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WP5

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Structure of the presentation

- Simulation as a modelling method
- Model framework
- Port modelling using Agent-Based Modelling and System Dynamics
- Simulation as a part of cost engineering
- Real options

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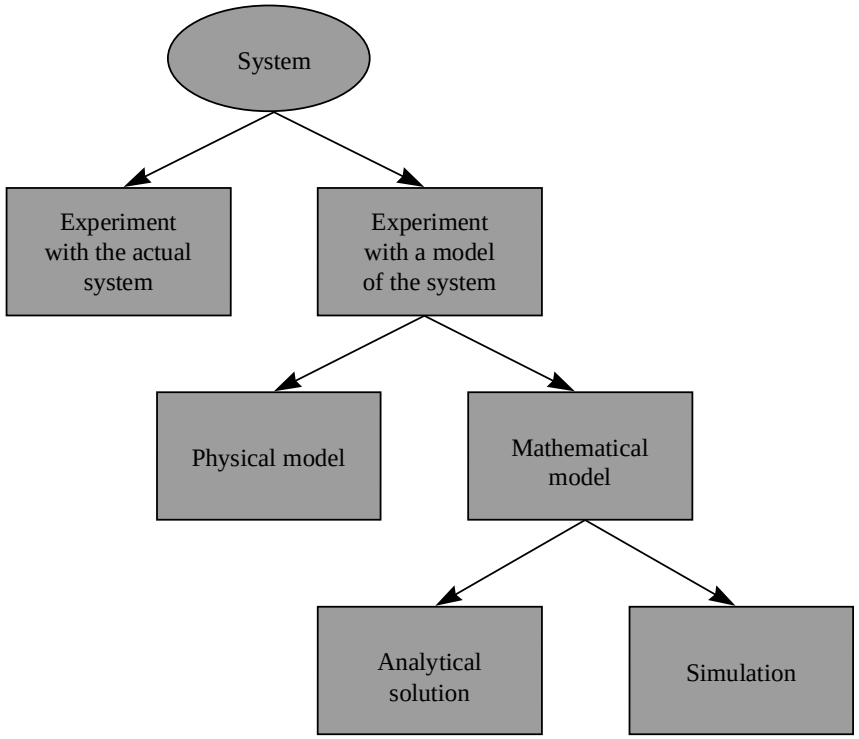
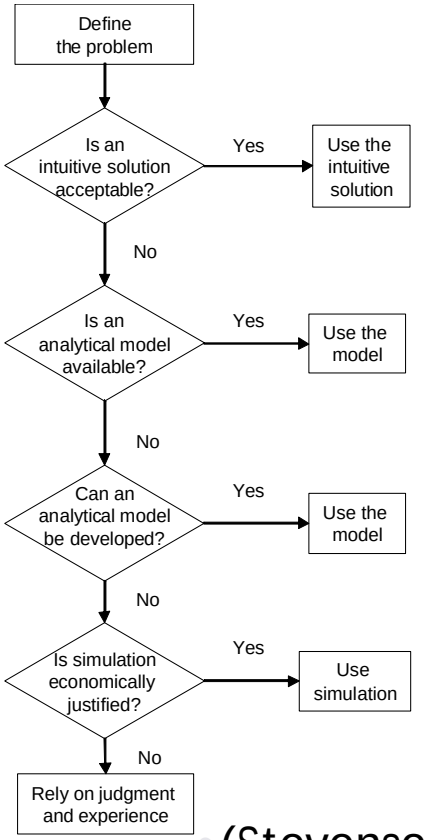
Simulation as a modelling method



(Law, 2006)



(Stevenson, 2007)

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Simulation as a modelling method

Transportation systems are an example of real-world systems that are too complex to be solved analytically.

- Recent examples of using simulation in transportation system analysis:
  - elevator planning (Tervonen et al., 2008), airport baggage handling system design (Rijsenbrij & Ottjes, 2007), evaluating segregation strategies of genetic manipulated grain (Coleno, 2008), modeling of national freight systems (de Jong & Ben-Akiva, 2007).
- Examples in sea transportation:
  - strategic and tactical decision making model for ship owners in the dry bulk sector (Engelen et al., 2006)
  - future capacity needs of the Rotterdam port area (Ottjes et al., 2006)
  - effect of information exchange in the Rotterdam port area on the waiting profiles (Douma et al., 2009)
  - operations of ditch wharfs and container yards in future mega-container terminals (Tu and Chang, 2006)
  - Grunow et al. (2006) have analysed strategies for dispatching AGVs at automated seaport container terminals in single and dual-carrier mode

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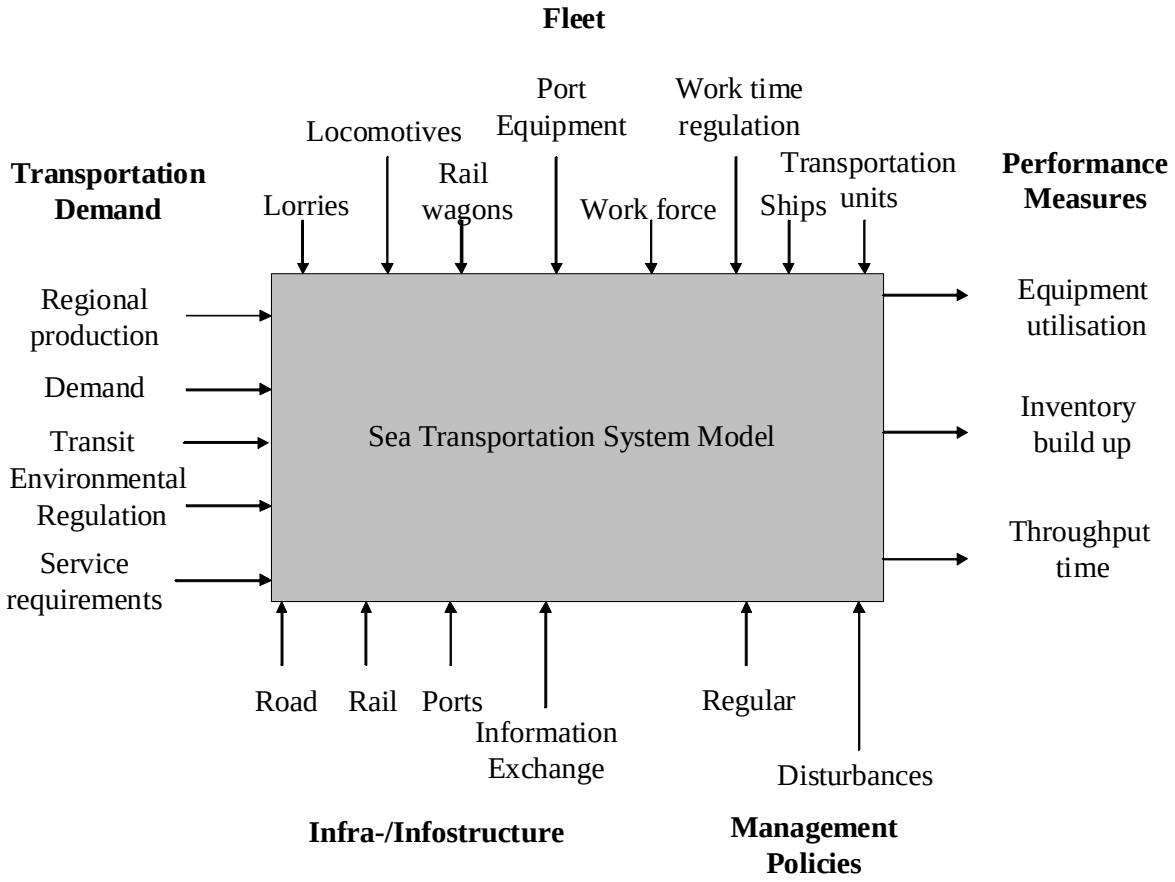
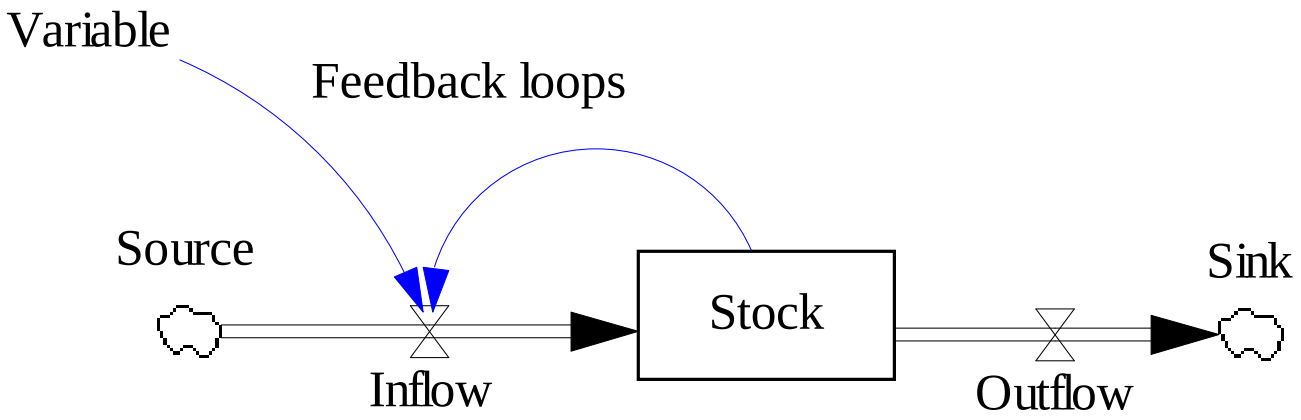
Sea transportation system model framework



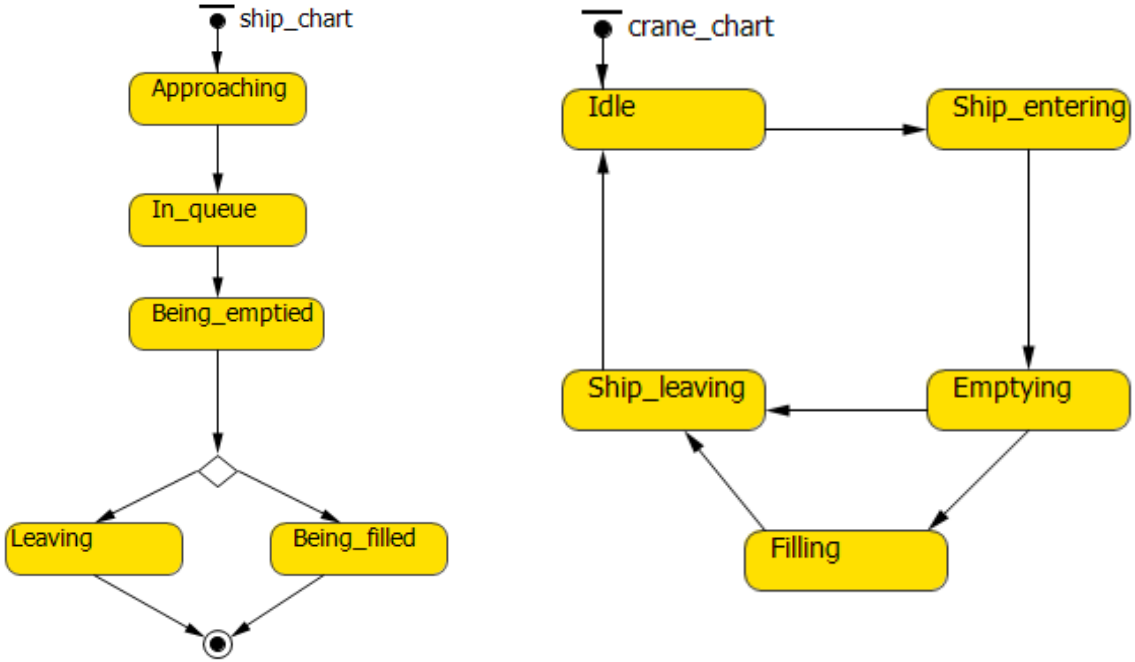
Agent-based modeling

- In agent-based modeling each individual agent is simulated separately
- The agents are able to perceive their environment, and create and follow plans
- The results for the simulation model are derived from the emergent behavior between the interaction of agents

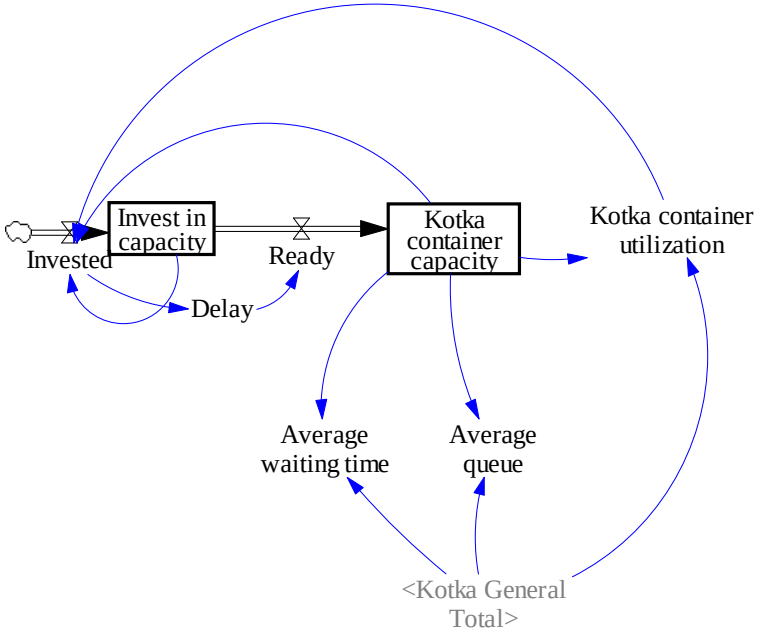
System Dynamics



Modeling a seaport using Agent-based modeling



Modeling a seaport using System Dynamics



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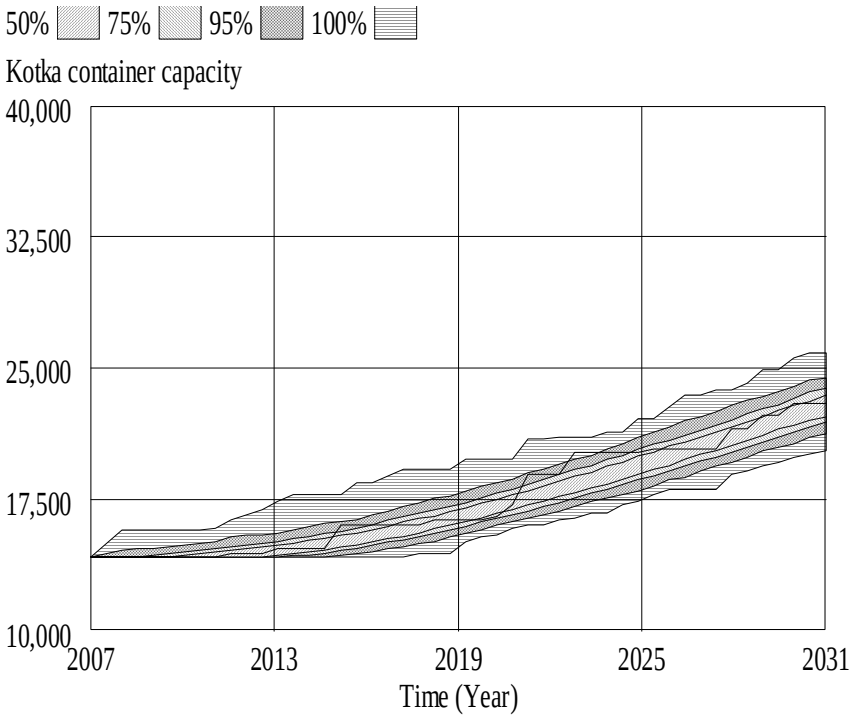
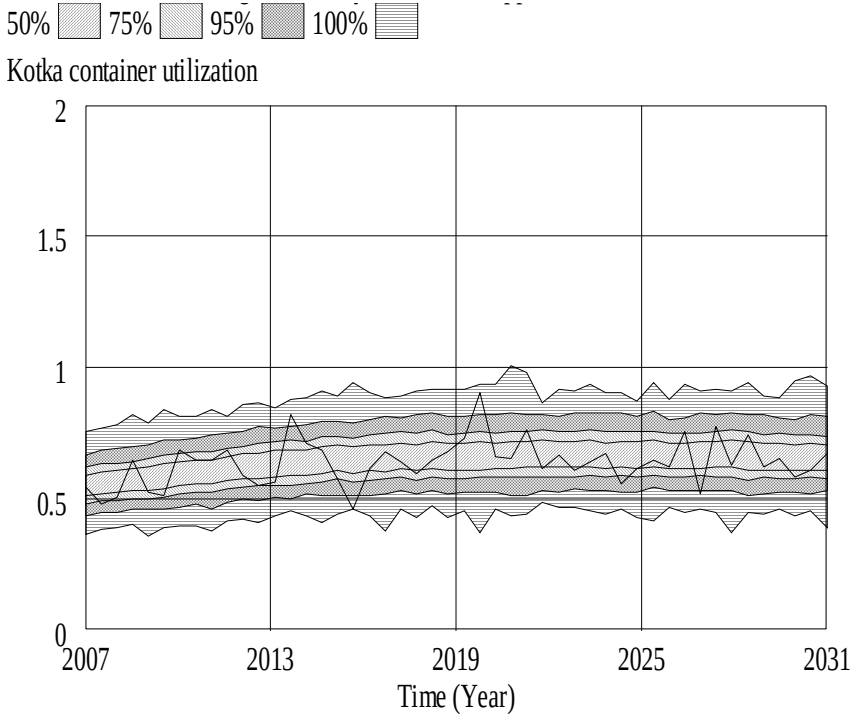
Kotka capacity and utilization in SD model





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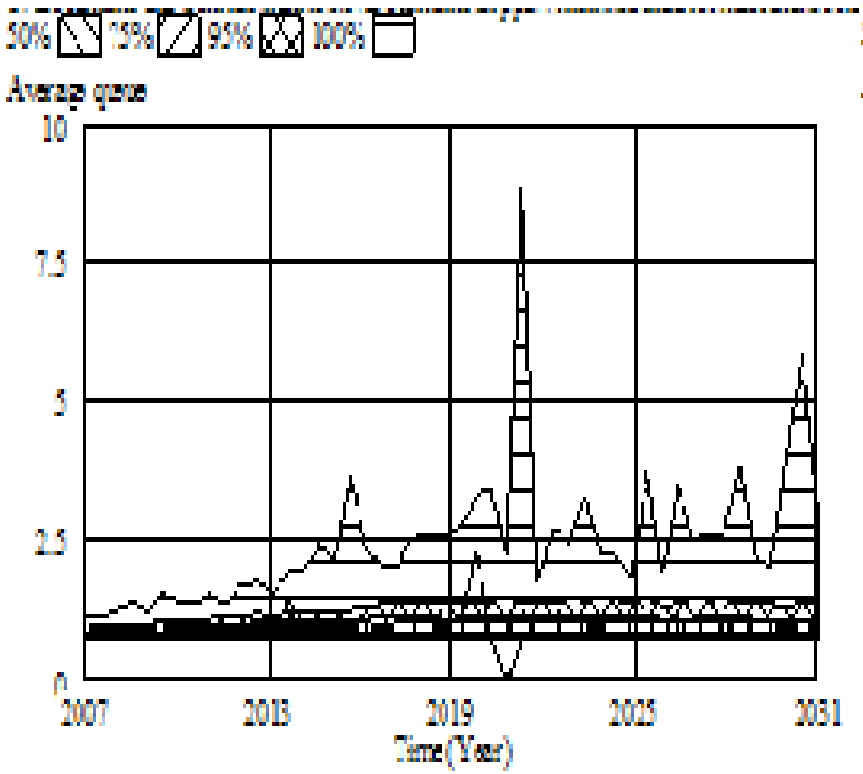
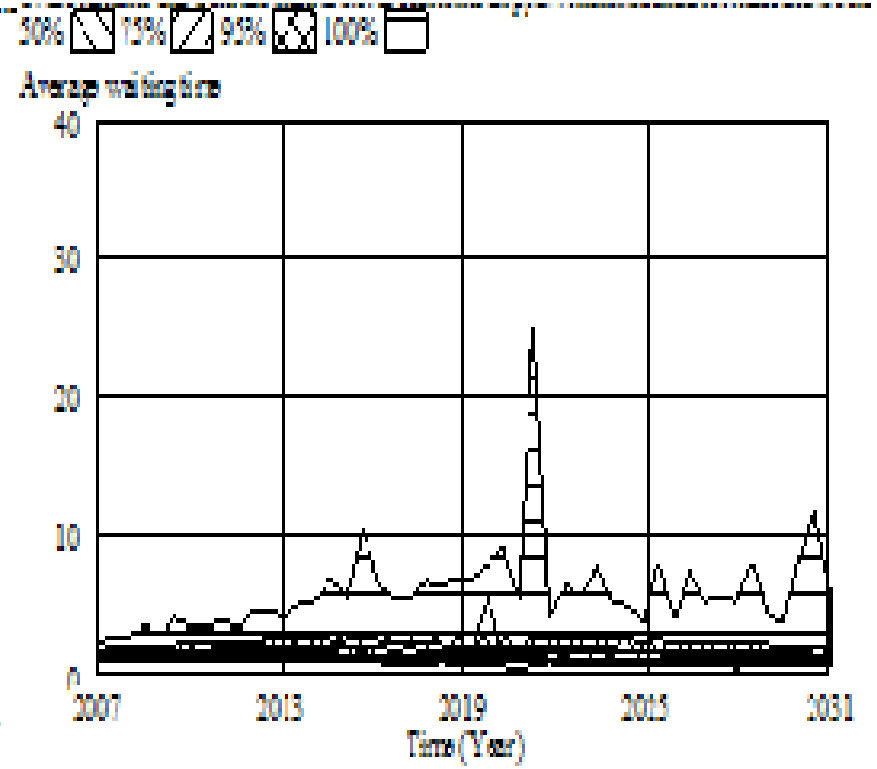
Kotka average queue length and waiting time and SD time





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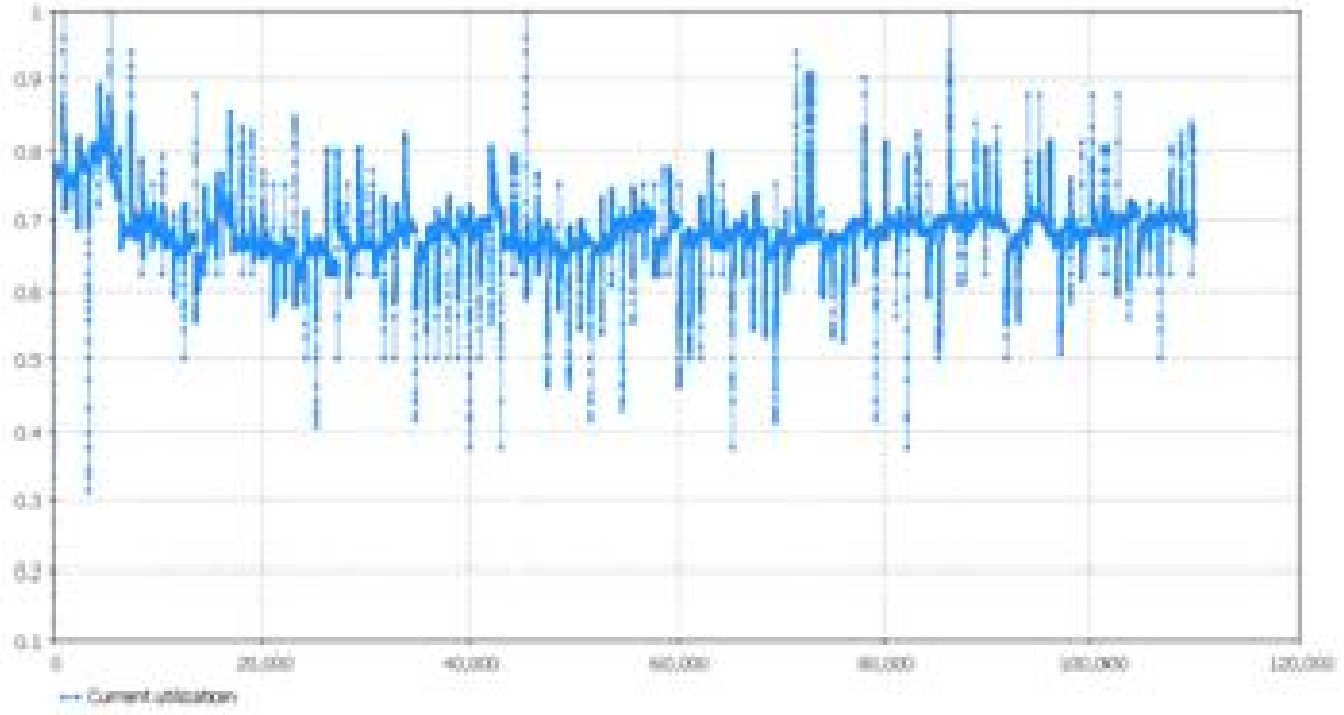
Utilization in AB model



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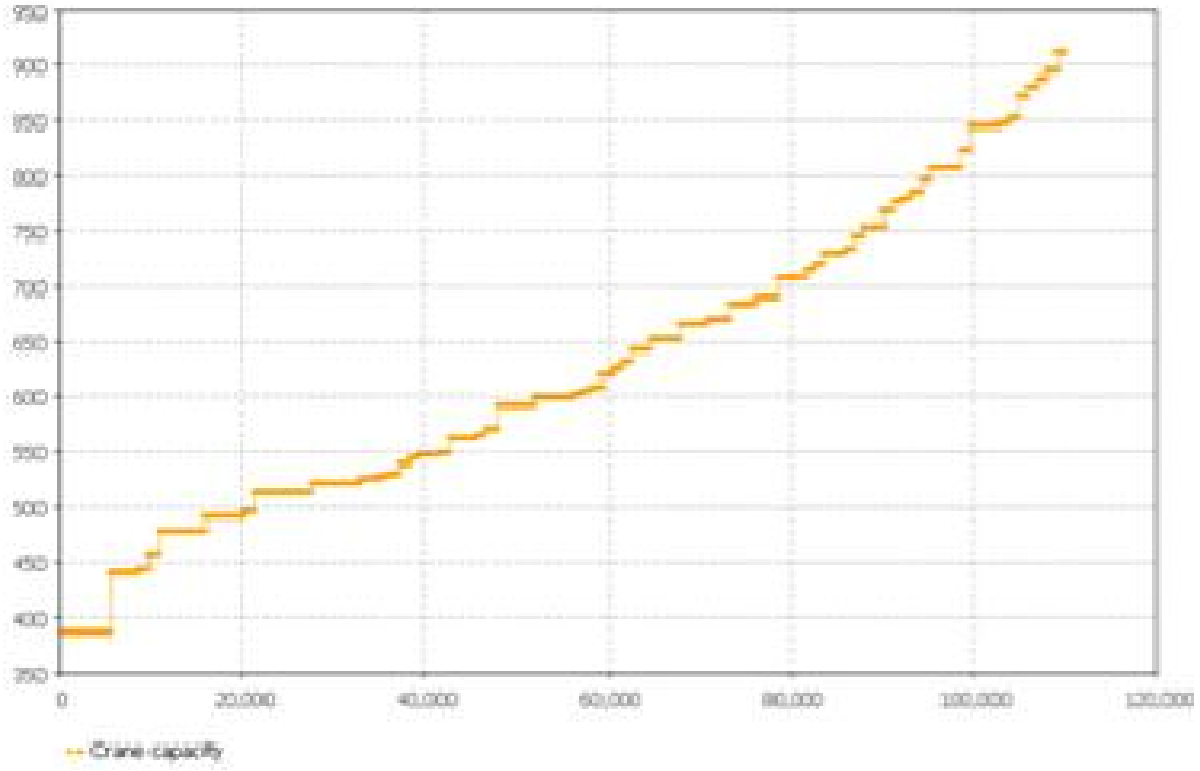
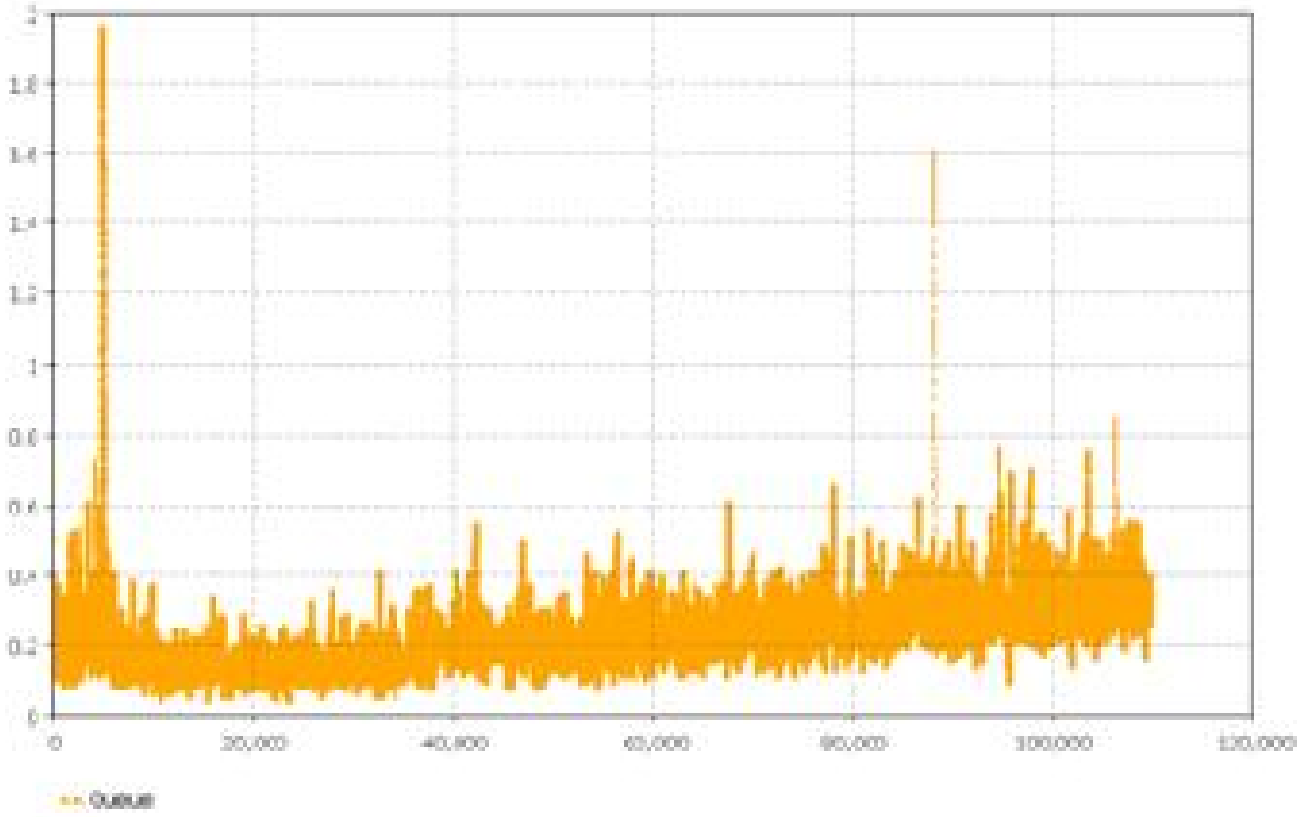
Capacity in AB model



Queuing time in AB model



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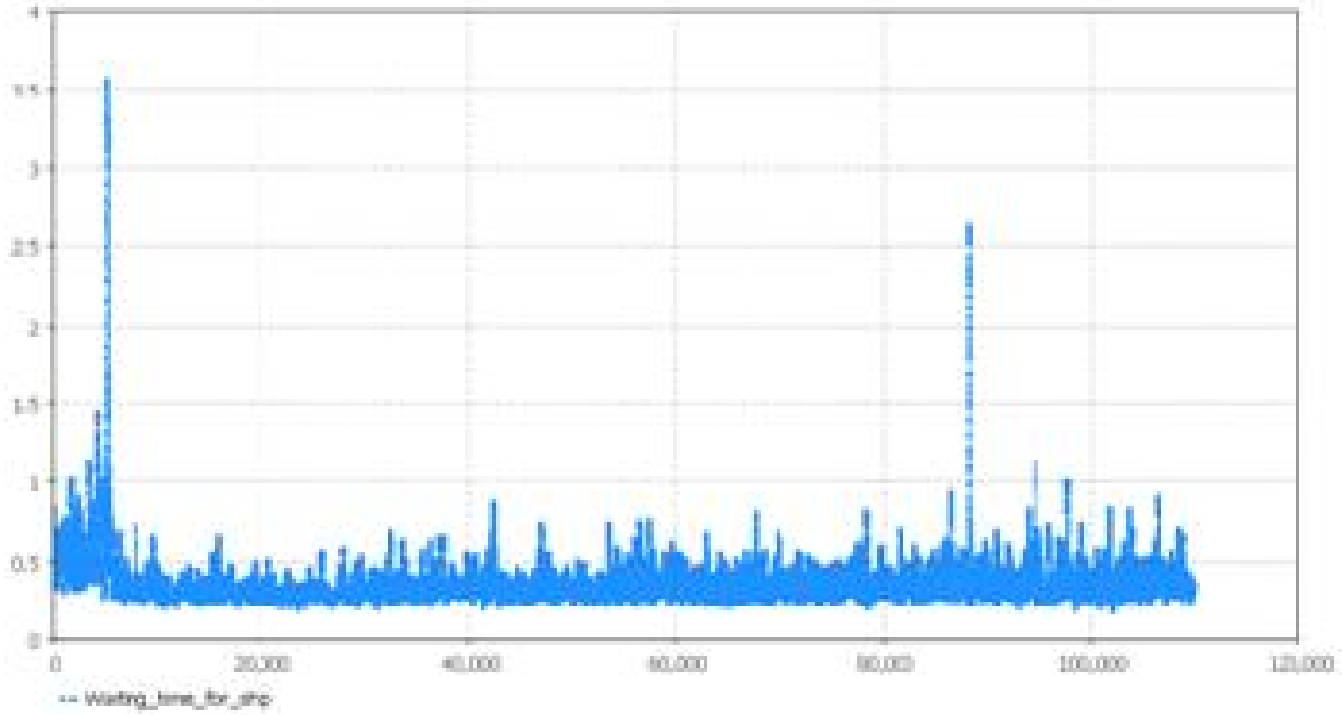
Waiting time in AB model



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Simulation & cost engineering

- Cost engineering is an area of practice engineering concerned with the application of scientific principles and techniques to problems of cost estimating, cost control, business planning and management science, profitability analysis, project management, and planning and scheduling (ICEC)
- Simulation is used to illustrade and solve cost engineering problems for purposes of investment planning, feasibility, costing, profitability and critical costs

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Real option

- Traditional discount cash flow approaches such as the NPV (Net Preset Value) cannot properly capture management's flexibility to adapt and revise later decisions in response to unexpected market developments.
- These approaches assume an expected scenario of cash flows and presume management's passive commitment to a certain static operating strategy. Whereas the real option word is characterized by change, uncertainty and competitive interactions.
- As the new information arrives and uncertainty about the markets conditions is resolved, management may have valuable flexibility to alter its initial operating strategy in order to capitalize favorable future opportunities or to react so as to minimize losses.
- These kinds of managerial operating flexibility modes are like financial options, and it is known as real options or strategic options in real life Myers (1984), Kester (1984) and Trigeorgis & Mason (1987).

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Real option

- Flexibility in an investment decision means a possibility to react to the changes in an operational environment: possibility to wait for further information or wait for a better time to make an investment. These possibilities have a strategic or another value. These kind of strategic attributes of real investments are called (strategic) real options SNPV.
- SNPV = NPV + R
  - where SNPV is investments strategic NPV
- NPV is normally calculated NPV for investment
- R is investments real option
- An investment can be accepted although its NPV is negative (NPV<0 if R>0 and SNA>0).

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Real option alternatives 1/2

- Option to defer, ”wait and see”
- Investor can seek more information about markets, rivals and future to get the best timing to investment
- Option to abadon is used in capital-intesive branches, when investment are proved to be unprofitable
- Time-to build option, staged investment
- Large infractructure plans like ports, railways, mills and development plans are buit in smaller phases

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Real option alternatives 2/2

- Option to alter operating scale, option to alter or option to shut down and restart
- Option enables to alter scale or adjust the capacity by the markets
- Option to switch use
- Different markets- different products (raw-materials or needs); Used in mobile and car industry
- Growth option
- Have strategy expectation value, encourage new options

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Case: Light Rail, CBA and real option

- Plan 1 is oval shaped light rail route
- Plan 2 Same, but the section Kasarminmäki-Sydänmaantie is removed
- Plan 3 Travel Center- Kuusankoskitalo
- Plan 4 China Center- Kuusankoskitalo
- Plan 5 Travel Center- Voikkaa Business Park

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Light Rail routes in map

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Real option: Energy and environmental costs

- Electrified light rail could substitude diesel-busses in public transportation in planned routes
- Real option:
- Annual growth rate of energy and environmental costs needed to compensate the light rail investment in an 30 year calculation period

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Results, CBA, Second hand train

Titles NPV, M€	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5
Benefits, M€	7.704	5.048	6.509	9.233	2.692
Environment benefits, M€	1.126	0.839	0.707	1.044	0.857
Residual value, M€	1.740	0.481	0.429	0.649	0.131
Total benefits, M€	10.569	6.368	7.645	10.926	2.692
Financing, M€	4.315	1.195	1.038	1.571	0.318
Investment, M€	30.072	8.319	7.414	11.223	2.272
Investment & Financing, M€	34.387	9.515	8.452	12.794	2.590
Investments NPV, M€	-19.504	-1.951	0.231	-0.297	1.409
Cost-benefit ratio	0.307	0.669	0.905	0.854	1.421

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Results, Real option, second hand train

Title, present value, M€	Plan 1	Plan 2	Plan 4
Environmental benefits an year, M€ Needed growth per cent (%) in year	0.073 17.900	0.055 9.000	0.068 2.000
Real option NPV, M€	19.504	2.790	1.341
Investment NPV, M€	-19.504	-2.790	-1.341

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Case: Maritime transportation investments of the ports of the GOF: Security of supply

- The Gulf of Finland (GOF) is one of the densest operated sea areas in the world that is economically vulnerable shallow: maximum dept is 60 metres and the average 37 metres
- Petroleum transport share is over 50 % of cargo traffic and its share will be growing up in the future
- The GOF is surrounded by three very different national economies with different maritime transportation structures
- Via the ports of Finland and Estonia a great deal of the Russian petroleium and consumer products such as cars and clothes are transported

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Real option in the ports capacity

- Growth options have a strategy expectation value that effects growth and other option in the future
- Many of the ports of the GOF had planned enormous investments for the future
- The economic situation and the Russian officials aim to transport its own import and export through the Russian ports in the future. The Russian plans have turned these investment plans to contain lot of risk.
- These risky investments could be avoided by co-operation with the other ports in the GOF
- However, the future development on maritime transportation is affected mostly by current economic instability and it seems to be quite uncertain just now

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Option to defer ”wait and see”

- In this economic situation option to defer investments to the better times can be recommended
- Reservoir of excess port capacity is chosen as real option:
- Could the ports of Finland and Estonia be resevoirs of the port capacity to each others
- In Finland the ports of Kotka, Hamina, Sköldvik, Helsinki, Hanko, Naantali and Turku lies in the shores of the GOF
- In Estonia the ports of Sillamäki, Muuga and Paldinski lies in the shores of the GOF
- Because every port of has a different infrastructure, the savings in every single port are almost a deal of its own extra capacity costs
- The ports of Finland handle mainly container cargo and single consigments
- The ports of Estonia handle mainly Russian oil.

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Results

- Light rail investment of operating network plays a pivotal role in determing the profitability of light rail public transportation in a middle sized town.
- In order to affect profitability, environmental and enegy benefits must increase annually nearly 20 %
- It will be more realistic to assume that environment and enegy benefits will give a 2-3 % advantage to the electrified railway traffic in the 30 years calculation period

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Results

- It can be stated that the development of marine transportation in the GOF is dominated by the economic situation in the Russian and Baltic Sea region.
- For that reason large investments to new extra capacity of maritime transportation are now risky
- The difference in the infrastructure between the ports of Finland and Estonia is palpable
- For these facts Finnish and Estonian ports have a limited capability to compensate each others in operations as need arises

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Conclusions

- Transportation systems are a typical example of real-world systems that are too complex to be solved analytically à simulation should be used
- Different simulation methods have different advantages in analysing a seaport
- Real options provide decision makers improved knowledge on the profitability of an investment

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