

Model Based Design @ Getinge in Solna

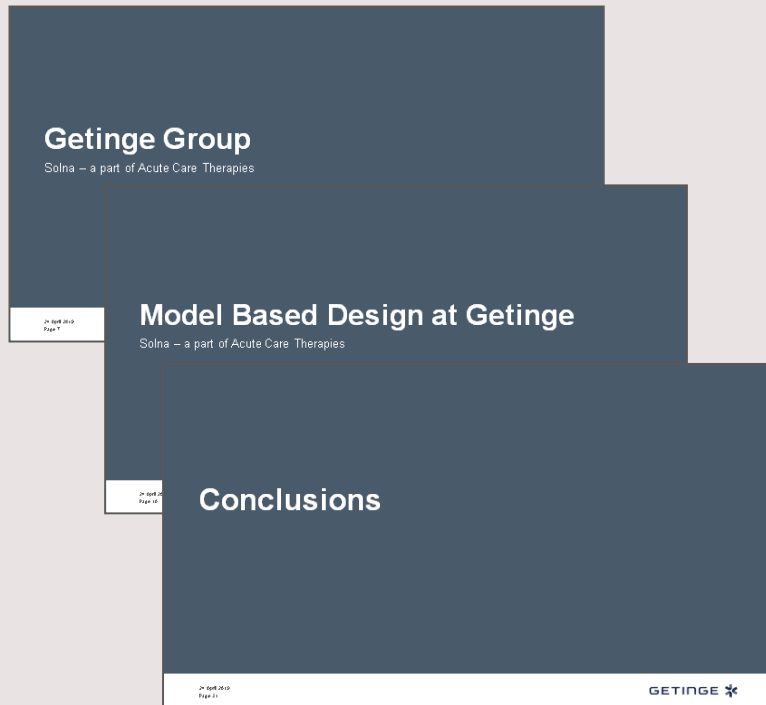


Who am I?

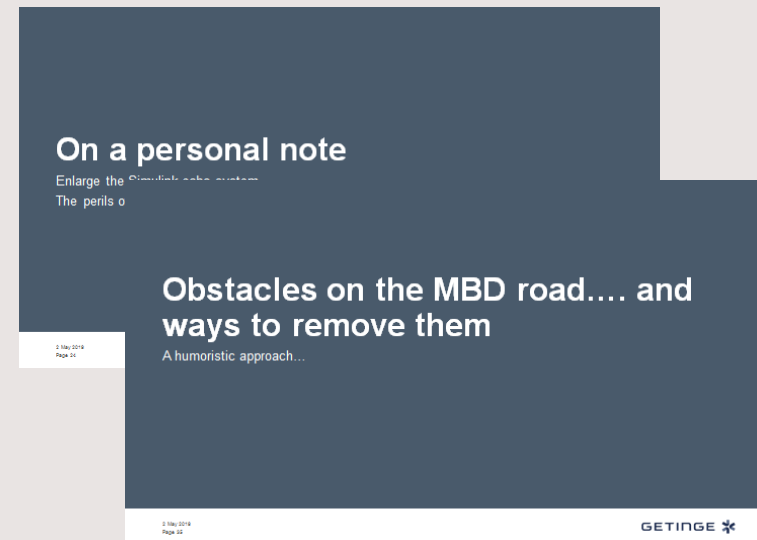
Magnus Nord - Model Based Design Enthusiast

Presentation Road Map

A fairly normal presentation



On a personal note



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

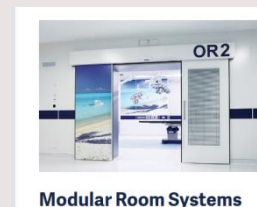
Sterilization



Operating Room



...and much more

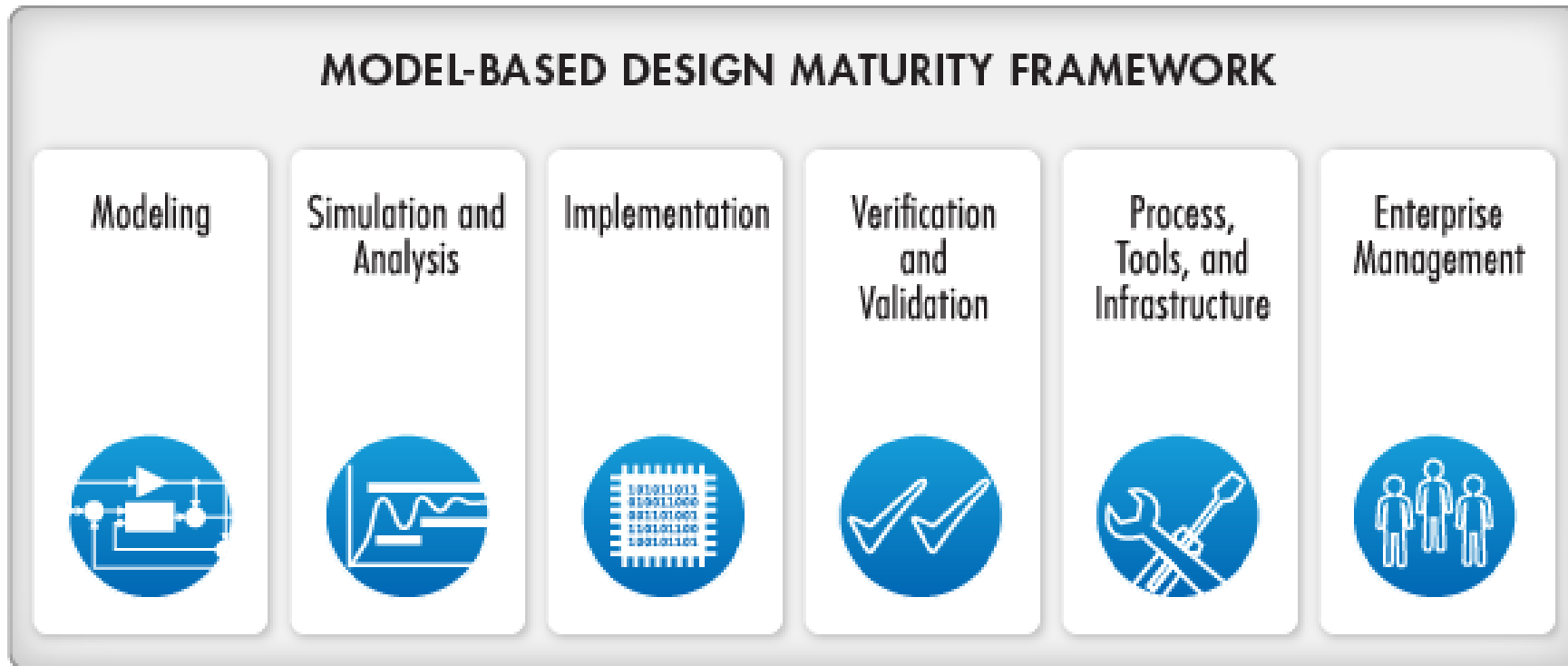


Model Based Design at Getinge

Solna

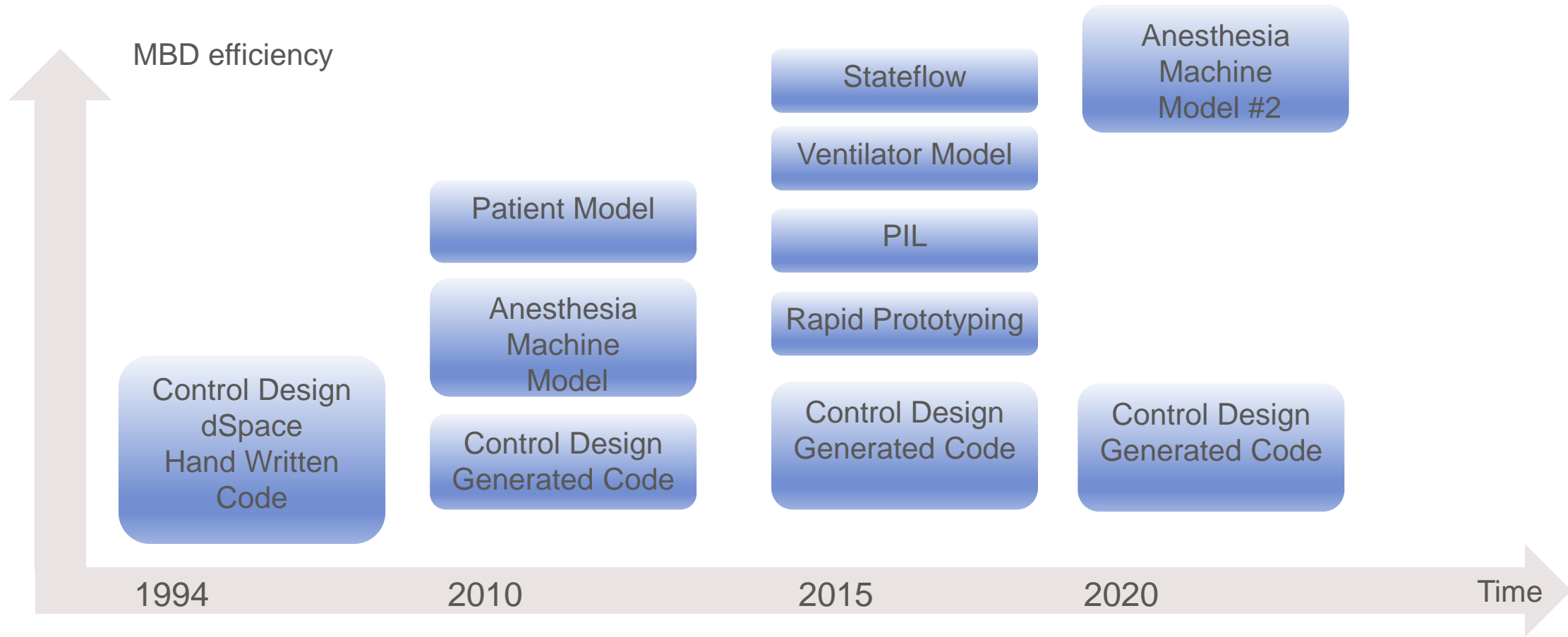
Model Based Design

Maturity Assessment



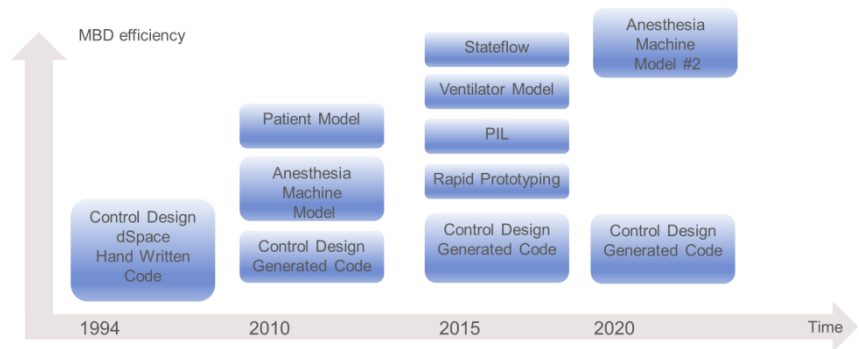
Model Based Design

A Timeline



Model Based Design

Results

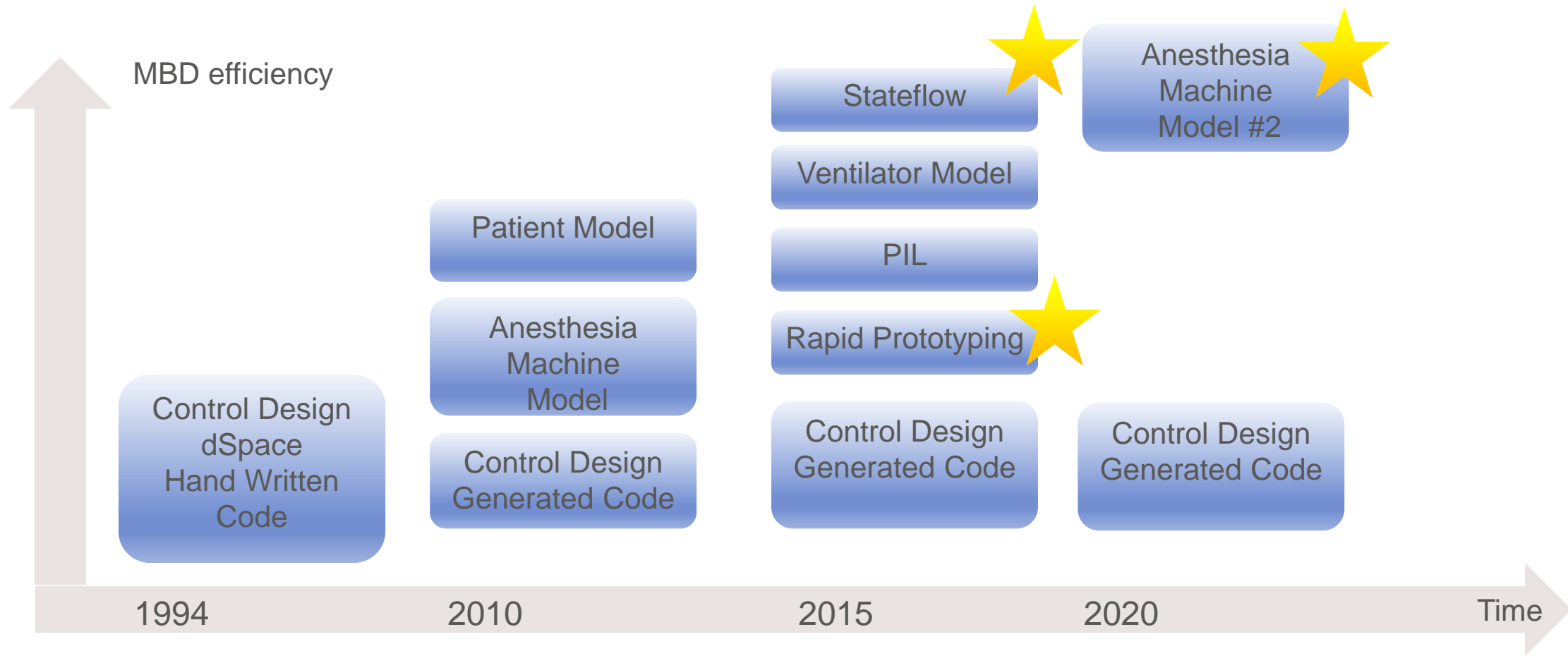


Results

- 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.

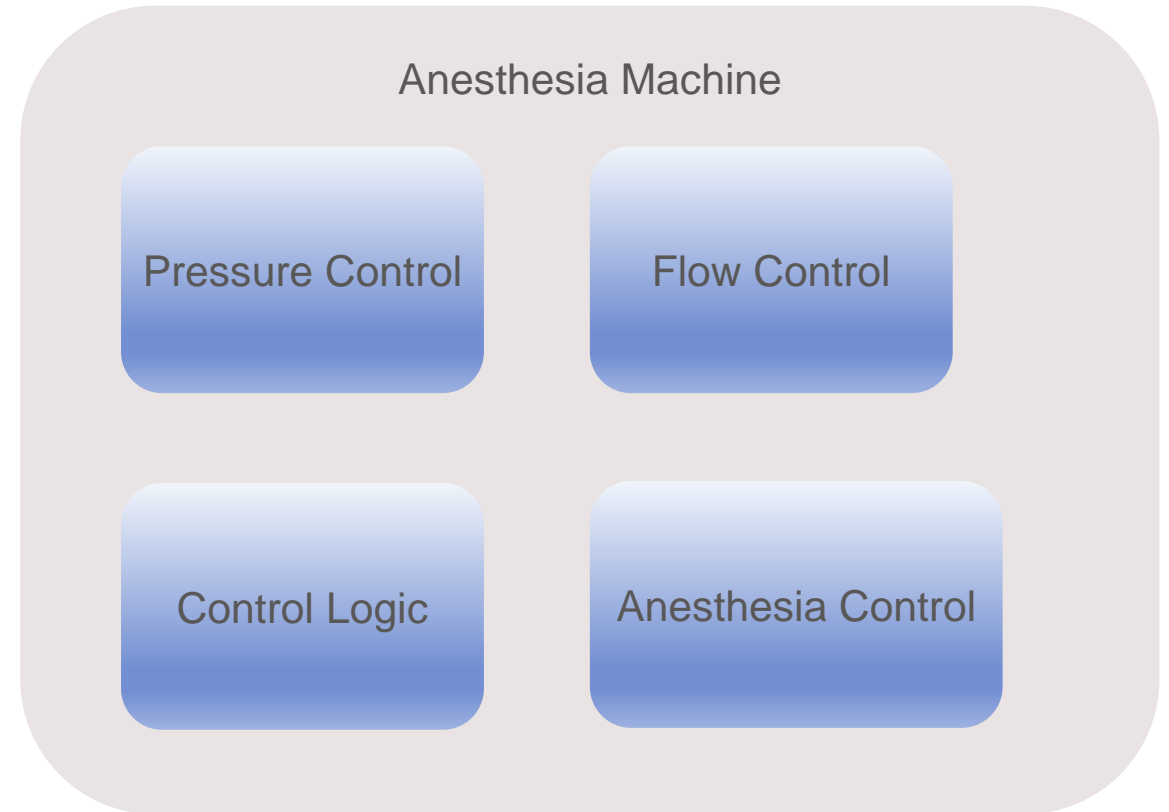
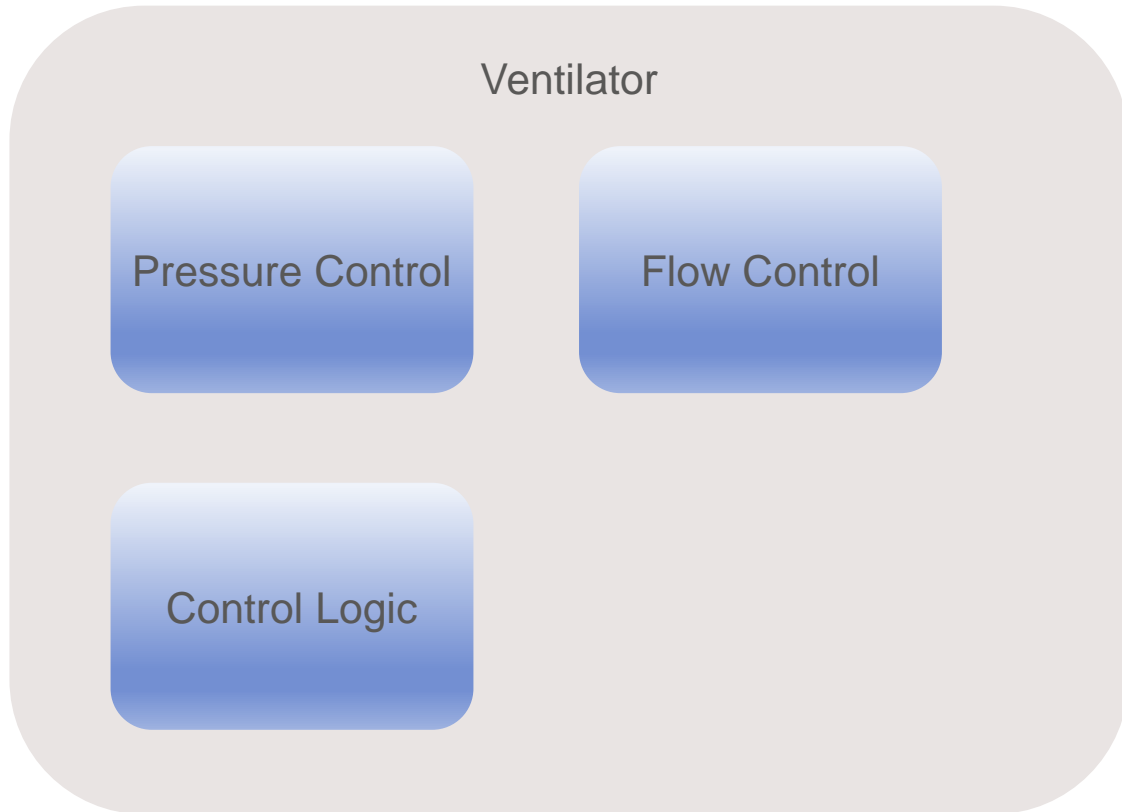
Model Based Design

A Timeline




Products - Solna

Products from an automatic control perspective

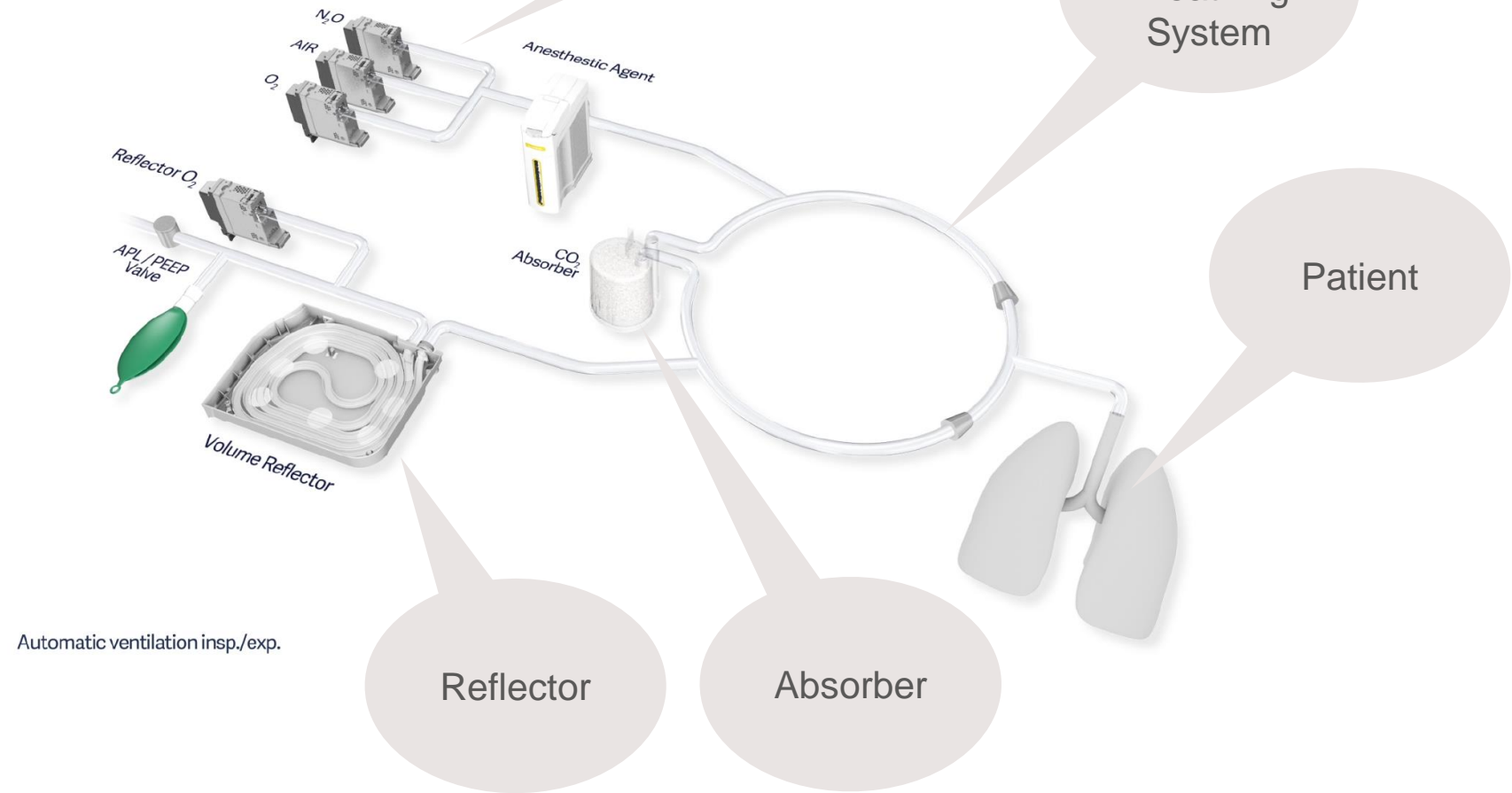


Model Based Design

Model Components and challenges

 Anesthesia Machine Model

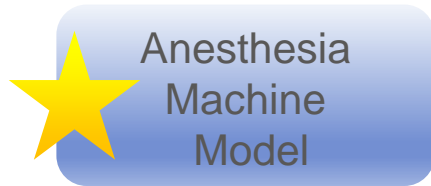
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Model Based Design

Anesthesia Model

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Model Based Design

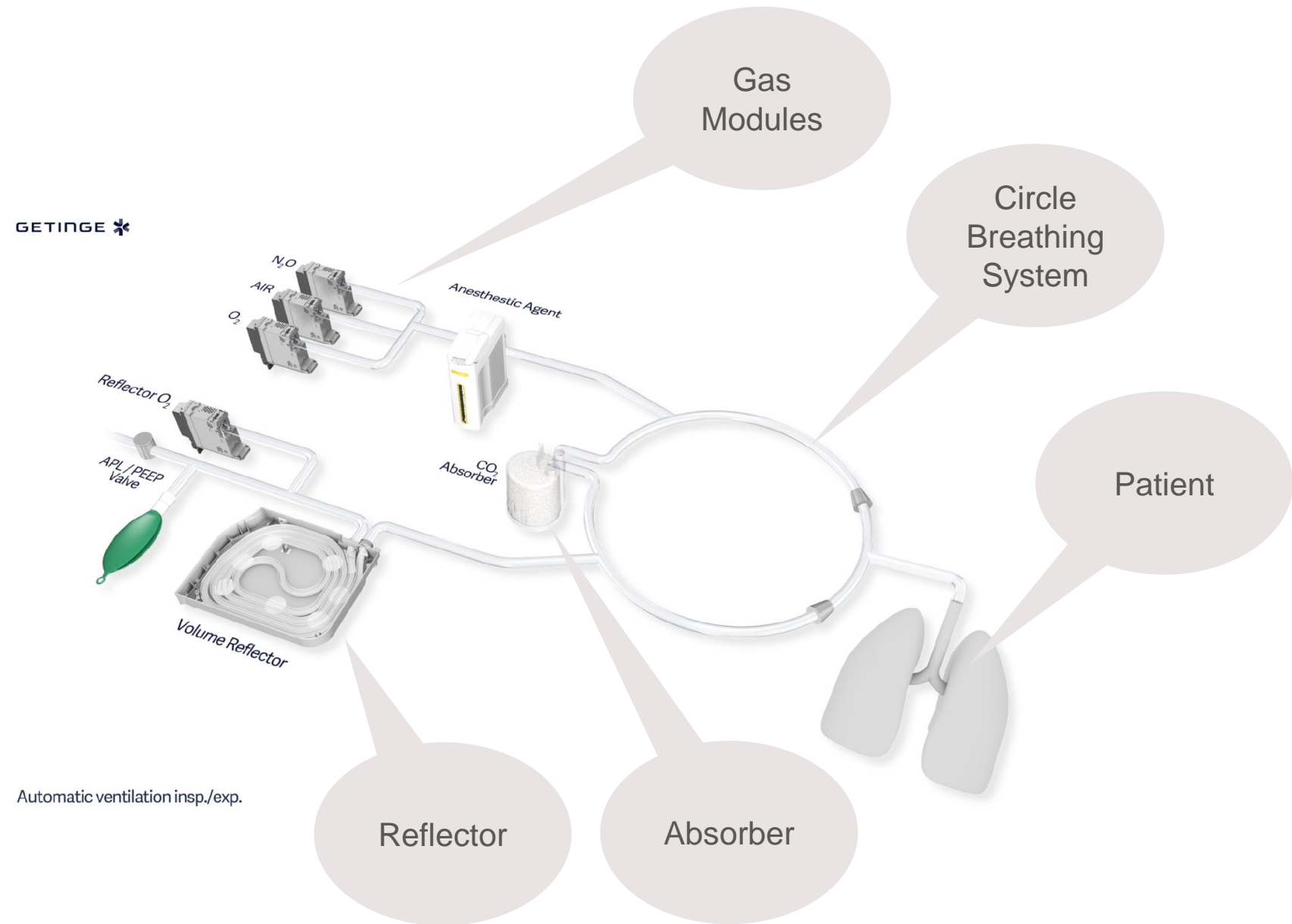
Model Components



Anesthesia
Machine
Model

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.



Model Based Design

Incremental improvements

 Anesthesia
Machine
Model



Model Based Design

Stateflow

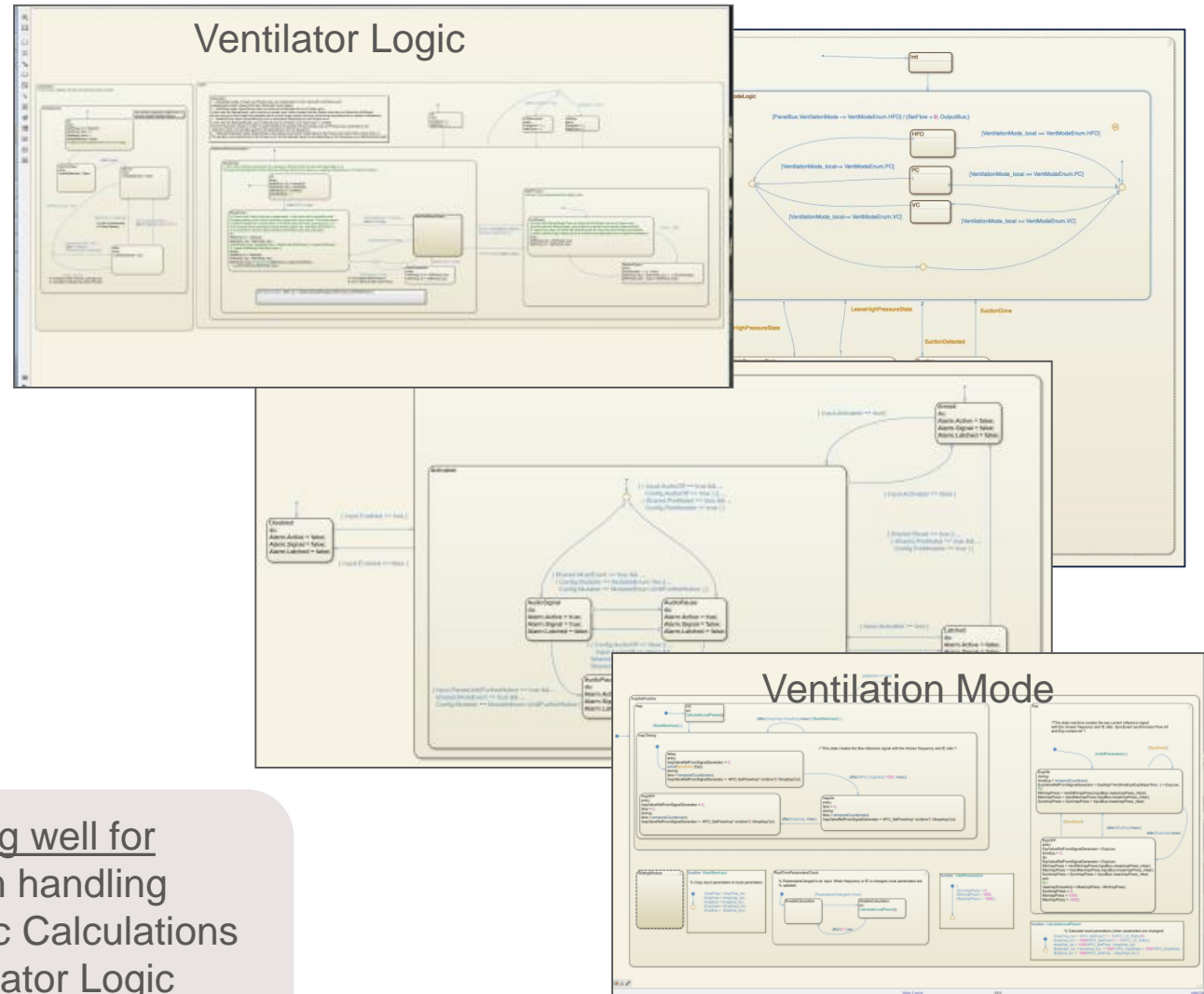


Advantages

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

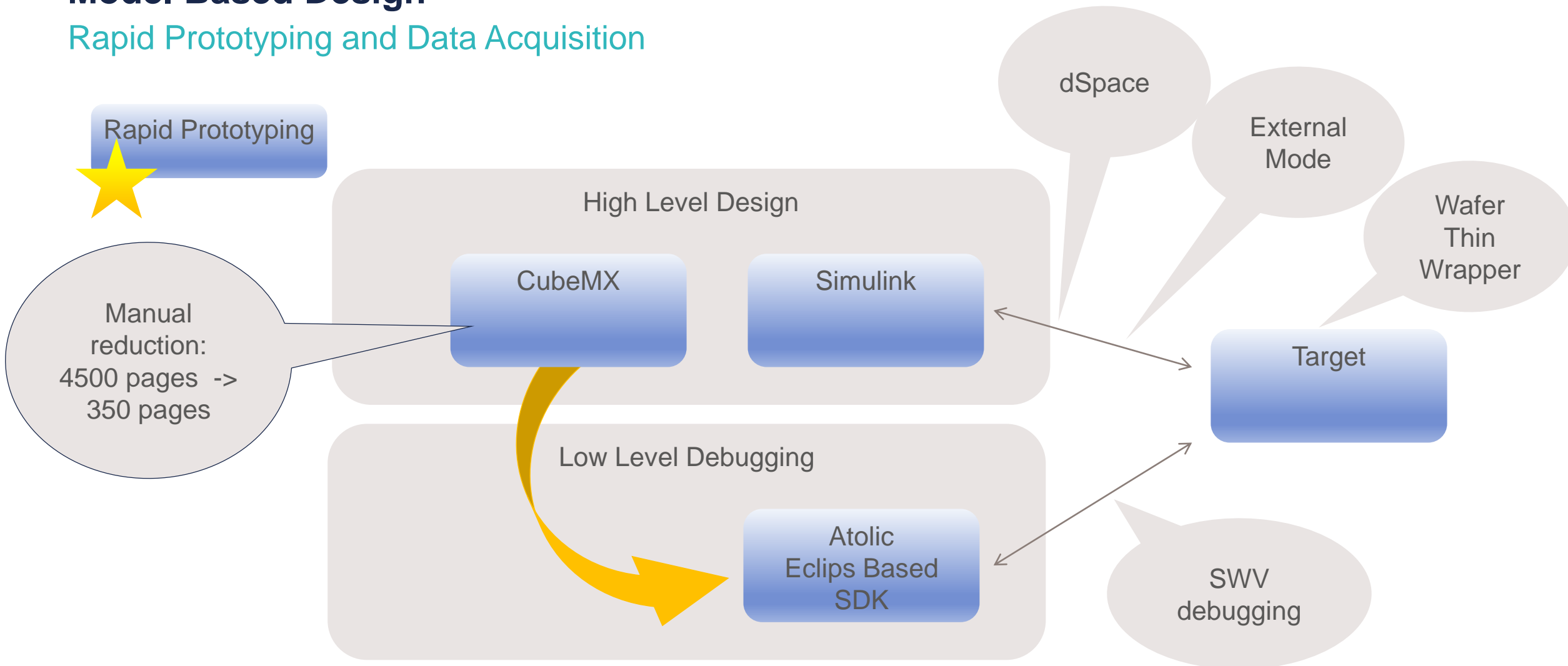
Working well for

- Alarm handling
- Metric Calculations
- Ventilator Logic



Model Based Design

Rapid Prototyping and Data Acquisition



On a personal note

Enlarge the Simulink ecosystem

Technical Paradigm Shifts and Division of Labor

Everyday Tools

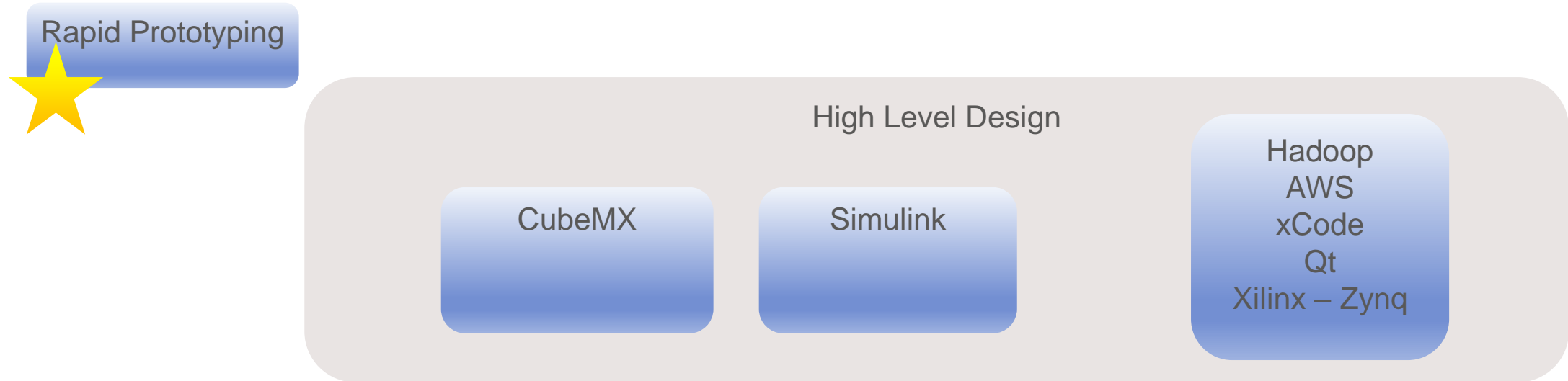
Model Based Design

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



“FULL STACK MBD development”

“One Man Development Department”

“Tony Stark Development Department”

Model Based Design

Everyday tools that work

The screenshot displays the MATLAB/Simulink environment with three main windows open:

- Linear Analysis Tool - Bode Plot 1:** Shows a Bode plot for the system 'insys1'. The plot displays Magnitude (dB) and Phase (deg) versus Frequency (rad/sec) on a logarithmic scale. The magnitude plot shows a resonance peak around 10 rad/sec.
- Solver Profiler:** Provides a detailed summary of solver performance.

Category	Item	Count
MODEL INFORMATION	Solver	ode15s
	Blocks with states	1
	States	2
	Start time	0
	Stop time	10
	Initial absolute tolerance	1.00e-09
STEP INFORMATION	Max step size	0.20
	Min step size	3.55e-15
	Average step size	3.45e-03
	Max step size usage(%)	0.59
	Total steps	2898
	Run time(s)	0.52
EVENT INFORMATION	Zero crossing source	1
	Zero crossing source triggered	1
	Total zero crossing	67
	Total Jacobian update	68
	Total solver reset	68
	Zero Crossing	67
	Discrete signal	0
	ZOH signal	0
	Block Change	0
	Initial Reset	1
Internal	1	
Total solver exception	780	
Error control	599	
Newton iteration	69	
- Step Size:** A log-linear plot showing the step size in seconds over time. The step size starts at approximately 0.2 seconds and rapidly decreases to a minimum of about 3.55e-15 seconds between 5 and 6 seconds, corresponding to the high-frequency resonance in the Bode plot.

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

Legacy Code Blockage

Solution #2

- Plant model for legacy code
- Interface to legacy code



Model Based Design

MBD-hurdles and how to jump over them

Problem

- Merge Tool

Solution #1

- Small team helps. Its easier to collaborate in small teams. Model and file ownership.

Solution #2

- Merge Tool improvements are needed!
We need from

Collaboration
Blocker



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.

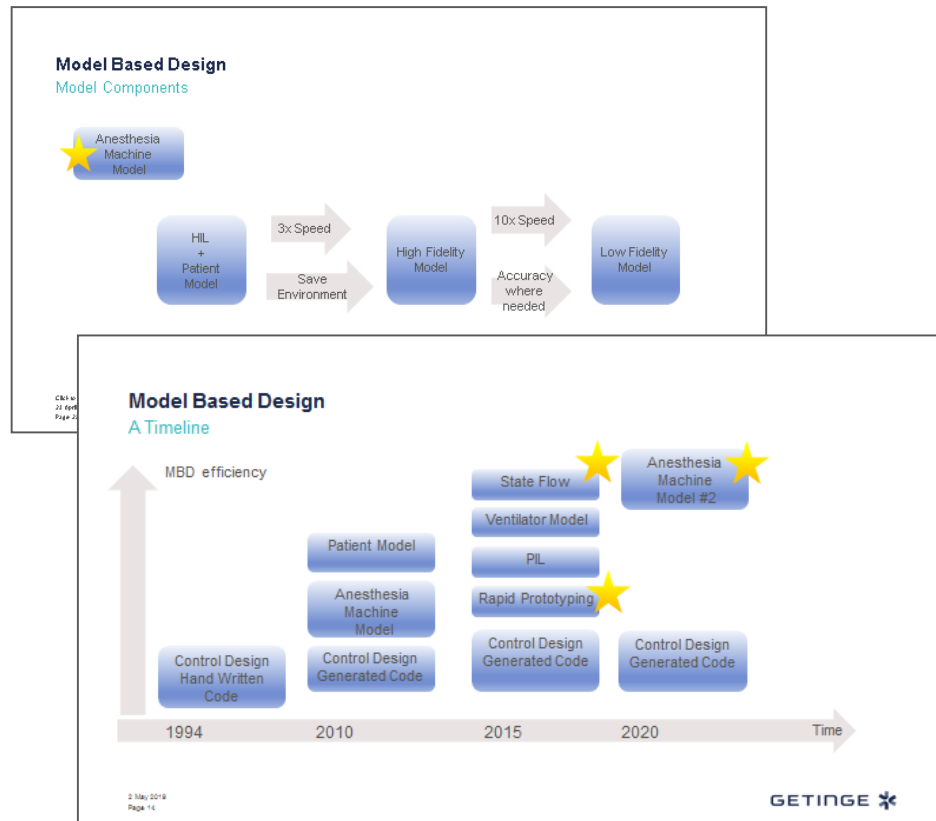
Argument: Initial Cost of Model Based Design



Conclusions

Model Based Design

Take away from this speech

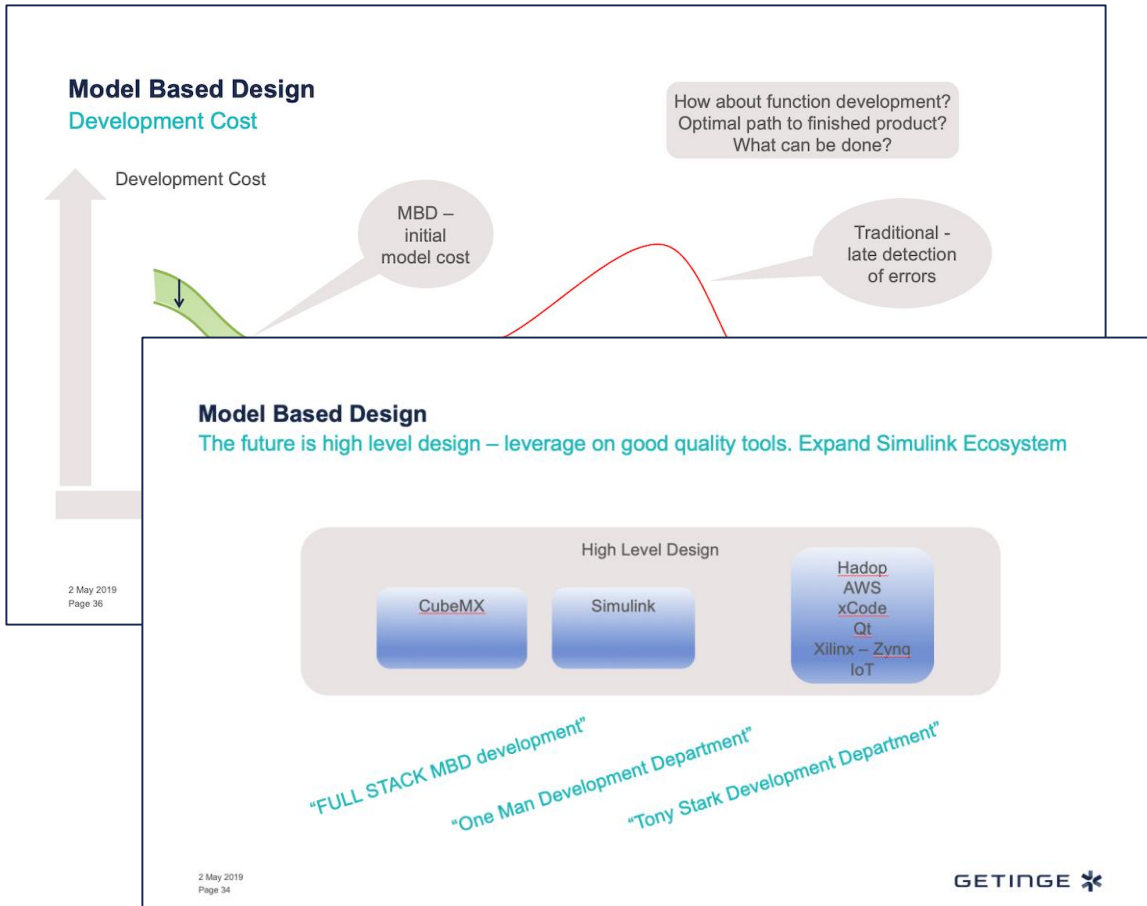


Take Away

- 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.

Model Based Design

Take away from this speech



Personal Take Away

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

Presentation Road Map

Questions?

A fairly normal presentation

Getinge Group
Solna – a part of Acute Care Therapies

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Solna – a part of Acute Care Therapies

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Conclusions

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On a personal note

On a personal note
Enlarge the Simulation system
The perils of...

Obstacles on the MBD road... and ways to remove them
A humoristic approach...

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