Grundfos – A Pump Company

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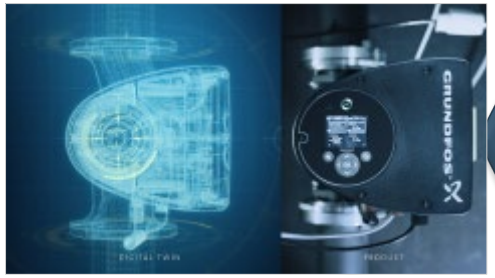
Senior Specialist, Sound & Vibration

be
think
innovate

GRUNDFOS

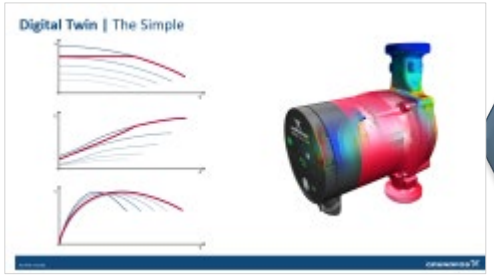
Agenda

Grundfos



Digital Twins

- In General
- In Grundfos



3x Digital Twin Examples

- The Simple
- The Modest
- The Advanced

Challenges and perspectives

The most global pump company in the world

1945
when it all started

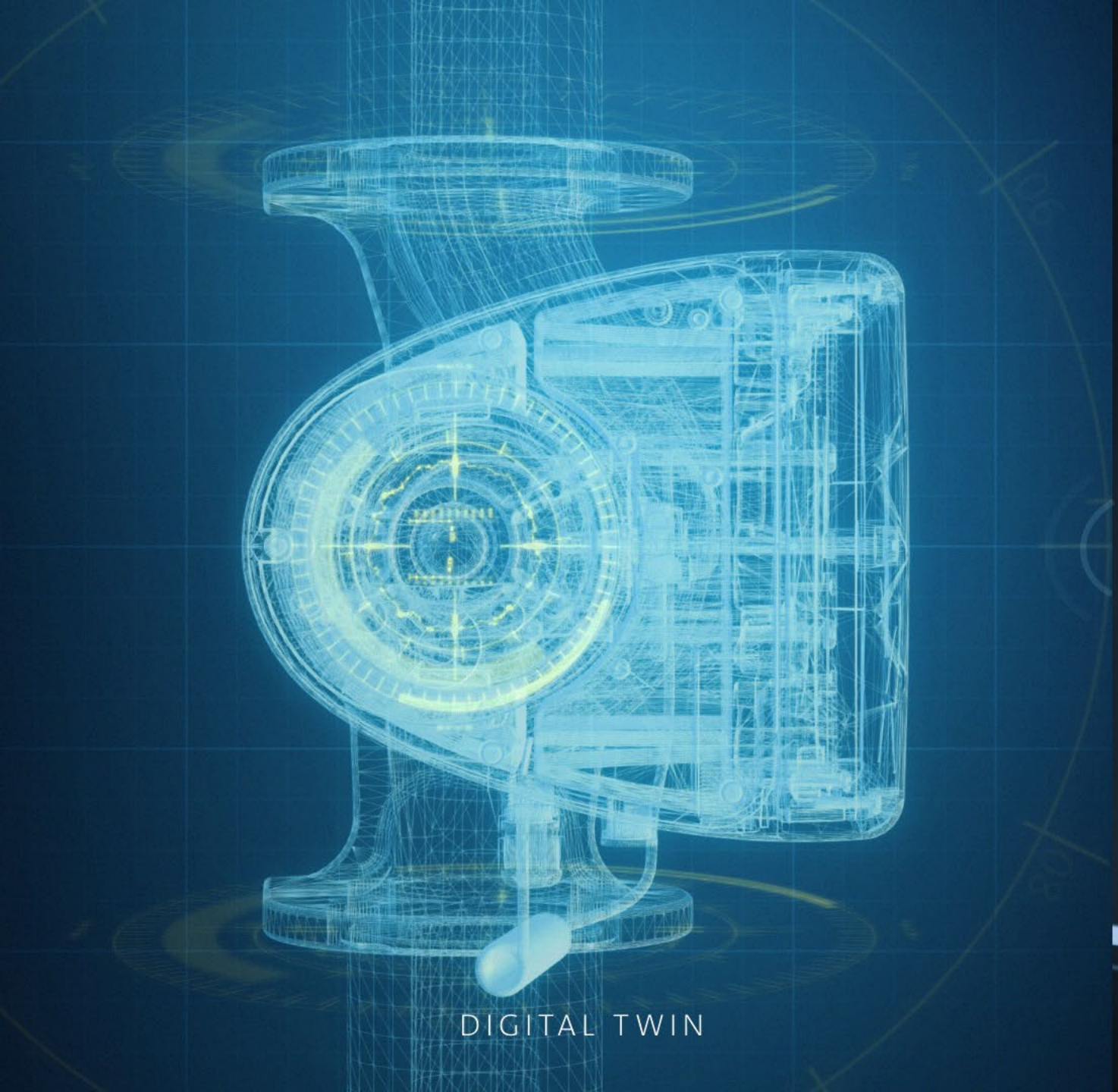
#1
pump manufacturer in the world

19,000+
employees

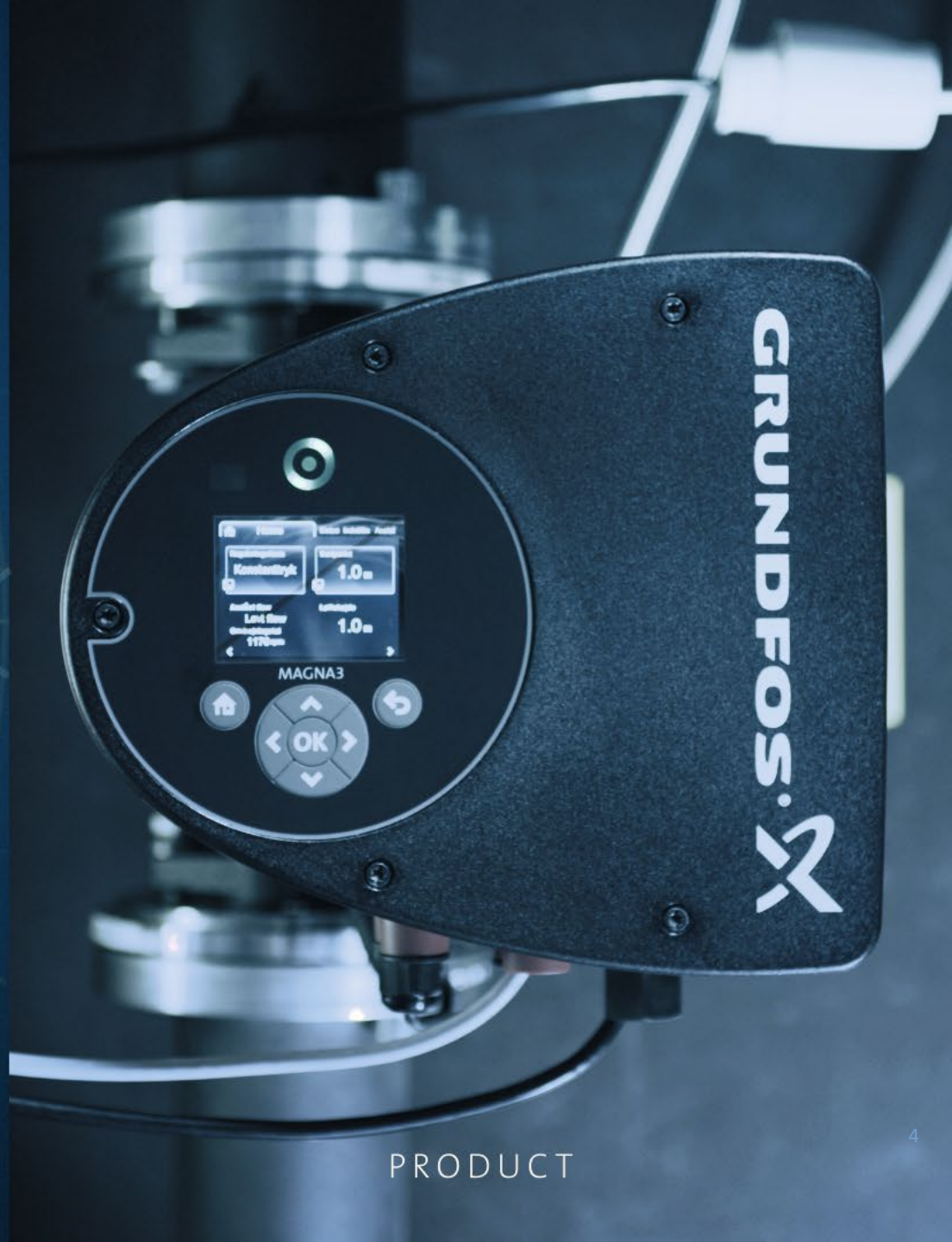
100+
companies worldwide

16,000,000
units produced per year

DKK 26.3
billion net turnover in 2020



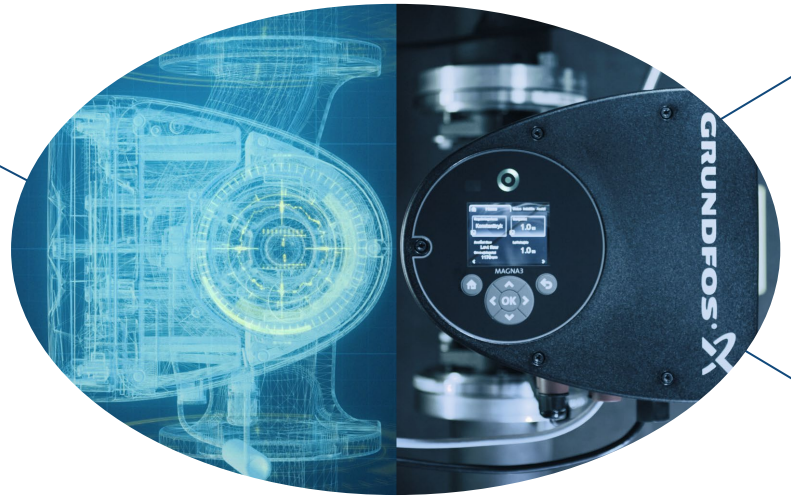
DIGITAL TWIN



PRODUCT

Digital Twin | General

Digital Twin of a Pump



Development

Digital Twin Prototype

Recipe for the pump

- Model-based definition
- Intelligent 3D CAD
- Simulation models

Operation

Field & Service

Operating the digital twin instance

- Operational and service history stored in the digital twin instance
- Data analysis using algorithms and simulation models
- Insights fed back to product development

Production

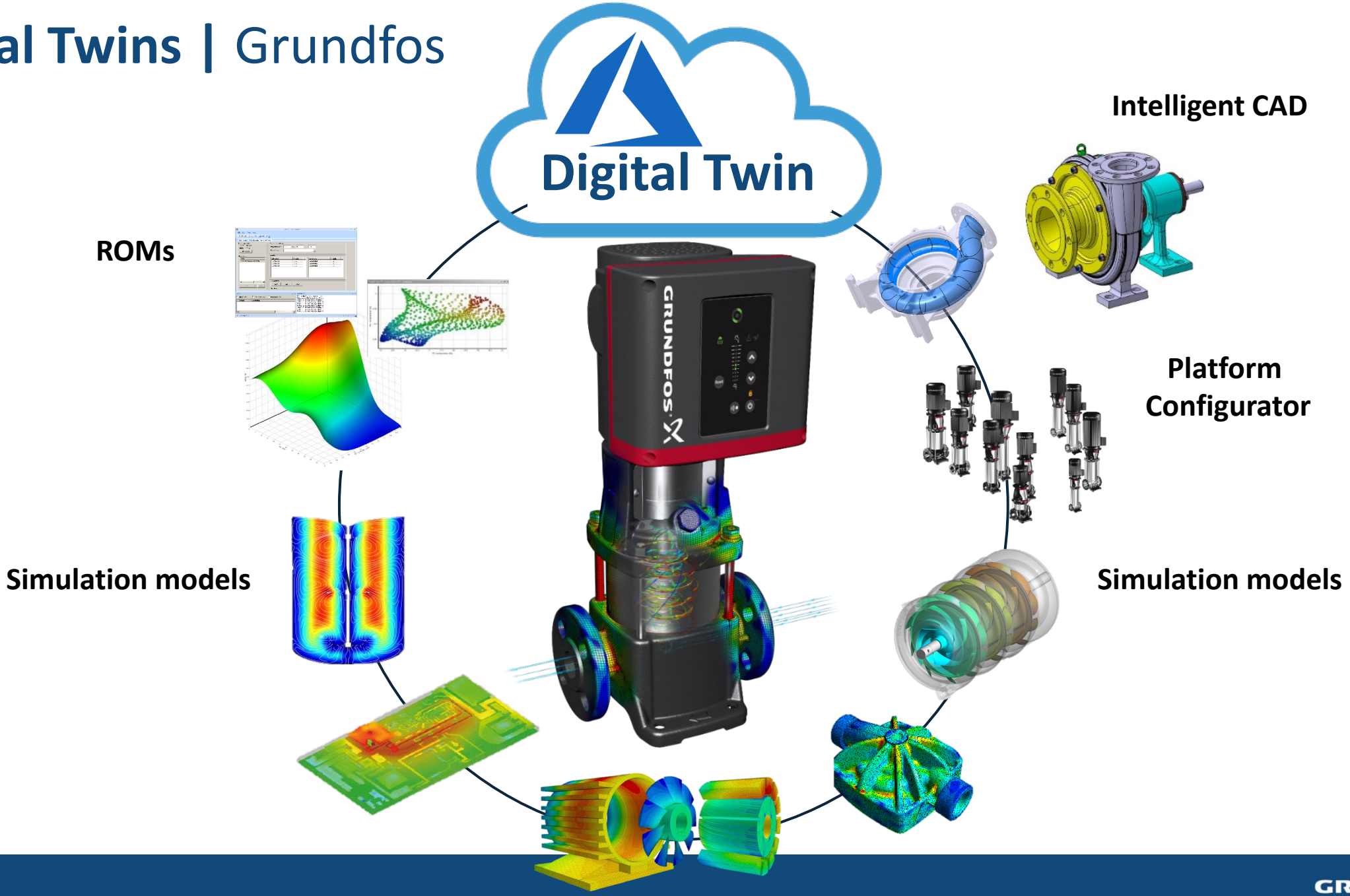
Digital Twin Instance

Instantiation of the digital twin

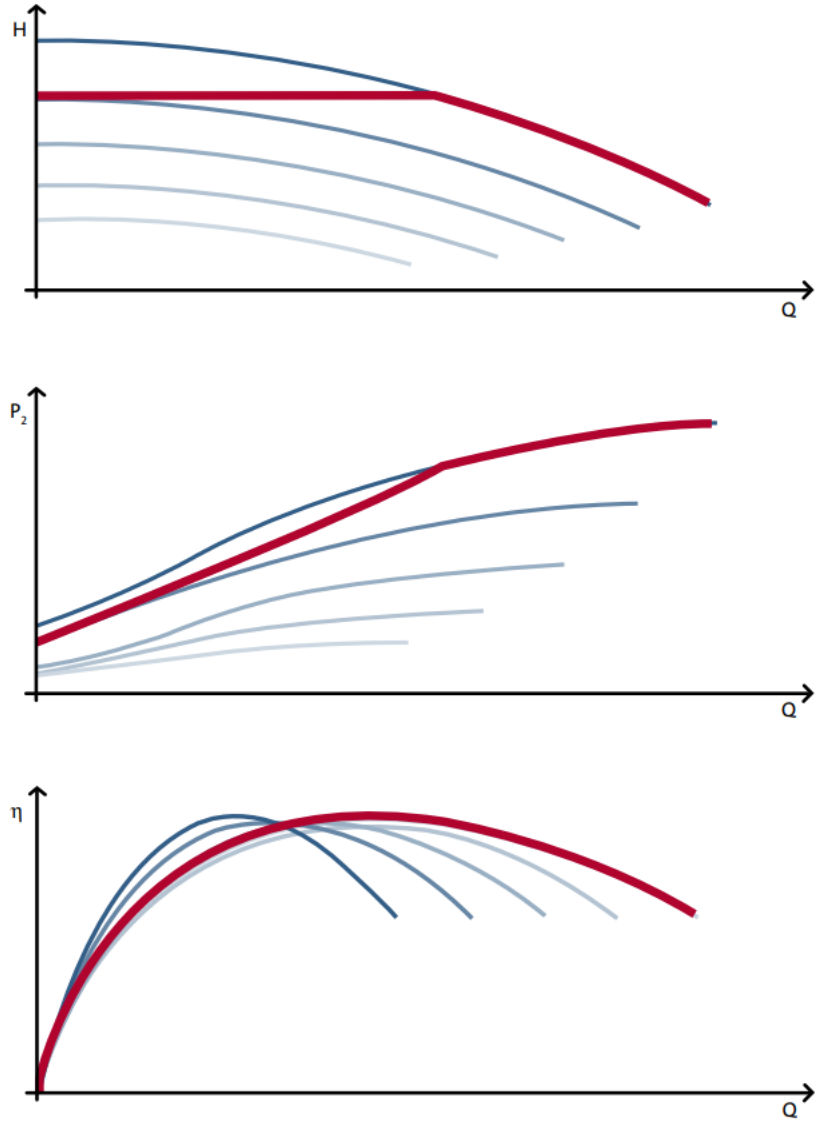
- Production data and actual geometry stored in the digital twin instance
- Data feedback to product development

Enabling new offerings and faster product development

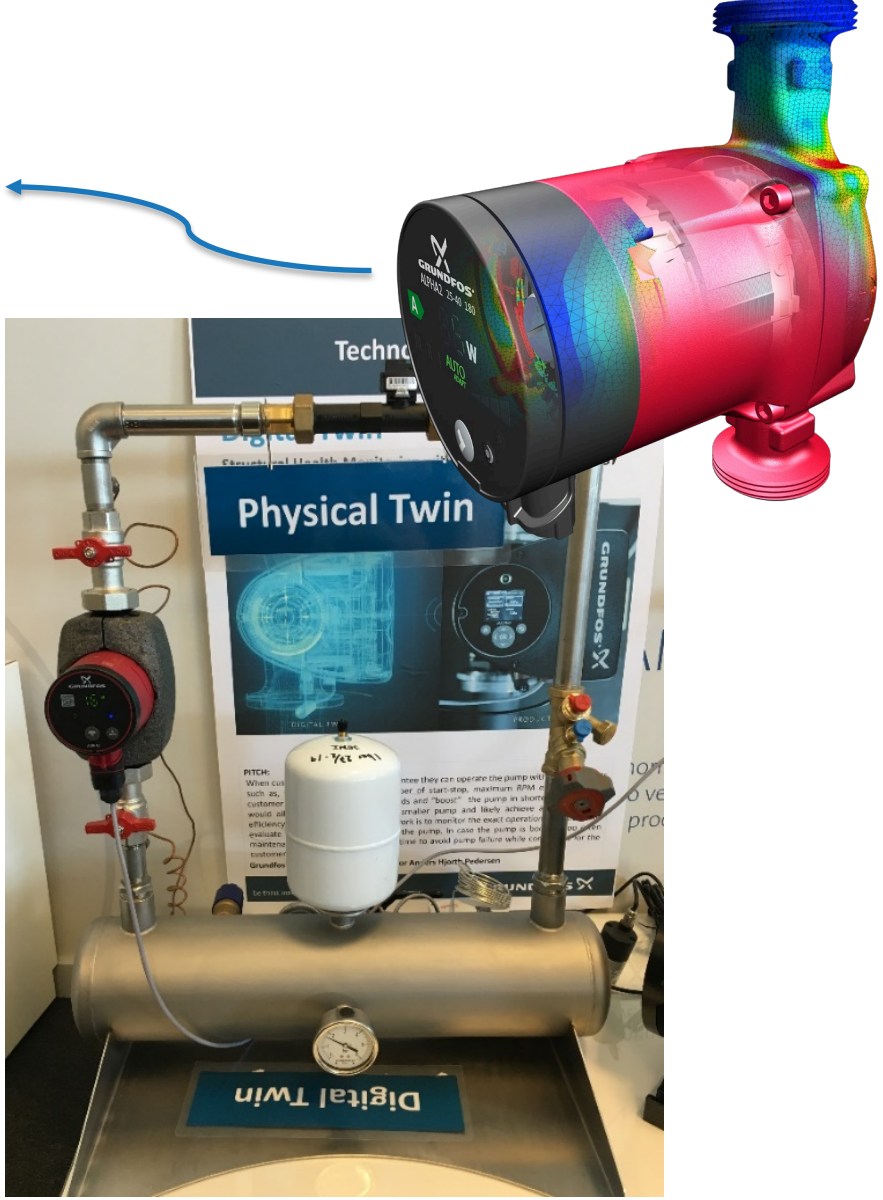
Digital Twins | Grundfos



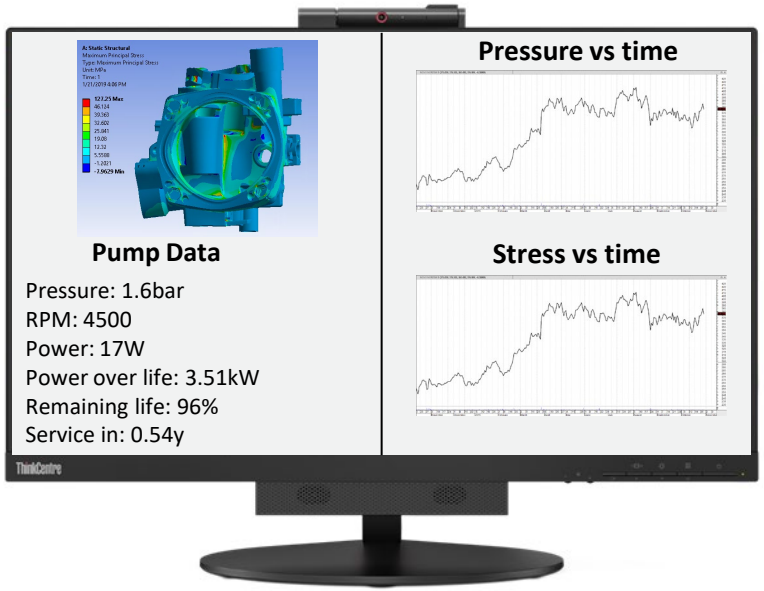
Digital Twin | The Simple



Digital Twin | The Modest

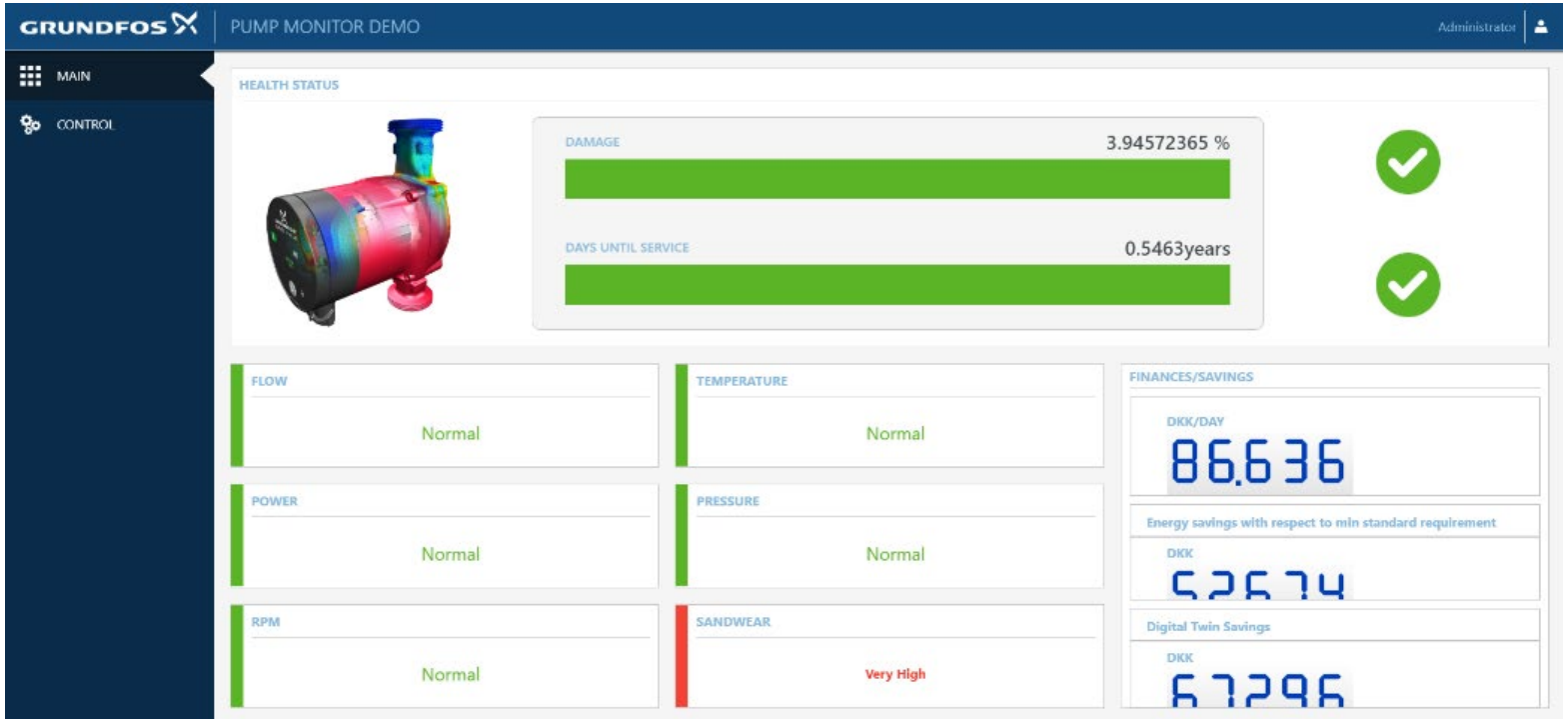


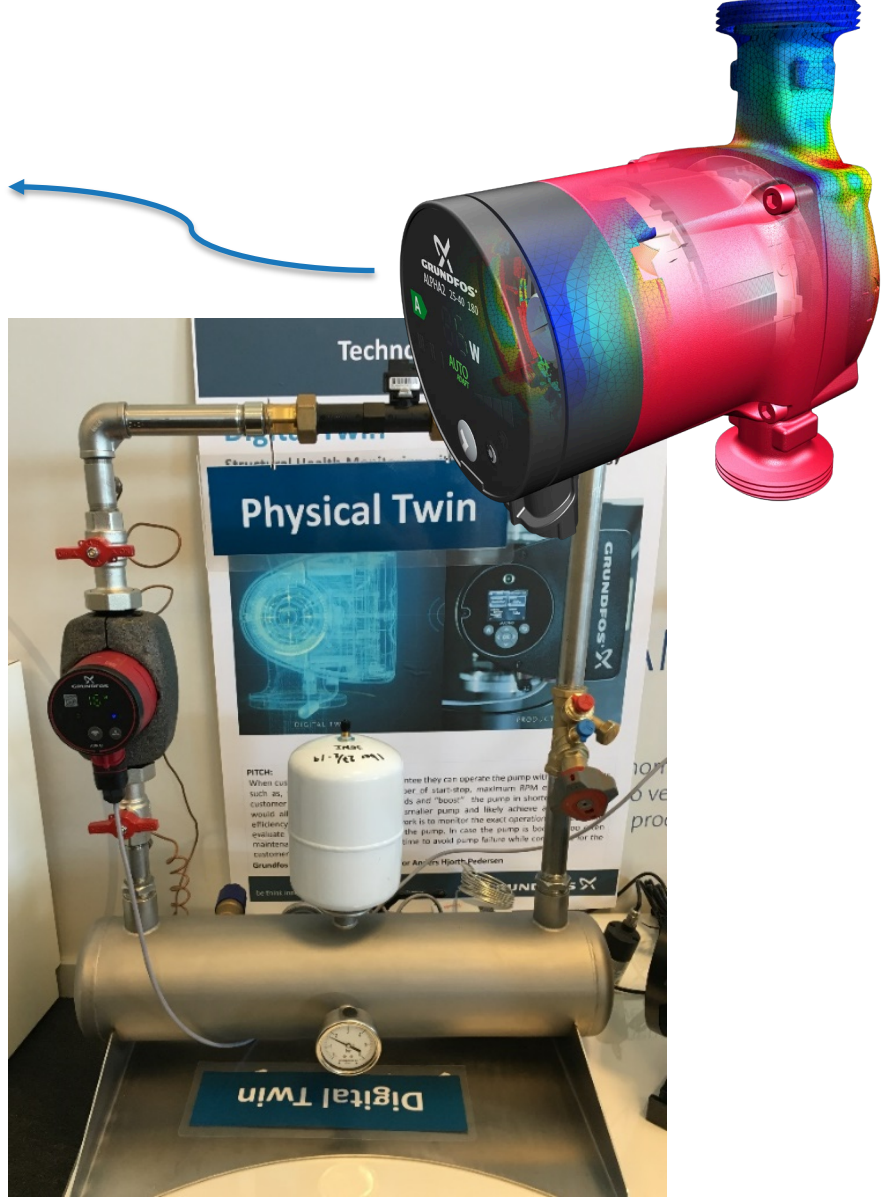
Digital Twin



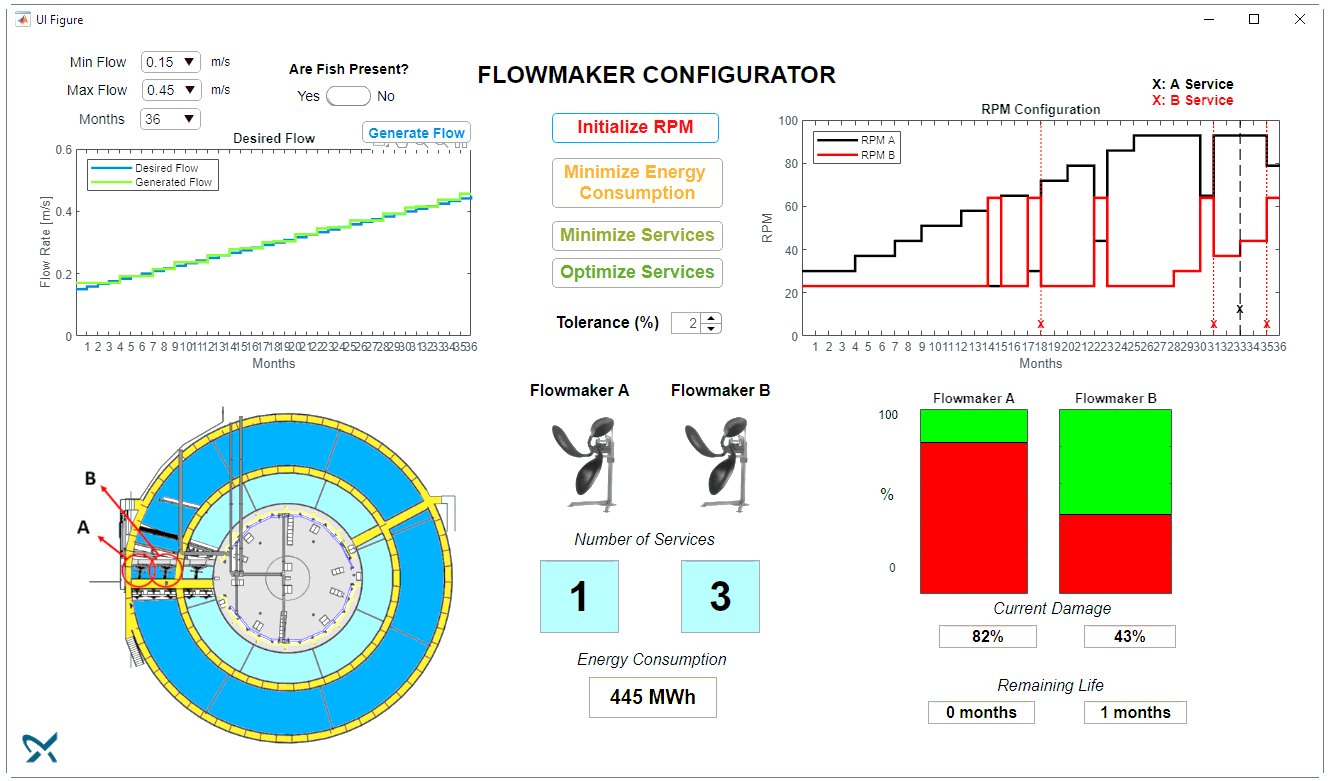
Digital Twin | The Modest

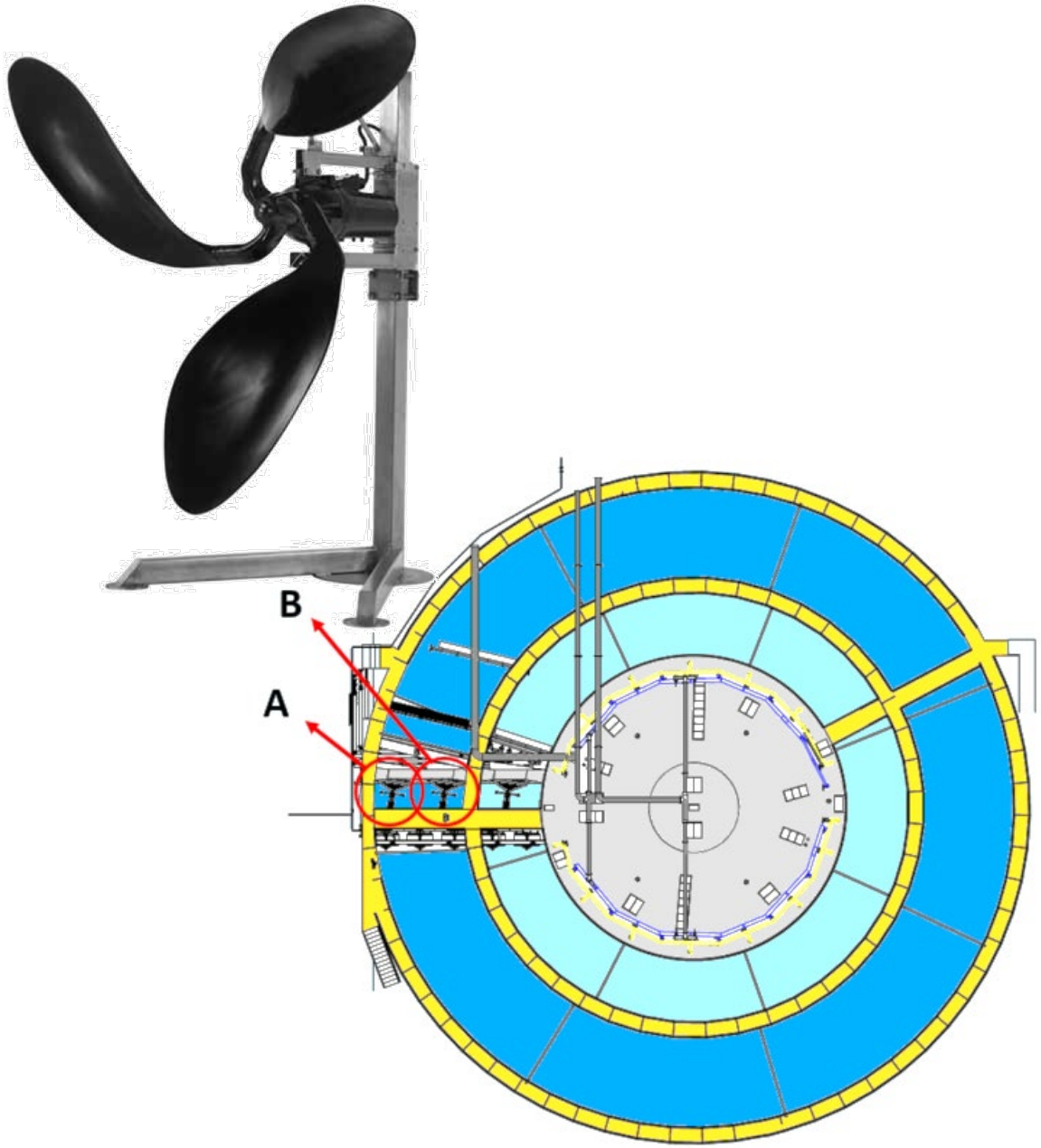
Digital Twin



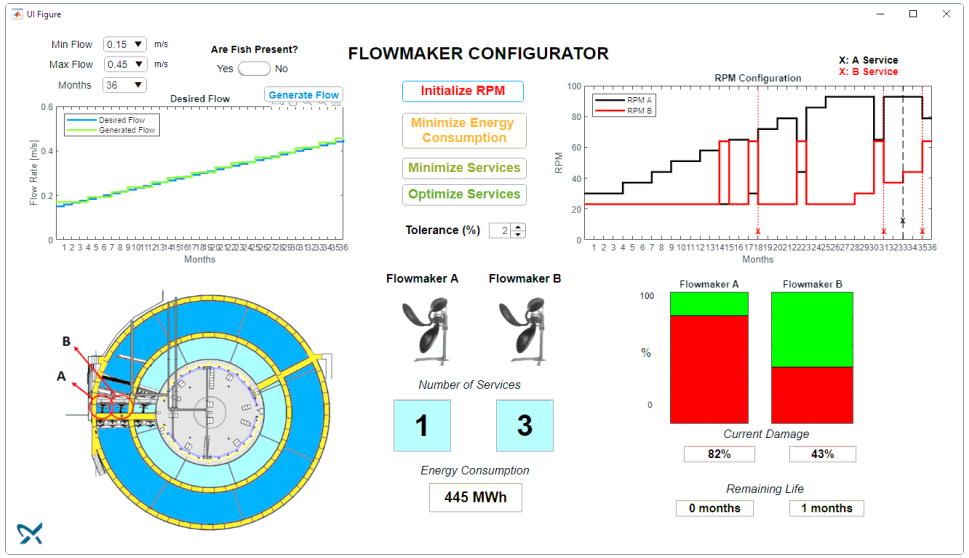


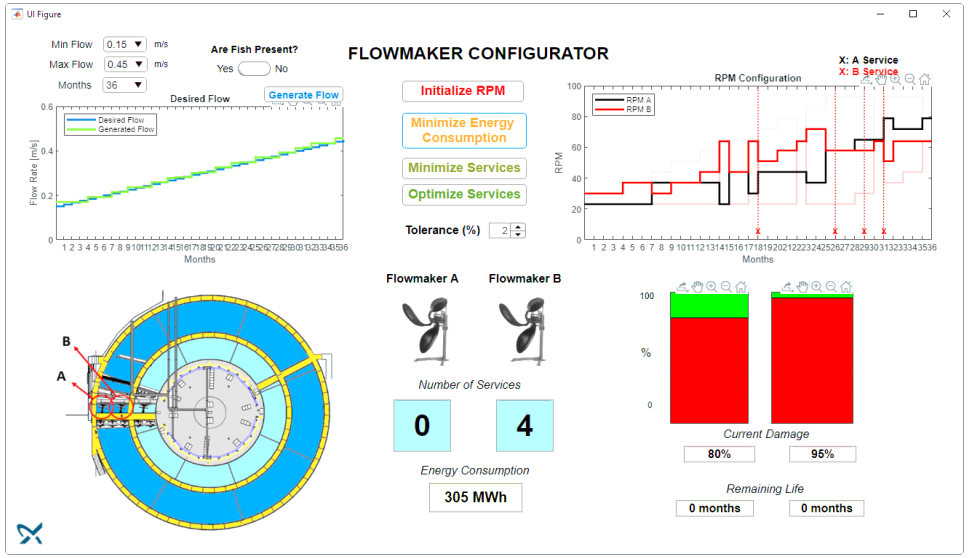
Digital Twin | The Advanced

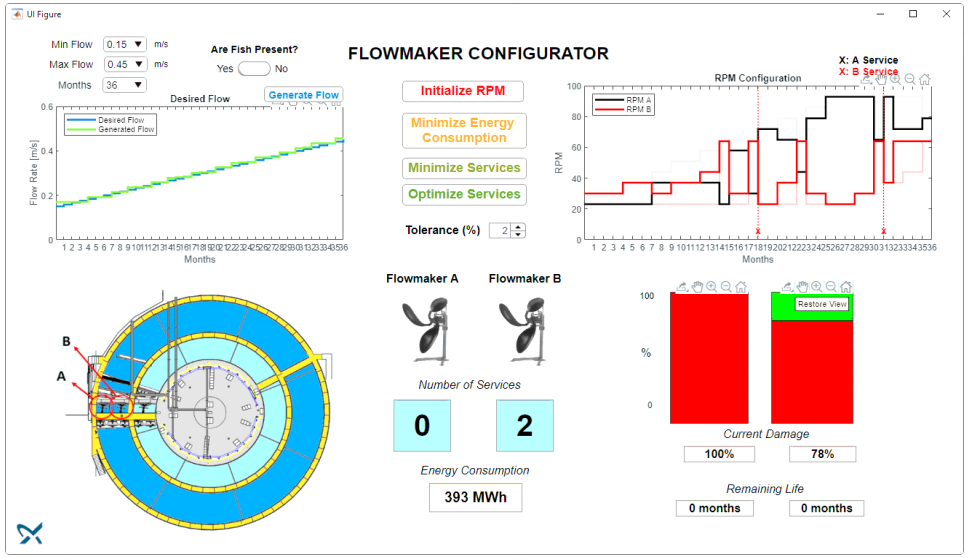


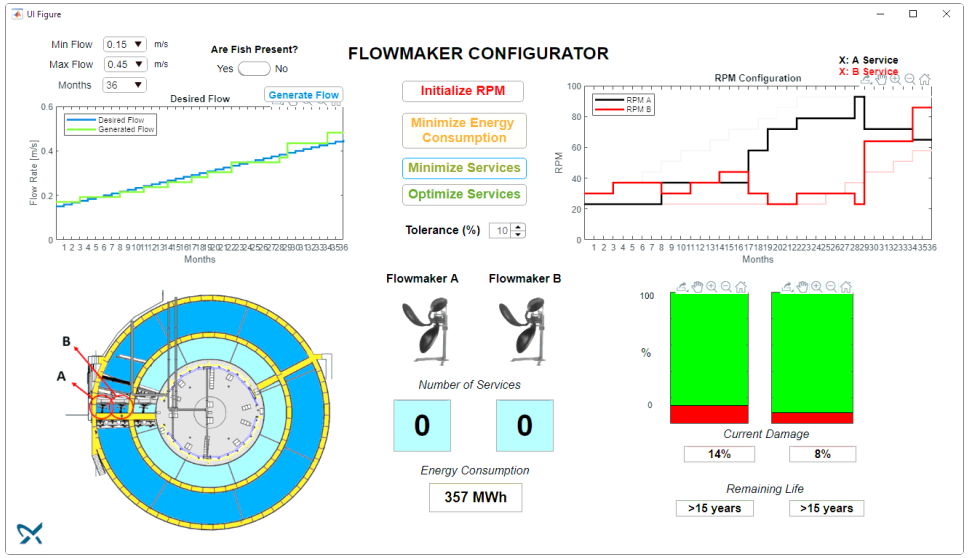


Digital Twin | The Advanced

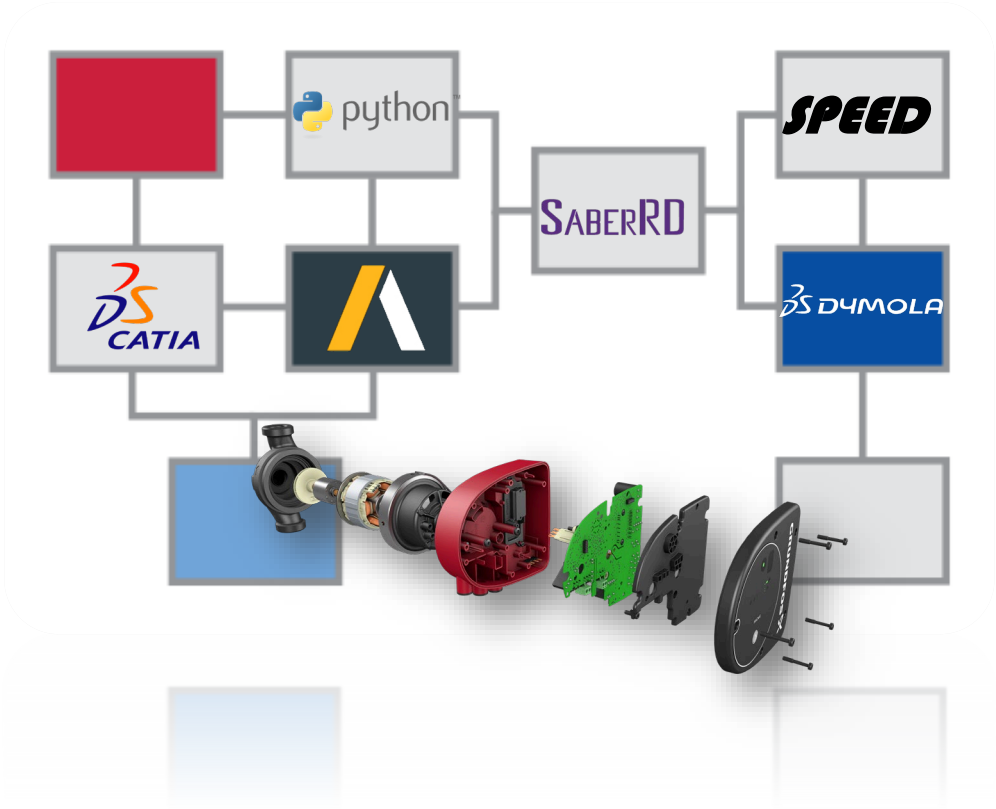




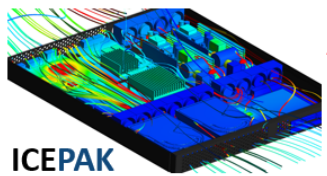


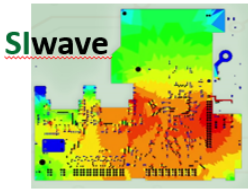


Challenges in SD-DT | Fast Simulation Models



Ansys





CATIA

Simulink

SABERRD

pads

SPEED...

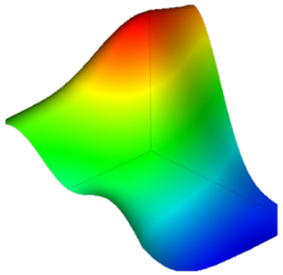
Motor Design Limited

DYMOLA

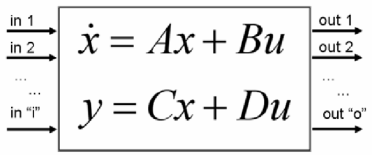
python

Challenges in SD-DT | ROM & FMU

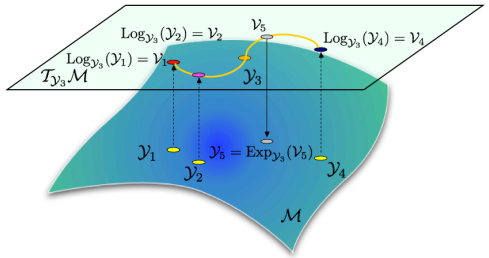
ROM



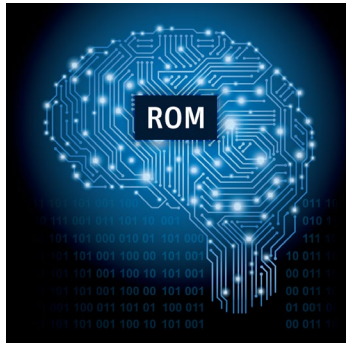
Response Surf.



State-Space



Krylov



$$A = U\,D\,V^{T}$$

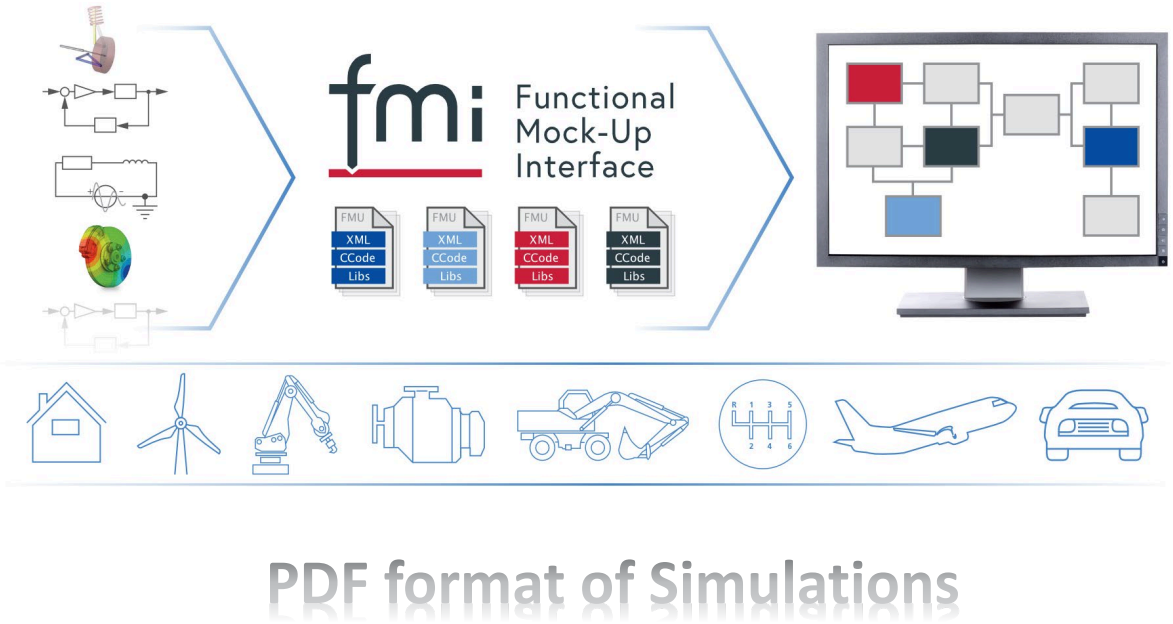
Left singular vectors

Singular values

Right singular vectors

Static/Dynamic ROM

FMI/FMU



PDF format of Simulations