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
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
Warehouse Design with SysML

Data & Estimations

 SKU Families

Order Families

Functions of the Functional Flow Network

Store functions
Move functions
Receive functions
Ship functions
Assembly functions

Data analysis and experience

determine

Need for analysis

Embodiment Design
Warehouse Design Example

Departments

Functions

 CW Sports, 2012-13 CICMHE Competition Case
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
Connecting SysML with Analysis Software

SysML

Instance Diagram
Parametric Diagram

ModelCenter

Analysis server

Solver and Scripts

TCP/IP Connection

Network & Information Barrier

etc..

perl

Georgia Tech
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
Example: Cycle Time Calculation for AS/RS

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Eingabe

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Indicate the inputs and outputs
Example: Cycle Time Calculation for AS/RS – Flow of Information

**SysML**

- Instance Diagram
- Parametric Diagram

**Diagram Components**

- **ModelCenter**
- **Analysis server**
- **TCP/IP Connection**
- **Network & Information Barrier**

**Technologies**

- **ModelCenter**
- **Perl**
- **TCP/IP Connection**
- **Network & Information Barrier**
Example: Cycle Time Calculation for AS/RS – Block Definition Diagram
Example: Cycle Time Calculation for AS/RS – Parametric Diagram
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 = 0.5 m/s²
- Maximum acceleration vertical = 0.5 m/s²
- Maximum delay horizontal = 0.5s
- Maximum delay vertical = 0.5s
- Maximum velocity vertical = 1 m/s
- Number of racking levels = 28
- Number of racking rows = 40
- Shelf width = 1.5 m
- Shelf height = 1.3 m
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
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!