation pre-run for 12 months to naturally distribute barges

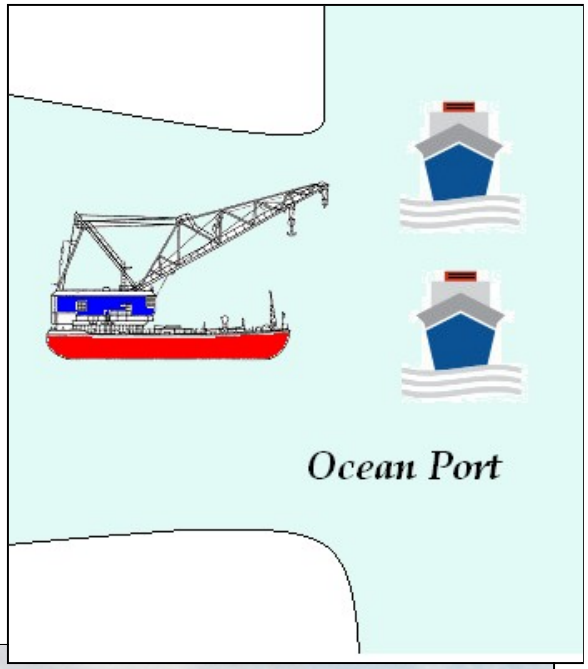
Passing Points

- 4 passing points in baseline model, equally spaced
- Priority given to loaded barges heading downstream



Ship Arrivals

- Capacity of 65,000t
- Hypothetical shipping company
- Limited control over arrival rates
- Gamma distribution
  - Regular arrivals for comparability
  - Annual tonnage drives mean inter-arrival time



Other Assumptions

- **Service Times**
  - Loading with Coal
  - Travelling downstream via passing points
  - Unloading with Coal
  - Travelling upstream via passing points
- **Queues**
  - Barges waiting to load with coal
  - Barges waiting to pass at the passing points
  - Barges waiting to unload with coal

Baseline Model Results

Output	Value	Units
Maximum number of empty barges queuing for a passing point	2	barges
Maximum number of full barges queuing for a passing point	3	barges
Average time a full barge waits to unload at the Ocean Port	63.48	hours
Number of full barges unloaded	507	barges
Tonnes of coal unloaded by the barges	2.535	million tonnes
Maximum number of ships at the Ocean Port	2	ships
Number of full ships departed	39	ships

- ➔ Target of approx. 2.5 Mt pa is achievable
- ➔ Average time spent waiting to unload appears quite high at 63 hours

Sensitivity Analysis - Barges

Output	Value	Units
Maximum number of empty barges queuing for a passing point	2	barges
Maximum number of full barges queuing for a passing point	3	barges
Average time a full barge waits to unload at the Ocean Port	52.69	hours
Number of full barges unloaded	507	barges
Tonnes of coal unloaded by the barges	2.535	million tonnes
Maximum number of ships at the Ocean Port	2	ships
Number of full ships departed	39	ships

➔16 barges can achieve same annual tonnage as 17 barges but with reduced waiting time to unload

Sensitivity of Passing Points

Output	Value	Units
Maximum number of empty barges queuing for a passing point	2	barges
Maximum number of full barges queuing for a passing point	3	barges
Average time a full barge waits to unload at Floating Crane	66.10	hours
Number of full barges unloaded	499	barges
Tonnes of coal unloaded by the barges	2.495	million tonnes
Maximum number of ships at the Floating Crane	2	ships
Number of full ships departed	38	ships

➔3 passing points

➔Still achievable but average waiting time has increased

Conclusions

- **What about varying prioritisation, etc?**
- **It probably would increase annual tonnage BUT**
  - Complicated prioritisation requires high level of communication between barge operators or sophisticated signalling
  - No longer "simple options"
  - Not a fit-for-purpose solution

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Thank You

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