Model Based Design @ Getinge in Solna

Who am I?

Magnus Nord - Model Based Design Enthusiast

GETINGE

Presentation Road Map

A fairly normal presentation

Getinge Group
Solna – a part of Acute Care Therapies

Model Based Design at Getinge
Solna – a part of Acute Care Therapies

Conclusions

On a personal note

On a personal note
Enlarge the Simulink echo system
The perils o

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

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Getinge Group

Solna – a part of Acute Care Therapies

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Products
Solna

Ventilation

Anesthesia

Advanced Monitoring

Numbers

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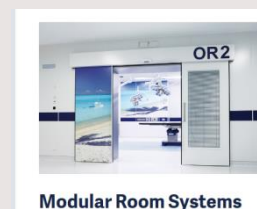- Revenue: ~ 2000 MSEK

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Products
Outside Solna

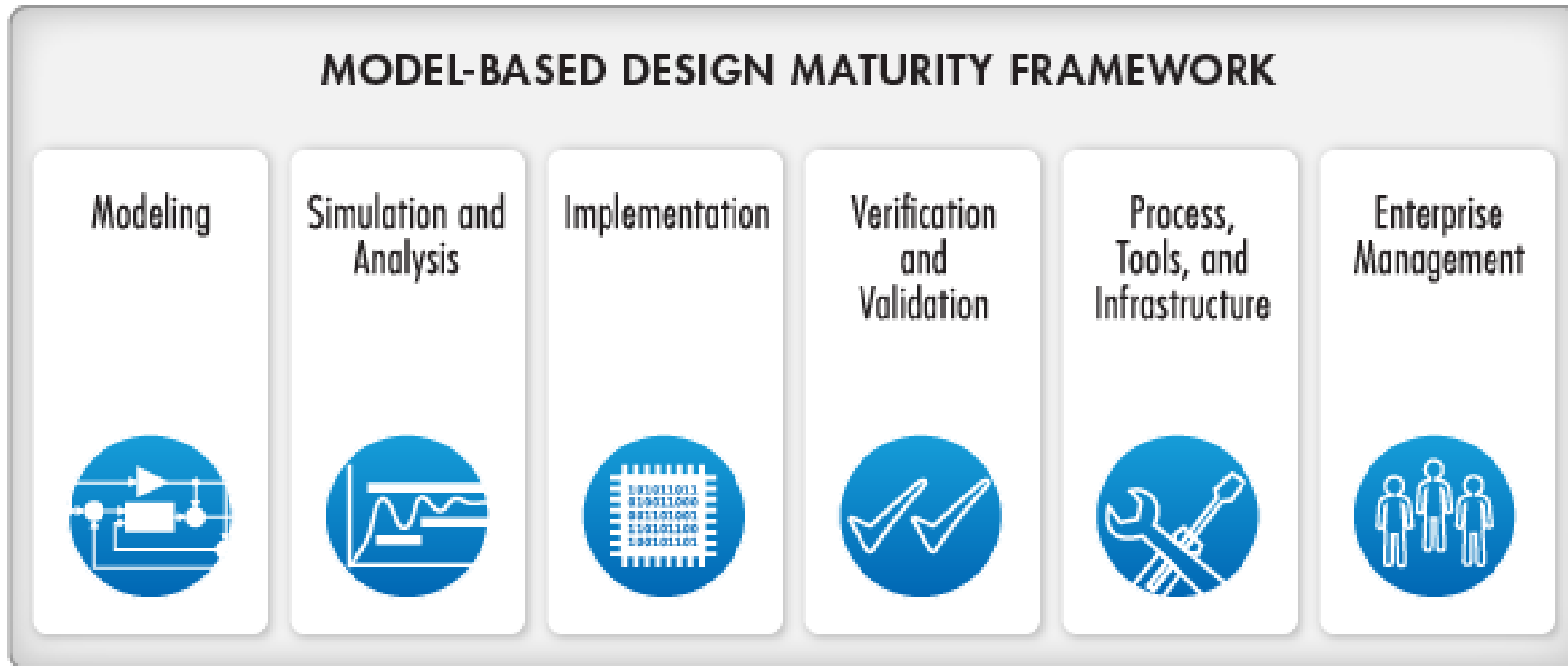
Sterilization

Operating Room

…and much more

Endoscopic Vessel
Harvesting (EVH)

Read more about Consumables →

Read more about Covered Stents →

Extracorporeal Life
Support

OR2

Modular Room Systems

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Model Based Design at Getinge

Solna

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Model Based Design
Maturity Assessment

MODEL-BASED DESIGN MATURITY FRAMEWORK

| Modeling | Simulation and Analysis | Implementation | Verification and Validation | Process, Tools, and Infrastructure | Enterprise Management |

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Model Based Design

A Timeline

MBD efficiency

Anesthesia Machine Model #2

Stateflow

Ventilator Model

Patient Model

PIL

Rapid Prototyping

Anesthesia Machine Model

Control Design dSpace Hand Written Code

Control Design Generated Code

Control Design Generated Code

Control Design Generated Code

1994   2010   2015   2020   Time

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Model Based Design
Results
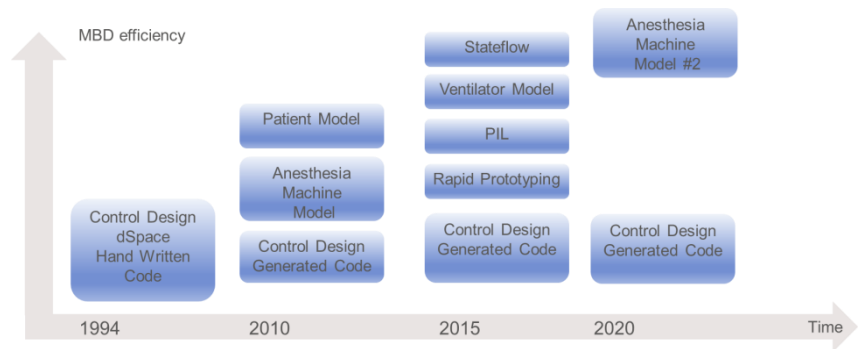
Results

- 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.

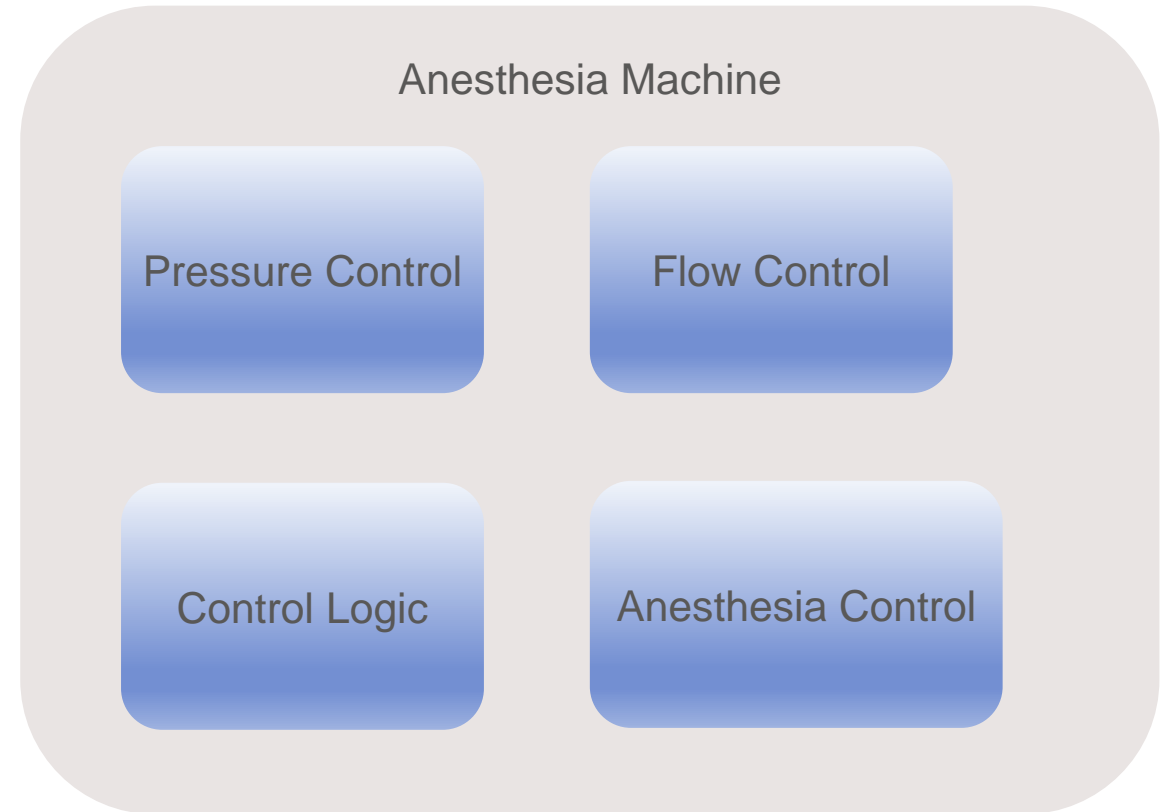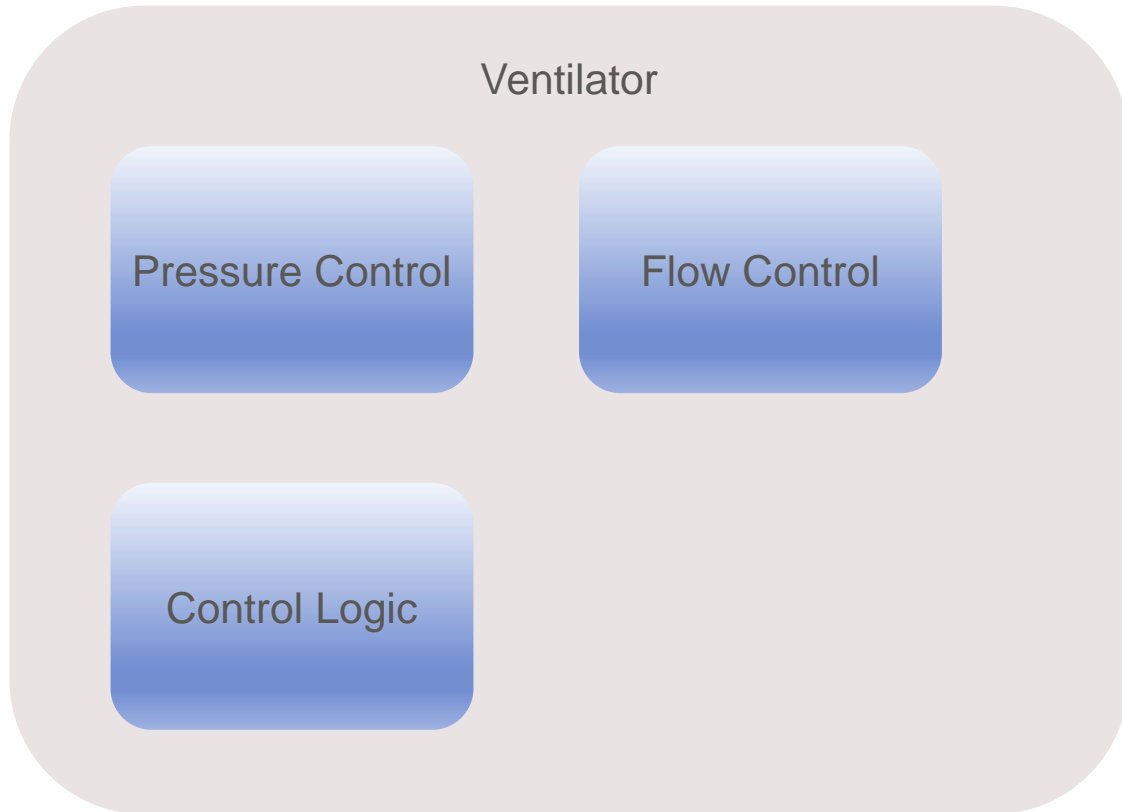- Incremental implementation. Let MBD-grow into place.

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Model Based Design

A Timeline

MBD efficiency

Stateflow

Anesthesia
Machine
Model #2

Ventilator Model

Patient Model

PIL

Anesthesia
Machine
Model

Rapid Prototyping

Control Design
dSpace
Hand Written
Code

Control Design
Generated Code

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Generated Code

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1994   2010   2015   2020   Time
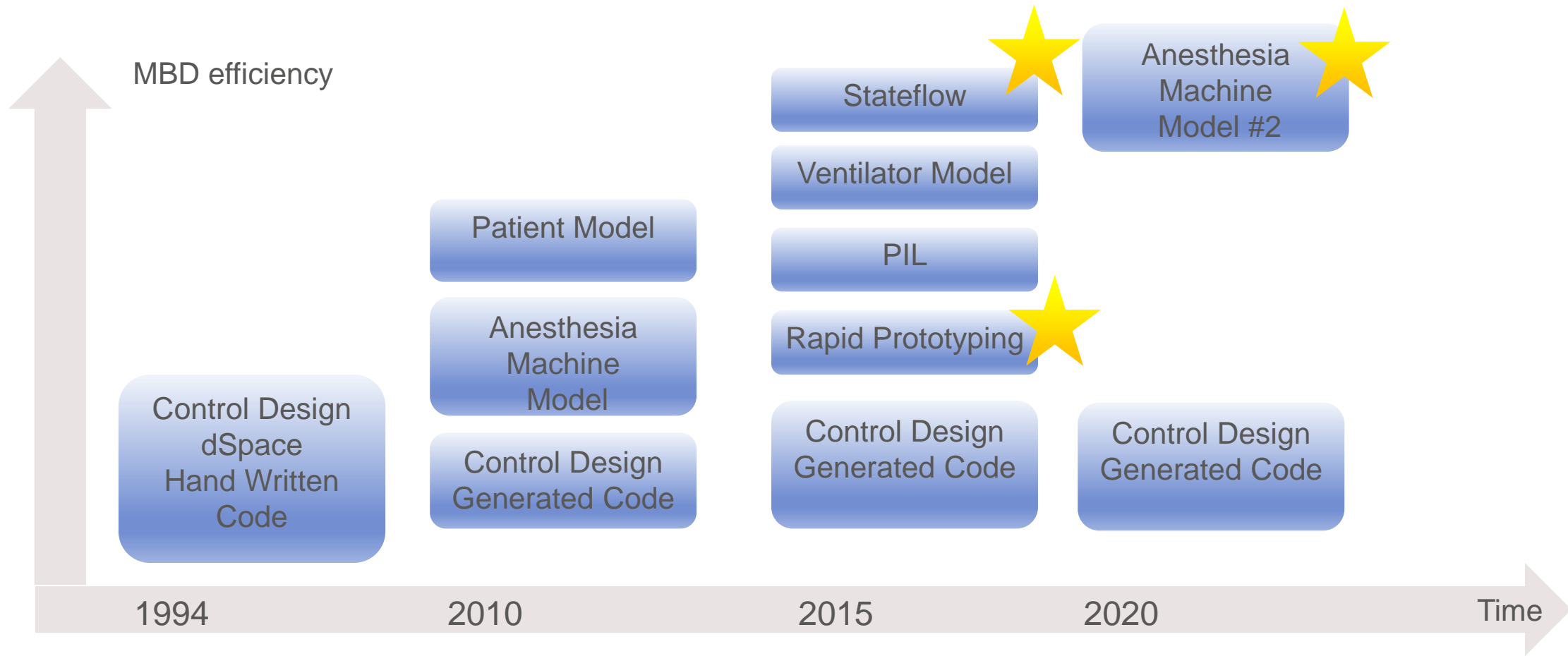
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Products - Solna

Products from an automatic control perspective

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Model Based Design

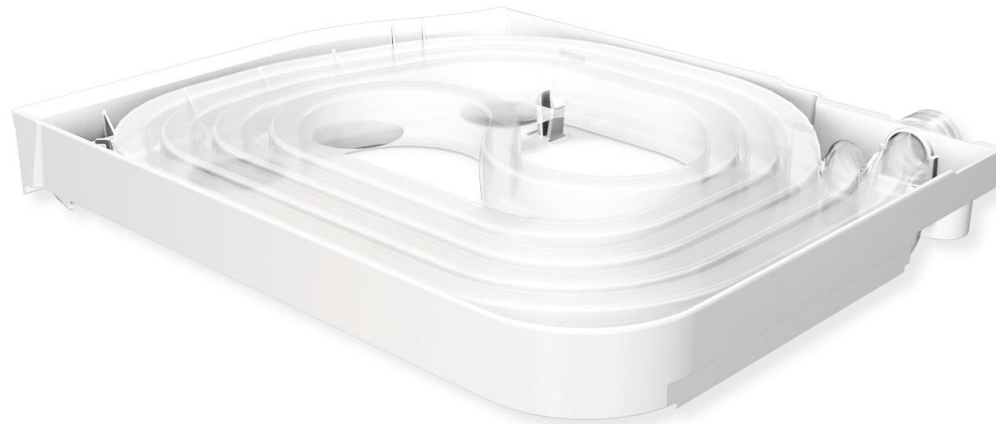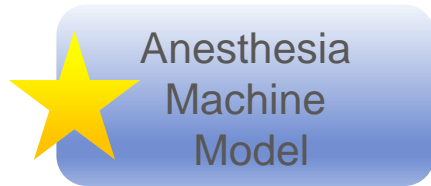## Model Components and challenges

Anesthesia Machine Model

Gas Modules

Circle Breathing System

Patient

Reflector

Absorber

Model Based Design
Anesthesia Model

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Anesthesia
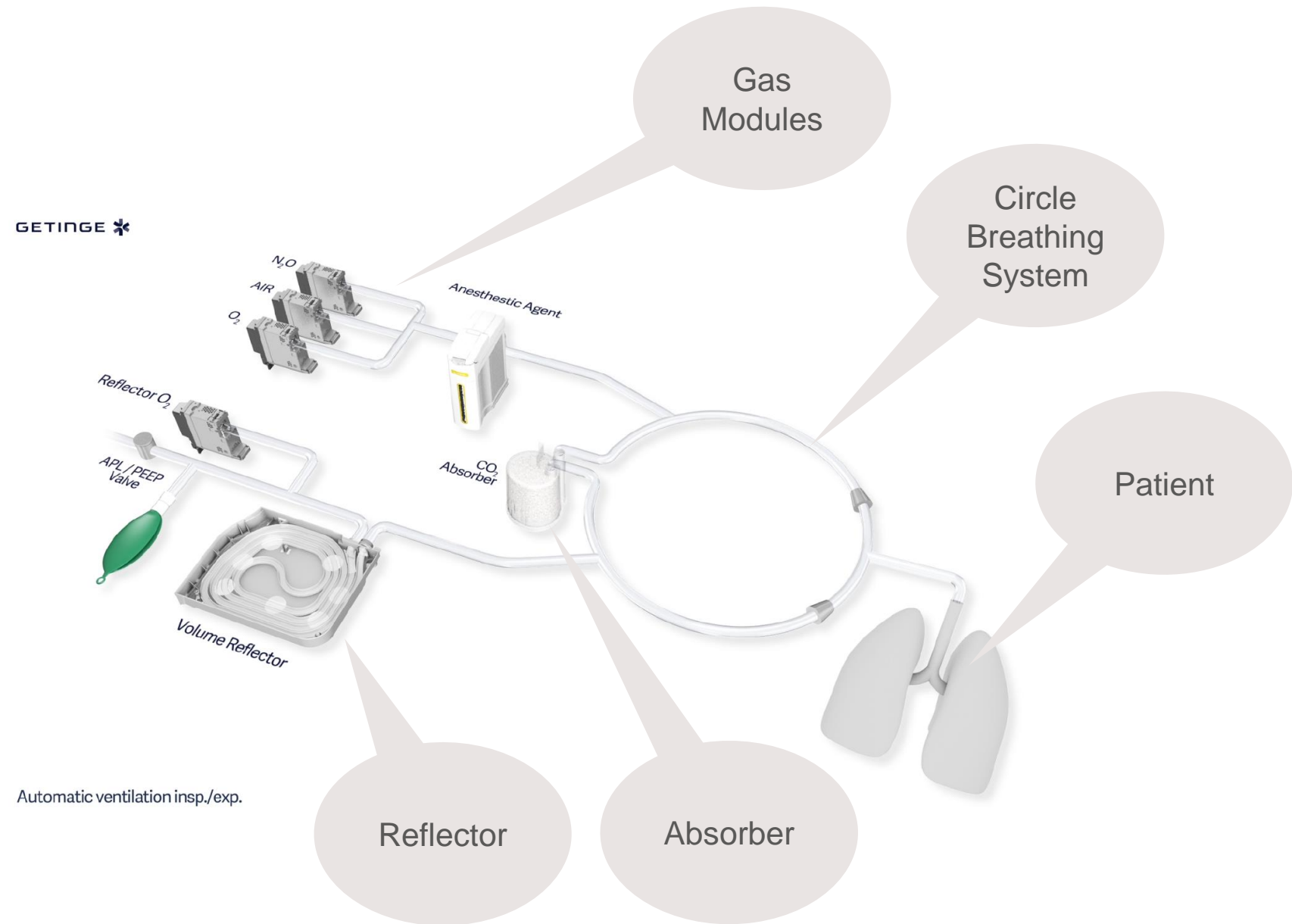Machine
Model

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Model Based Design
Model Components

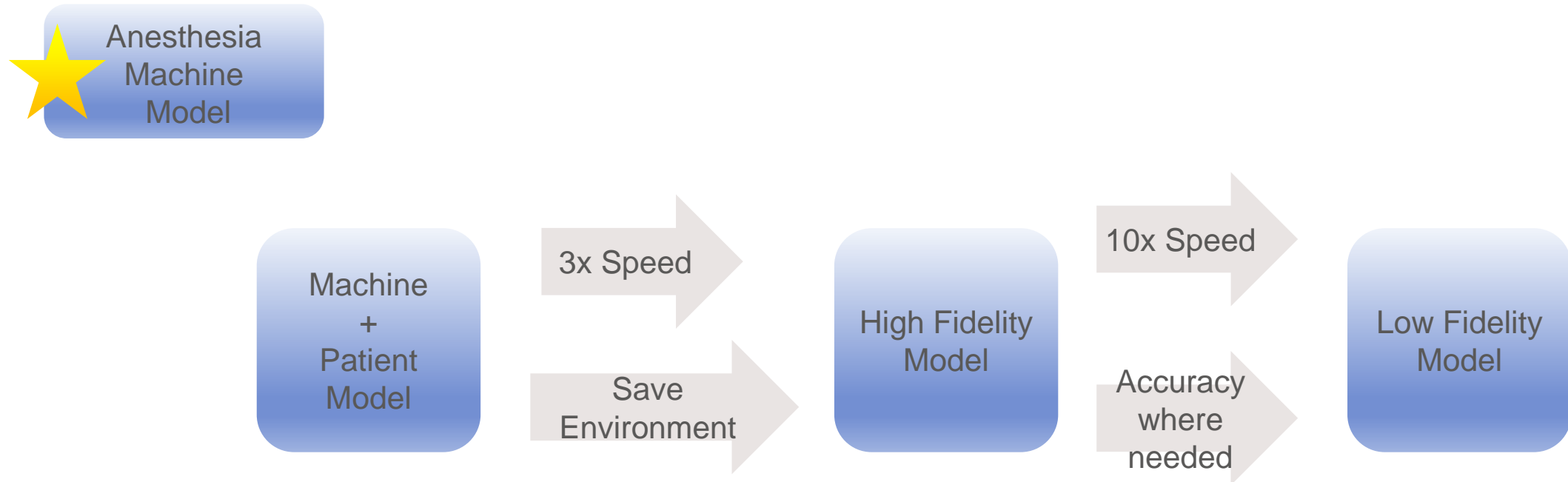⭐ **Anesthesia Machine Model**

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.

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N₂O

AIR

O₂

Anesthestic Agent

Reflector O₂

APL / PEEP Valve

CO₂ Absorber

Volume Reflector

Automatic ventilation insp./exp.

Gas Modules

Circle Breathing System

Patient

Reflector

Absorber

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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

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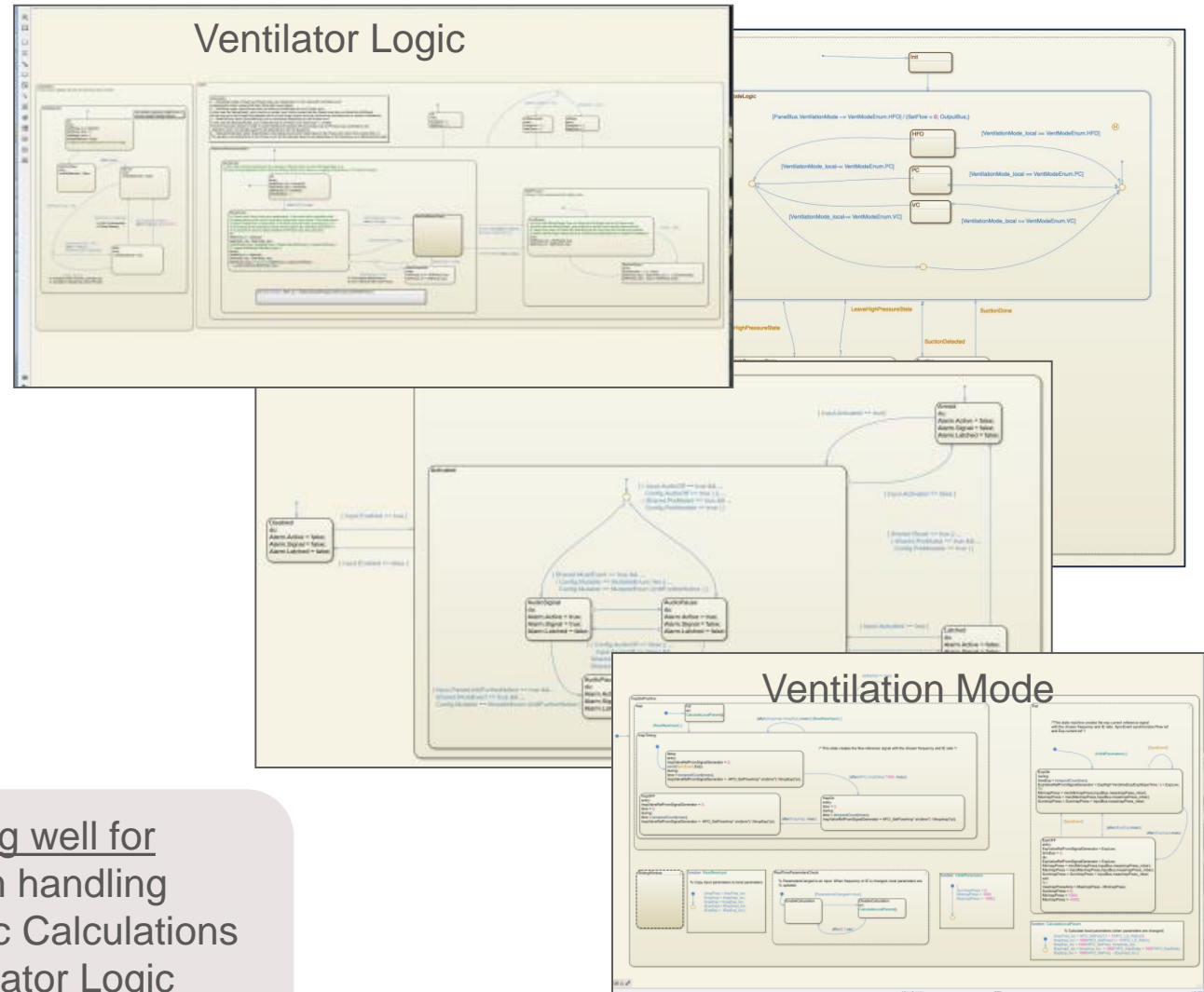# Model Based Design
Stateflow

Stateflow

⭐

Advantages

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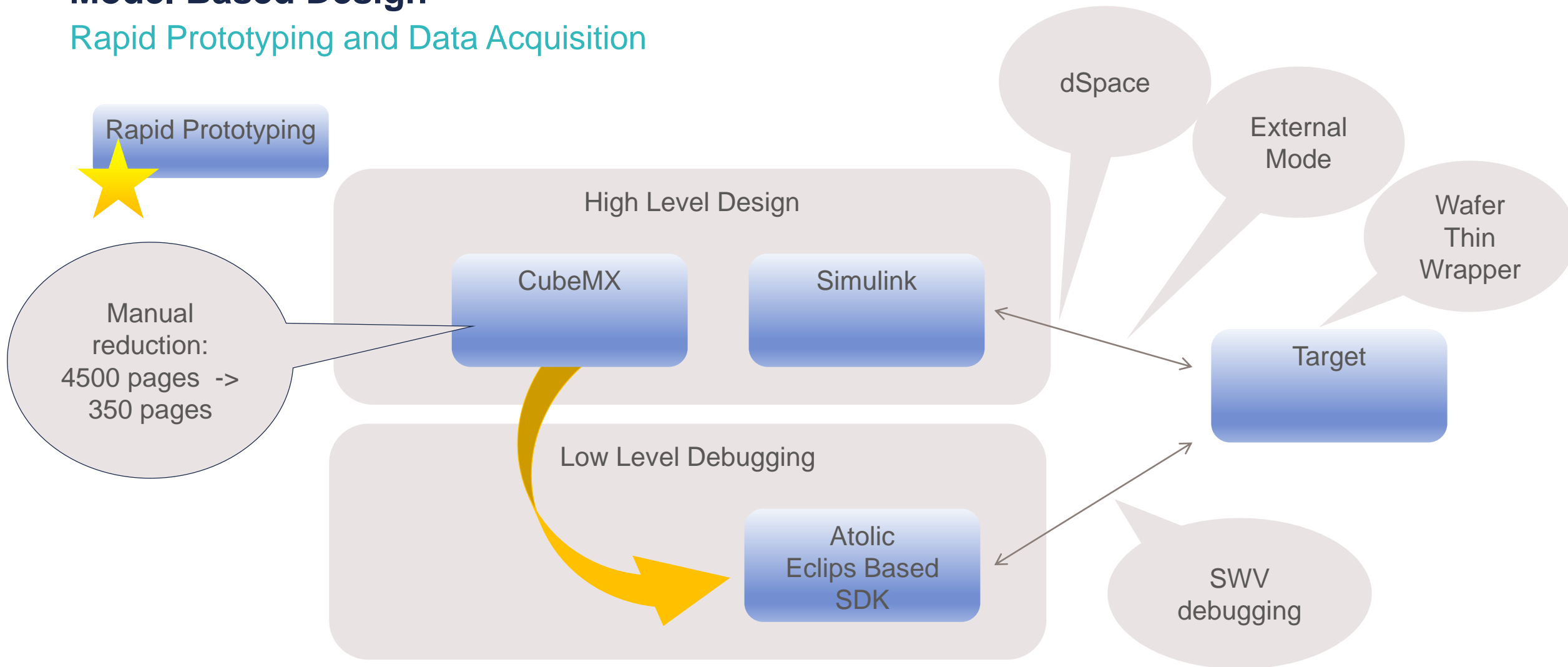- Surrounding controller logic sometimes more complex than the controllers – Stateflow helps!

Working well for
- Alarm handling
- Metric Calculations
- Ventilator Logic

Ventilator Logic

Ventilation Mode

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Model Based Design
Rapid Prototyping and Data Acquisition

Rapid Prototyping

High Level Design

CubeMX

Simulink

Manual reduction:
4500 pages ->
350 pages

Low Level Debugging

Atolic
Eclips Based
SDK

dSpace

External Mode

Wafer
Thin
Wrapper

Target

SWV debugging

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On a personal note

Enlarge the Simulink ecosystem

Technical Paradigm Shifts and Division of Labor

Everyday Tools

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Model Based Design

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

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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
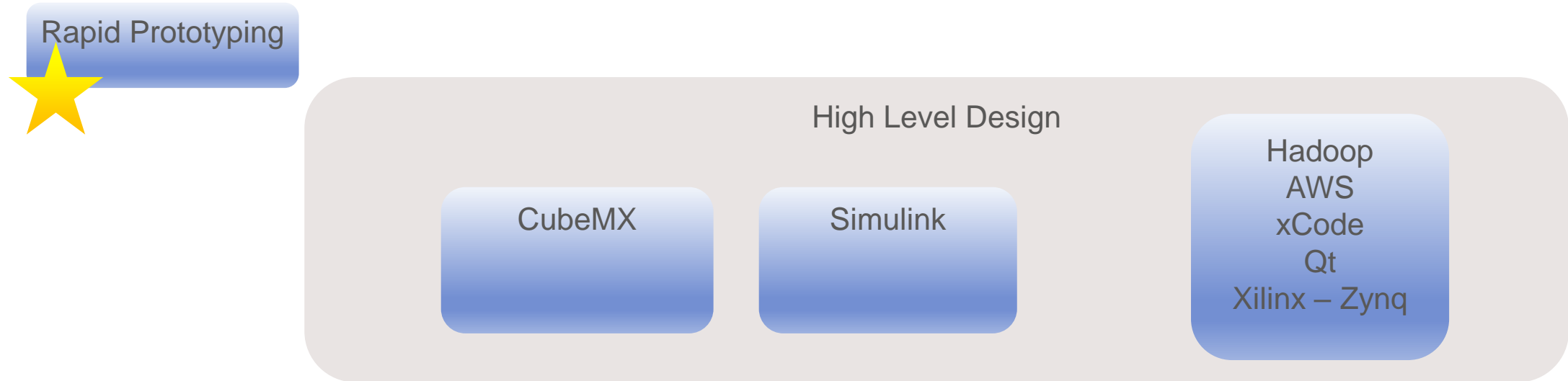
"FULL STACK MBD development"

"One Man Development Department"

"Tony Stark Development Department"

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Model Based Design
Everyday tools that work

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

PDF version

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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?

MBD

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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

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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

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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.
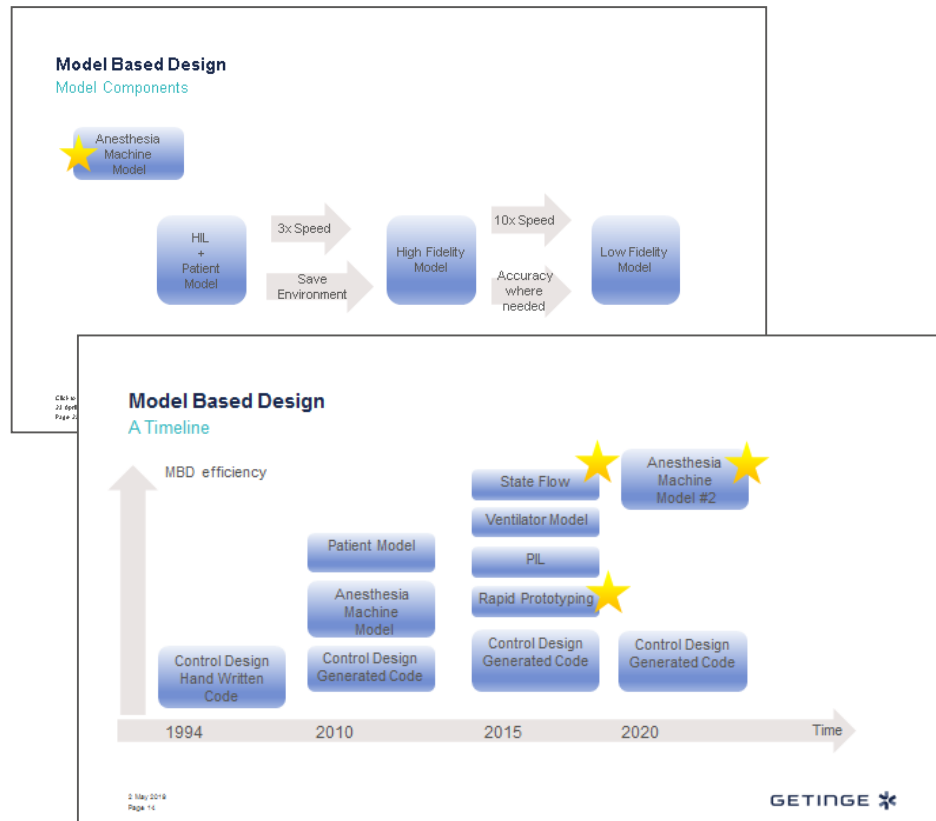
Argument: Initial Cost of Model Based Design

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Conclusions

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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.

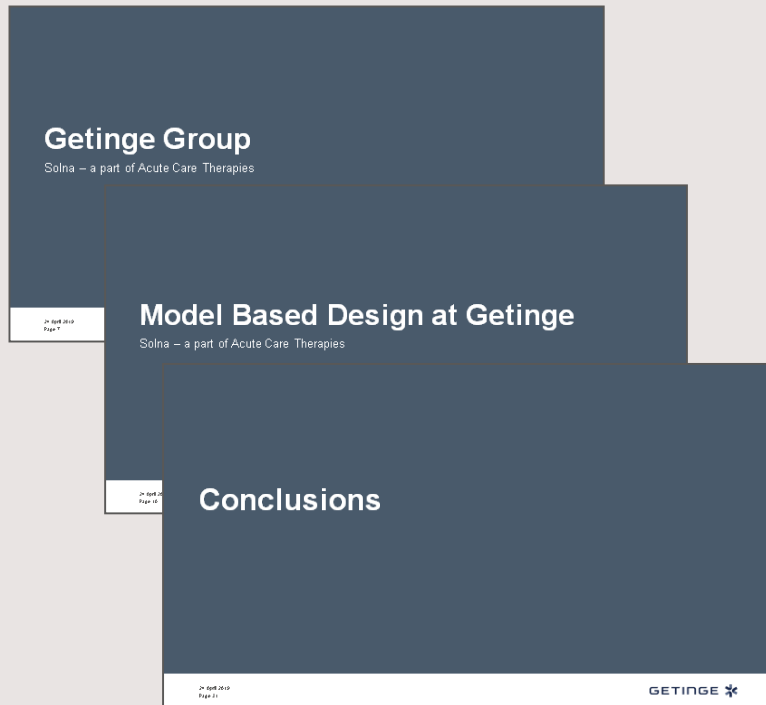GETINGE ✳

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.

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Presentation Road Map

Questions?

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