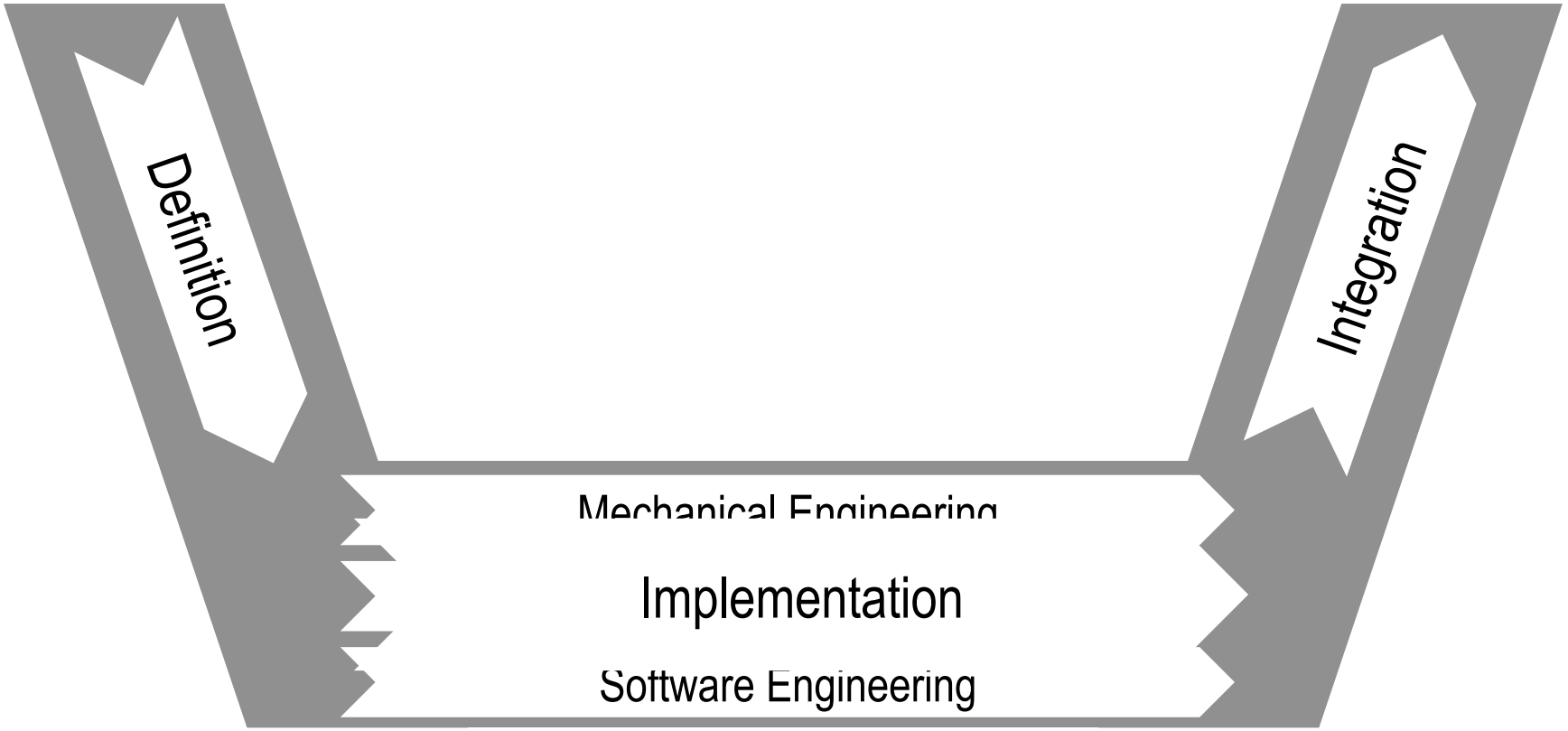
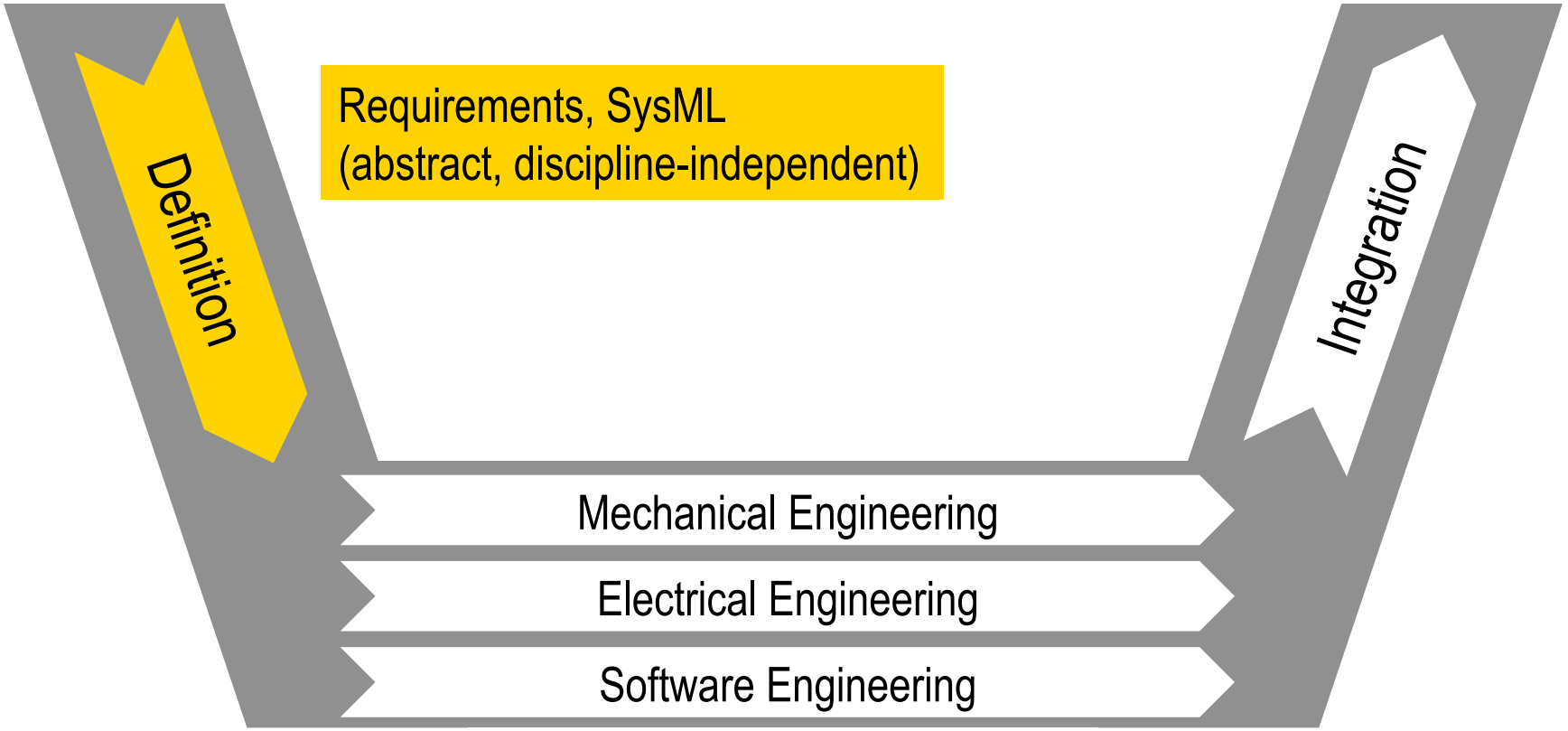
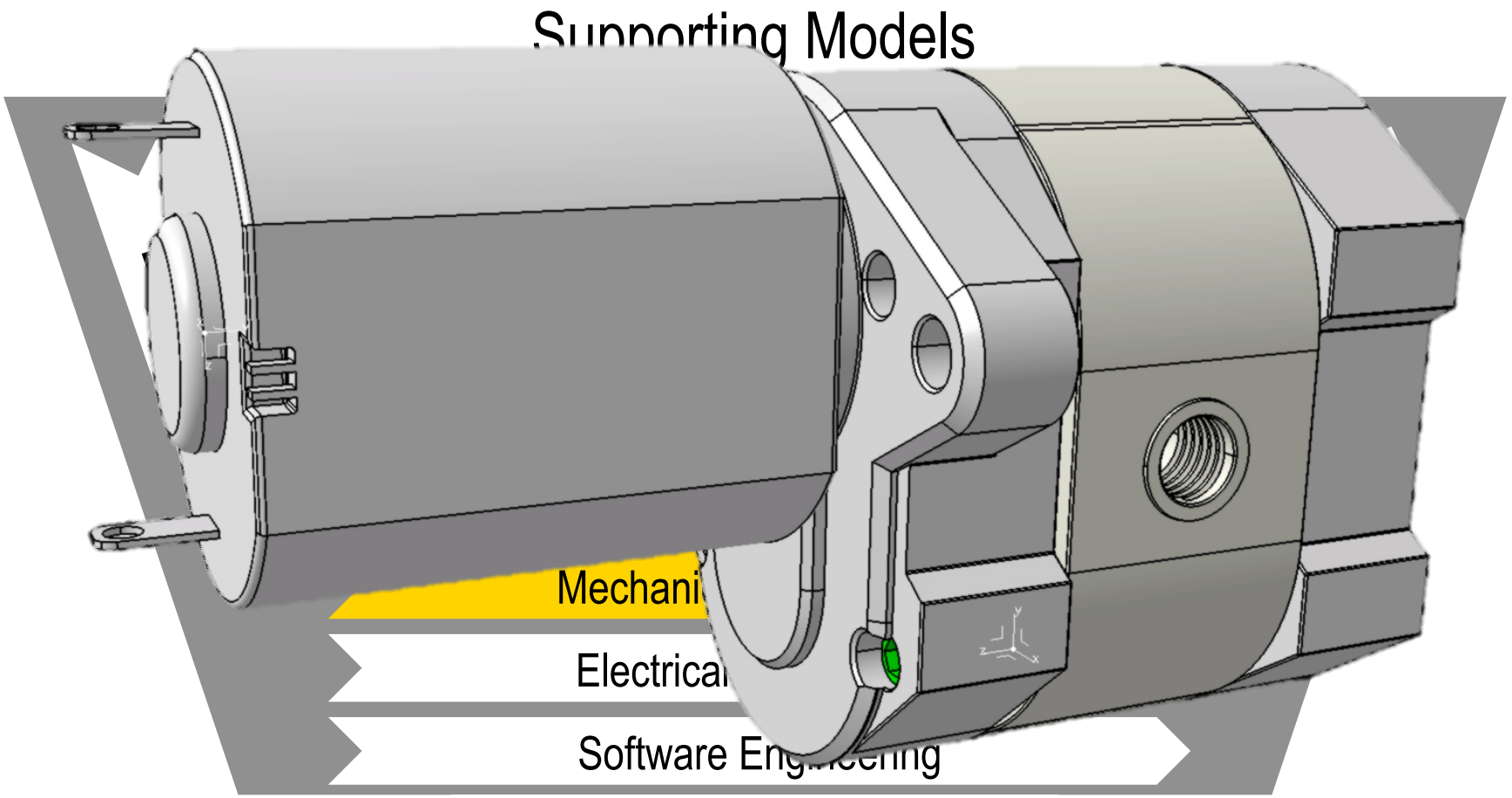
SkiPo:
A sketch and flow based model to develop mechanical systems

The Vee Model

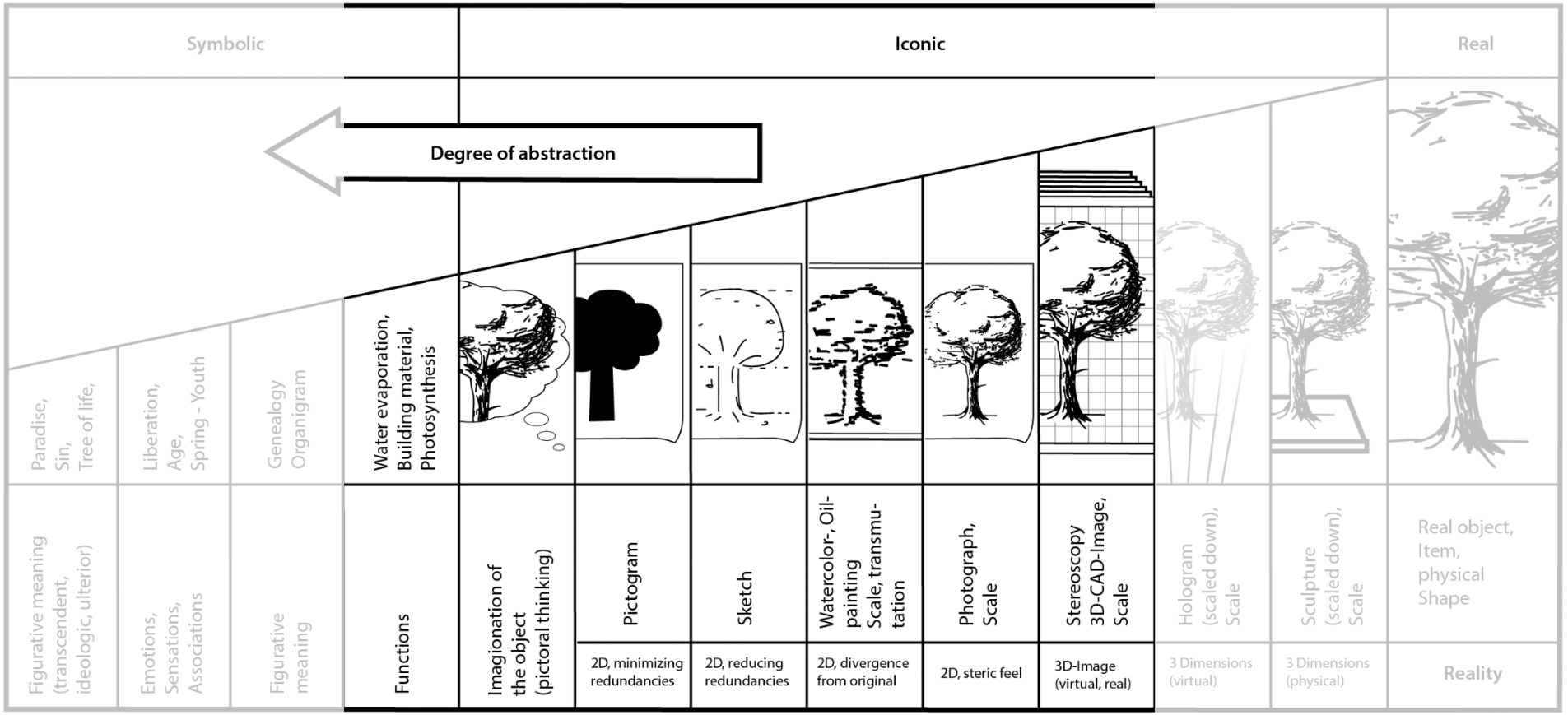


Supporting Models

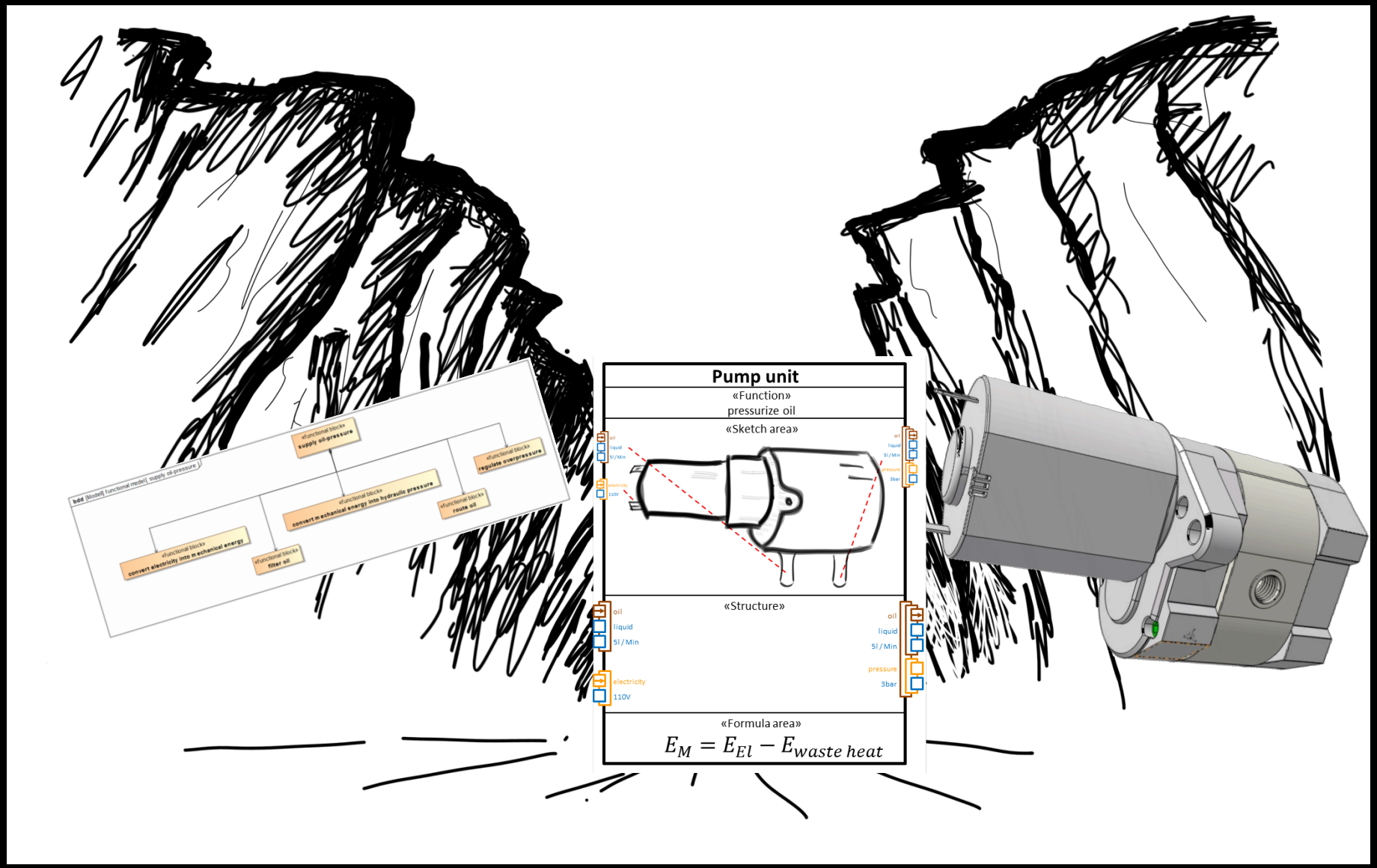



Supporting Models
Mechani
Electrica
Software Eng

Layers of Abstraction according to VDI 2803

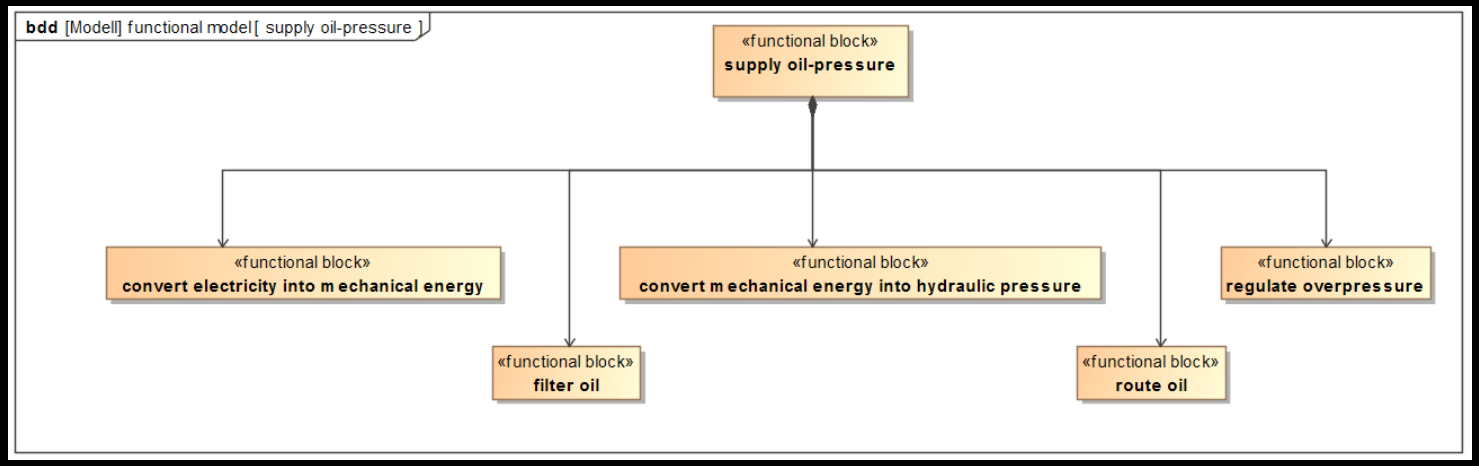


Gap in the Mechanical Engineering Chain of Models

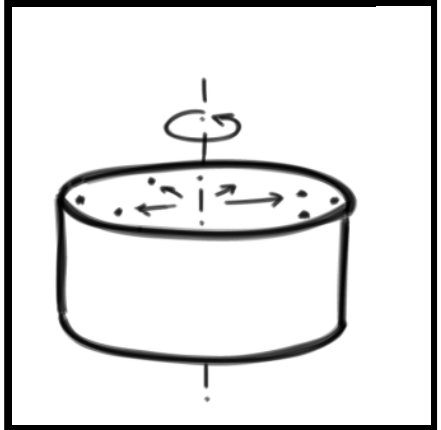
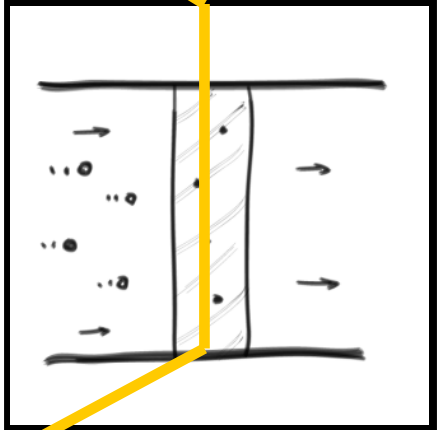
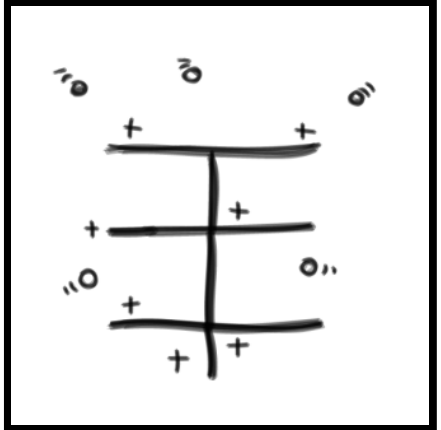


Abstract Models in the early Stage of System Definition

1	1	pumping capacity	The oil-pump has to pump 5l per minute
2	2	oil-pressure	The oil-pressure has to be 3bar
3	3	safety	In no modes a fire has to be possible
4	4	maintanance	every 20000 hours of operation
5	5	endurance	100000 hours of operation
6	6	weight	max. 1kg
7	7	oil	jet propulsion oil
8	8	connection power	200W electrical power



Morphological Box

Function	Solution Principle 1	Solution Principle 2	Solution Principle 3
Generate oil pressure			
Separate oil from foreign matter			

Morphological Box

Function	Solution Principle 1	Solution Principle 2	Solution Principle 3
Actuate flap	Electrical actuation	Pneumatic actuation	Hydraulic actuation

Auxiliary Functions

Function	Solution Principle 1	Solution Principle 2	Solution Principle 3
Actuate flap	Electrical actuation	Pneumatic actuation	Hydraulic actuation *

Store oil

Generate oil pressure

Regulate oil pressure

Limit oil pressure

Dampen pressure peaks

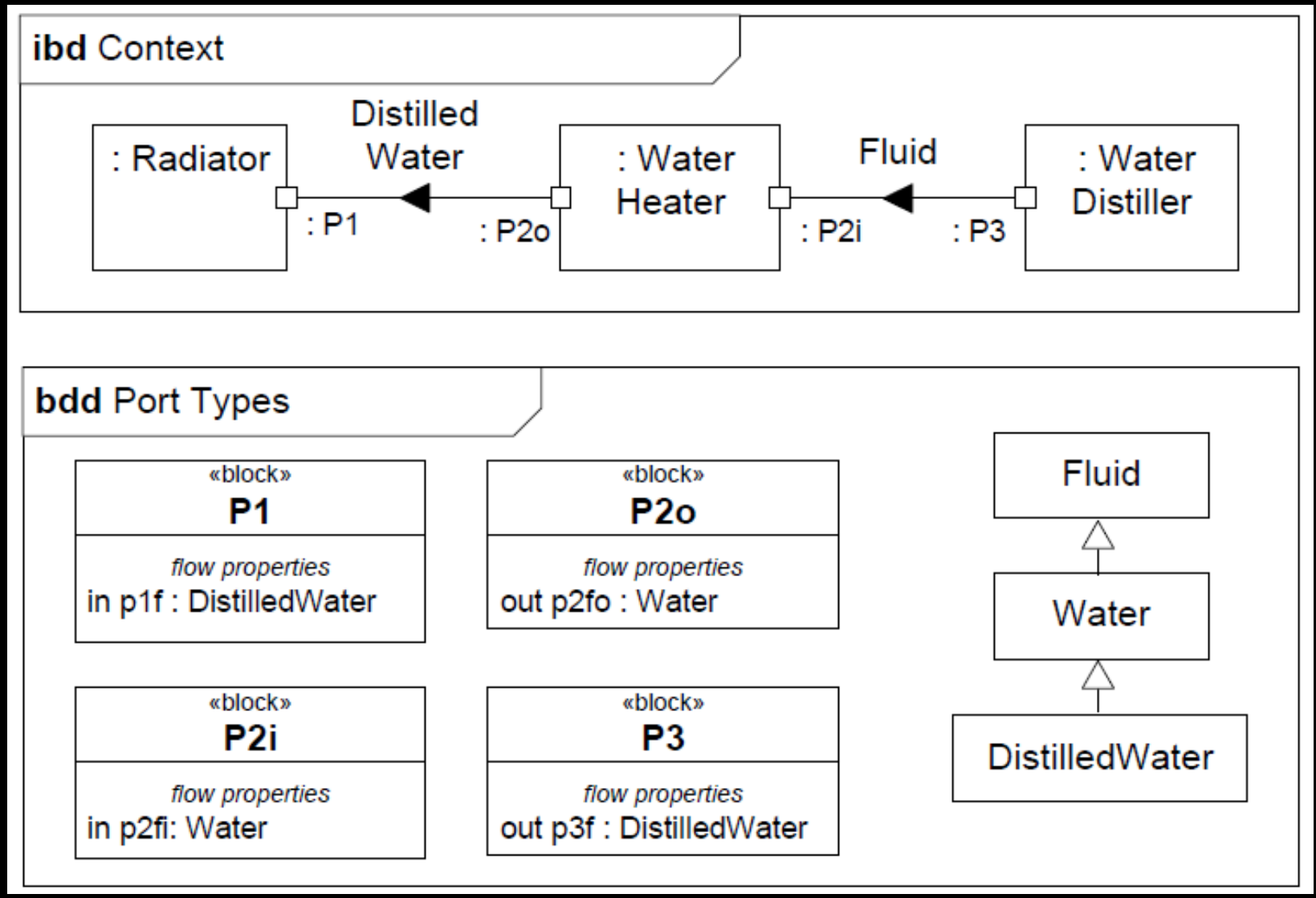
Indicate oil pressure

Consistency of Overall Solution

Function	Solution Principle 1	Solution Principle 2	Solution Principle 3
Actuate flap	Electrical actuation	Pneumatic actuation	Hydraulic actuation

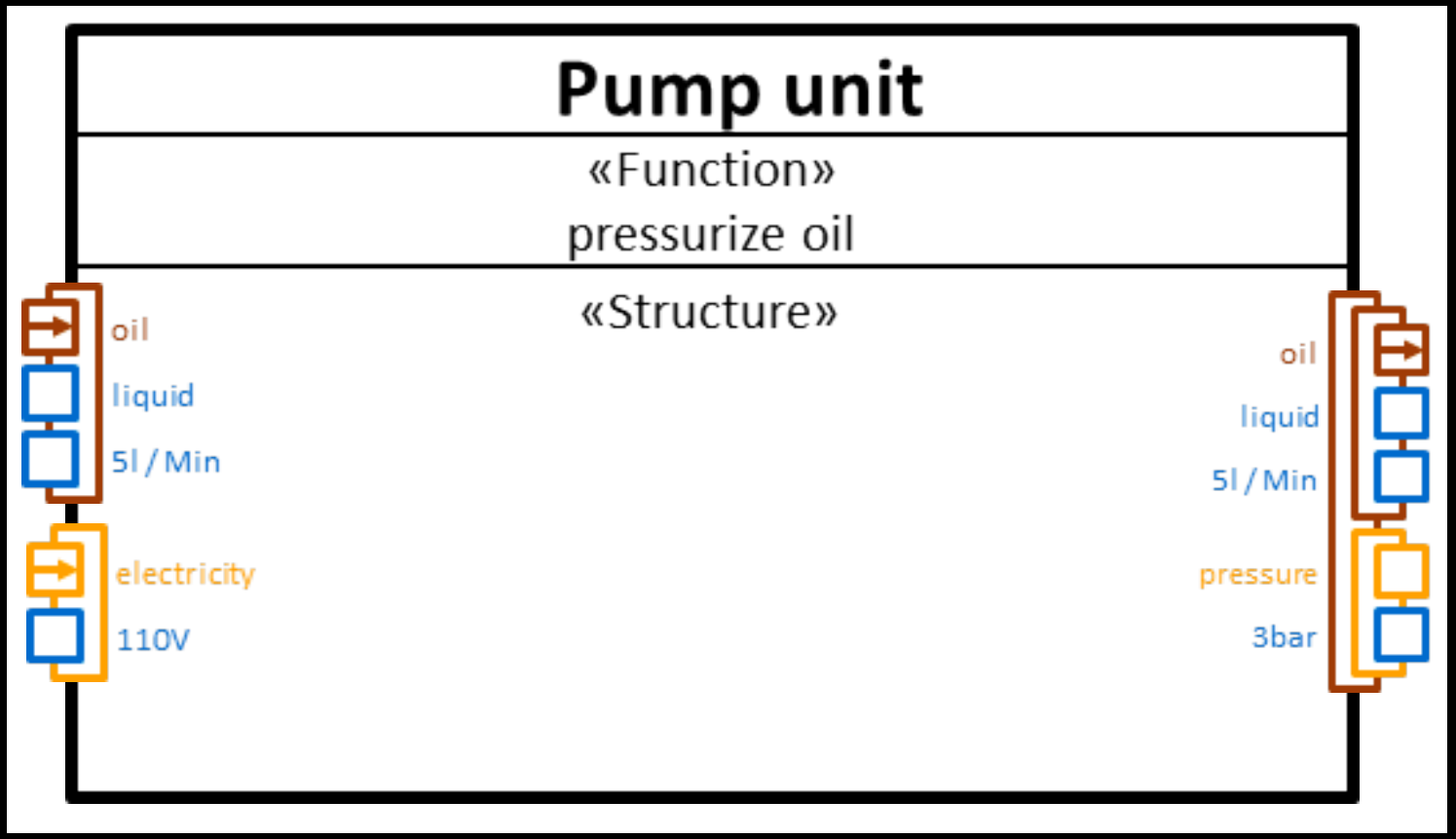
- (many) Auxiliary functions
- It is difficult to assess the consistency/completeness
- No formal assessment method available
- Properties of item flows are not considered

Modeling Ports and Flows in the Systems Modeling Language (SysML)

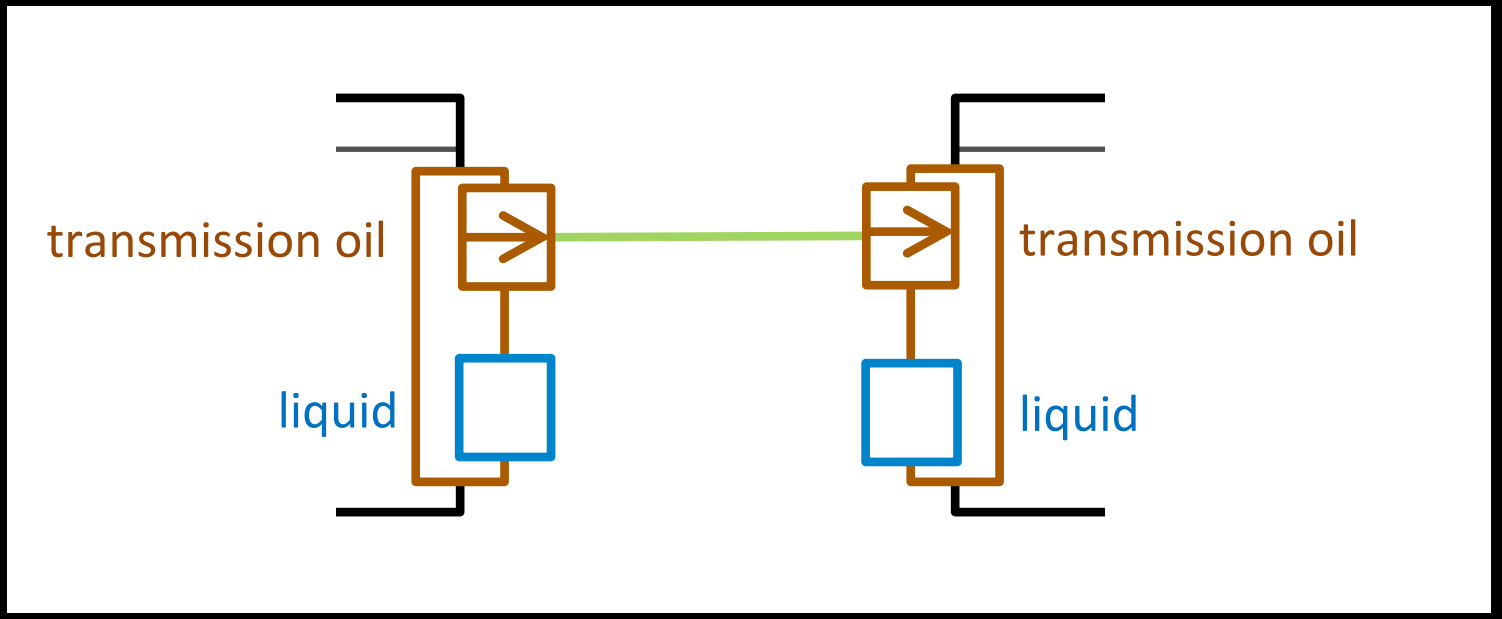


[Usage example of item flows in internal block diagrams from the SysML specification]

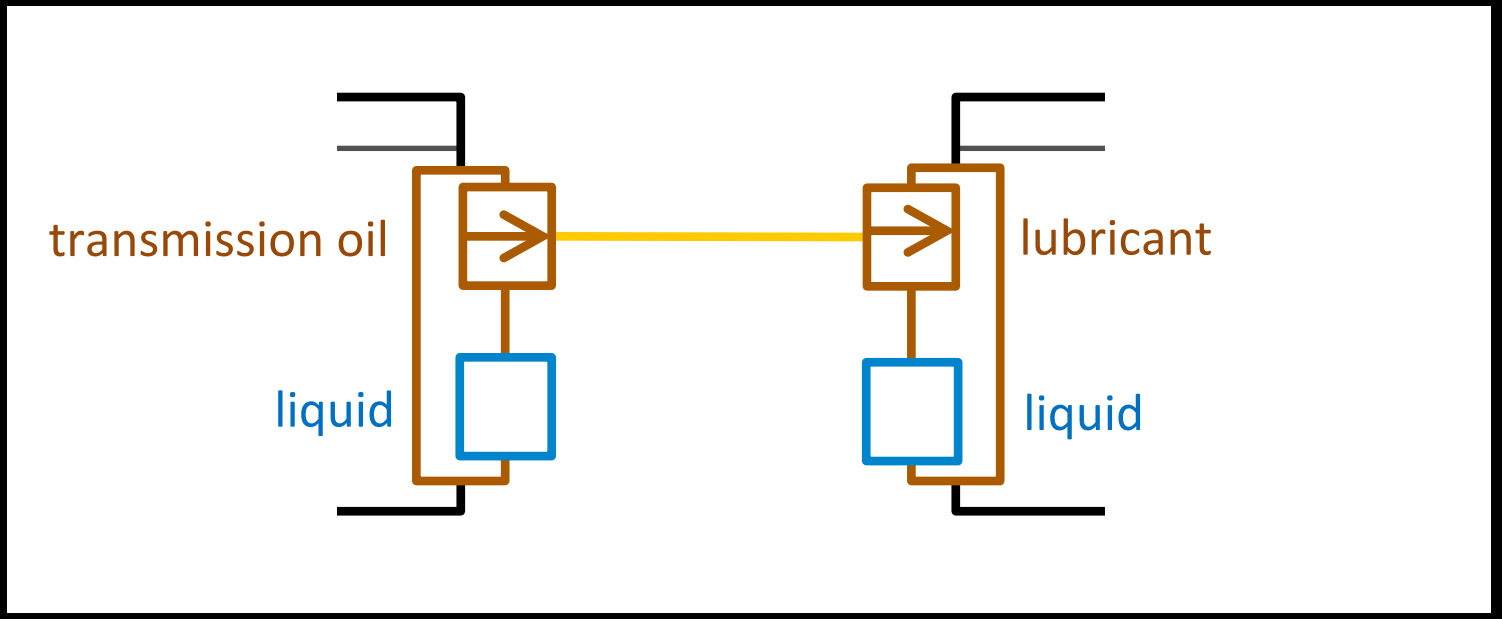
Modelling Ports



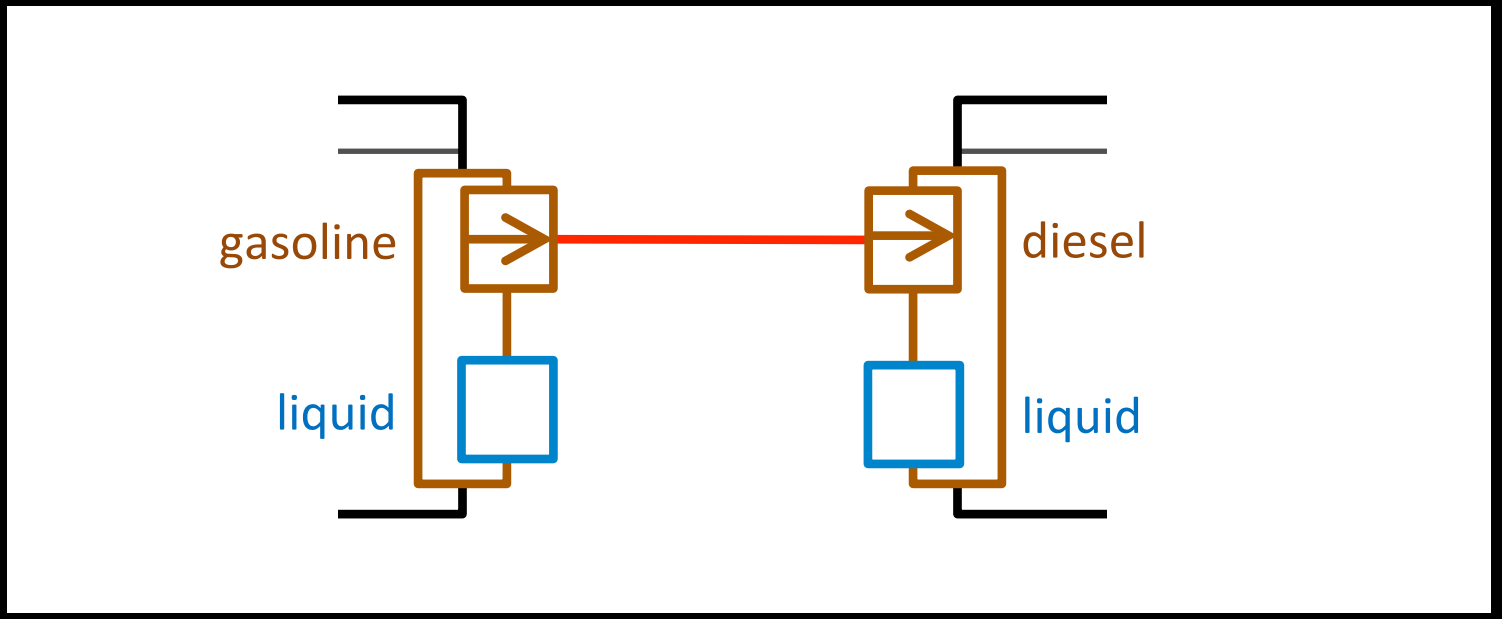
Valid connection



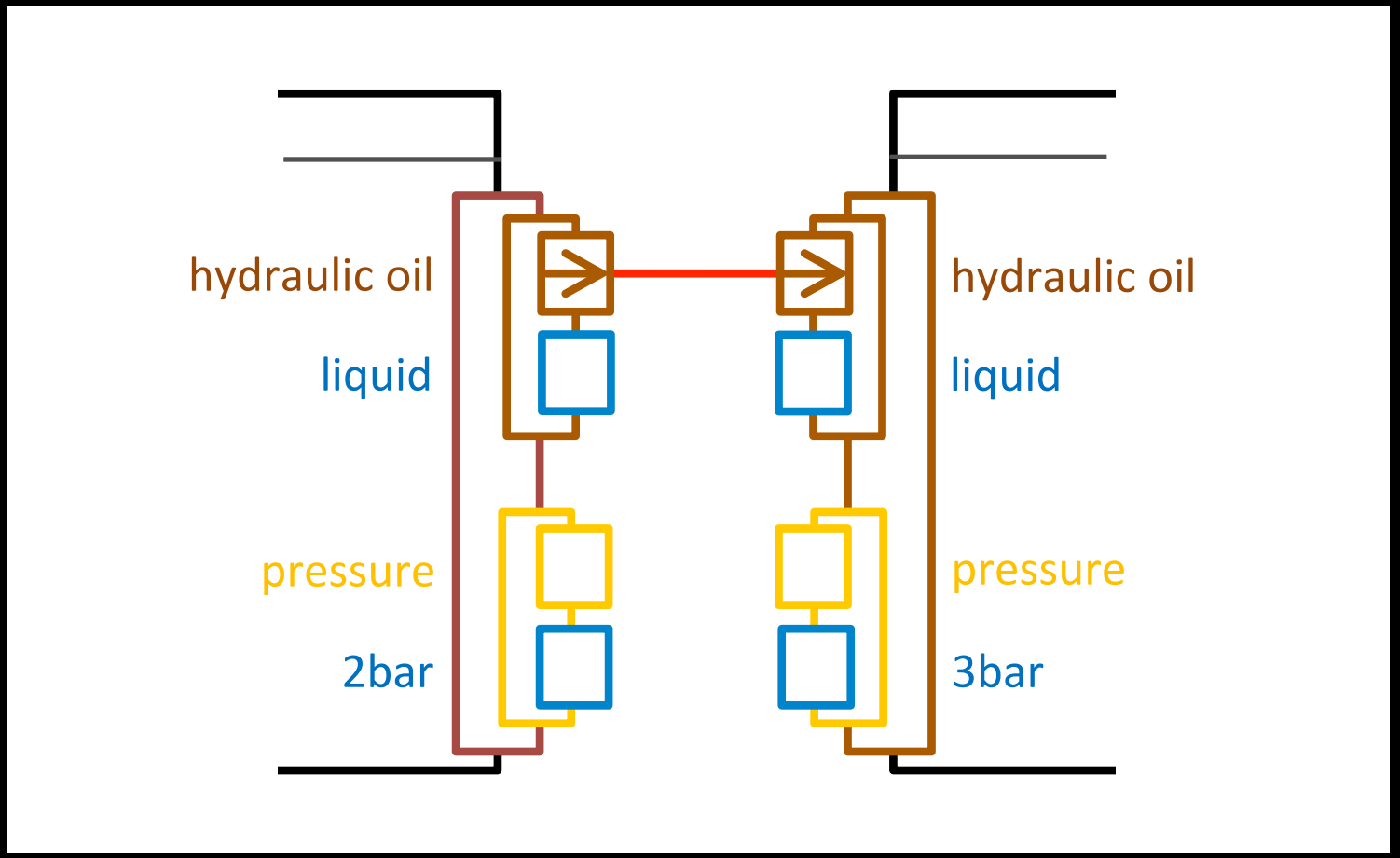
Possible connection



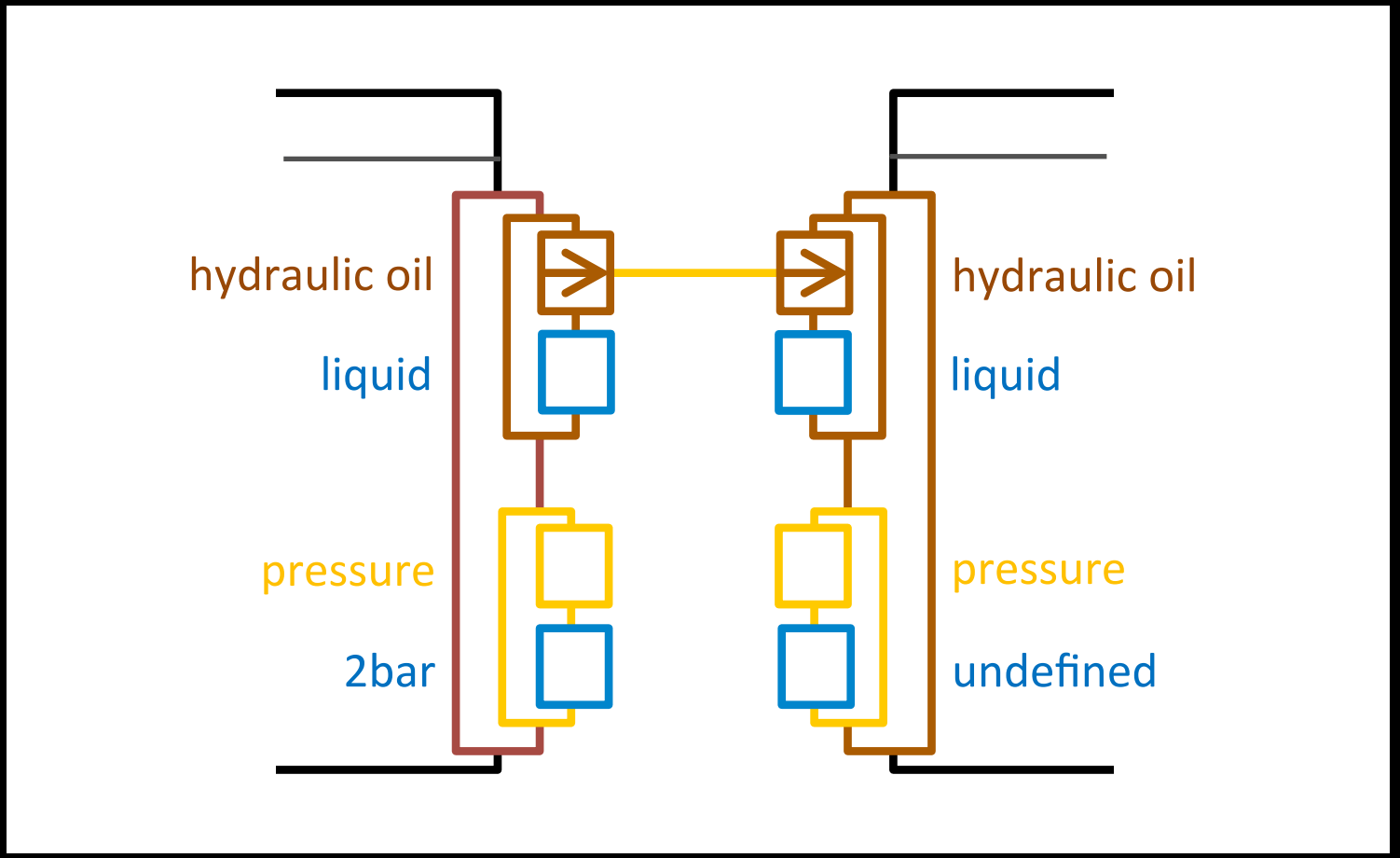
Impossible connection



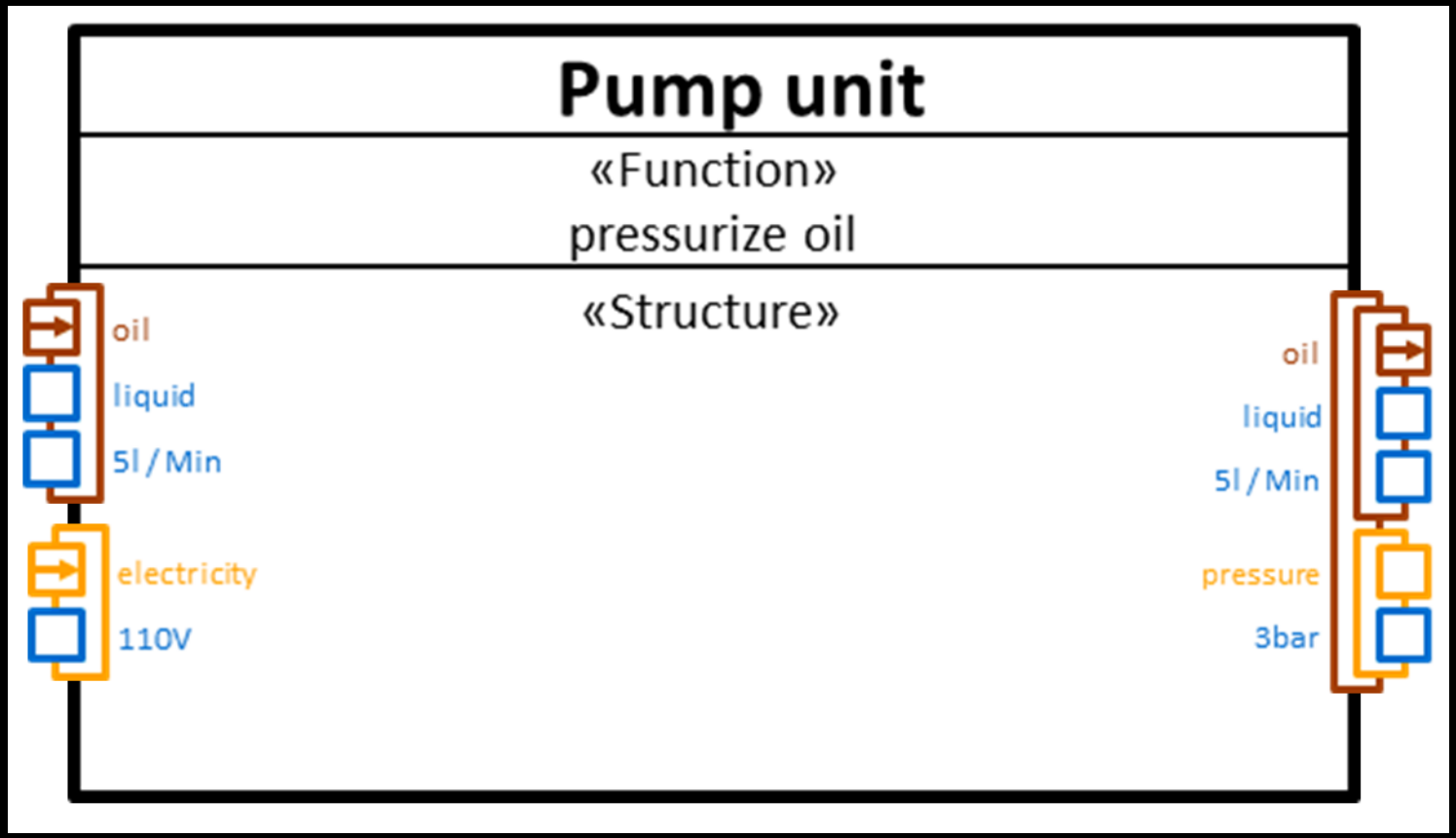
Impossible connection



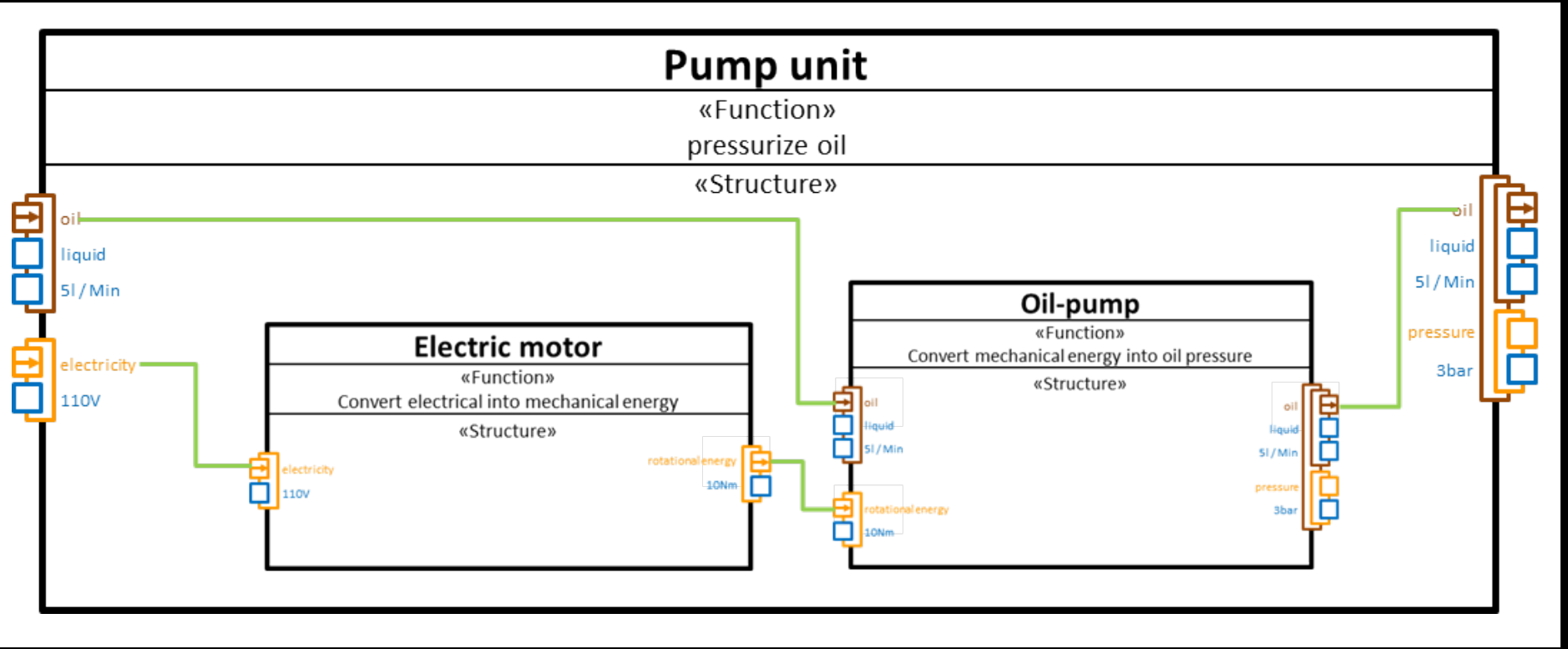
Possible connection



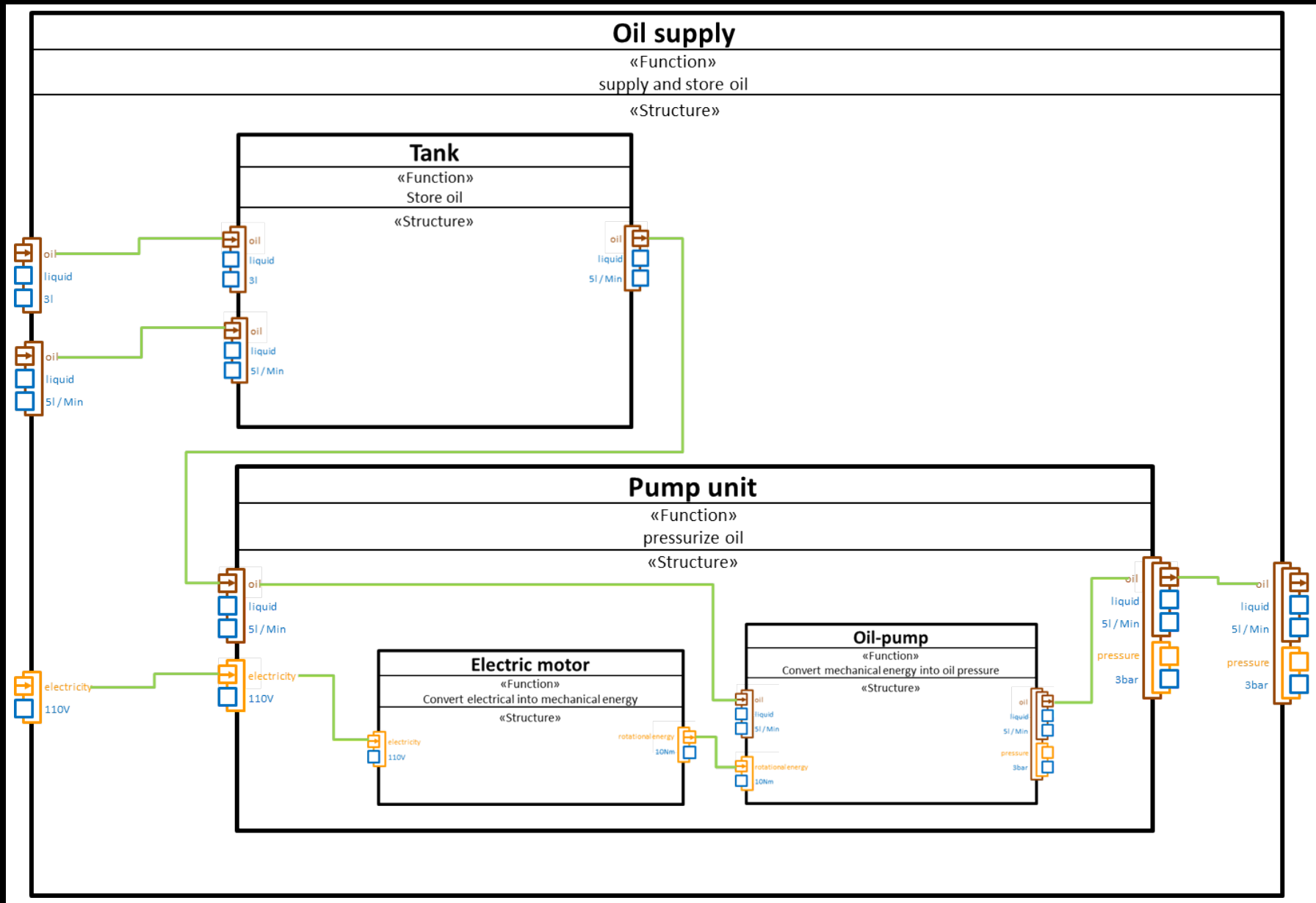
Scalability



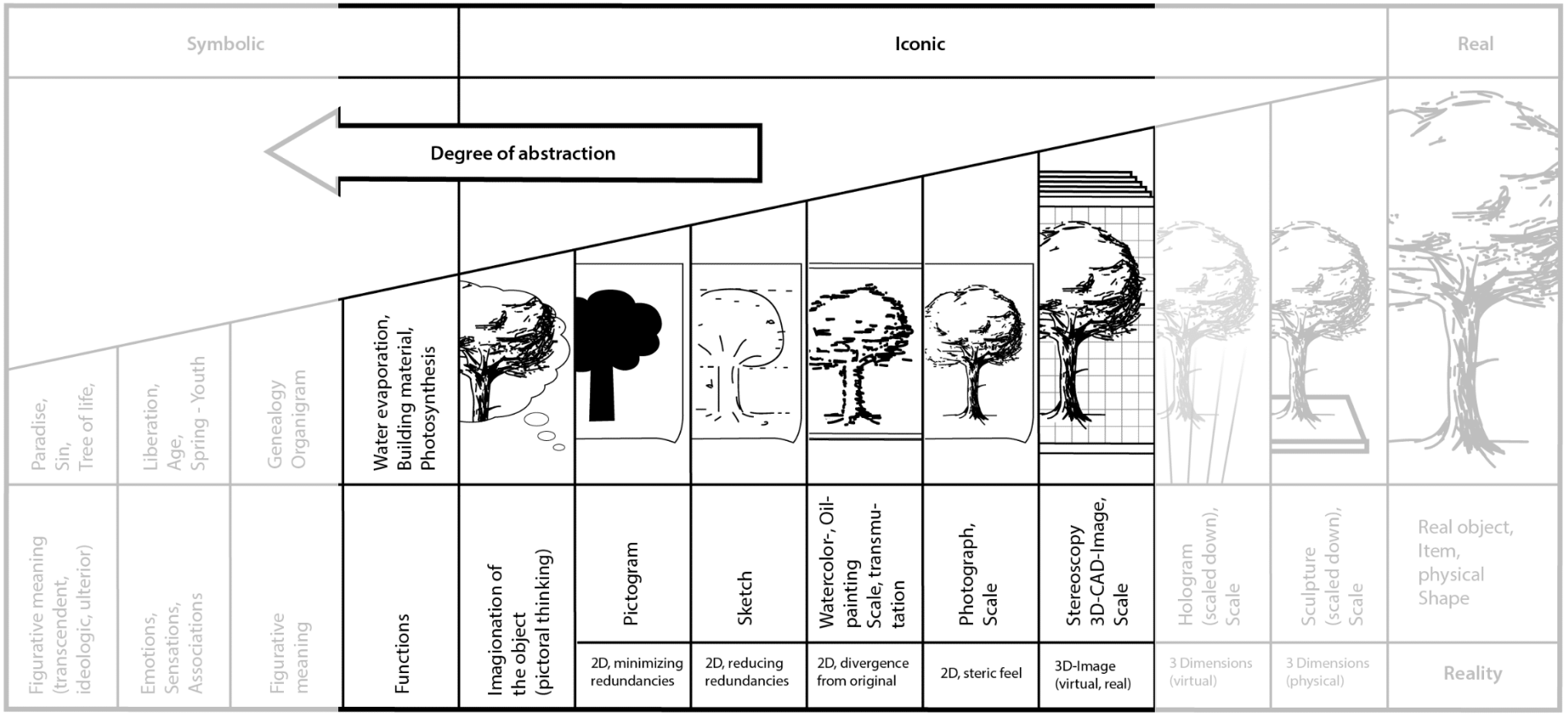
Scalability



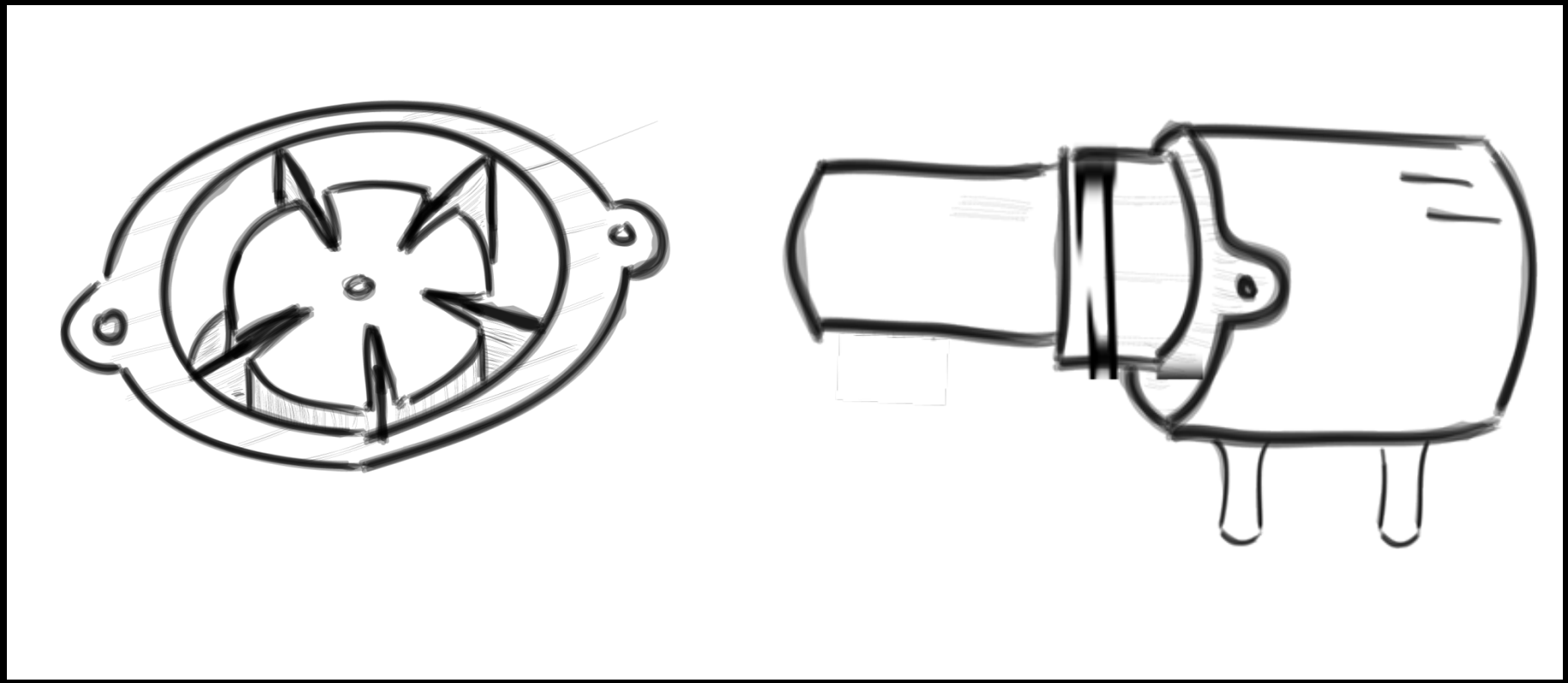
Scalability



Sketches: half way between abstract functional model and detailed CAD model

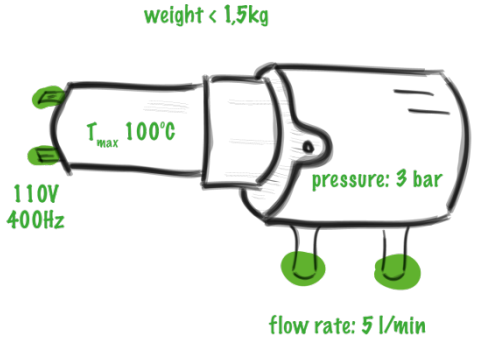


Sketches – Lingua Franca of Mechanical Engineers

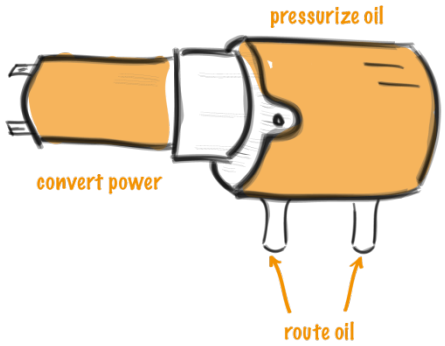


Elaboration of Design Details in Sketches with Systematic Annotations

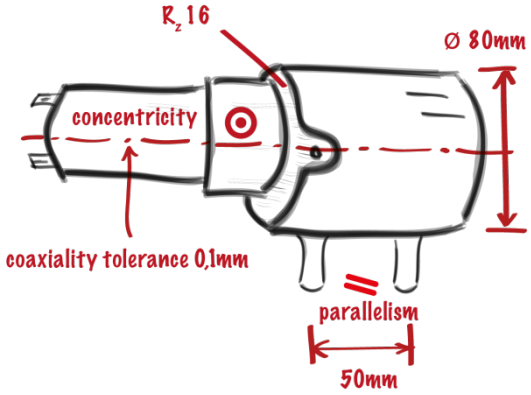
bdd oil pump [allocation of requirements]



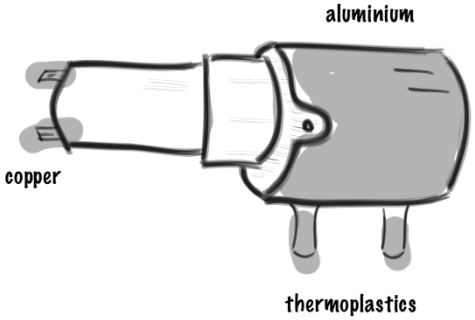
bdd oil pump [allocation of functions]



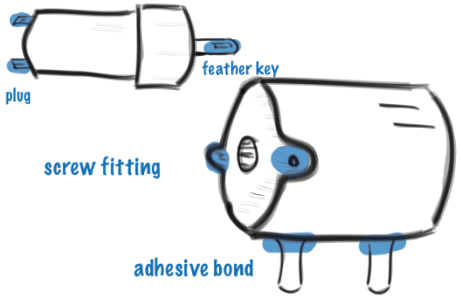
bdd oil pump [geometric constraints]



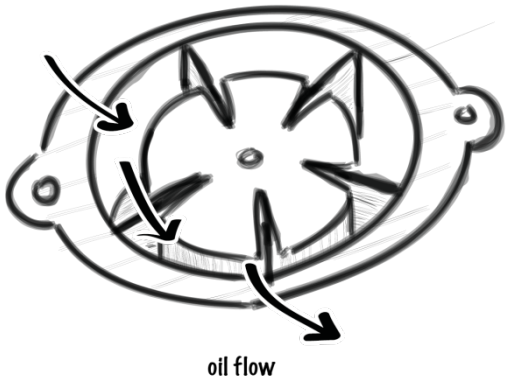
bdd oil pump [materials selection]



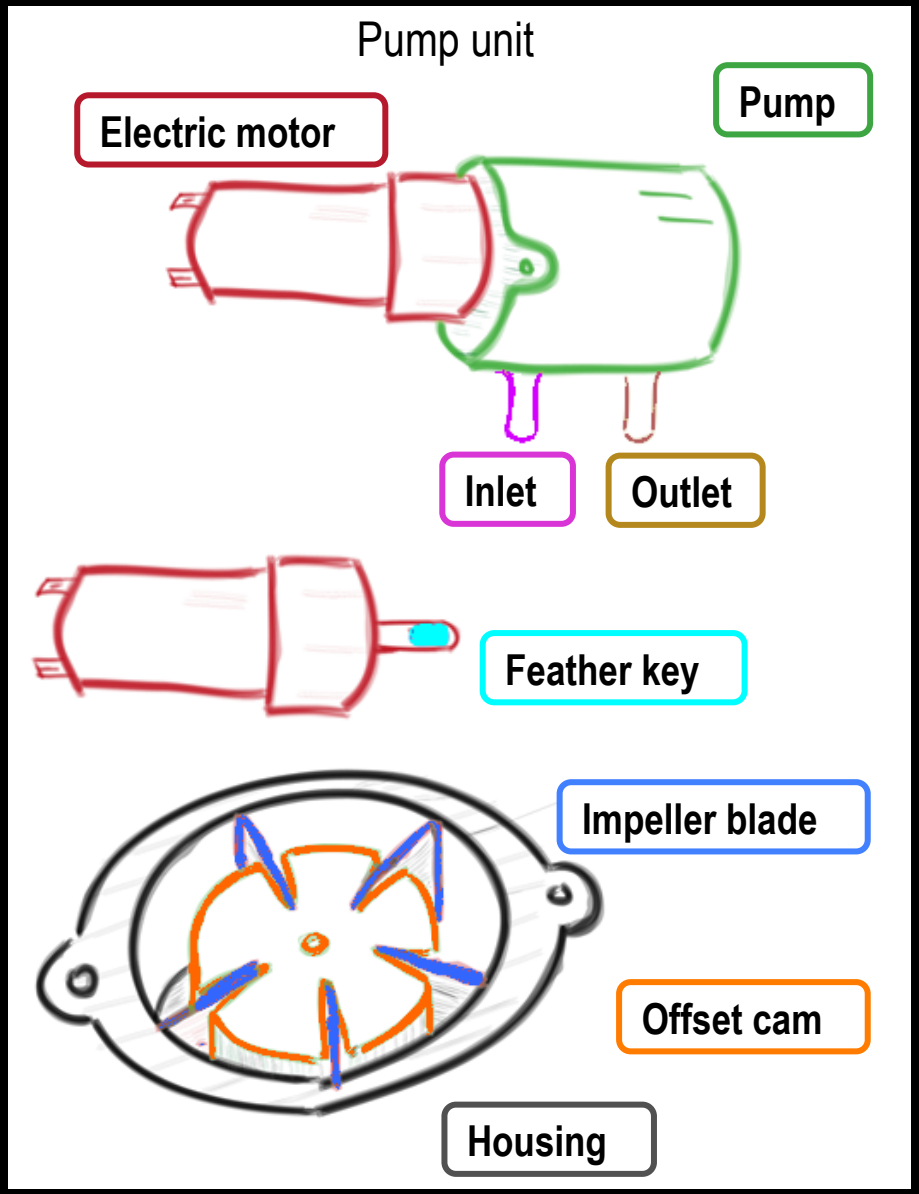
bdd oil pump [joining technology]

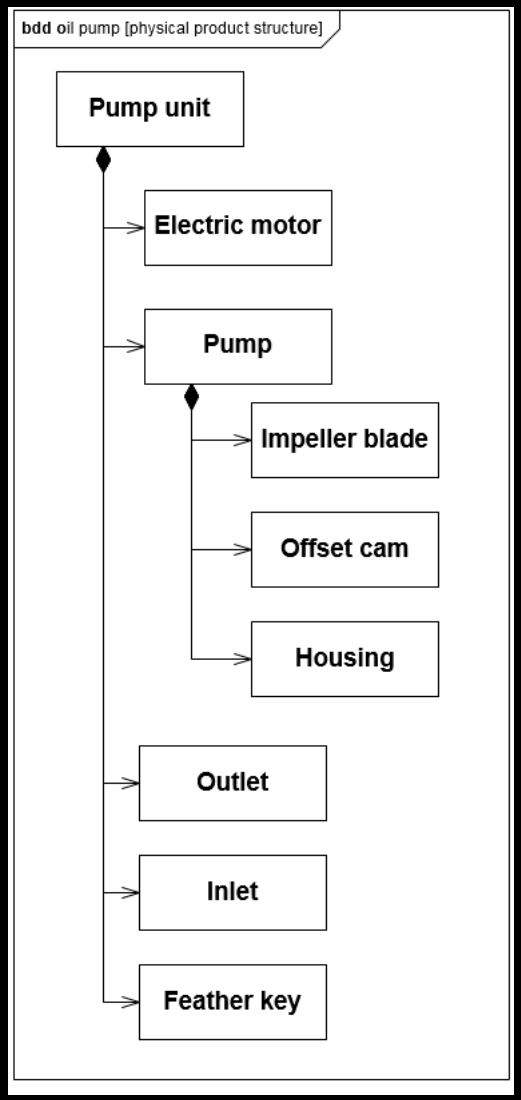


bdd oil pump [kinematics]

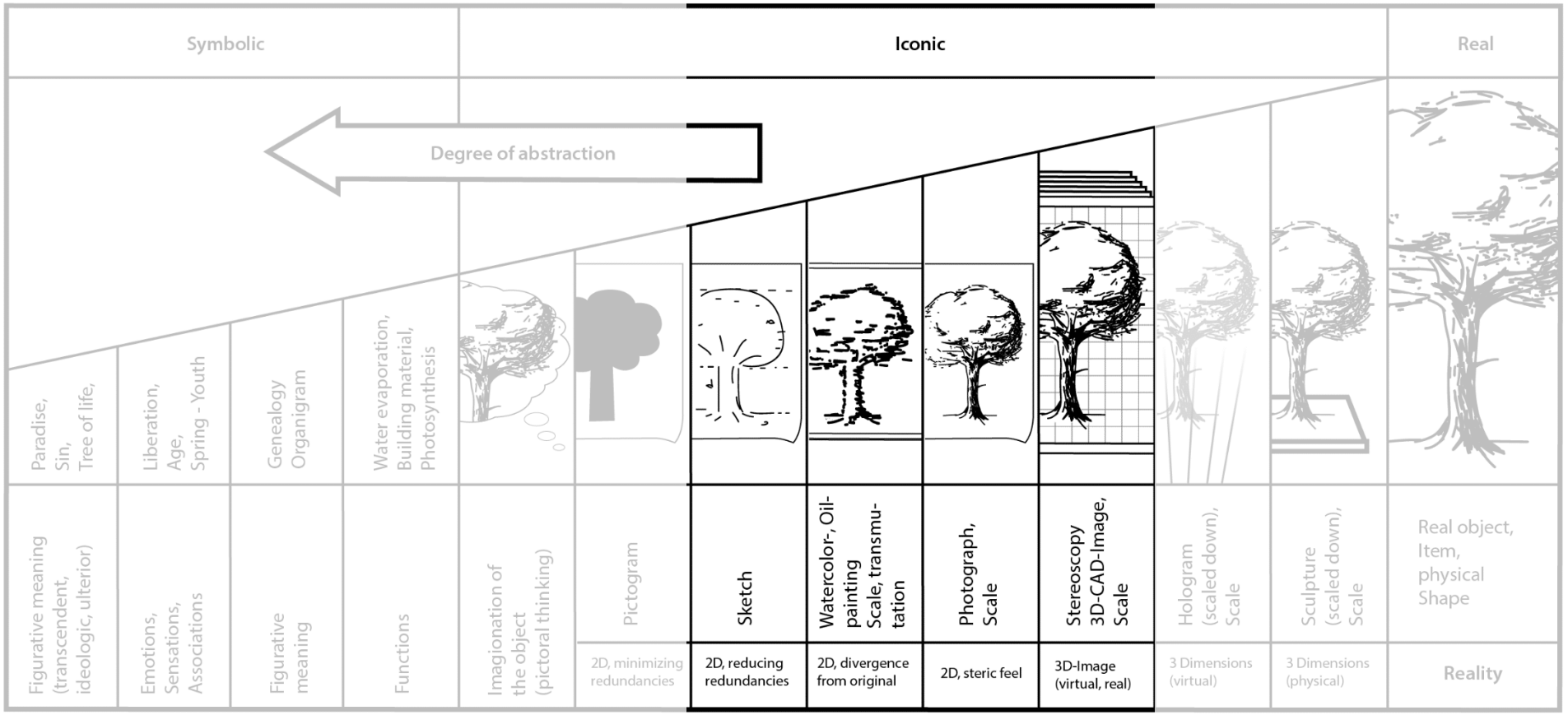


Physical Product Structure Definition

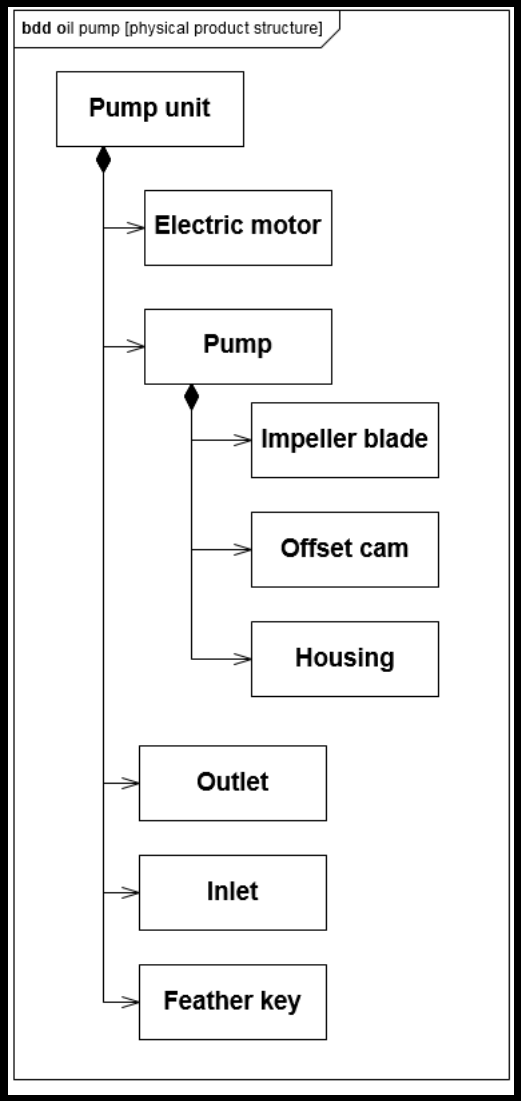


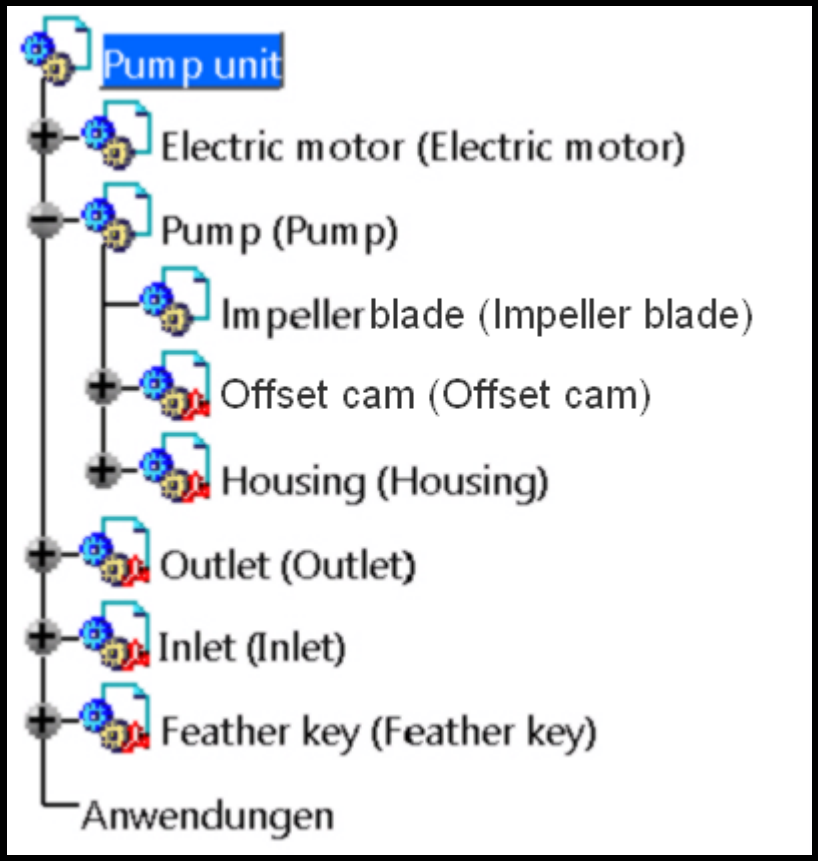


Next Step: CAD Model Creation

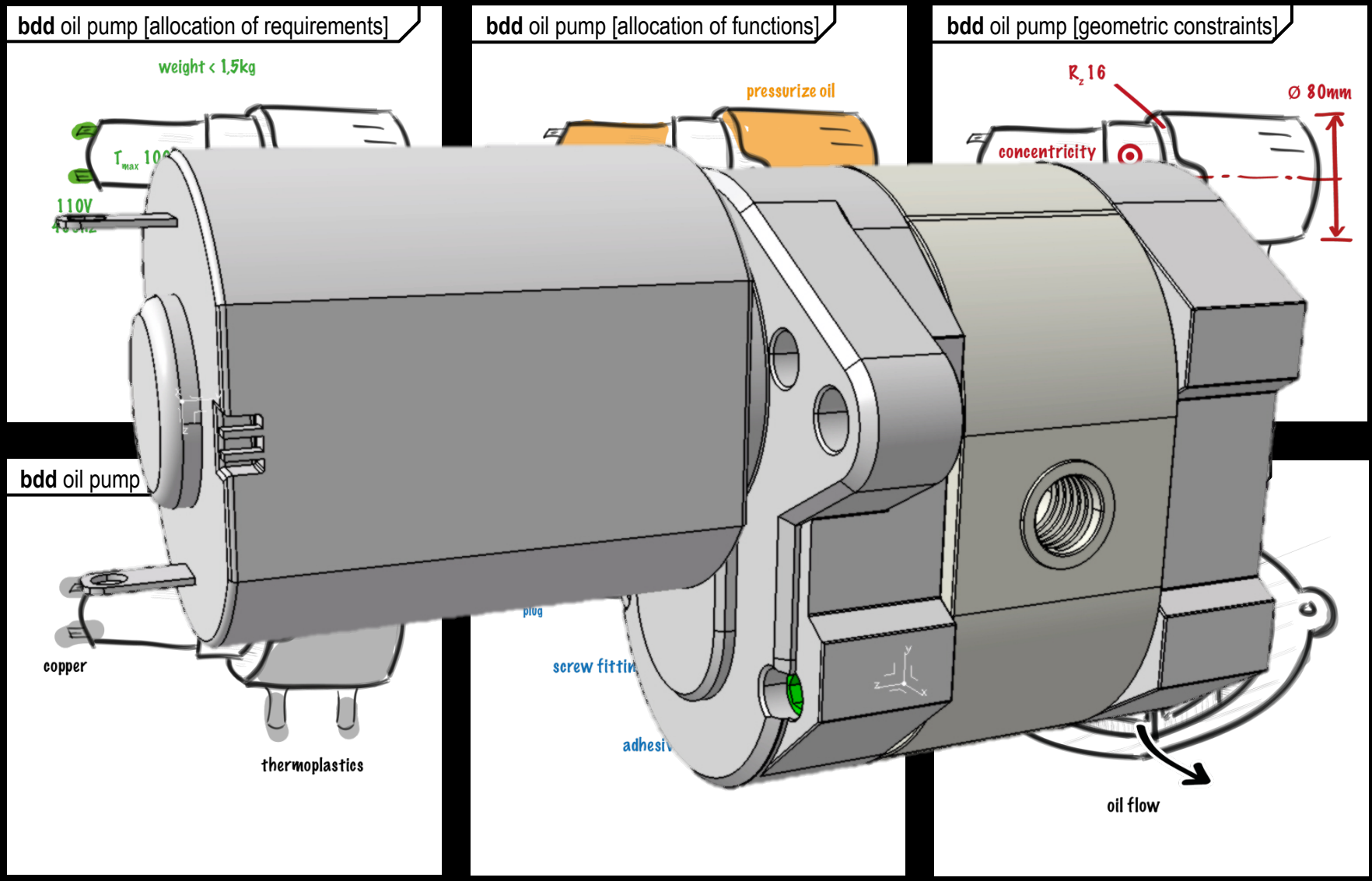


Create Product Structure in CAD System

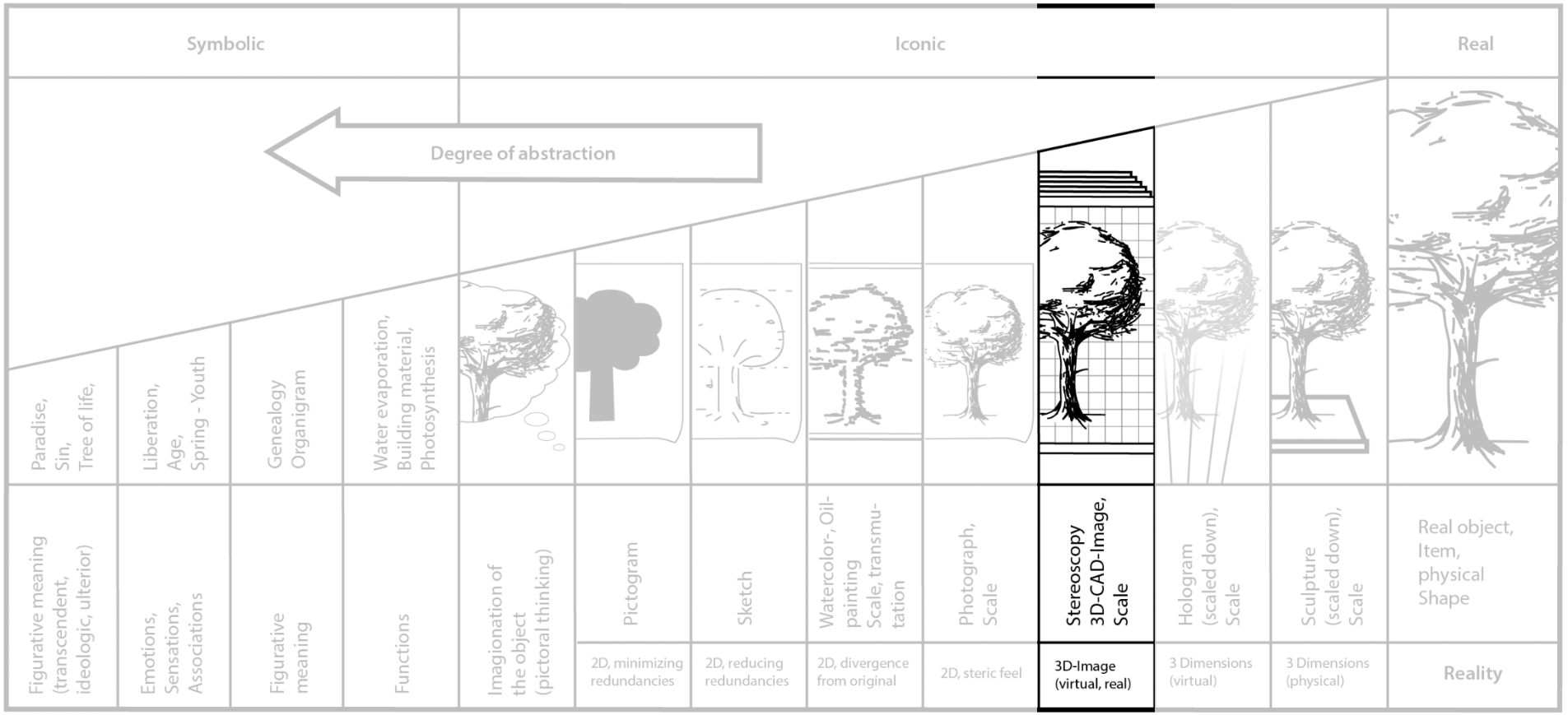




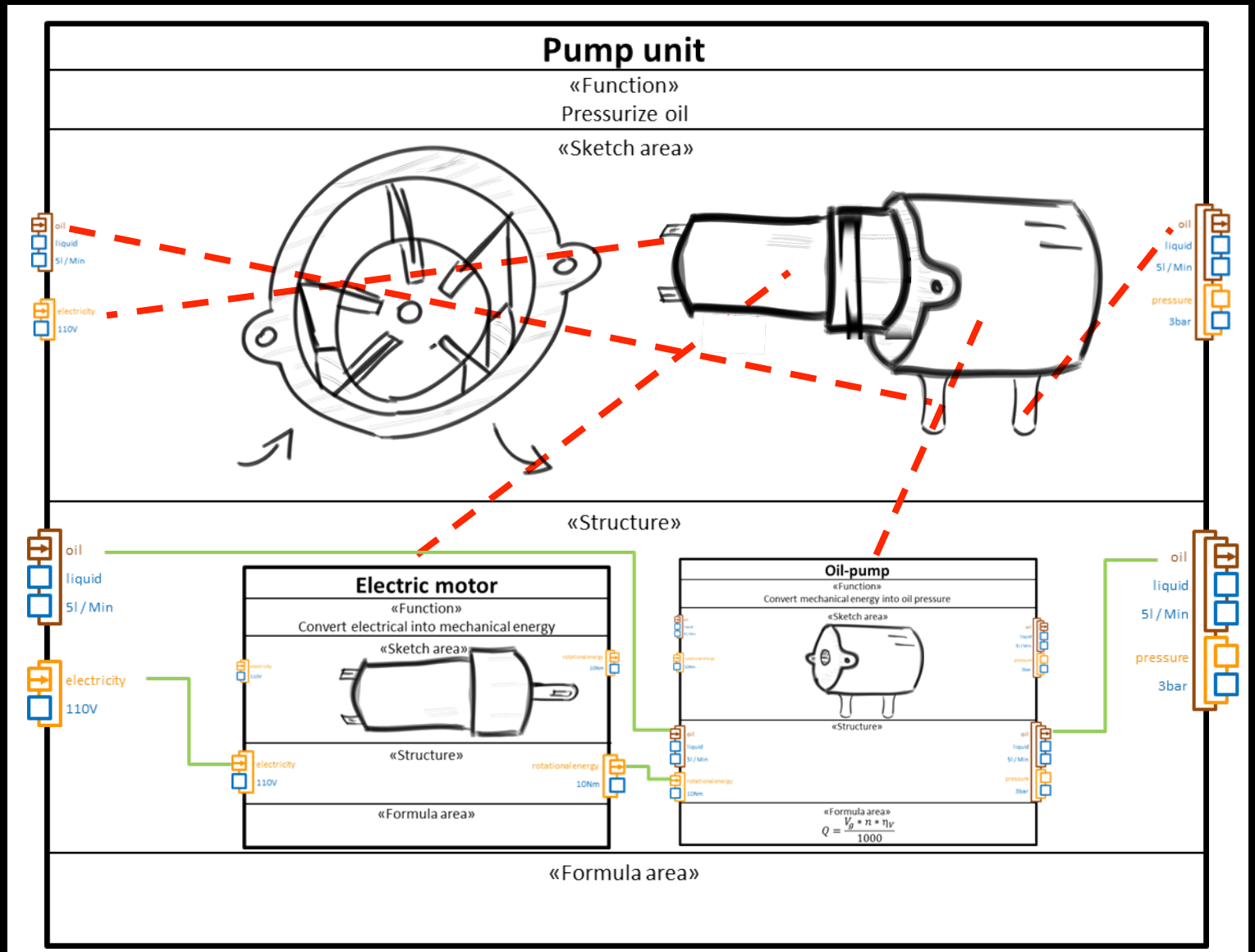
Detailed Mechanical Design in CAD System



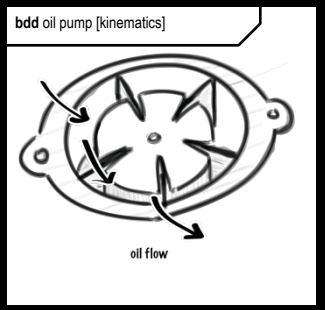
CAD accomplished

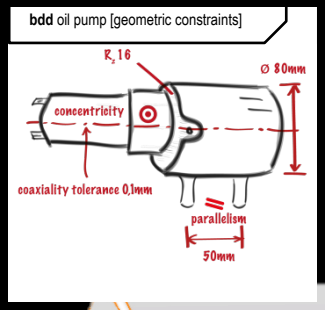


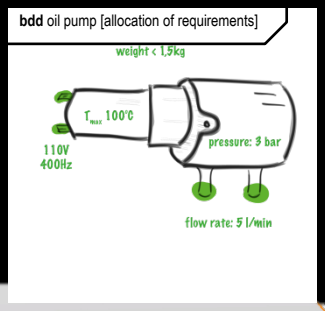
Model Synthesis: SkiPo-Model (bdd with ports and sketches)

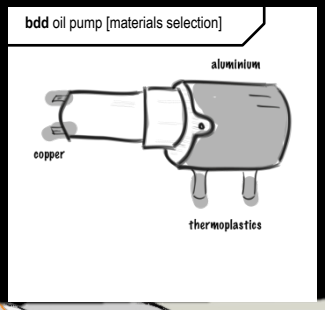


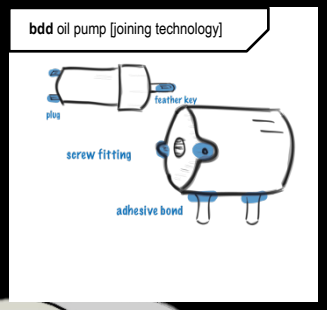
Traceabilty

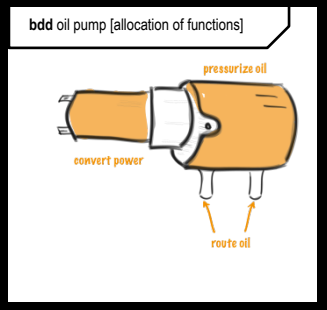


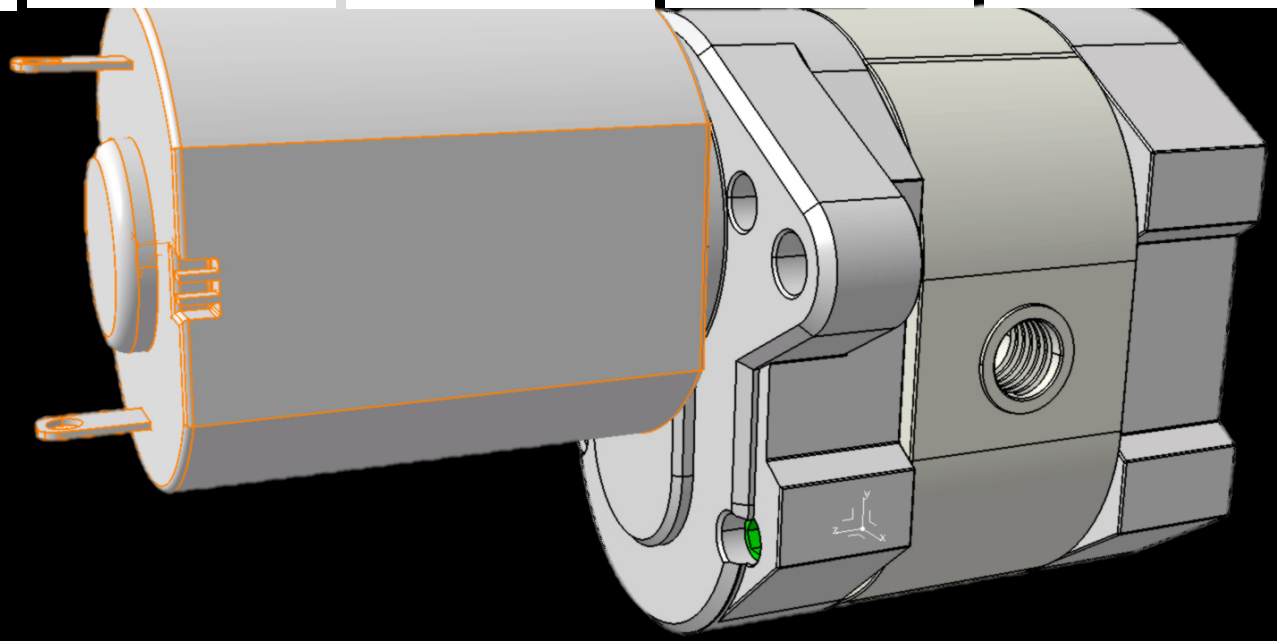




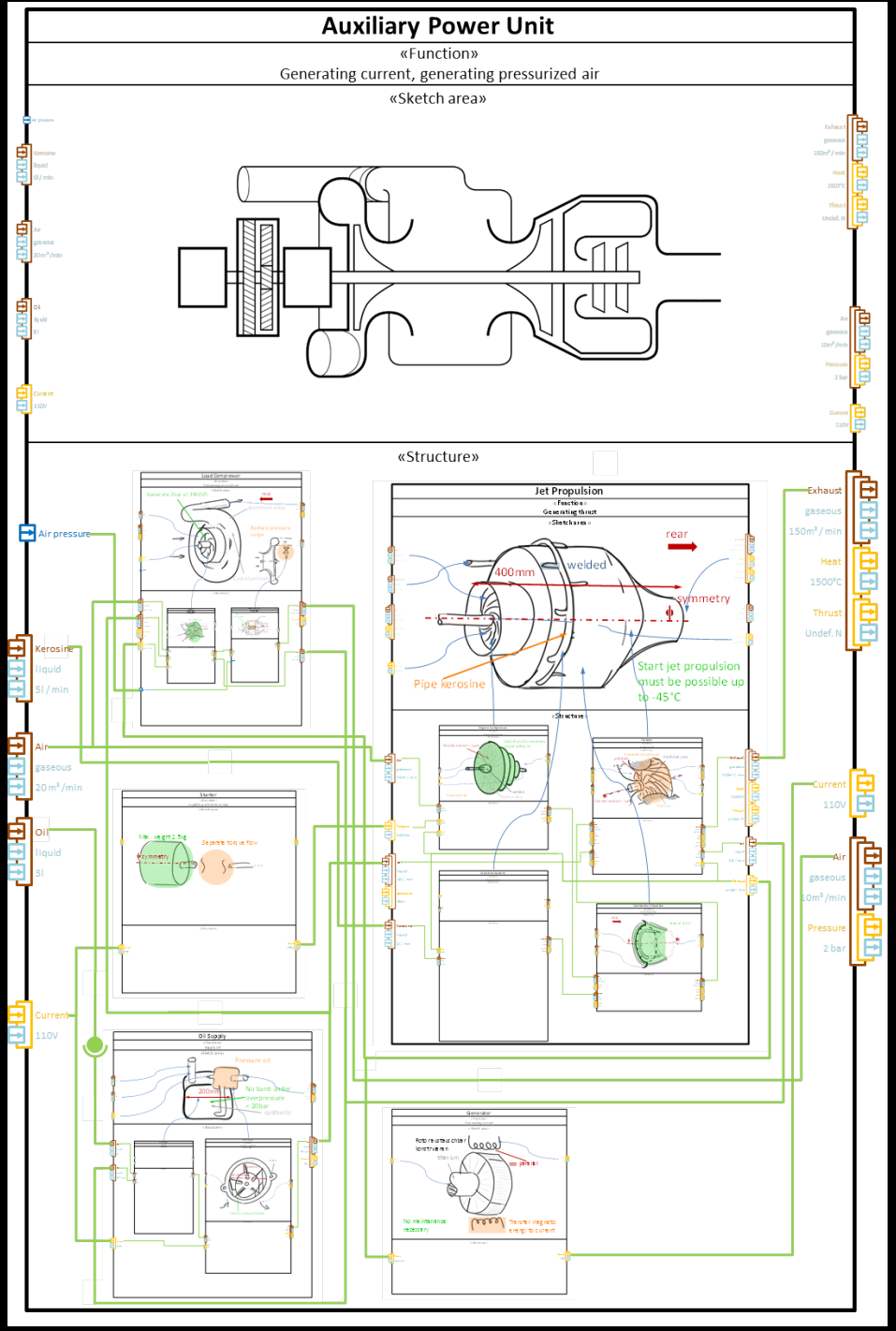








SkiPo – APU


Auxiliary Power Unit
«Function»
Generating current, generating pressurized air
«Sketch area»
«Structure»
Air pressure
Kerosine
liquid
5l / min
Air
gaseous
20 m³/min
Oil
liquid
3l
Current
110V
Jet Propulsion
rear
400mm
welded
symmetry
Pipe kerosine
Start jet propulsion must be possible up to -45°C
Exhaust
gaseous
150m³/min
Heat
1500°C
Thrust
Undef. N
Current
110V
Air
gaseous
10m³/min
Pressure
2 bar

Summary

Consistency check of system design

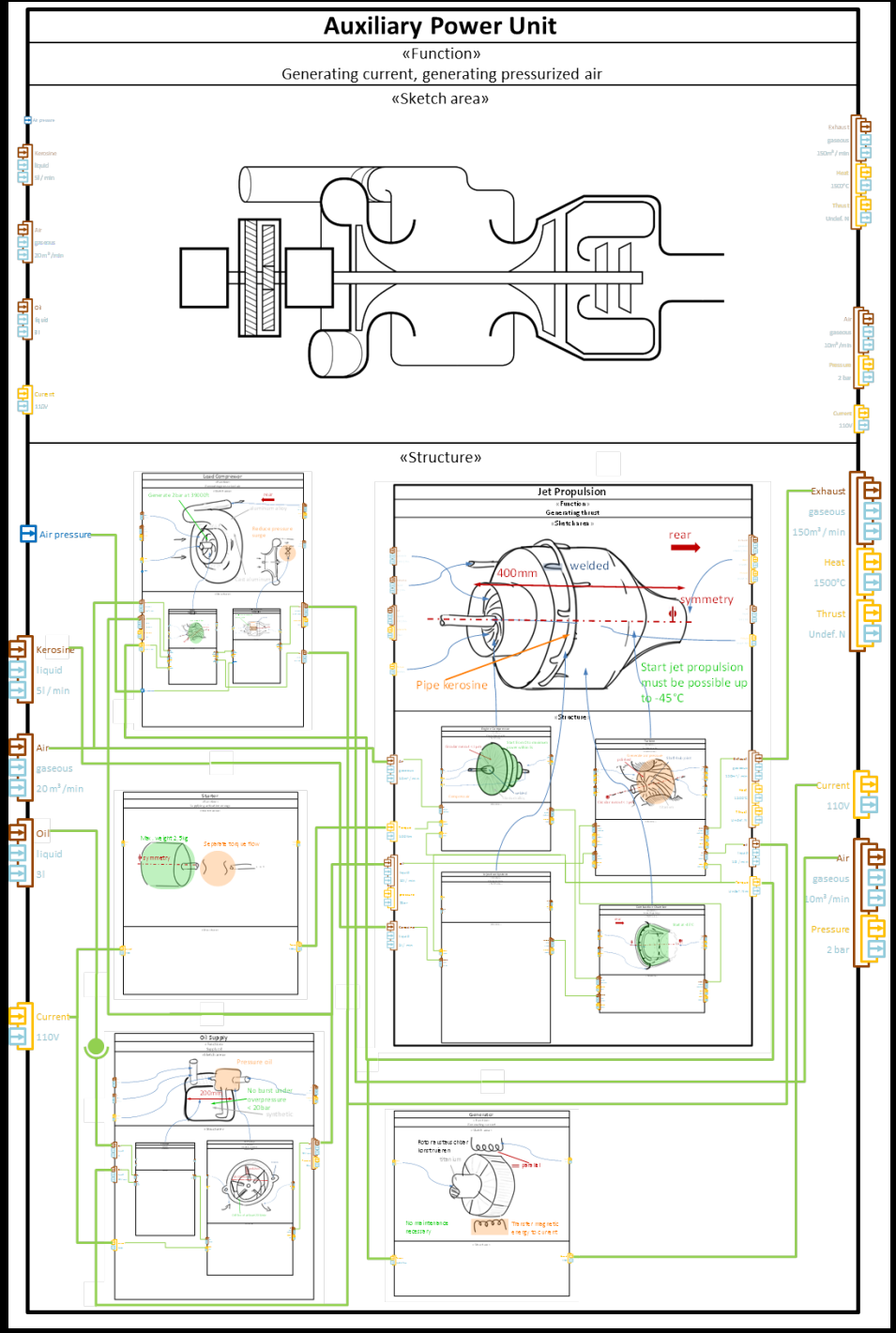
- Port model helps specify and check properties and consistency of internal & external item flows

Systematic documentation of Design decisions in sketches

- Sketches improve communication in teams and reduce misunderstandings

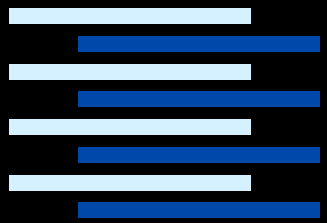
Sketches are no longer thrown away

- Sketch integration in the SysML model facilitates traceability



Thank you for your attention!
Questions?

Please do not hesitate to contact us



HAW HAMBURG

Martin Grundel M.Sc.

martin.grundel@hsu-hh.de

Prof. Dr.-Ing. Jutta Abulawi

jutta.abulawi@haw-hamburg.de