



HELMUT SCHMIDT  
UNIVERSITÄT  
Universität der Bundeswehr Hamburg

**LaFT**

LABORATORIUM FERTIGUNGSTECHNIK

NATO OR&A Conference

**Integrating additive manufacturing to support  
temporarily self-sufficient systems**





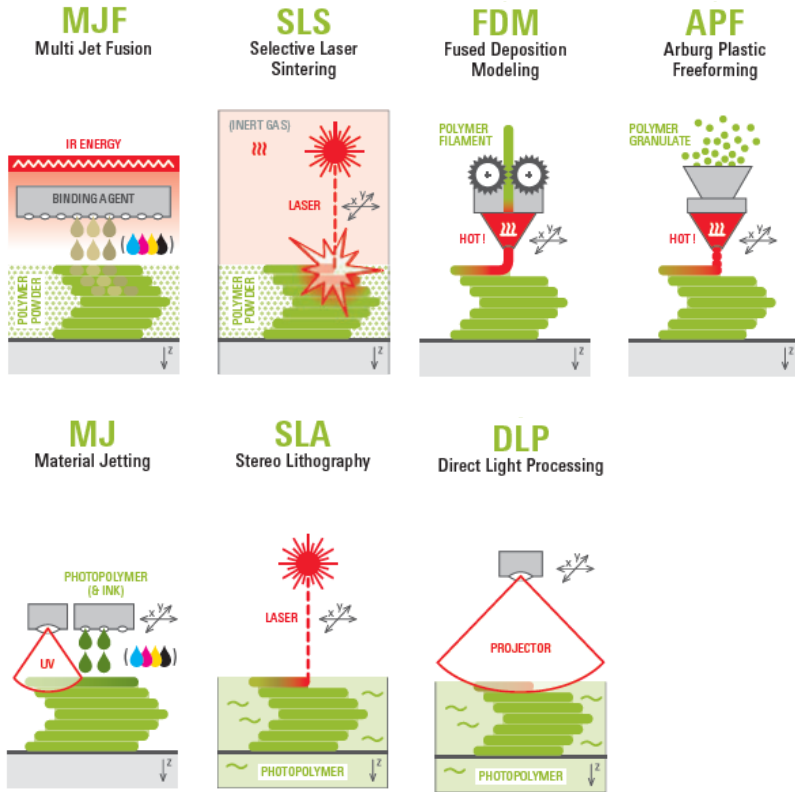
## KptLt Sascha Hartig, M.Sc.

### Research topics:

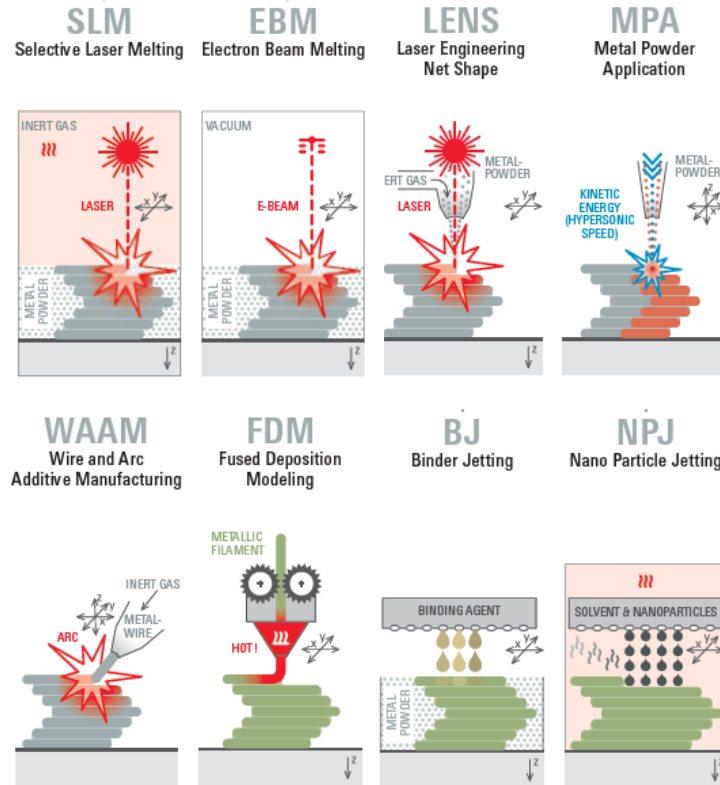
- ▶ Integration of additive manufacturing in the German Armed Forces to curb the spare parts problem.
- ▶ Integration of additive manufacturing and implementation of a recycling process for ships and boats of the German Navy
- ▶ Additive manufacturing as an innovation driver in the military environment

# Hurdles of the implementation

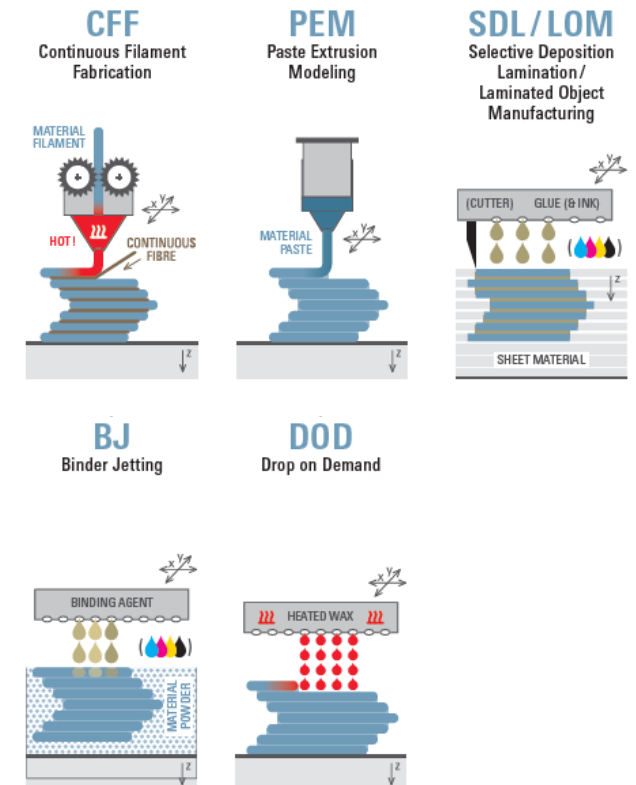
## Plastics



## Metal

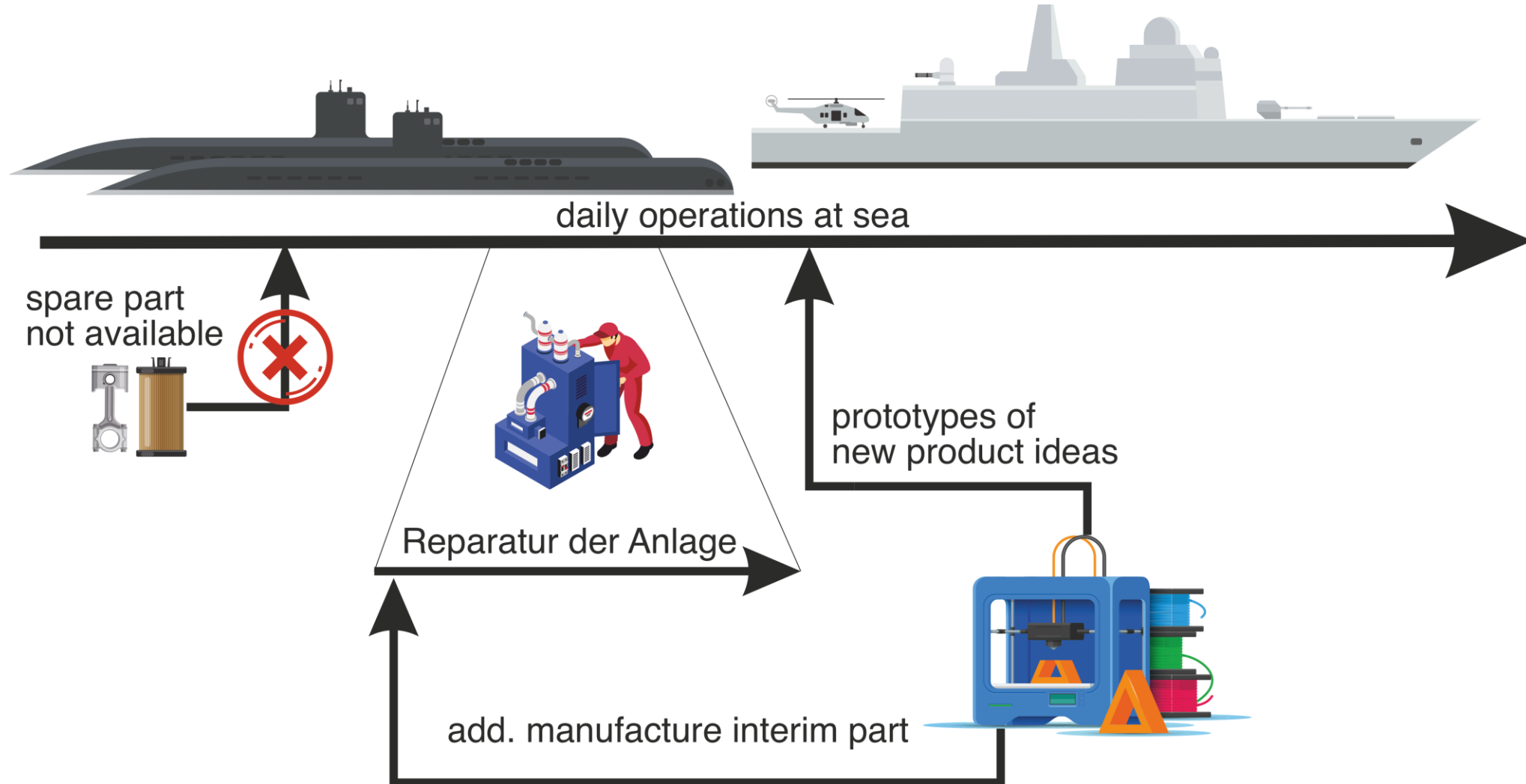


## Other

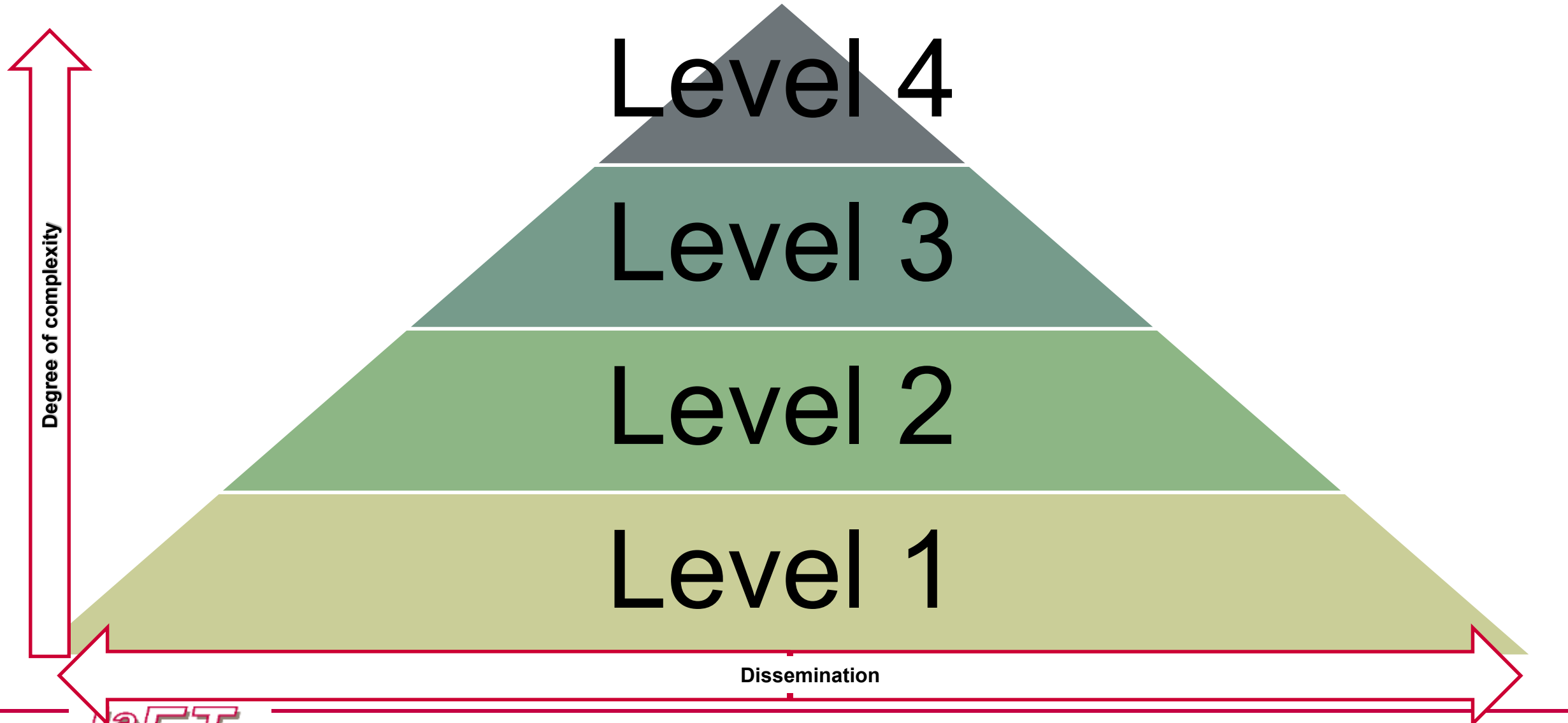


Ritter, Steffen (2020). formnext  
AM Field Guide compact 2020

# Hurdles of the implementation



# Additive manufacturing in the level system according to Hartig



- ▶ User-friendly
- ▶ Little space required for the equipment (less than 1m x 1m x 1.8m)
- ▶ Operator only needs a 2-week training course
- ▶ Low effort before process preparation and follow-up
- ▶ Due to the low complexity, widely used in the professional sector as well as in the private sector.
- ▶ Use on board possible



# Level 1





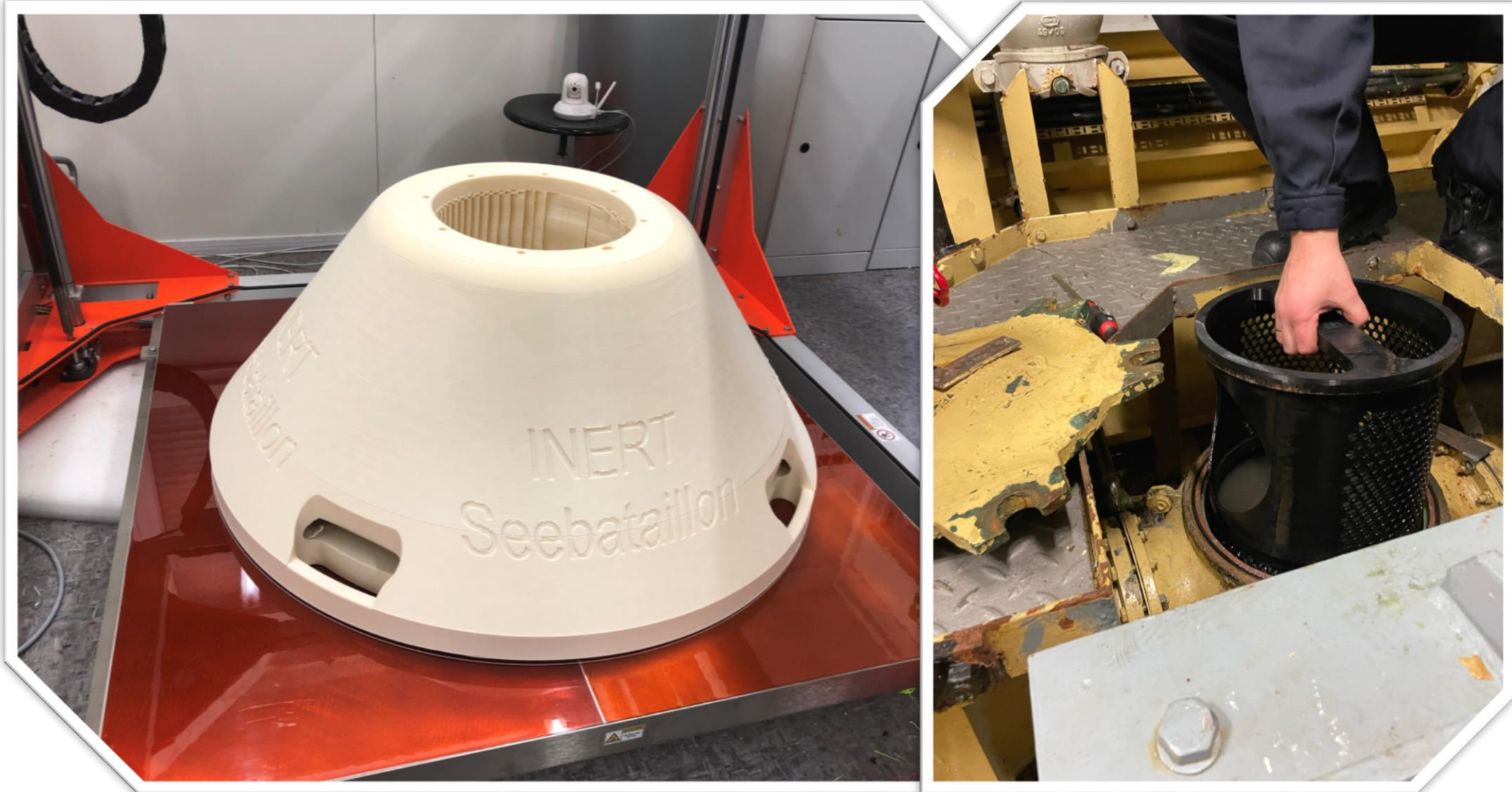
- ▶ Complex industrial plants in the field of thermoplastics
- ▶ High-strength polymers, and polymers with special production conditions, e.g. heated build chamber
- ▶ Peripherals required for main unit e.g. washing station
- ▶ Increased training requirements for operating personnel
- ▶ Increased requirements for the installation site and ambient conditions



# Level 2

- ▶ Use possible on board selected units where applicable





- ▶ Processes that pose an increased safety risk for the operating personnel due to the raw material, e.g. powder processes.
- ▶ High demand on peripheral equipment for pre- and post-process preparation e.g. CNC milling machine, oven, debinding station



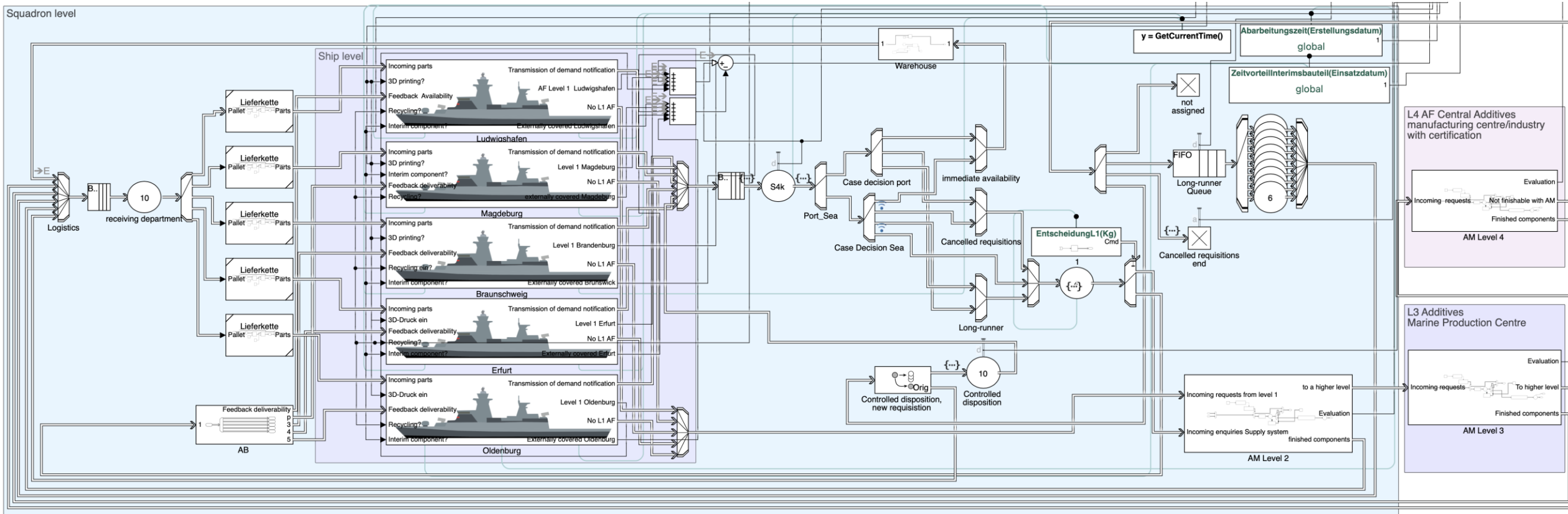
# Level 3

- ▶ Considerable effort in training the operating personnel, system-specific training.
- ▶ Considerable effort in terms of space requirements and installation conditions, e.g. foundation, inert gas storage tank.

# Level 4

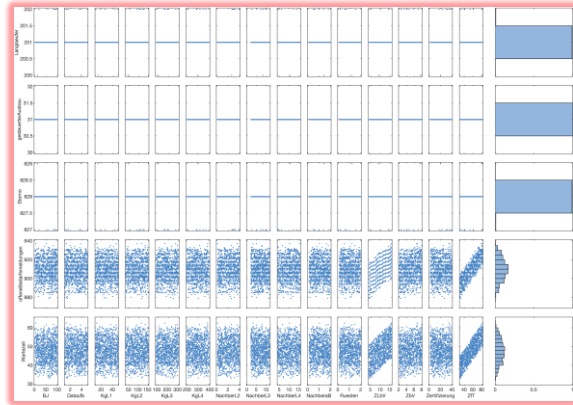
- ▶ Integrated or final certification process so that production of certified components is possible.
- ▶ Small batch production
- ▶ Increased requirements compared to Level 3 in terms of investment costs, installation site and installation conditions.
- ▶ Operators have industry-equivalent training, some of which is system-specific.

# Discrete Event Simulation of the German Navy Corvette Squadron

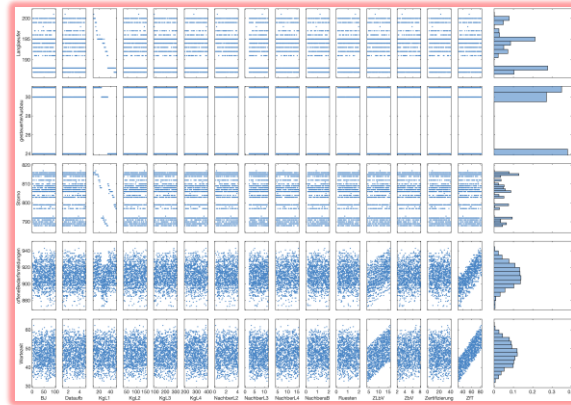




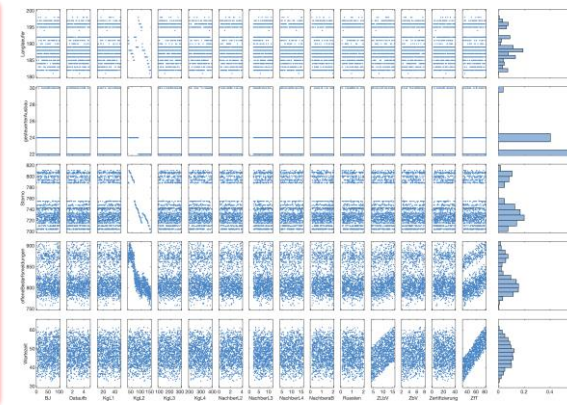
# Discrete Event Simulation of the German Navy Corvette Squadron



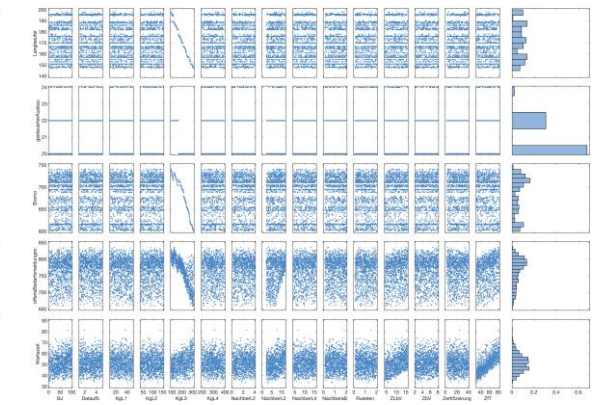
L0



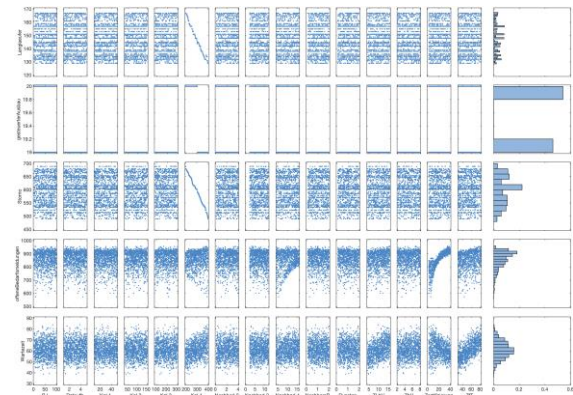
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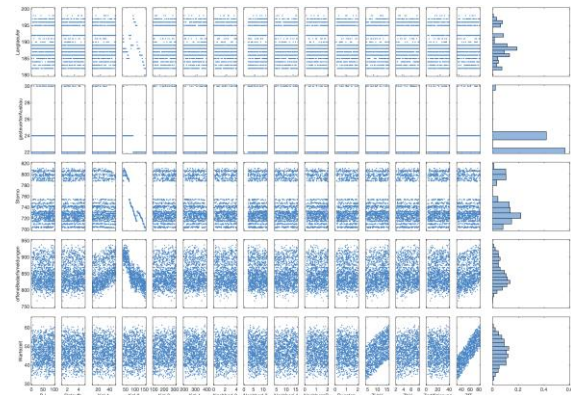
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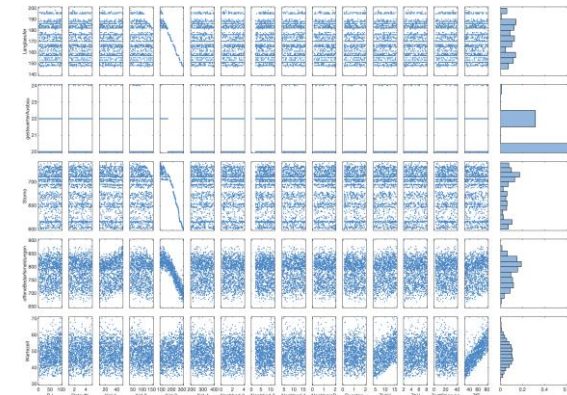
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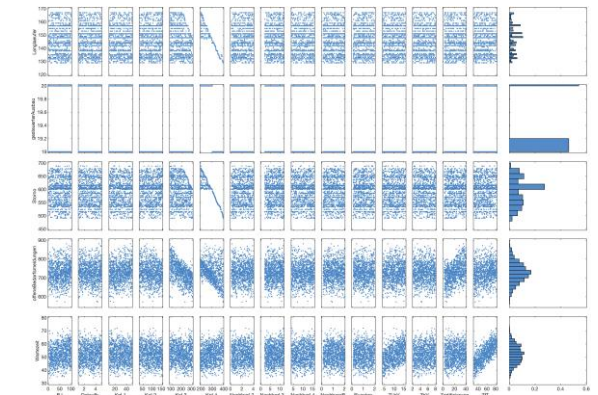
L4



L1L2

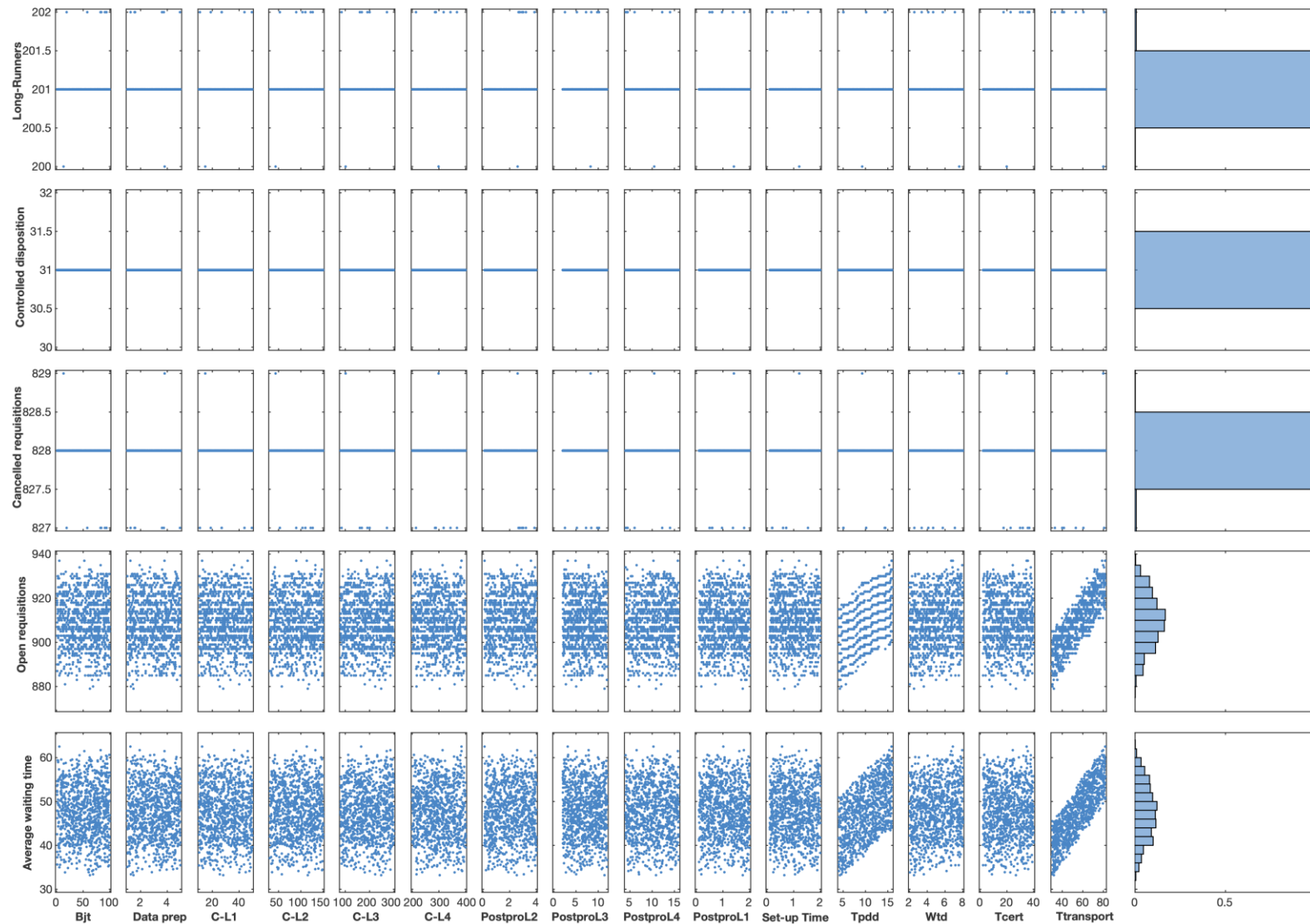


L1L2L3



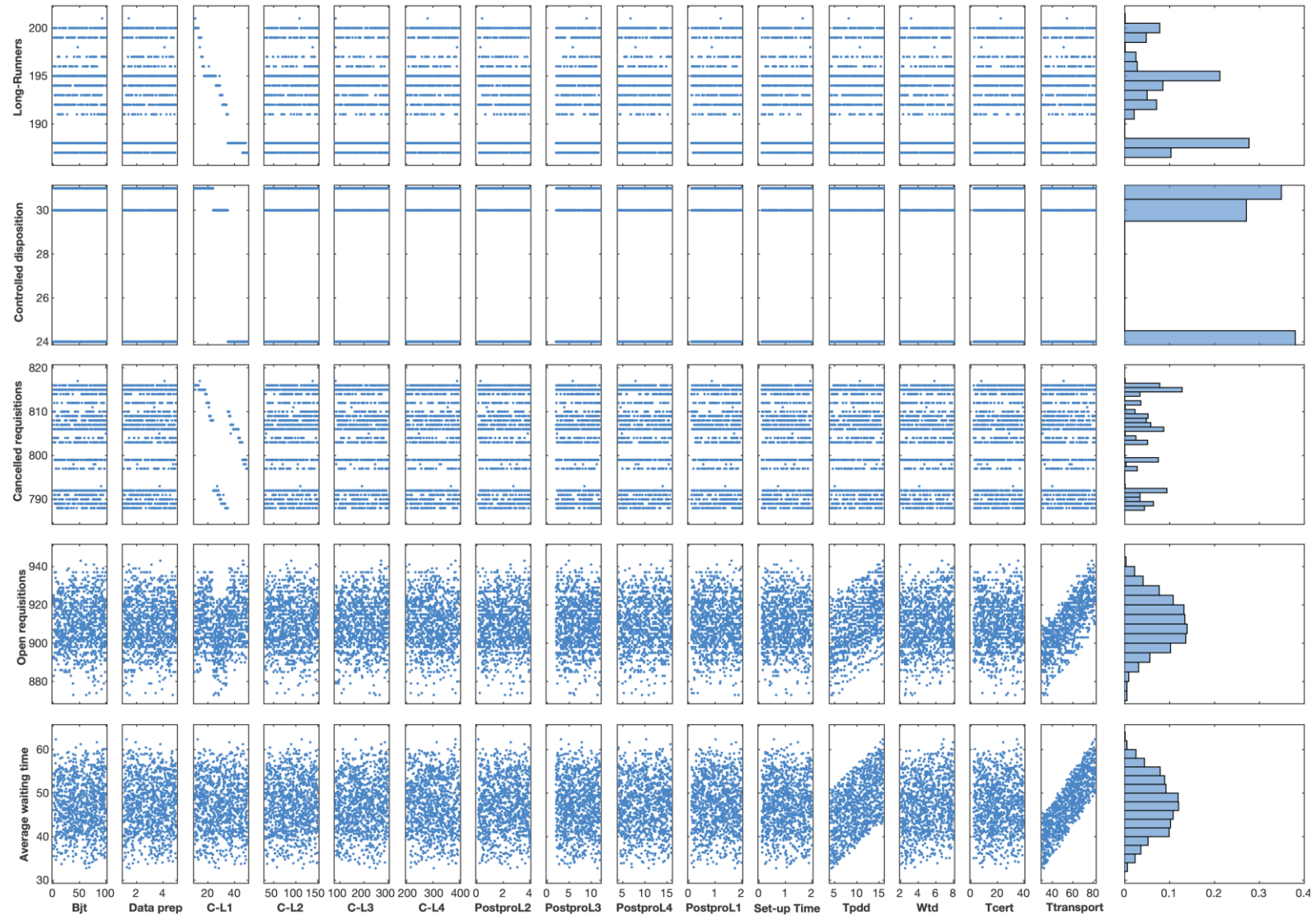
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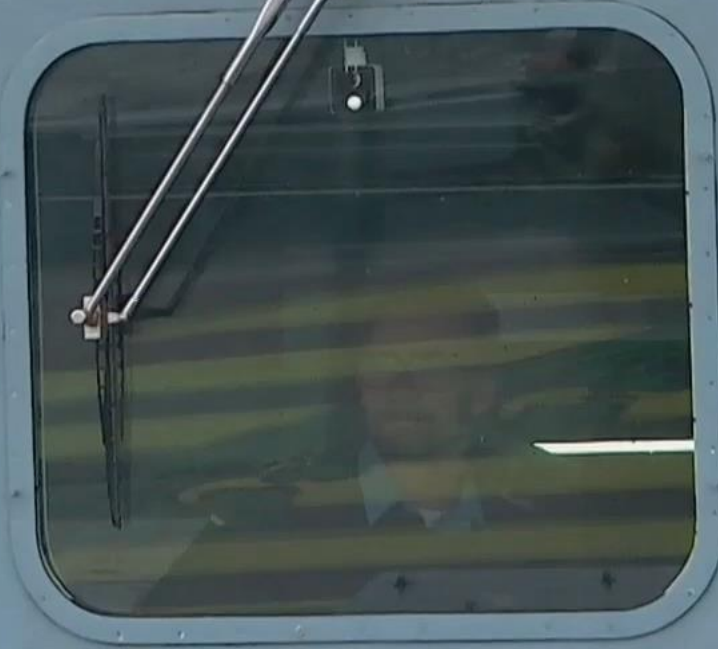
# Discrete Event Simulation of the German Navy Corvette Squadron





# Discrete Event Simulation of the German Navy Corvette Squadron







- ▶ Implementation of additive manufacturing based on the presented scheme.
- ▶ Starting with Level 1 equipment.
- ▶ Step-by-step integration with evaluation between the integration steps.
- ▶ Level 2 will be deployed where the greatest benefits are anticipated and resources are available.





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**Many thanks for the  
attention!**



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