Formal Design Models for Order Picking Systems

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Outline

1. Problem description
2. Model of the order picking zone
3. Design decision support
4. Performance calculation example

Problem description

- What is the best procedure when designing a warehouse?
- What are the best tools to support decisions?

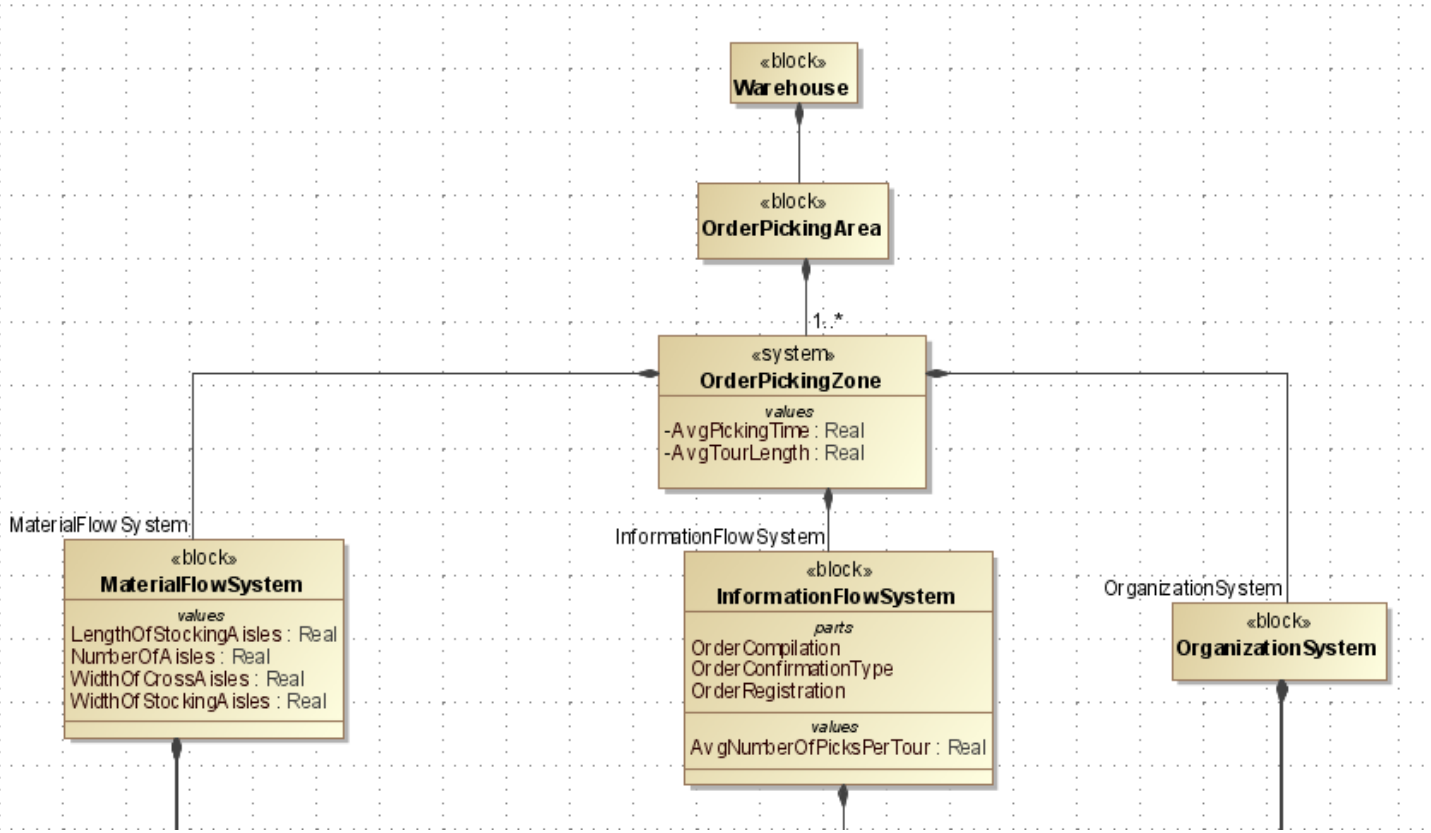
→ A systematic design process requires a systematic description

Usage of SysML

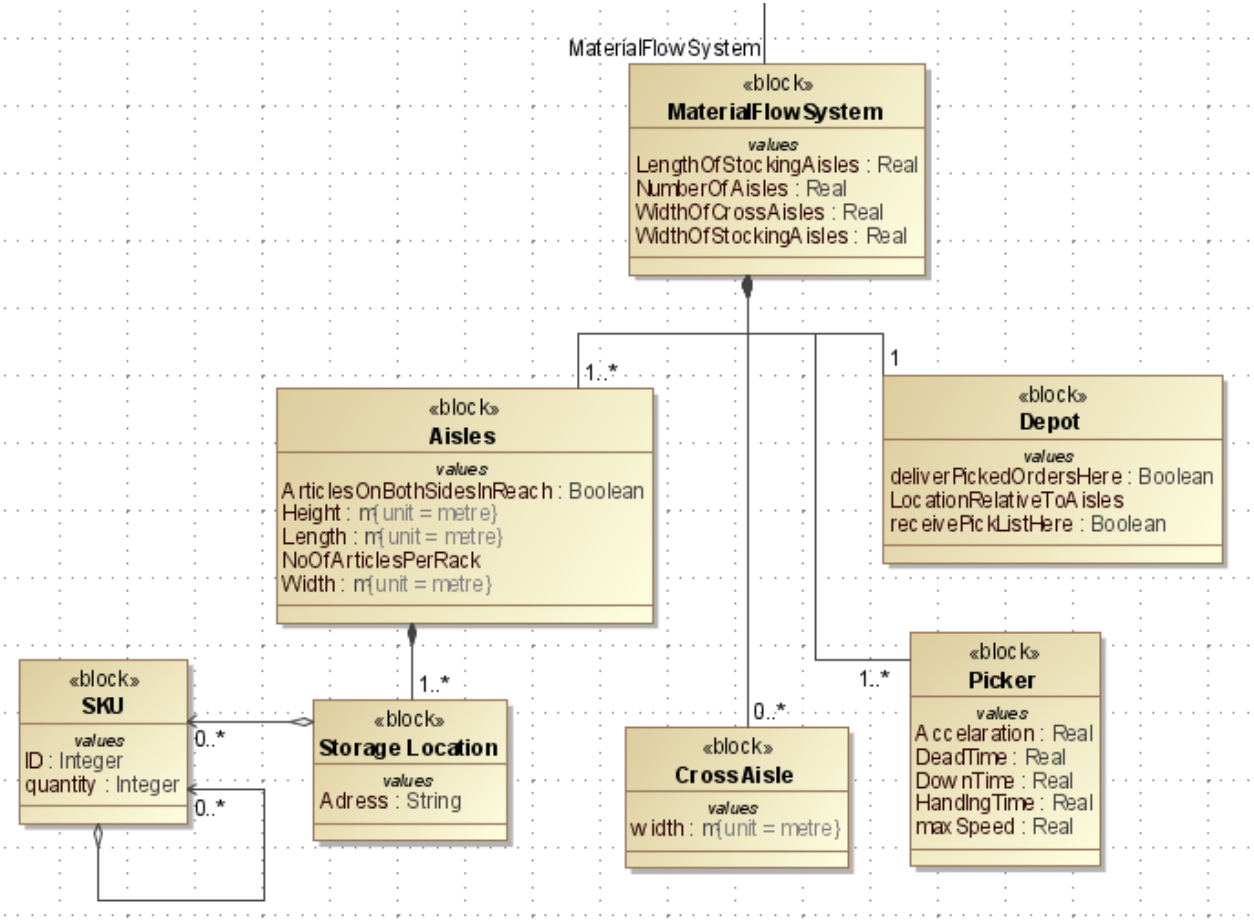
Benefits

- Combines description and analysis
- Expert knowledge becomes accessible
- “Easy“ to read the diagrams
- Different “views“ on one model possible

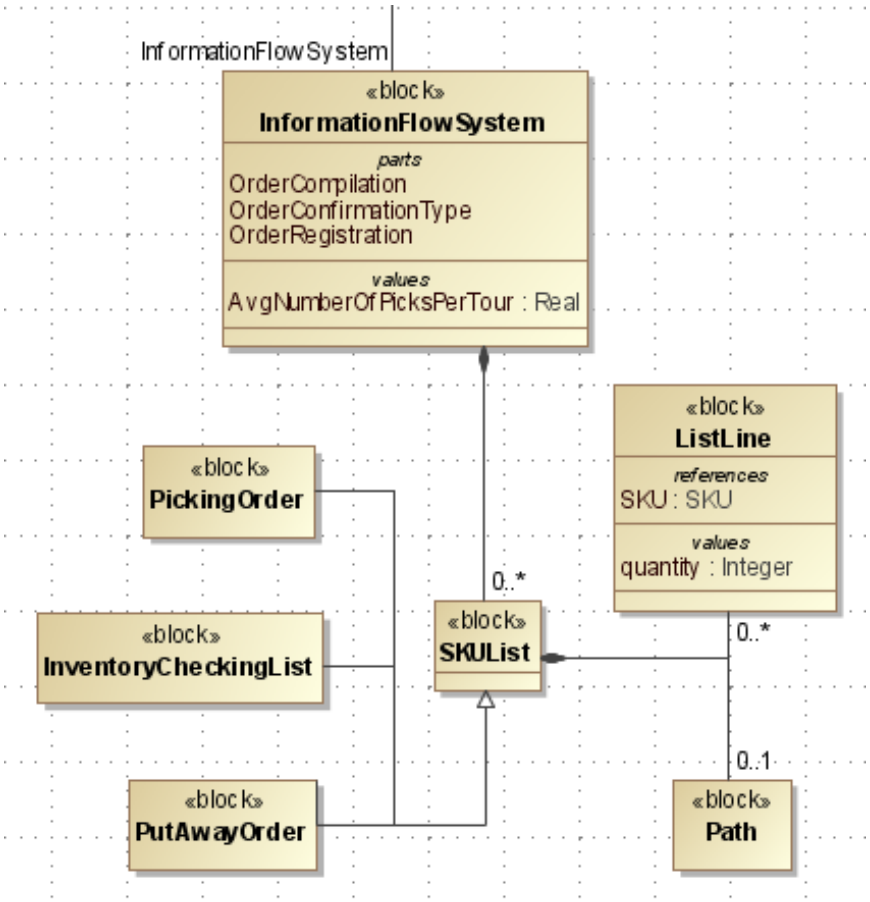
Order Picking Zone



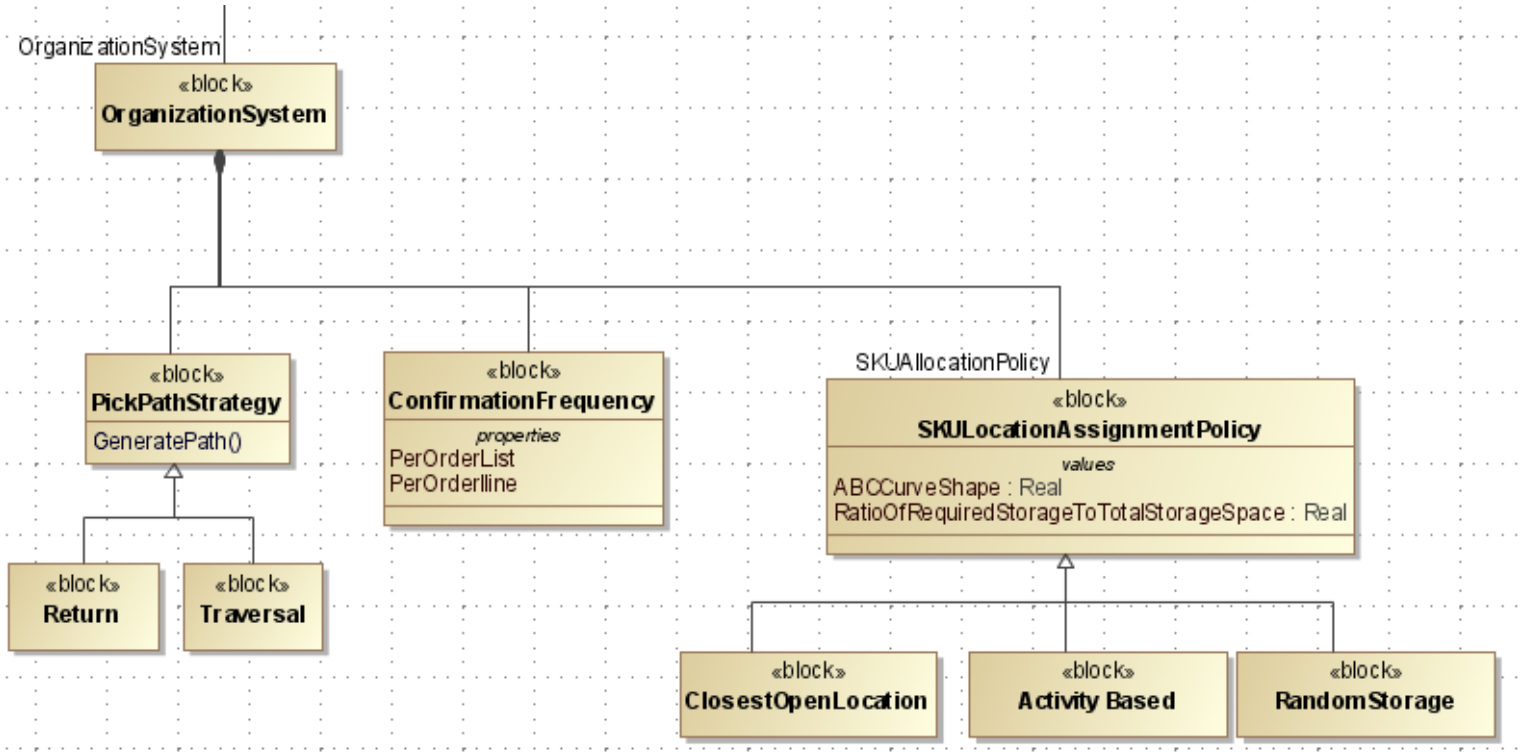
Material Flow System



Information Flow System



Organization System



Analytical Model

- Model differs depending on choices for

Minimum Picking Unit	Manually vs. Automatically	Location Assignment Strategy	Pick Path
Cross Aisles (Y/N)	Location of Depot	Articles in reach (One side/both sides of aisle)	Overtaking within aisle (Y/N)

→ Library of Organization Options

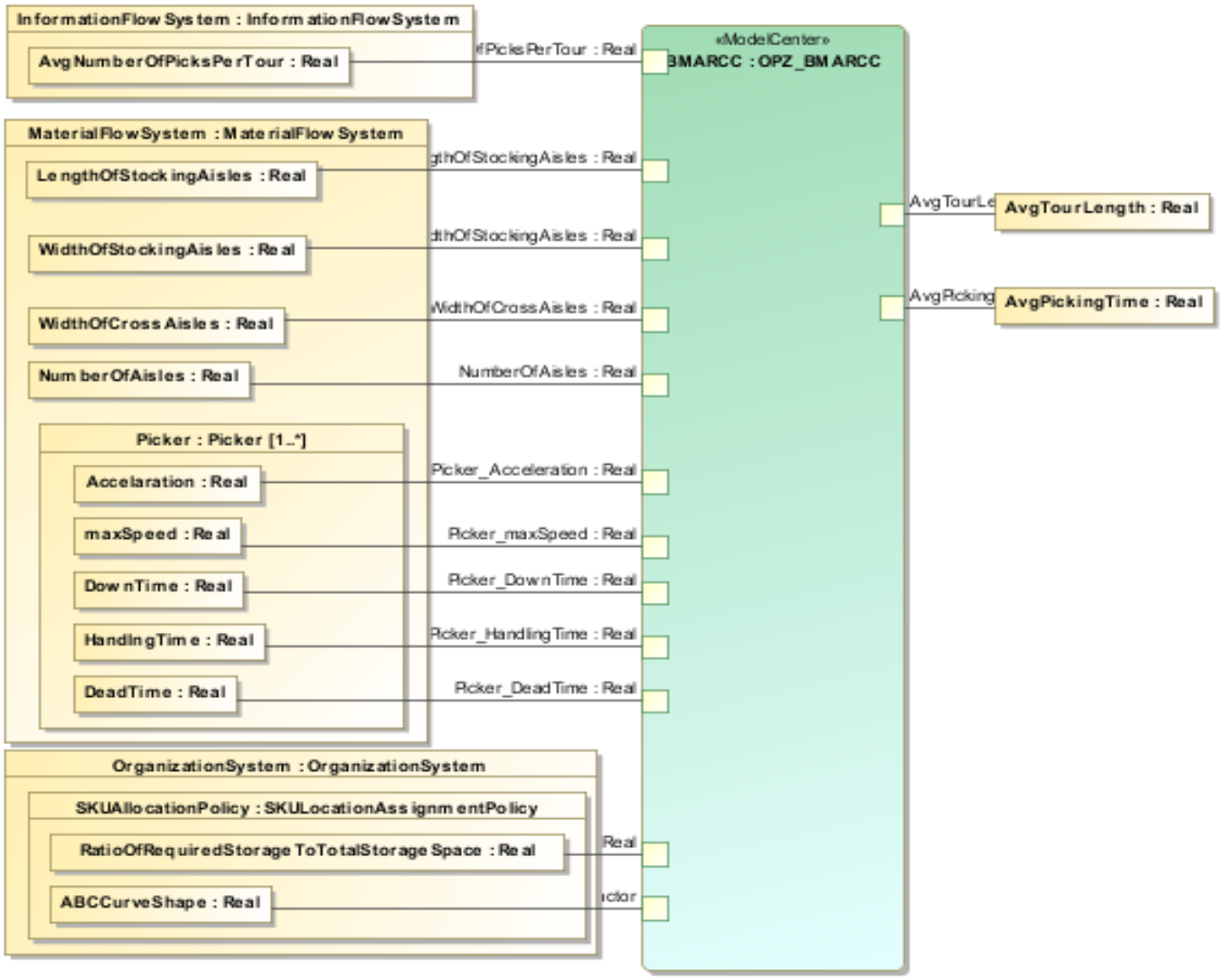
Example

- Analytical models based on Caron et al. 1998[1]
- Bin picking with cross aisle
- Return vs. Traversal Policy
- Random vs. Activity based SKU allocation

→ 4 options!

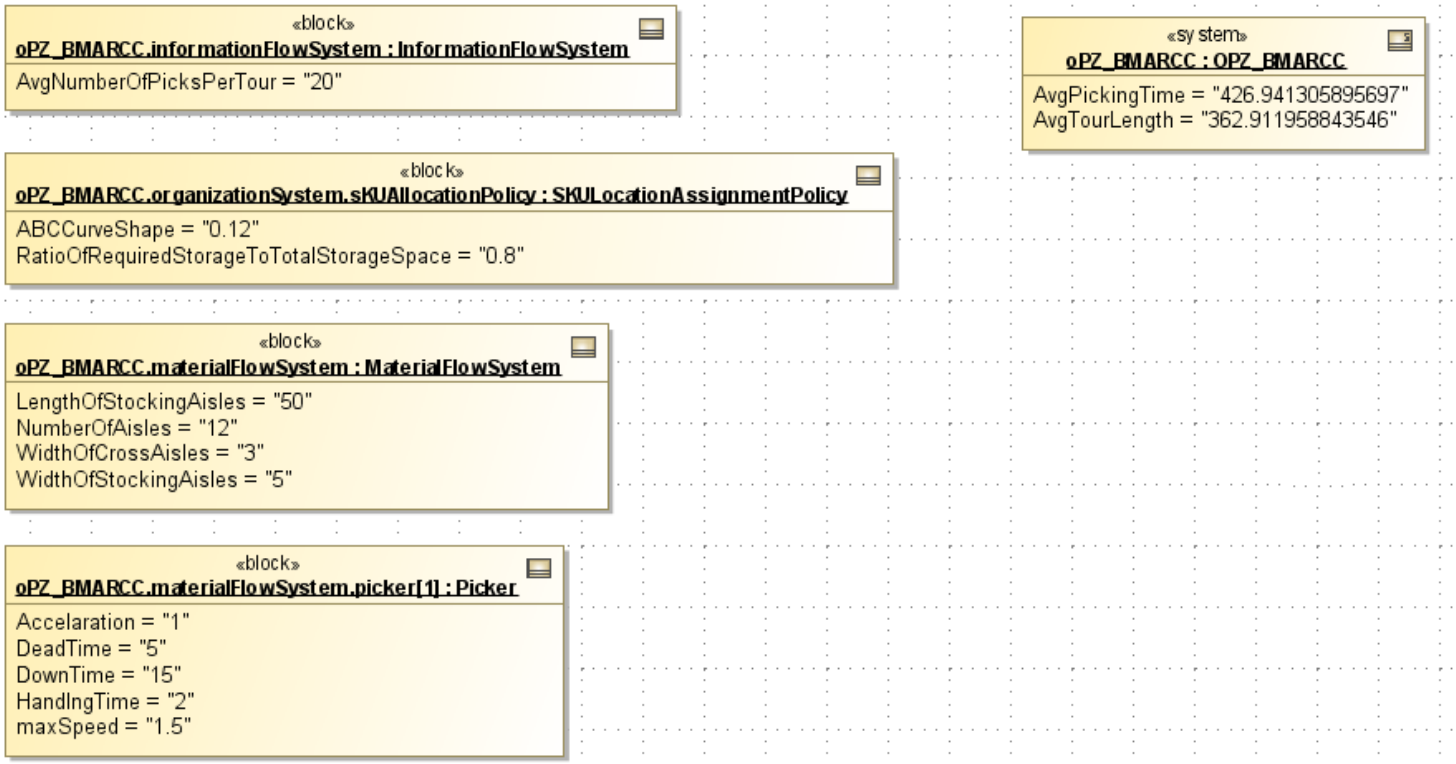
[1]: Caron, F, Marchet, G, & Perego, A 1998, 'Routing policies and COI-based storage policies in picker-to-part systems', *International Journal of Production Research*, 36, 3, pp. 713-732

Design Decision Support

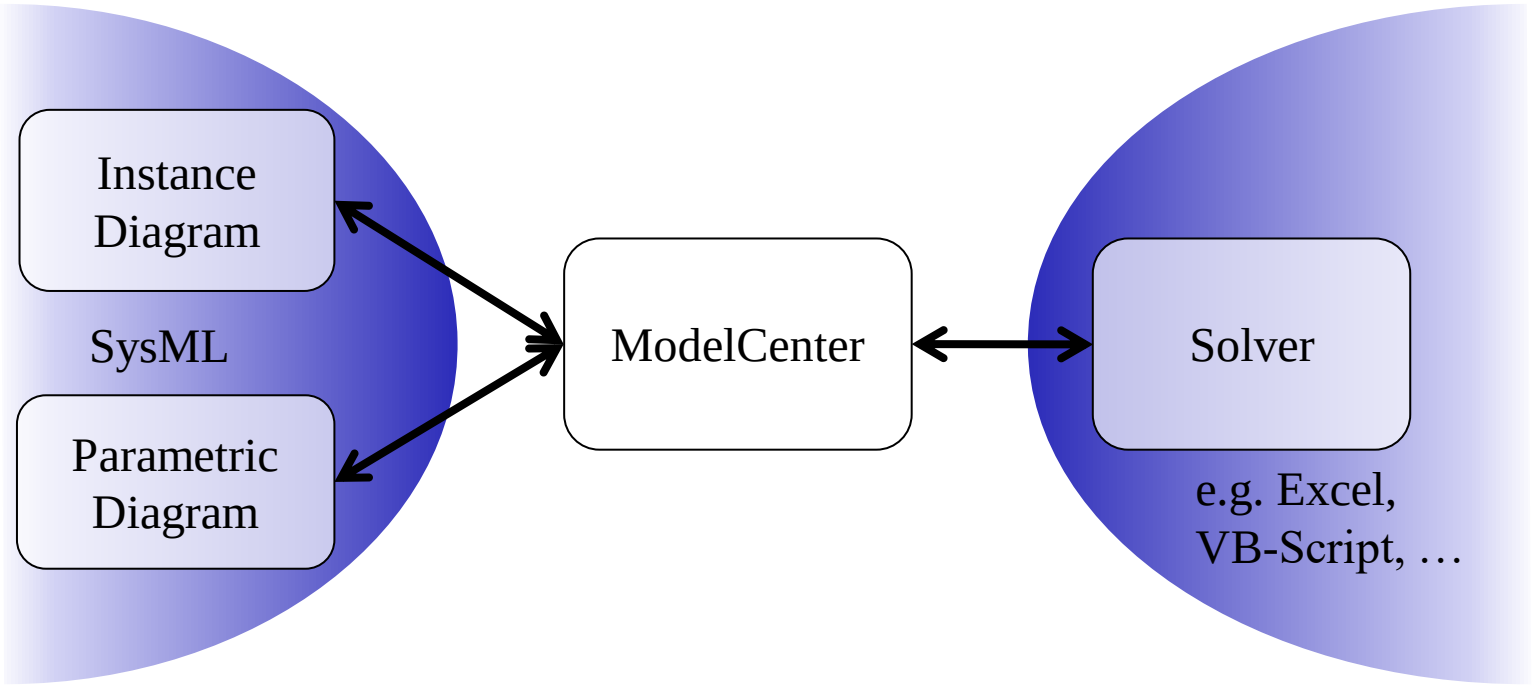


Observing Picking Performance

- Instance in SysML

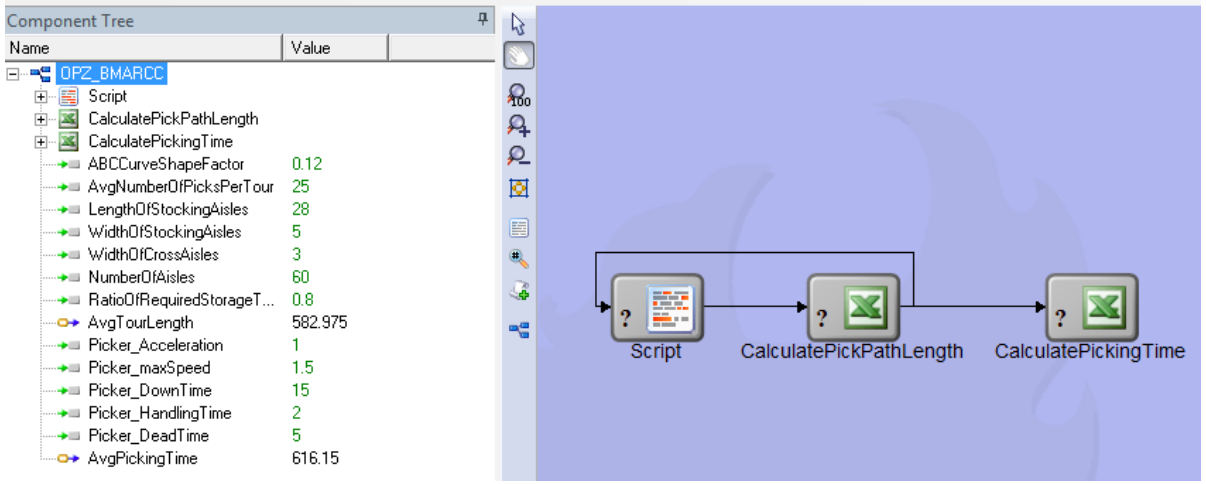


Connecting the Models



Design Decision Support

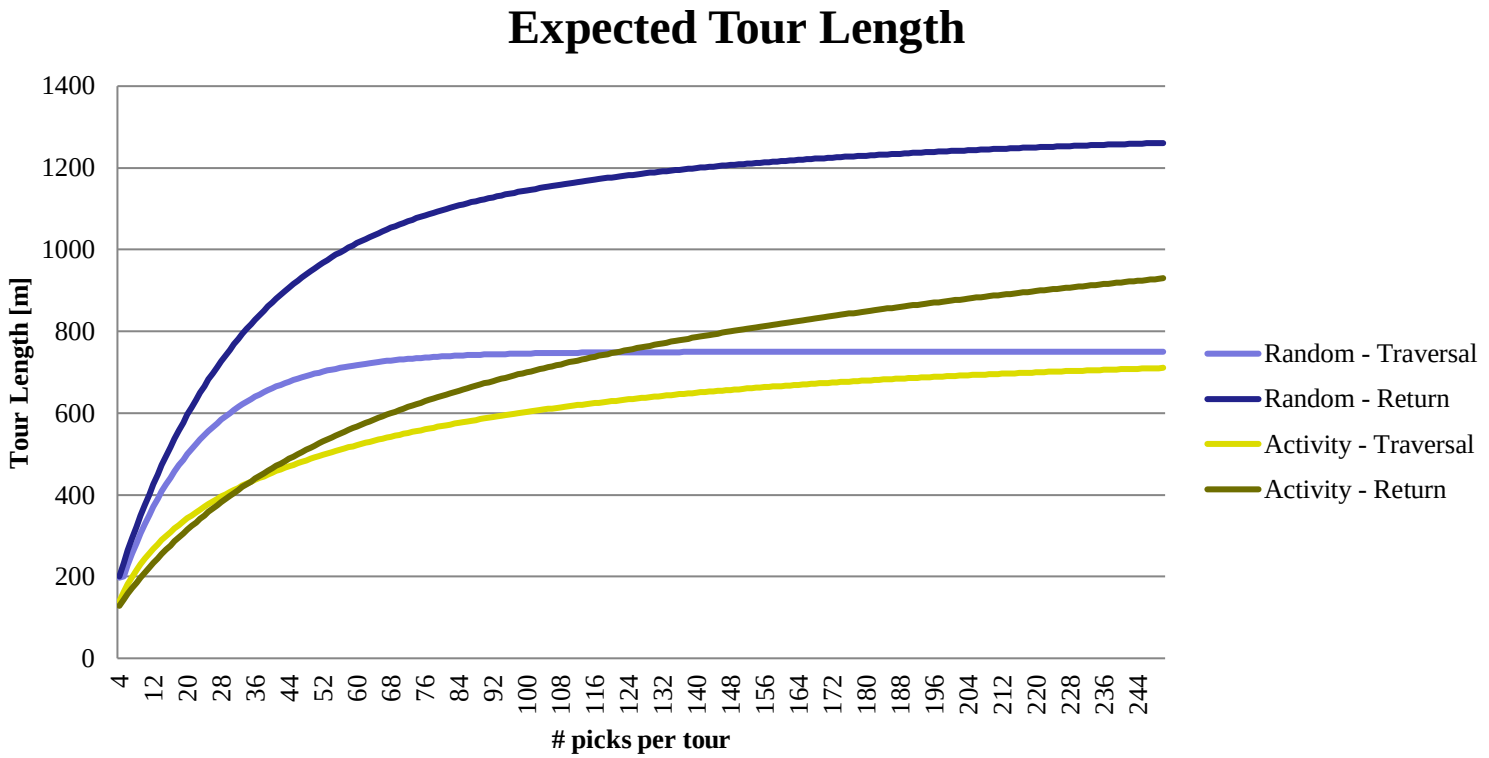
- Connecting block represents interface to external solver ModelCenter®



- Here we use “MS Excel” and “VB Script”

Design Space Exploration

- Increasing number of picks per tour



Design Space Exploration

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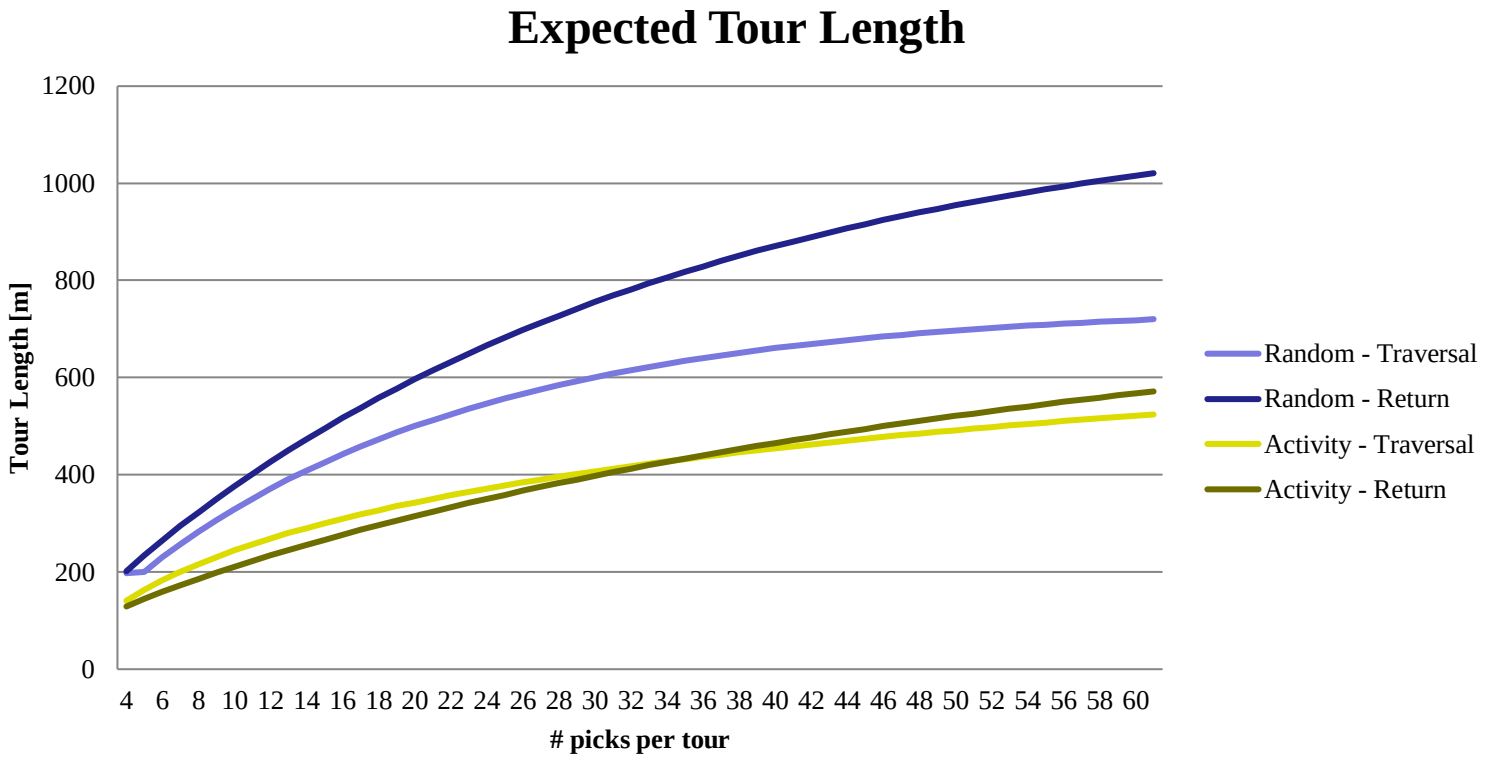
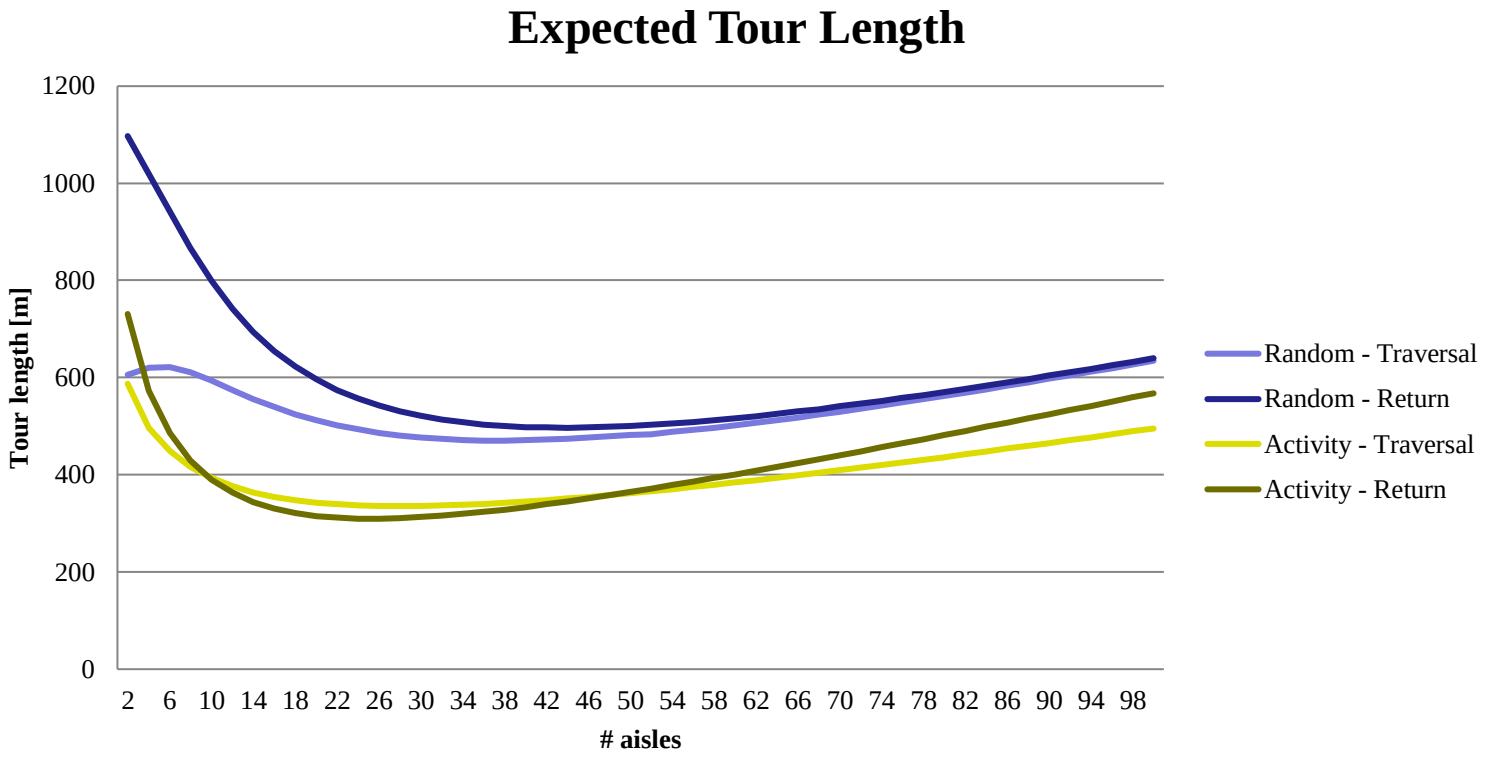


Design Space Exploration

- Increasing number of aisles



What you can do with it

- Optimize over organization policies and parameters
- Estimate performance easily during planning process
- See impact of constraints on performance
- Integrate formal model with analytical tools

Wrap Up/How do I use it?

- Create single Instance in SysML, calculate performance metrics
  - Use results directly in design process
- Design Space Exploration
  - Use ModelCenter and Excel to run analysis over set of possible designs

Thank you!

We are glad to answer your questions!