Model Based Design
@ Getinge in Solna
Who am I?
Magnus Nord - Model Based Design Enthusiast
On a personal note

A fairly normal presentation

Model Based Design at Getinge

Conclusions

Obstacles on the MBD road…. and ways to remove them

Alphanumeric approach.
Getinge Group

Solna – a part of Acute Care Therapies
Products

Solna

- Ventilation
- Anesthesia
- Advanced Monitoring

Numbers
- Tot Solna: ~ 450
- R & D: ~ 150
- Matlab/Simulink: ~ 20 licences
- MBD: ~ 4-8
- Revenue: ~ 2000 MSEK
Products

Outside Solna

Sterilization

Operating Room

...and much more
Model Based Design at Getinge
Solna
Model Based Design

Maturity Assessment

MODEL-BASED DESIGN MATURITY FRAMEWORK

- Modeling
- Simulation and Analysis
- Implementation
- Verification and Validation
- Process, Tools, and Infrastructure
- Enterprise Management
Model Based Design
A Timeline

Control Design
dSpace
Hand Written
Code

Patient Model
Anesthesia Machine Model
Control Design Generated Code

Stateflow
Ventilator Model
PIL
Rapid Prototyping
Control Design Generated Code
Control Design Generated Code
Anesthesia Machine Model #2

MBD efficiency

1994 2010 2015 2020

Time
Results

- Overall good performance and development speed!
- From prototype to production code in short time.
- Several ventilation and anesthesia products and ventilation modes with generated code.
- Promising results from Lo-fi model and new control strategy. Model will increase development speed of future control improvements.
- Incremental implementation. Let MBD-grow into place.
Model Based Design

A Timeline

- **1994**
  - Control Design
  - Hand Written Code

- **2010**
  - Patient Model
  - Anesthesia Machine Model
  - Control Design Generated Code

- **2015**
  - Stateflow
  - Ventilator Model
  - PIL
  - Rapid Prototyping
  - Control Design Generated Code

- **2020**
  - Anesthesia Machine Model #2
  - Control Design Generated Code

MBD efficiency

Time
Products - Solna

Products from an automatic control perspective

Ventilator
- Pressure Control
- Flow Control
- Control Logic

Anesthesia Machine
- Pressure Control
- Flow Control
- Control Logic
- Anesthesia Control
Model Based Design

Model Components and challenges

Anesthesia Machine Model

Gas Modules

Circle Breathing System

Patient

Reflector

Absorber

Automatic ventilation insp./exp.
Model Based Design

Model Components

Challenges

• Minimize Gas Consumption
• Diffusion – bidirectional flow
  • Reflector
  • Absorber
• Nozzle characteristics in Gas Module
• Model Speed!!
• Non minimum phase control with long time-varying group delay.

Gas Modules
Circle Breathing System
Patient
Reflector
Absorber
Model Based Design
Incremental improvements

Anesthesia Machine Model

Machine + Patient Model
3x Speed
Save Environment
High Fidelity Model
10x Speed
Accuracy where needed
Low Fidelity Model
Model Based Design

Stateflow

Advantages

• Readability
  • “Code looks like a design document”
  • Intuitive coding
• Surrounding controller logic sometimes more complex than the controllers – Stateflow helps!

Ventilator Logic

Ventilation Mode

Working well for
• Alarm handling
• Metric Calculations
• Ventilator Logic
Model Based Design
Rapid Prototyping and Data Acquisition

Manual reduction: 4500 pages -> 350 pages

Rapid Prototyping

High Level Design
- CubeMX
- Simulink

Low Level Debugging
- Atolic Eclips Based SDK

Target
- dSpace
- External Mode
- Wafer Thin Wrapper

SWV debugging
On a personal note

Enlarge the Simulink ecosystem
Technical Paradigm Shifts and Division of Labor
Everyday Tools
Model Based Design

The future in high level design – leverage on good quality tools. Expand Simulink Ecosystem
Model Based Design
The future in high level design – leverage on good quality tools. Expand Simulink Ecosystem

Rapid Prototyping

High Level Design

CubeMX
Simulink

Hadoop
AWS
xCode
Qt
Xilinx – Zynq

“FULL STACK MBD development”

“One Man Development Department”

“Tony Stark Development Department”
Model Based Design
Everyday tools that work
Obstacles on the MBD road…. and ways to remove them

PDF version
Model Based Design

MBD-hurdles and how to jump over them

MBD has a proven track record of reducing time and cost for complex development projects.

Where do we need improvements?

What hurdles are blocking the MBD-runner?
Model Based Design – function development
MBD-hurdles and how to jump over them

Solution #1
• Incremental Improvements
  • Thesis Projects
  • Replacement strategy
  • Add “structural” improvements to each project

Solution #1 areas
• Alarms
• Metrics
• Control Logic
  • Ventilator alternative

Solution #2
• Plant model for legacy code
• Interface to legacy code

Legacy Code Blockage
Model Based Design

MBD-hurdles and how to jump over them

Problem
• Merge Tool

Solution #1
• Small team helps. It’s easier to collaborate in small teams. Model and file ownership.

Solution #2
• Merge Tool improvements are needed! We need from
Model Based Design

MBD-hurdles and how to jump over them

Solution
- Show success stories
  - Bombardier
  - Scania
  - Practically all car manufacturers
  - Getinge
  - etc.....

Solution
- Show hidden costs without MBD
- A validated model always adds IP - even if its done in preparation for next project.

Argument: Initial Cost of Model Based Design
Conclusions
Model Based Design

Take away from this speech

Take Away

• Incremental implementation
• Let MBD grow into place
• Model Based Design Works
  • Development speed has been proven.
  • Validated model always adds vital IP – even if its done in preparation for next project.
Personal Take Away

- Leverage on good quality tools
- Find tools and processes that enables job enrichment and implementation efficiency.
Presentation Road Map

Questions?

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On a personal note

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Model Based Design at Getinge

Conclusions