SIMULATION OF DRY BULK TERMINALS

Teus van Vianen
Rotterdam, the 21st of April 2016
Dry Bulk Terminals Group – Operational and Technical Meeting
1. Introduction
2. Study 1: Flexible staffing
3. Study 2: Belt conveyors layout
4. Conclusions
Introduction of Exspecta’s origin

Exspecta = Latin for Waiting time

The company’s objectives are:
1. To reduce waiting times for customers in the logistic industry.
2. To apply logistic knowledge in the industry.
3. Focus on dry bulk as well as liquid bulk terminals.

The logistic knowledge has been gathered during my PhD research project at Delft University of Technology entitled “Simulation-integrated Design of Dry Bulk Terminals”.

Overview PhD Thesis
Simulation (dis)advantages (1)

Why should simulation been used?

1. To take the stochastic processes into account that occur during daily operation.
   Stochastic means variations, for dry bulk terminals:
   - Ships arrive later then expected due to storms during sea-journey, speed losses, unavailability of pilots and tug boats, etc.
   - (Un)loading or transportation equipment breaks down.
   - Variation in amount of cargo per ship.
   - Material is stored for different times at stockyards.

2. To realize a ‘virtual terminal’ where settings can be altered to determine the impact on terminal performance.
Simulation (dis)advantages (2)

Many simulation tools have already been applied in the maritime industry. Especially,

- for seaside modeling and design
- for container terminals

However, there are significant less examples for dry bulk and liquid bulk terminals. Some examples exist, but these are dedicated for specific terminals.

Disadvantages for simulation:

- Hardly software-on-the-shelf available
- Time consuming
- Garbage in = Garbage out

Courtesy: FlexTerm

Courtesy: Kongsberg Maritime
Exspecta has performed several simulation studies for a dry bulk terminal operator, some examples:

1. Assessment of several designs for a new belt conveyors layout.
2. Flexible staffing versus terminal performance.

More details for both studies will be described in this presentation.
Other simulation studies have been performed in the liquid bulk industry, some examples:

3. Determination a plan for the renovation of one of the unloading jetties.
4. Terminal performance improvement.
5. Reduction of the waiting times for the inland tankers.
1. Introduction
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Flexible staffing: Research background – variation workload

Terminal operators are confronted by a varying workload at the terminal’s seaside. Reason: large variation in ship interarrival times and ship sizes.

August 4th, 2015

August 7th, 2015

August 12th, 2015

August 16th, 2015
Flexible staffing: Research background – work schedules

Current work schedule for production staff: 5-shifts non-stop

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5-shifts non-stop
Fixed number of employees per shift

Introduction of a flexible work schedule: E-flex

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E-flex
Lower number of permanent staff per shift and the E-flexers can be assigned to shifts when needed.

No E-flexers needed
All E-flexers in one shift
No E-flexers available anymore
The objective for this study was:

*Determine the terminal performance for the workschedules “5-shifts non-stop” and “E-flex”*

Historical data from EMO was used to generate the ships arrivals (arrival time, batchsizes, material type and equipment disturbances).
Flexible staffing: Number of staff per shift – 5-shifts non-stop

Registration of the needed and available number of staff per shift

5-shifts non-stop

Permanent occupation

More personnel required then available

Less personell required then available
Flexible staffing: Number of staff per shift – E-flex with 25 persons in flex-group

Registration of the needed and available number of production staff per shift

Conclusions:
1. With the E-flex work schedule production staff is employed when needed (match between FTE needed and FTE at work).
2. Peaks in workload can better be managed.
Registration of the demurrage costs (or despatch) per work schedule for some values of the annual throughput.

- 5-shifts non-stop
- E-flex (25)
- E-flex (50)

1. Because the peaks in workload can better be managed, demurrage costs can be reduced significantly (it will result in despatch).
2. E-flex performs better, especially, at a high value of the annual throughputs compared to 5-shifts non-stop.
3. More E-flexers result in a better performance for increased values of the annual throughput, although the performance improvement is marginal.
Registration of the costs for the hours worked

The E-flex work schedule results in lower costs for hours worked because of the reduced use of temporary staff (personnel is deployed more efficiently).

Cost for hours worked versus the annual throughput for different work schedules (relative to high throughput with 5-shifts non-stop work schedule)
Flexible staffing: Simulation results – comparison work schedules

Comparison between the work schedules investigated

<table>
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<th>High value for the annual throughput</th>
<th>Relative costs(^1) [%]</th>
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<tbody>
<tr>
<td>Work schedule</td>
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<tr>
<td>5-shifts non-stop</td>
<td>100%</td>
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<tr>
<td>E-flex(25)</td>
<td>69%</td>
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<td>E-flex(50)</td>
<td>65%</td>
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1. Improvement of the terminal performance is possible by applying flexible staffing.
2. More E-flexers increases the employability of production staff, however, the improvement is marginal.
3. Using the E-flex work schedules enables production staff to determine their work schedules, although last-minute changes of the schedule remain possible.

\(^1\) Relative costs = Costs for hours worked ± Demurrage/Despatch
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A simulation study was performed for EMO concerning the renovation of a major part of it’s belt conveyor network.

Several designs were formulated by EMO technicians. Several questions arise:

1. Which designs performs the best?
2. Is extra flexibility for route selection required?
3. How can this project been performed with less hindrance during daily operation?
4. Etc…
Belt conveyors layout: Several designs were evaluated

The entire terminal operation was modelled and historical data was used as input for the simulation model.
Belt conveyors layout: Simulation model – screen dump
During simulation the ship’s port times (waiting + unloading time) and port times of landside transportation modalities (trains, barges and batches to power plants) were registered.

Terminal performance for bulk ships

Terminal performance for landside jobs
• Best design performs 10% better for ships and 20% better for landside modalities compared to the existing layout.
• The simulation study underpinned the investment proposal successfully.

First activities for the renovation project have been started at the terminal in March 2016!
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Conclusions

Simulation has been proved as a probate technique for dry bulk terminals for:

1. Improving the terminal performance by evaluating flexible staffing.
2. Assessing several belt conveyors designs for a major renovation project.
END OF PRESENTATION