IE ANNUAL CONFERENCE & EXPO | 2013

Integrating Warehouse Design Models and Warehouse Analysis Models Using ModelCenter

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Outline

1. Problem Description
2. Warehouse design with SysML
3. Example design
4. Connecting SysML with Analysis software
5. Example: Cycle time calculation for AS/RS
6. Conclusion & Future Work

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Problem Description

- **Warehouse design today:**
  - Design uses empirical knowledge Apple, Meller, and White
  - Design decisions based more on rules of thumb than on analytic tools, because of lack of integration

  → **Ad-hoc design process**, not generalizable
- **The need:** Standardized design tools, which:
  - Connect design decisions to analytic submodels
  - Provides useful design libraries
  - Does not overly constrain design decisions

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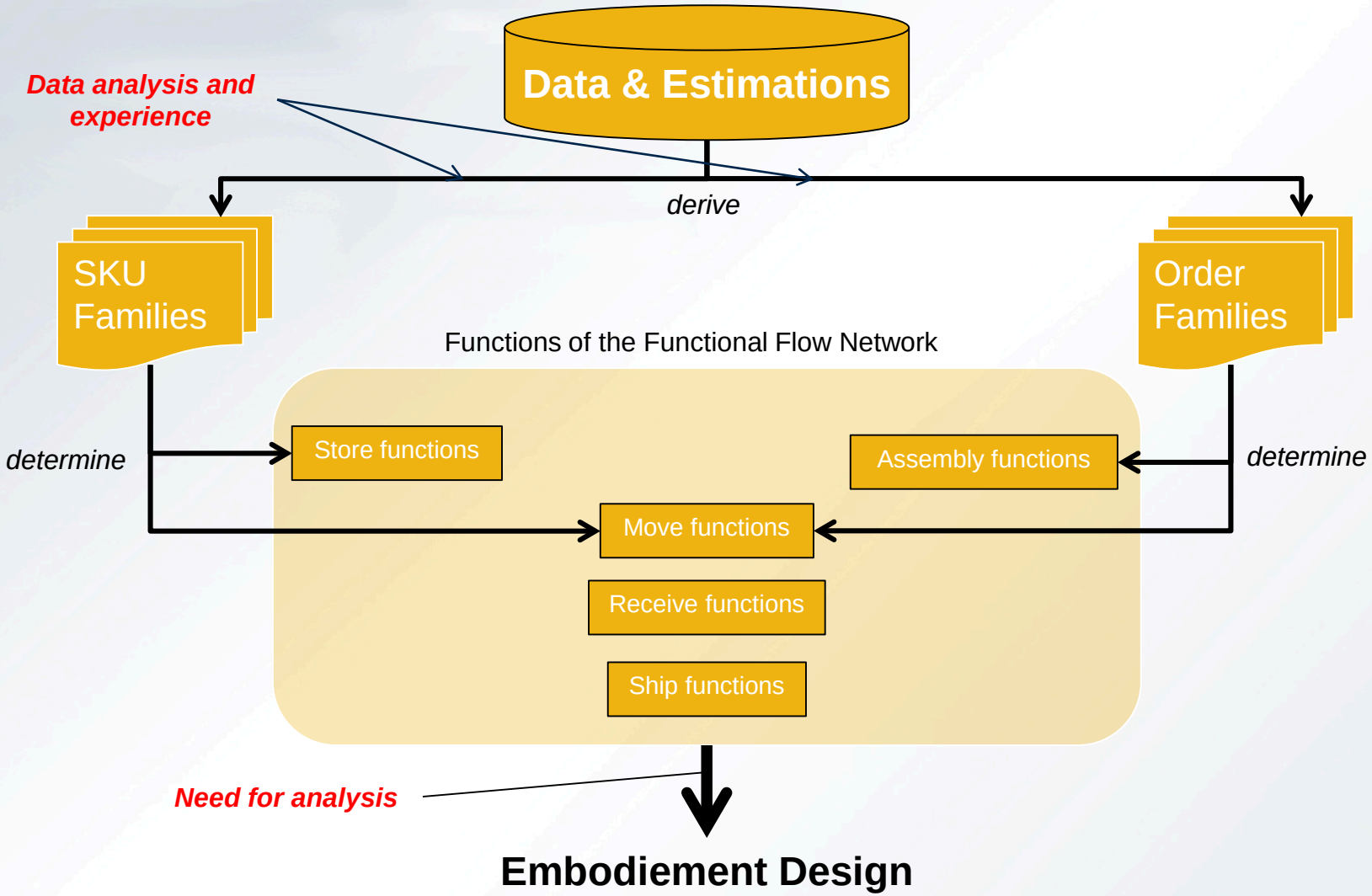
Warehouse Design with SysML



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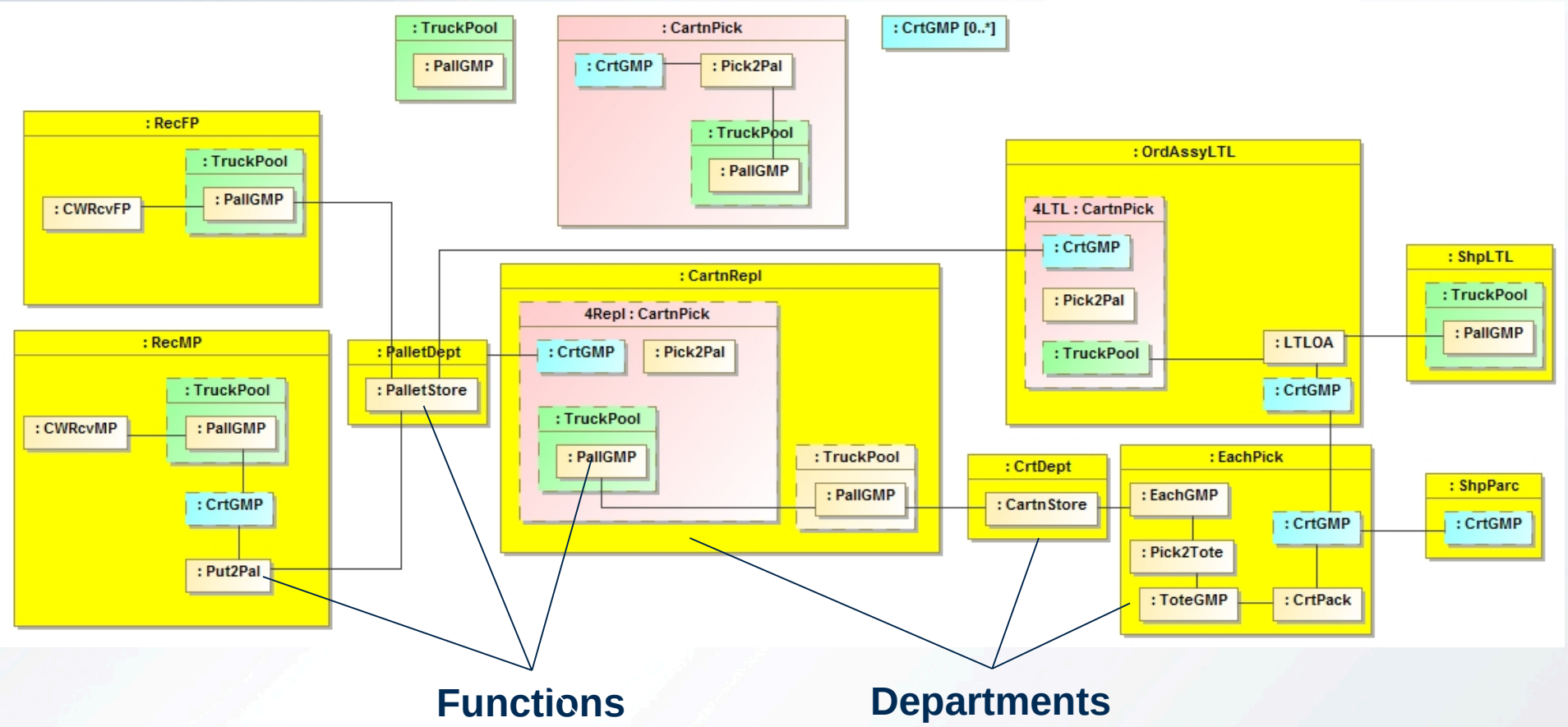
Warehouse Design Example



CW Sports, 2012-13 CICMHE Competition Case

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Embodiment Design

- Architecture of design (departments and flows) is given
- For each department, select technology, size and configure the technology
- Apple, Meller, and White suggest a way to use empirical knowledge to guide technology selection
- This presentation focuses on exploiting analytic models to support sizing and configuring

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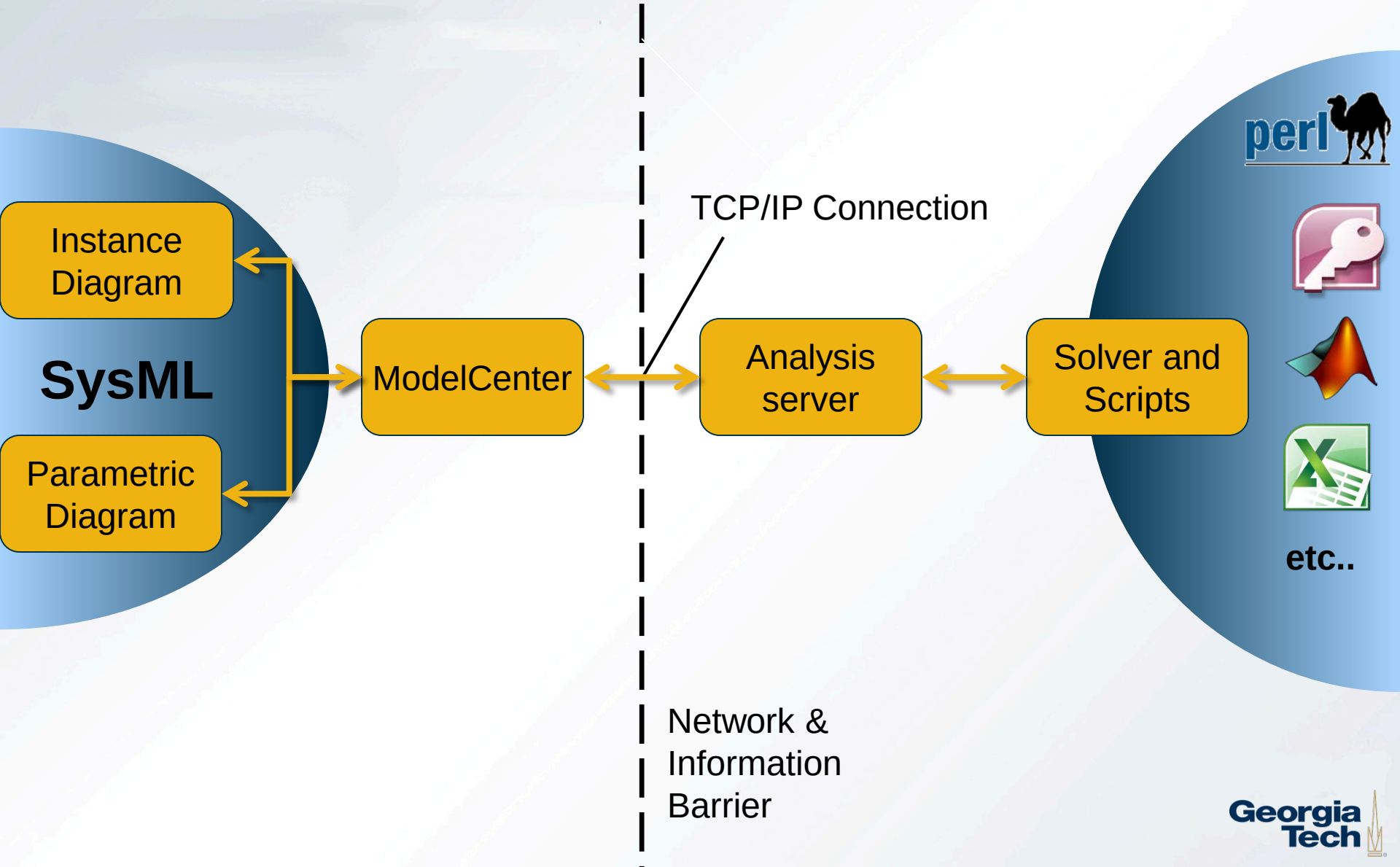
Connecting SysML with Analysis Software



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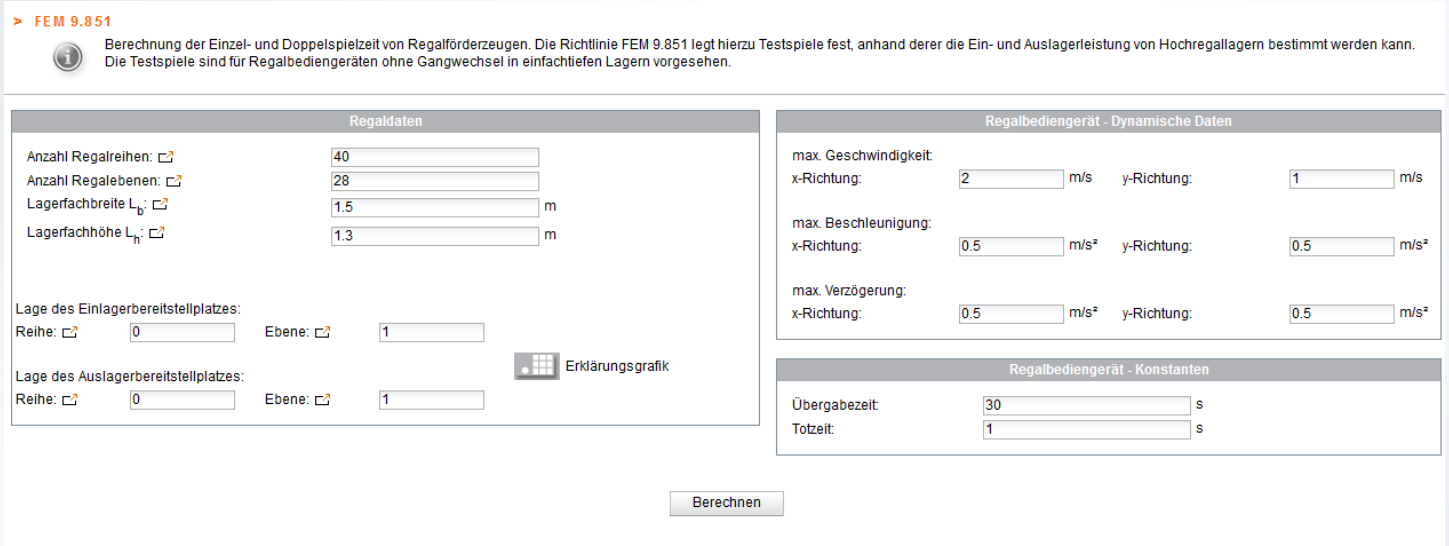
Example: Cycle Time Calculation for AS/RS

- Analytic tools for warehouse design purposes available on the web
  - Example: Cycle time calculation according to FEM 9.851



url for the tool

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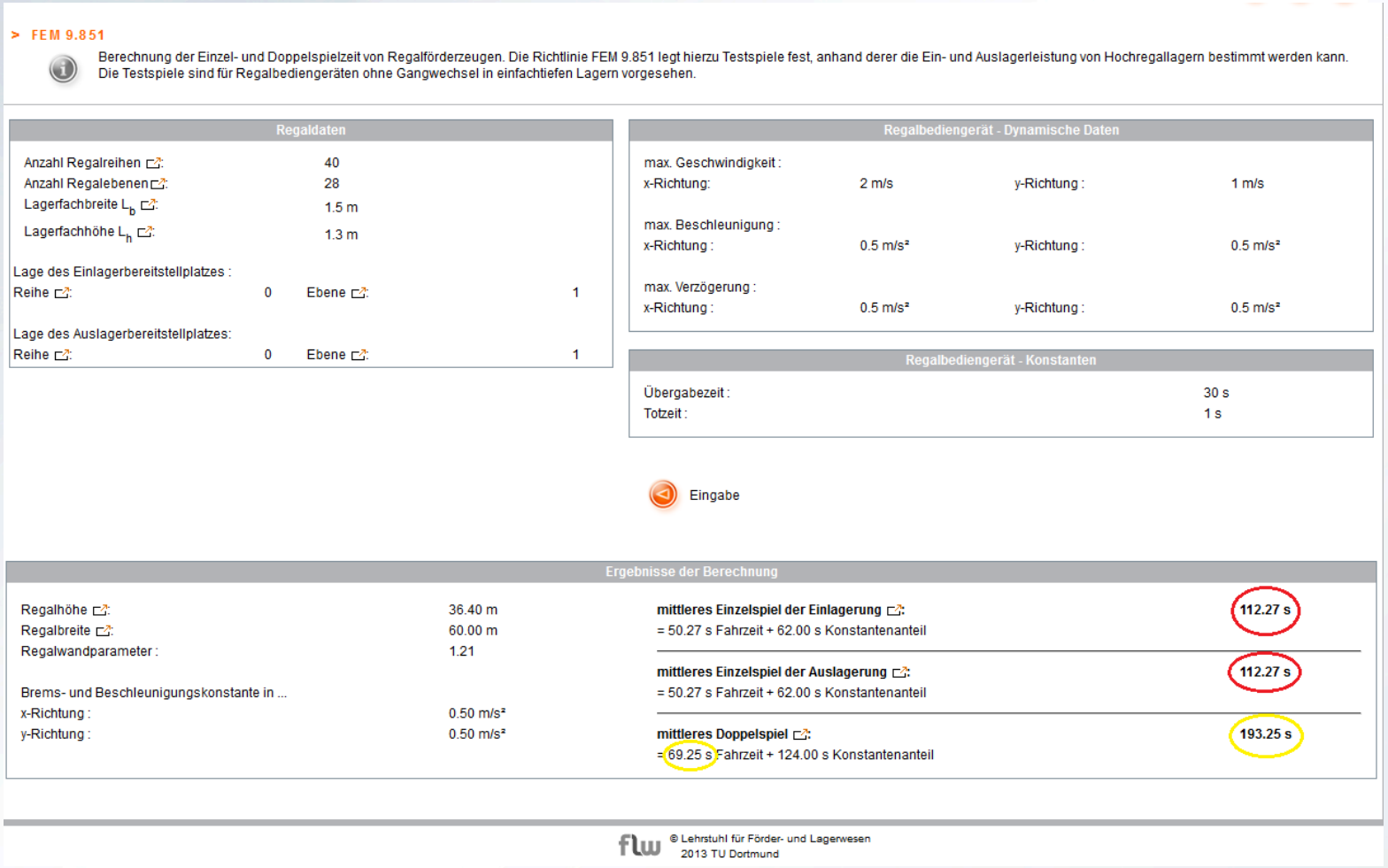
Example: Cycle Time Calculation for AS/RS



> FEM 9.851

Berechnung der Einzel- und Doppelspielzeit von Regalförderzeugen. Die Richtlinie FEM 9.851 legt hierzu Testspiele fest, anhand derer die Ein- und Auslagerleistung von Hochregallagern bestimmt werden kann. Die Testspiele sind für Regalbediengeräten ohne Gangwechsel in einfachtiefen Lagern vorgesehen.

Regaldaten

Anzahl Regalreihen:	40
Anzahl Regalebenen:	28
Lagerfachbreite L_b:	1.5 m
Lagerfachhöhe L_h:	1.3 m

Lage des Einlagerbereitstellplatzes :
Reihe: 0 Ebene: 1

Lage des Auslagerbereitstellplatzes:
Reihe: 0 Ebene: 1

Regalbediengerät - Dynamische Daten

max. Geschwindigkeit :			
x-Richtung:	2 m/s	y-Richtung :	1 m/s
max. Beschleunigung :			
x-Richtung :	0.5 m/s²	y-Richtung :	0.5 m/s²
max. Verzögerung :			
x-Richtung :	0.5 m/s²	y-Richtung :	0.5 m/s²

Regalbediengerät - Konstanten

Übergabezeit :	30 s
Totzeit :	1 s

Eingabe

Ergebnisse der Berechnung

Regalhöhe:	36.40 m
Regalbreite:	60.00 m
Regalwandparameter :	1.21
Brems- und Beschleunigungskonstante in ...	
x-Richtung :	0.50 m/s²
y-Richtung :	0.50 m/s²

mittleres Einzelspiel der Einlagerung: 112.27 s
= 50.27 s Fahrzeit + 62.00 s Konstantenanteil

mittleres Einzelspiel der Auslagerung: 112.27 s
= 50.27 s Fahrzeit + 62.00 s Konstantenanteil

mittleres Doppelspiel: 193.25 s
= 69.25 s Fahrzeit + 124.00 s Konstantenanteil

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Indicate the inputs and outputs

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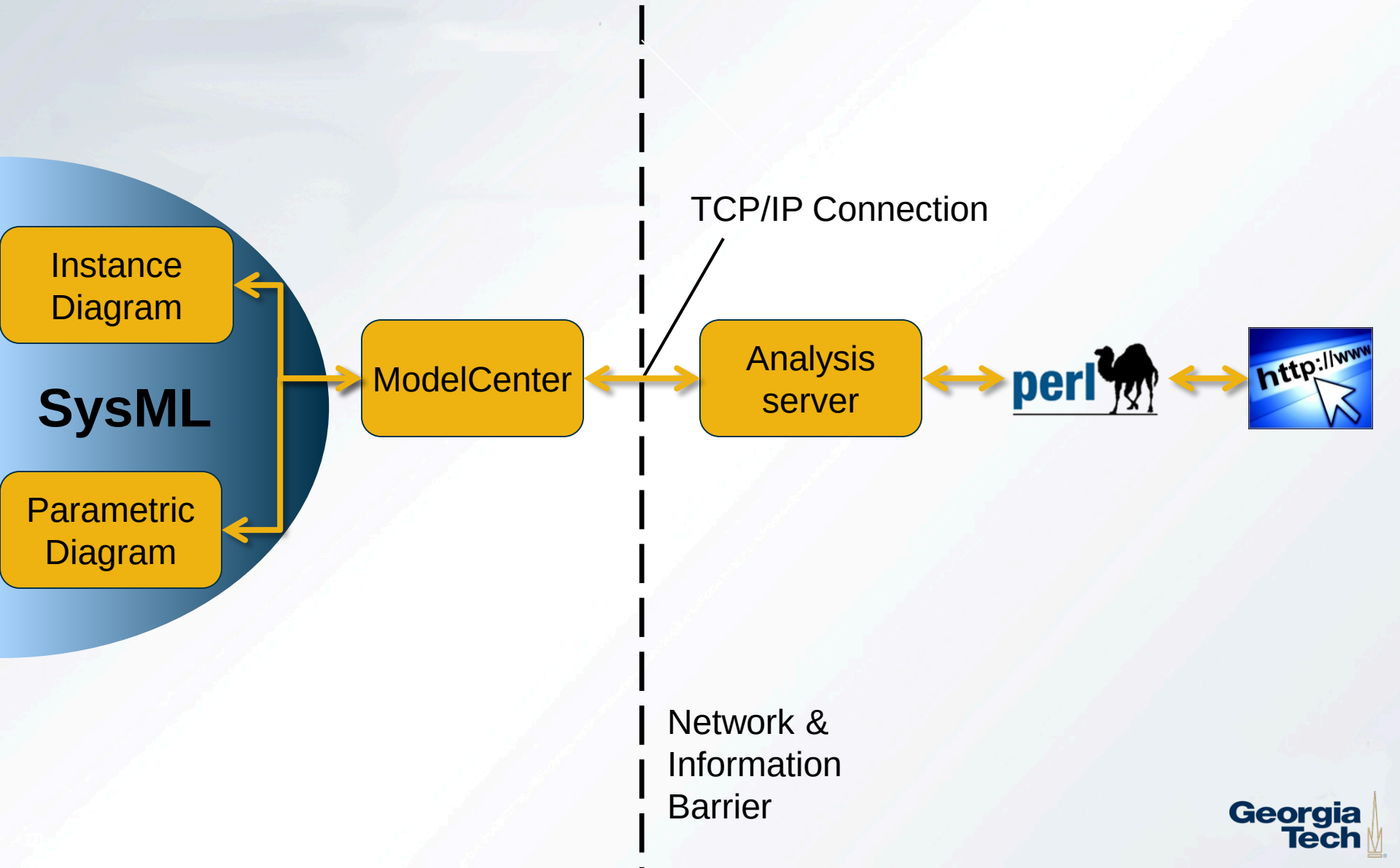
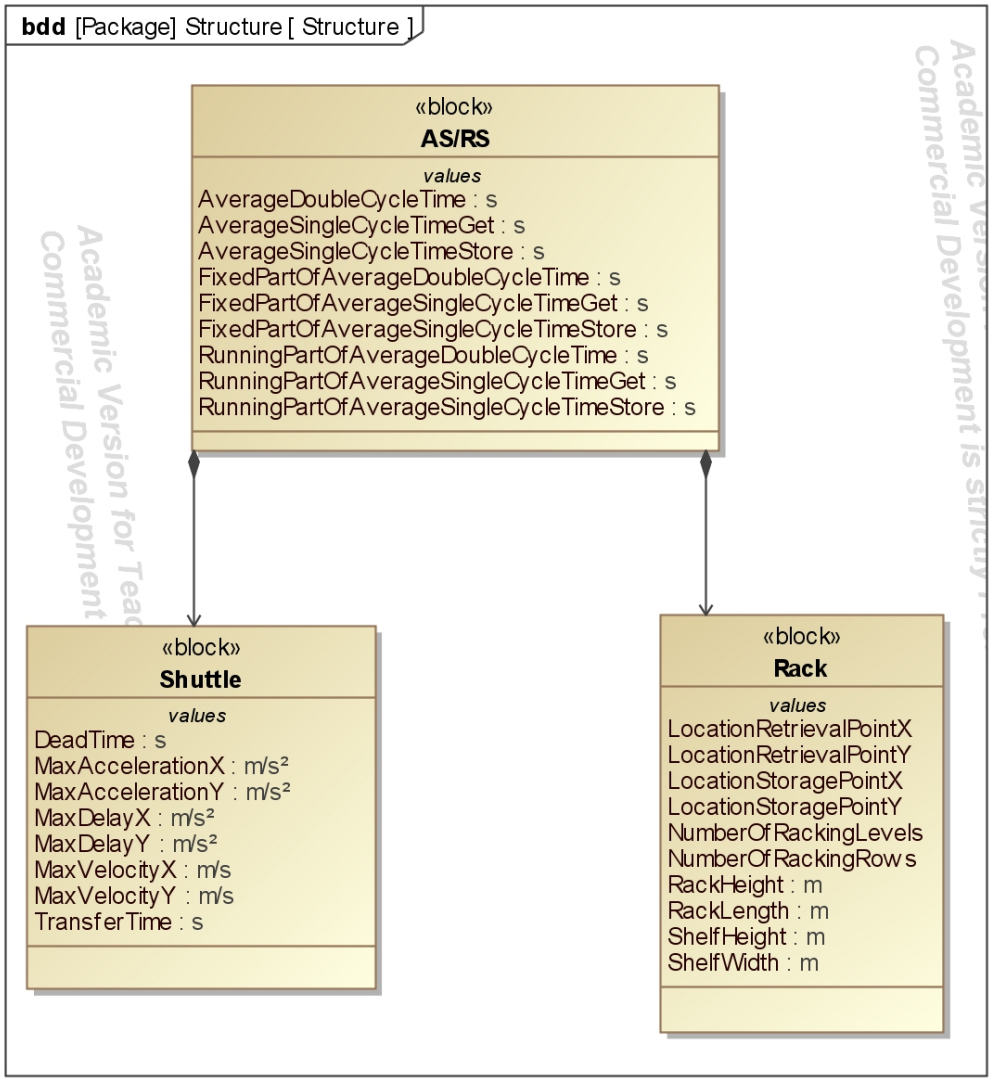
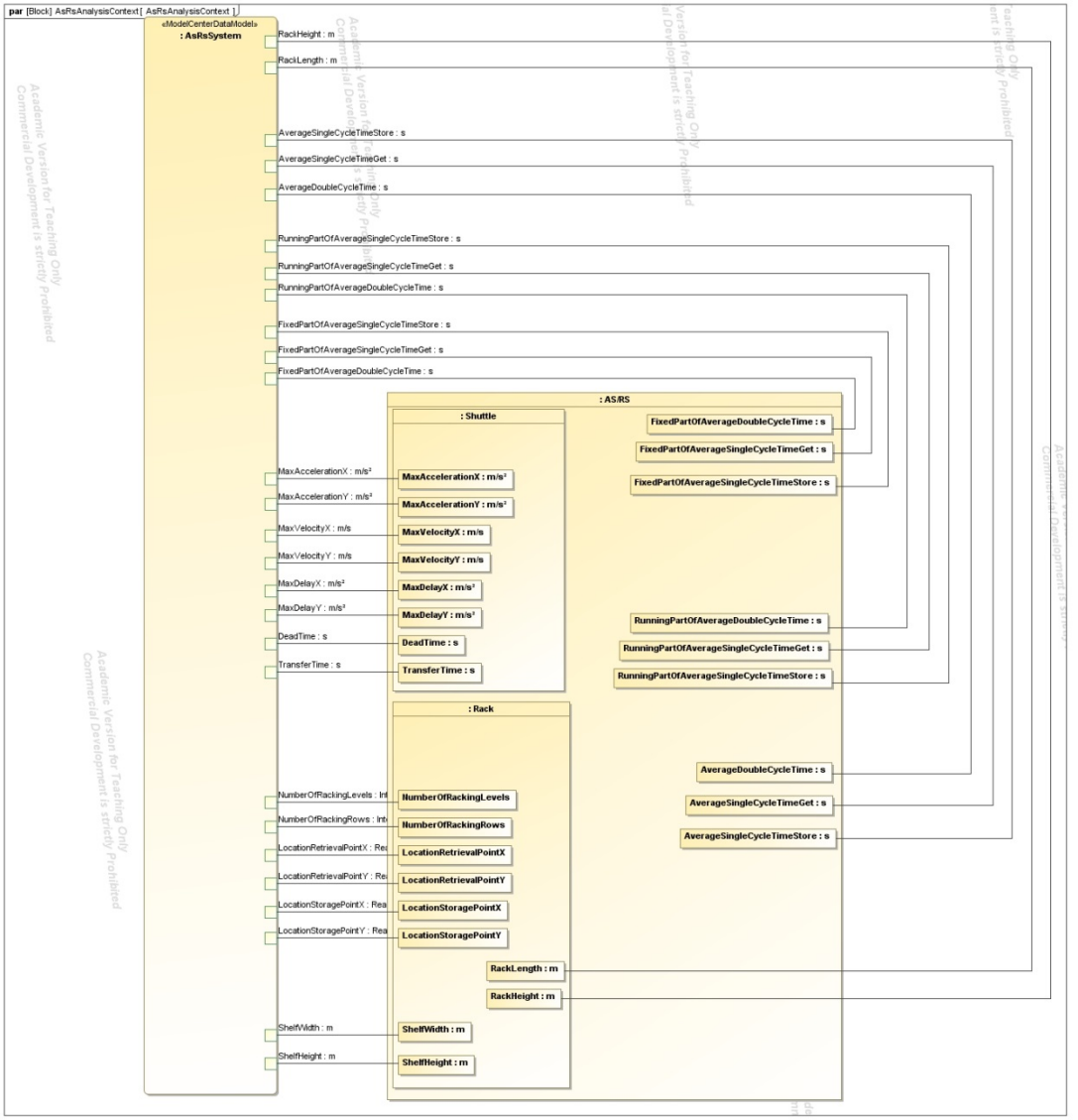
Example: Cycle Time Calculation for AS/RS – Flow of Information



Example: Cycle Time Calculation for AS/RS – Block Definition Diagram



Example: Cycle Time Calculation for AS/RS – Parametric Diagram



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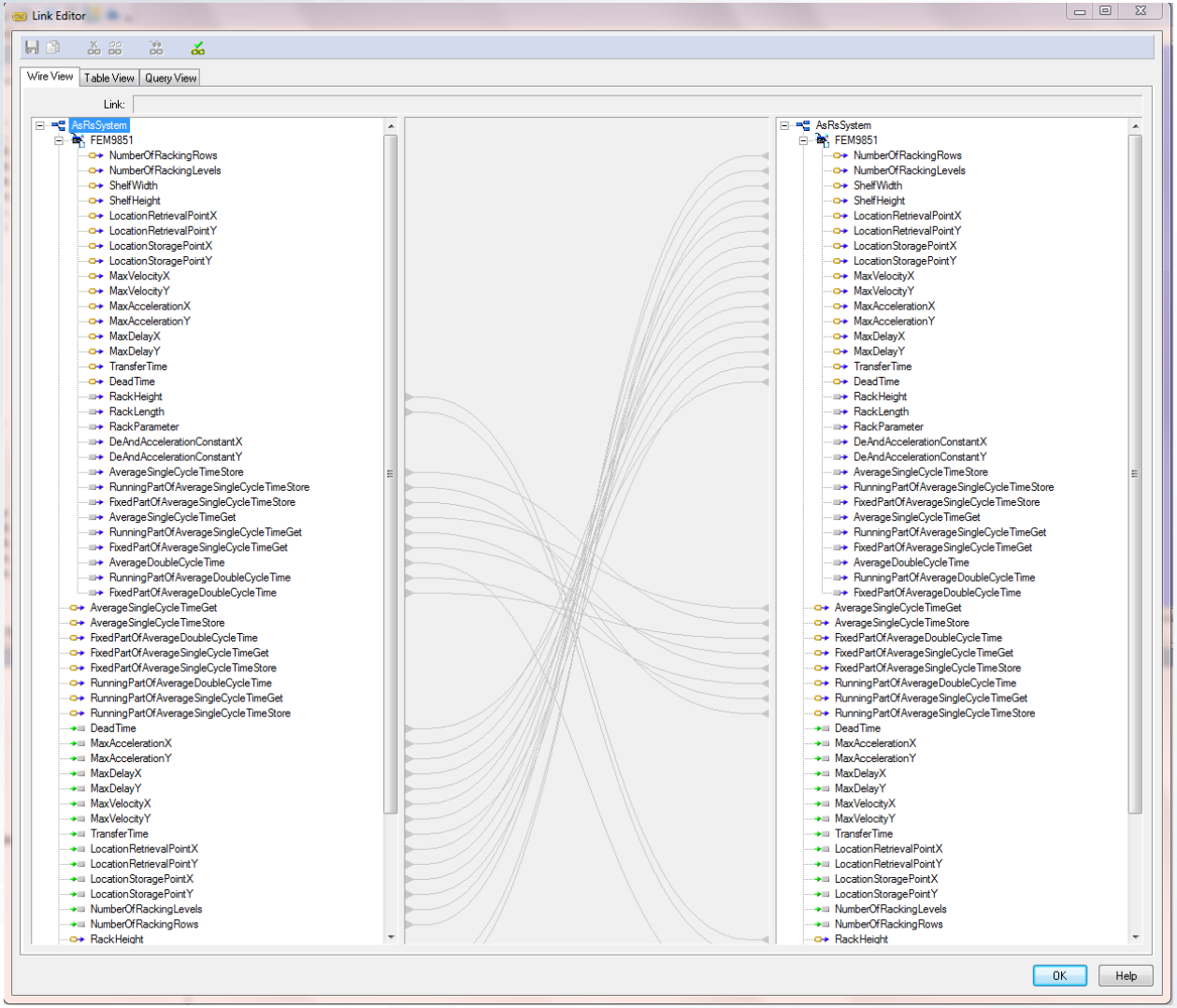
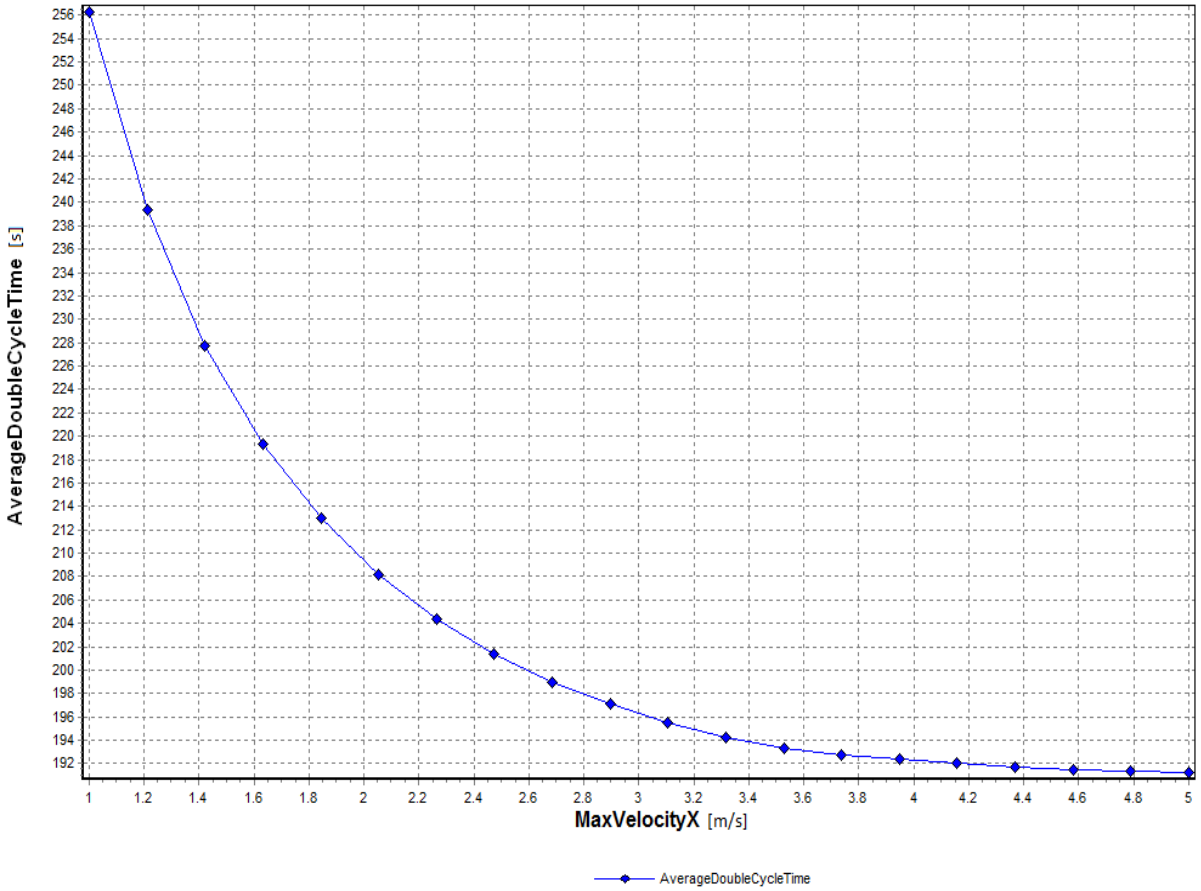
Example: Cycle Time Calculation for AS/RS – Linkage in ModelCenter



Example: Cycle Time Calculation for AS/RS – Parametric Study in ModelCenter

Fixed parameters:

- Dead time = 1s
- Maximum acceleration horizontal = 0.5m/s²
- Maximum acceleration vertical = 0.5m/s²
- Maximum delay horizontal = 0.5s
- Maximum delay vertical = 0.5s
- Maximum velocity vertical = 1m/s
- Number of racking levels = 28
- Number of racking rows = 40
- Shelf width = 1.5m
- Shelf height = 1.3m



Conclusion & Future Work

We have:

- Analysis in MagicDraw with Modelcenter in combination with analysis server tool
  - Also using excel components over LAN
  - Offers very high flexibility
  - Analysis can be a black box

To Do:

- Further integration into the warehouse design process
- Incorporate empirical knowledge
- Extension of libraries and analysis

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References

- FEM 9.851 online cycle time calculation http://logscout.de/faces/modules/lager/lagerleistung/fem9851/eingabe.jsp

We are glad to answer your questions!

THANK YOU!

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