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Simulation based Digital Twins in the Different Phases of the Life-Cycle of a Cruise Ship

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Meyer Group in a nutshell

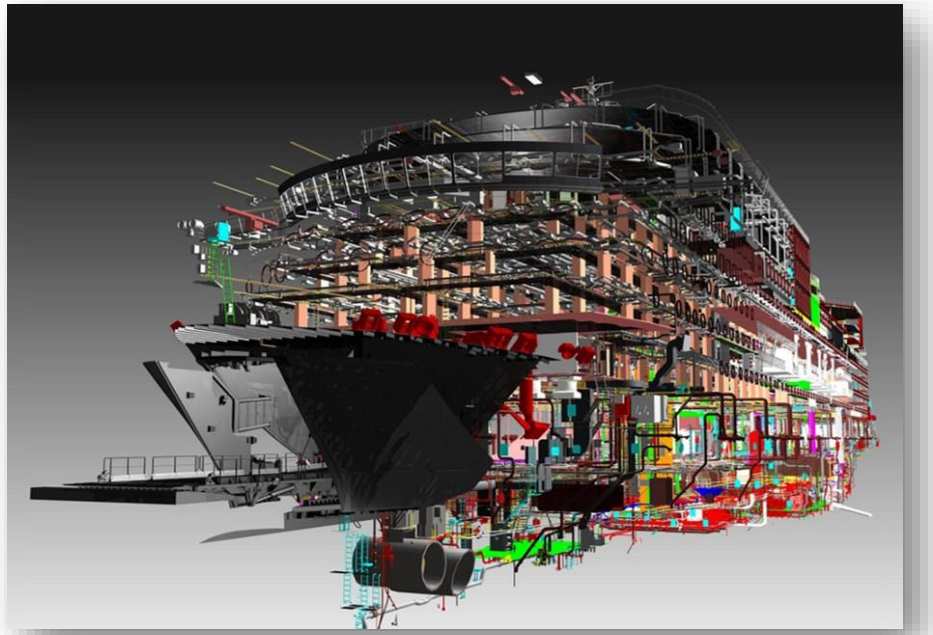
- Meyer is a family owned company – Seventh generation
- Meyer group consists of three shipyards
  - Meyer Werft in Papenburg, Germany
  - Meyer Turku, Finland
  - Neptun Werft in Rostock, Germany
- Altogether approximately 7 000 employees
- Turku shipyard has a long history of shipbuilding, starting from 1737
- Meyer Turku nowadays specializes in the design and construction of large-scale luxury passenger ships, especially cruise ships
- Energy Efficiency is one of the focus fields and unique selling point

Typical life-cycle of a cruise ship

1-3 years	2-3 years	6-12 months	1-2 weeks	Up to 30 years
Concept development	Newbuilding (Design & Construction)	Commissioning	Sea trial	Operation

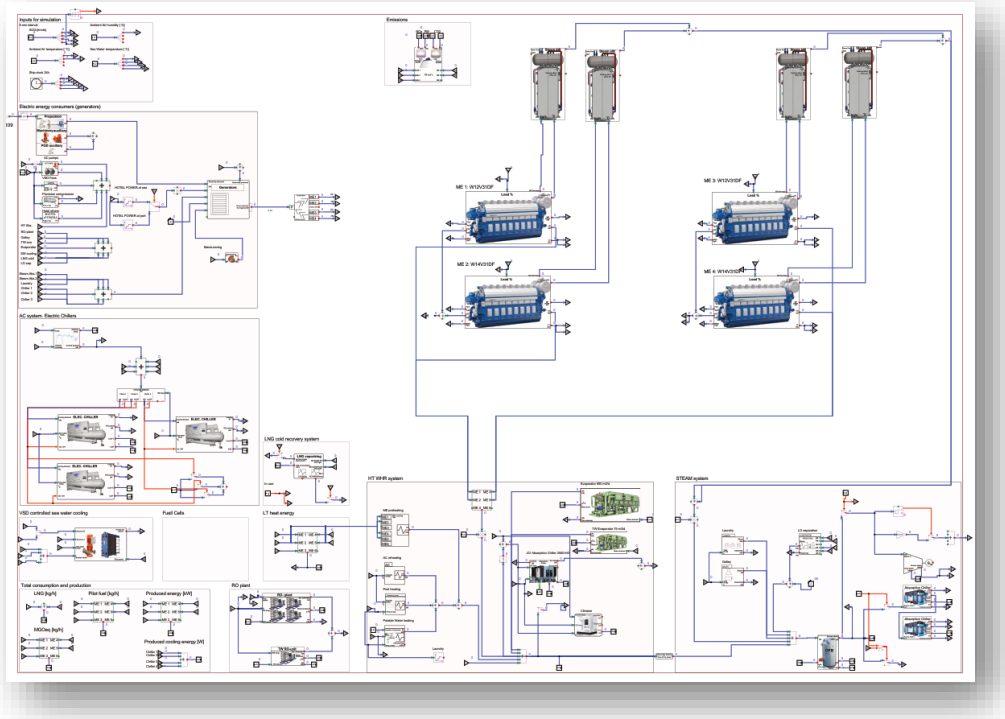
Special features of a cruise ship

- New cruise ship concept always include multiple novel and advanced solutions
- Prototype is the first ship in the class
- Complex combination of ship systems
- Short lead time of ship design, construction, commissioning and testing phases
- Long operational life-time
- Extremely varying operation profile and circumstances



Concept development phase

- Starts by creating a simplified “Digital passenger ship energy model/twin” by utilizing the automation modelling features of Apros
- Interconnects tens or hundreds of ship systems and components into a combined ship level digital twin
- Separate data-driven user components for single equipment or systems are used as far as practical – Based on reference vessel’s actual operation data
- Simulation model is used for
  - Baseline benchmarking
  - Dimensioning & optimization of main components
  - Feasibility studies of optional energy efficiency improvements
  - Energy efficiency development follow-up in the project
- Benefits
  - Reliable and quick study results
  - Enables handling complex combination of ship systems in varying operation circumstances
  - Combined Fuel, electrical energy and heat balance



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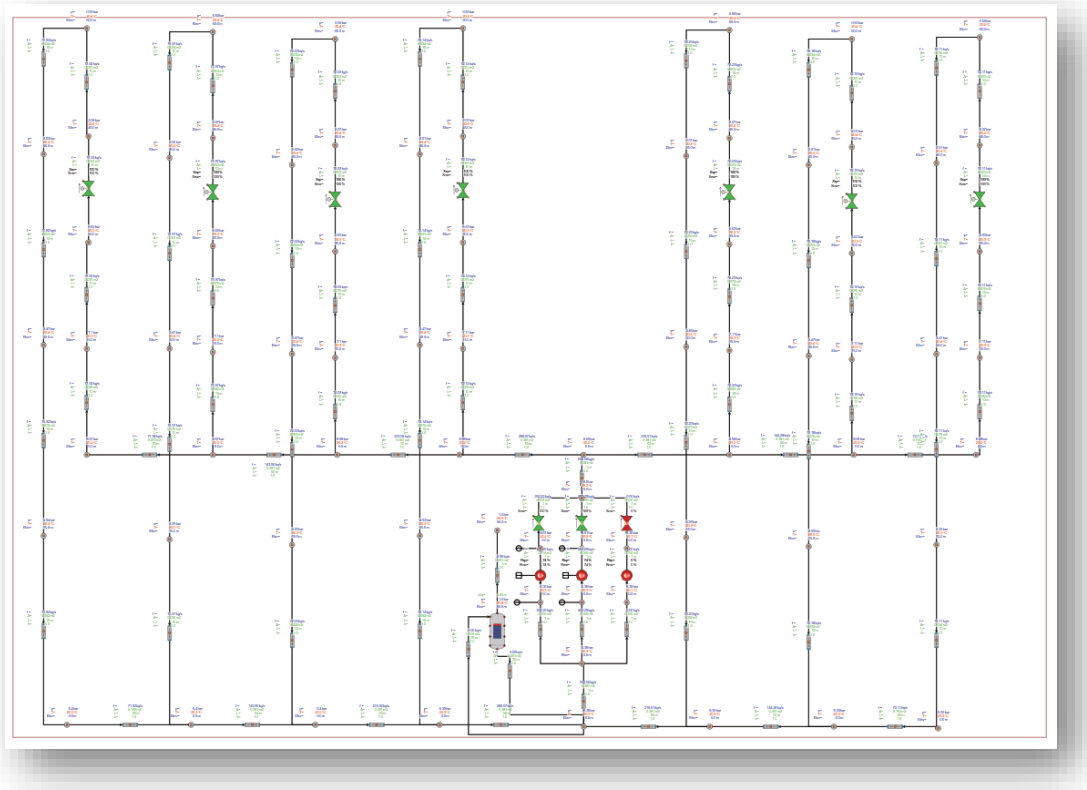
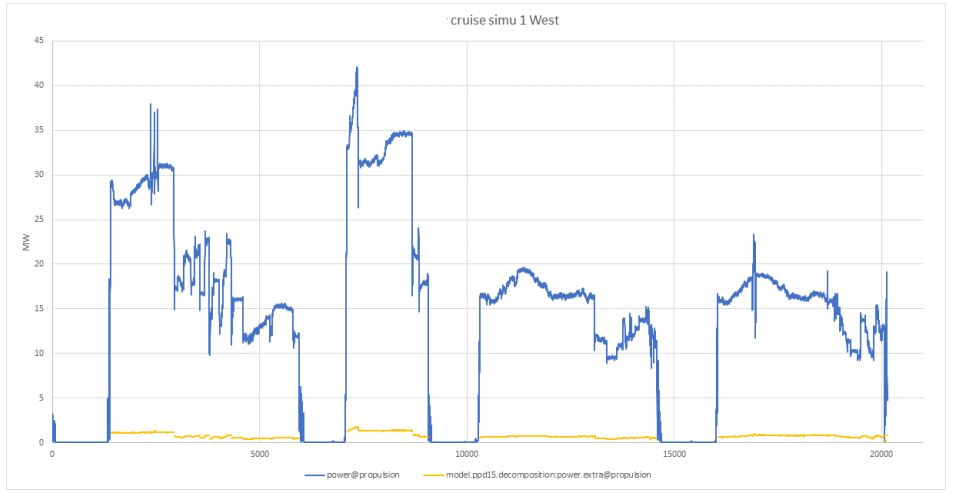
New building & commissioning phase

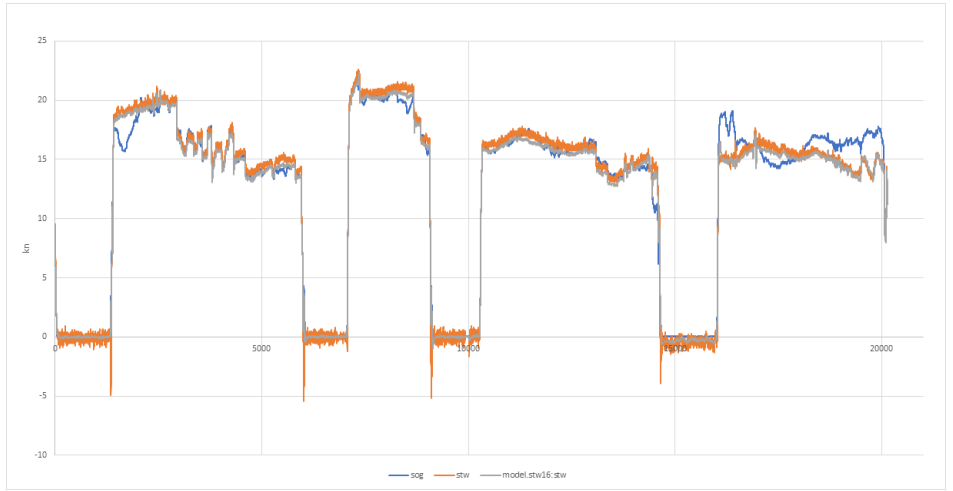
- Process simulations models of the selected ship systems created – Ship system digital twins
- Process simulation models are used for
  - Design validation & component dimensioning
  - System design optimization
  - Control principle validation
  - Commissioning support
  - MIL/SIL/HIL testing
  - Possibly for “the crew training-simulator” use in the future
- Benefits
  - Design mistake observation in earlier phase
  - More efficient system commissioning
  - Increased safety of the operations by means of compressive system testing of the safety critical systems already during design phase



Pre-delivery phase

- Target is to provide actual operative instructions for the ship operator prior the ship delivery to enable efficient operations from the day one
- Based on the virtual energy model created during the concept development phase
- Deep simulation-based virtual demonstration and analysis process
- Benefits
  - Fuel consumption & emission reduction in the very beginning of the ship's operational lifetime
  - Shorter learning and optimization period after the start of operation





Post-delivery phase

- Current development project on-going aiming for a data-driven and simulation-based predictive energy management & advisory system
- Target is to create advanced operations supporting solution which provides concrete operational guidance for the ship operator in advance
- Benefits
  - Life-cycle support for the continuous vessel's operational energy efficiency development
  - Fuel consumption and emission reduction throughout the ships' life-cycle
  - Comply with the ever tightening environmental targets of shipping

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THANK YOU

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