

# Workshop Mechatronics



## Master Mechatronics and Robotics

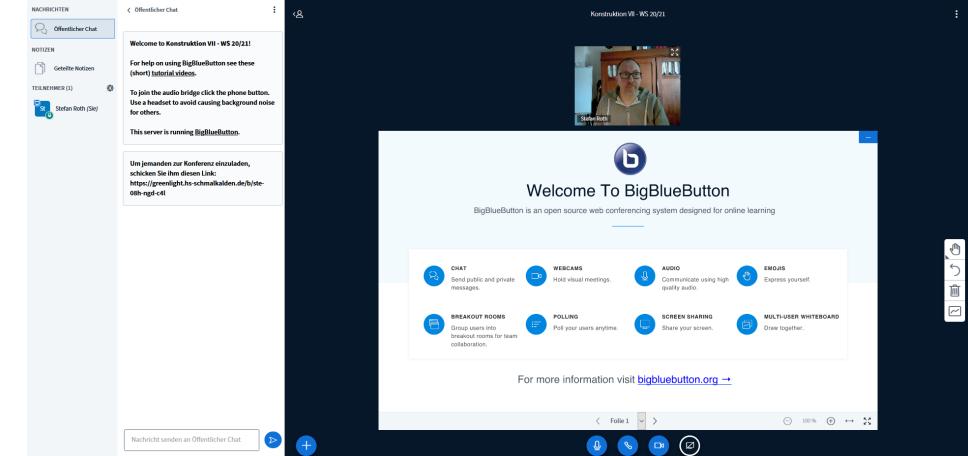
Welcome!

Schmalkalden University of Applied Sciences, SS 2023

Prof. Dr.-Ing. Stefan Roth

# Online - Netiquette

- Please log in by your complete name + surname
- **Switch on your camera!**
- switch your mic off, unless you would like to ask or comment something



- please talk slowly and clearly if you ask questions
- you can use the chat for questions as well
- recording of session is prohibited due to law EU data processing agreement
- Give feedback!

Video Call Conference in Real Life  
<https://www.youtube.com/watch?v=JMOOG7rWTPg&feature=youtu.be>



Bildquelle: kudla/Shutterstock.com

# Workshop Mechatronics I

Prof. Silvio Bachmann

## Objectives

- Exercise and project work in development of a microcontroller, based electronic control unit for mechatronic systems

## Content

- Thermal calculation of heat sink and casing for electronic control unit
- Design and testing of a printed circuit board as main board for all components of the electronic control unit
- Programming of the microcontroller in C
- Design of casing for electronic control unit

## Course Outline

- 1 Lecture + 3 Lab = 4 SWS
- 5 Credit Points
- Assignment (written report + oral presentation) of workshop project
- Workshop Exercise in groups Monday and Tuesday

## Workshop Mechatronics II

Prof. Stefan Roth

### Objectives

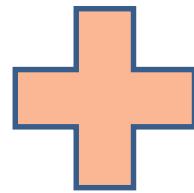
- Design and realisation of mechatronic systems

### Content

- Exercise in development of mechatronic system
- Based on solution guideline for development of mechatronic systems, i.e. 2208 (V-Model)
- student has to work out the design of simple mechatronic systems,
- The conceptual idea has to be realised with means of mechanical processing like rapid prototyping
- Fundamental elements of the development process for mechatronic systems, namely specification of requirements, implementation, verification and corresponding documentation are trained by the workshop.

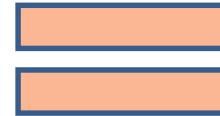
### Course Outline

- 1 Lecture + 3 Lab = 4 SWS
- 5 Credit Points
- Assignment (written report + oral presentation) of workshop project
- Workshop exercise Tuesday & Wednesday in groups
- Lecture Thursday 2 – 3.30 pm



## Workshop Mechatronics II

Prof. Stefan Roth



## Workshop Mechatronics I

Prof. Silvio Bachmann

### Students' Team Project

- work in teams of three people on assigned task
- design, documentation, realization and testing
- free work in groups
- regular consultation with Professor
- lectures for support whenever necessary
- period: summer semester period
- 5 + 5 Credit Points
- exam: assignment (written report + oral presentation) of workshop project

# Workshop Assignment – Pen Plotter

- Whole **concept** of the mechanic and the electric **design, assembling and programming** is part of this workshop
- A construction kit should not be used
- Mechanic components should be designed by yourself. For the production of the components use 3D printing

## Goal

- Work out linear XY-plotting device

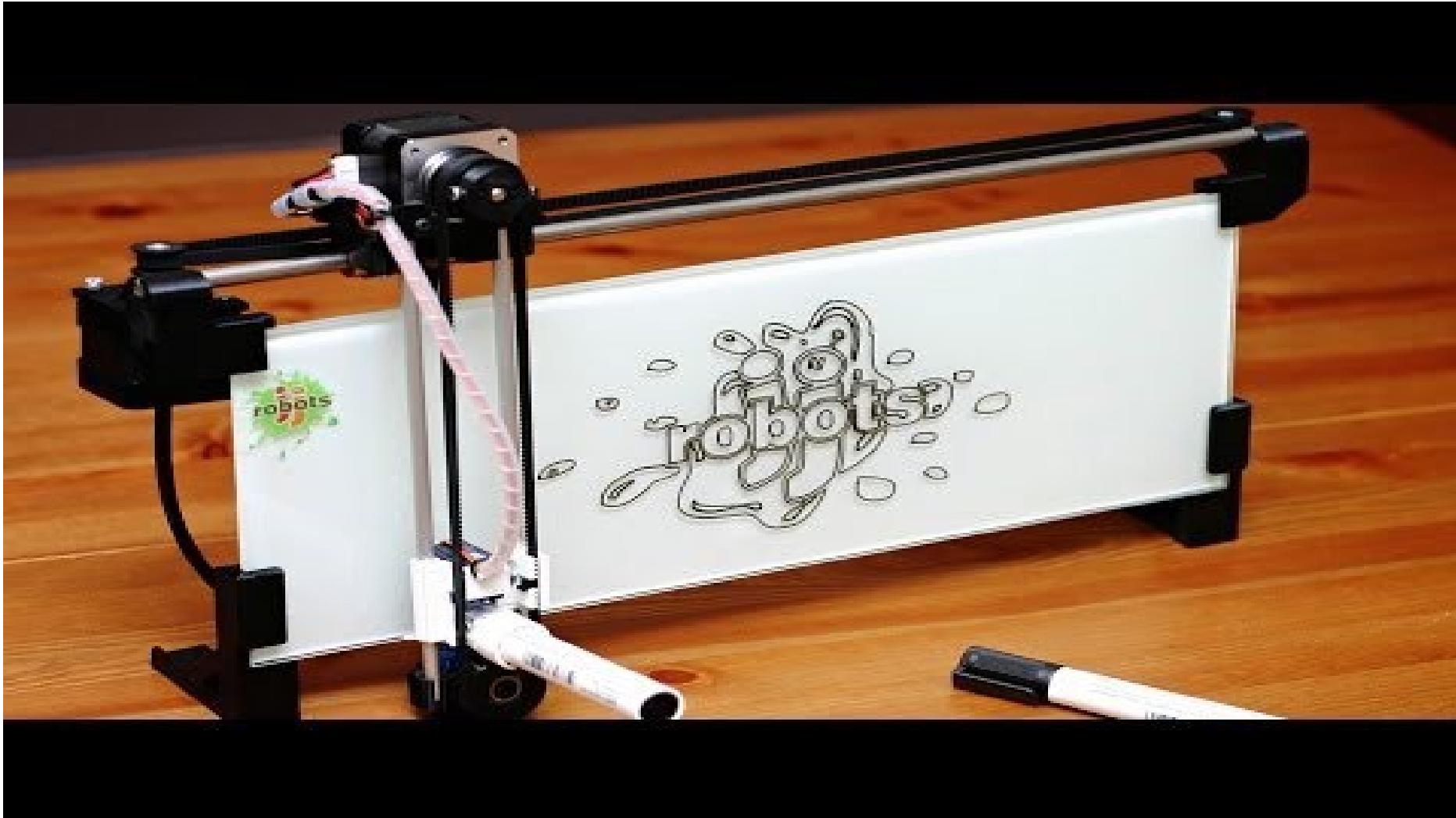
## Actions

- design mechanics
- design IC-layout
- software coding
- built up prototype
- test it!



ref.: <https://spectrum.ieee.org/geek-life/hands-on/the-iboardbot-brings-xy-plotters-into-the-cloud-age>

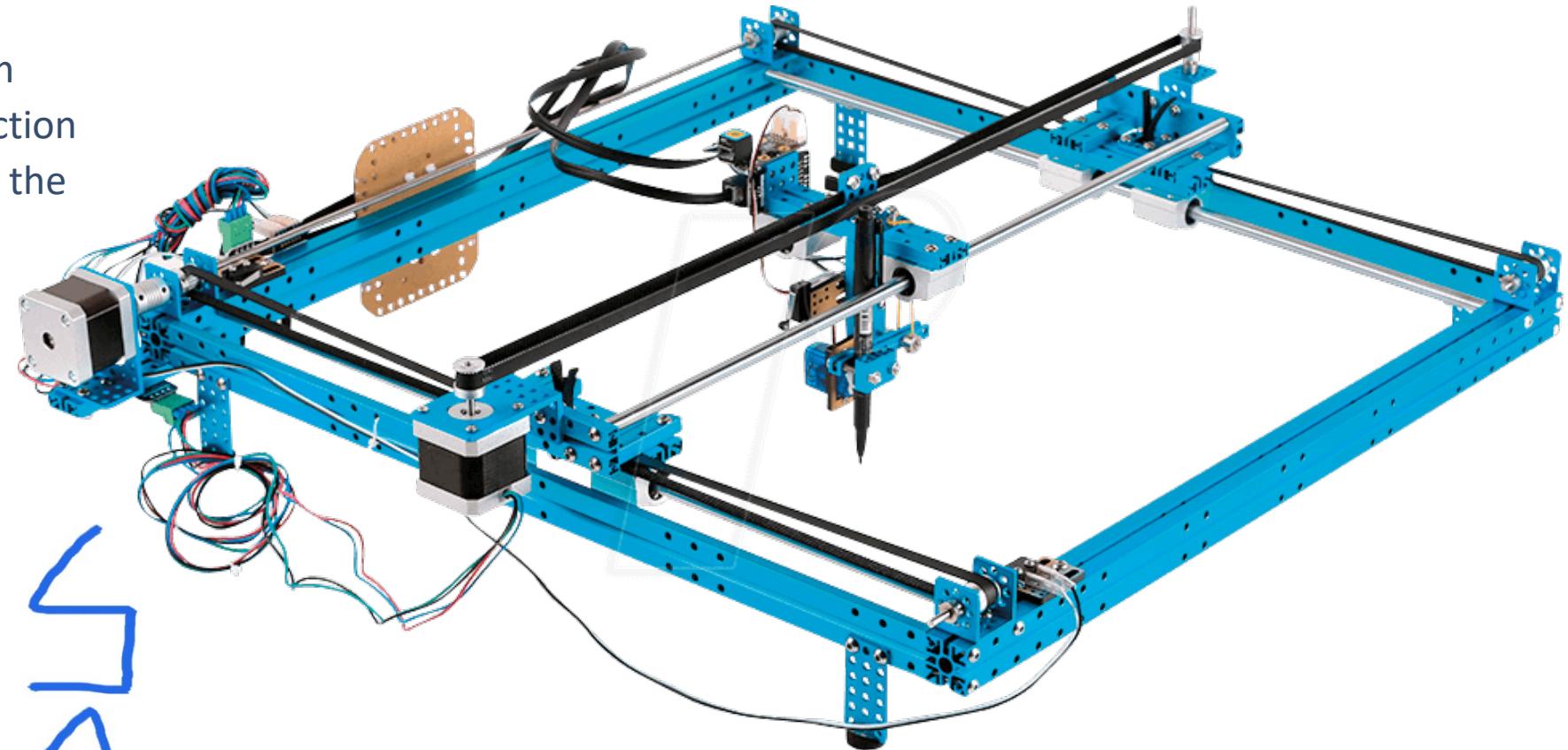
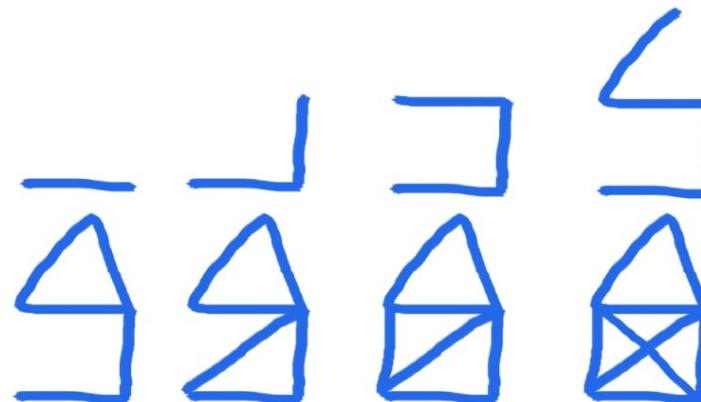
....just an example ☺



ref.:  
<https://www.jirobots.com/the-iboardbot/>  
<https://www.youtube.com/watch?v=zr3JZYXoIVg>

# Functions to be realised

- pen holder
- plot area: 100mm x 100mm
- movement in x- and y-direction
- point of reference (0, 0): in the bottom left hand corner
- programmable to draw a Nikolaus' house



ref.: leil.de/di/pics/haus\_vom\_nikolaus.jpg, reichelt.de

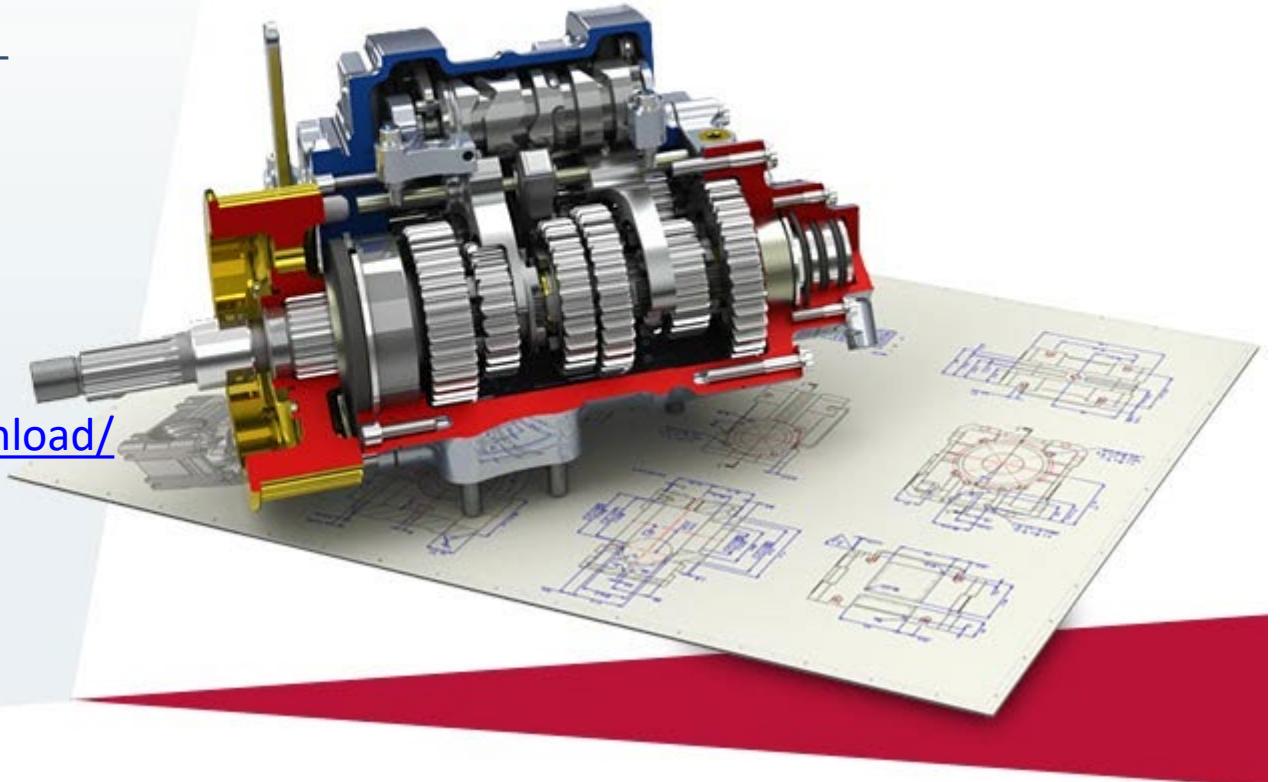
- Use your university email account to register with SolidWorks and note the information that SolidWorks has made available to you.
- SOLIDWORKS Student Premium 2022/23 (Home-Use-Lizenz): 9020005367515682655GBP37  
<https://www.solidworks.com/support/community-download#no-back>

alternative this link:

<https://www.solidline.de/angebote/solidworks-download/>

Installation Guide:

<https://www.solidworks.com/de/support/student>



ref.: Solidworks

# Further Specification – Hardware & Software

## Control of the Plotter

- For the control should be used the “*Arduino Uno*” and the Step motor control “*Emsis SMC-Arduino 2.2A*”
- The step motors have no internal feedback about the steps.
- The steps have to be counted.
- For the programming of control functions should be used the language C.
- The functions should be able to run as Sketch on the Arduino.
- the “*Arduino Uno*” of the plotter should receive form the PC a “*HPGL-File*”. This file has at first only a reduced syntax:
  - Line Type                    solid
  - PU - Pen Up    **PU [ X,Y [...] ] [ ; ]**
    - X; X coordinate of the cursor movement destination
    - Y; Y coordinate of the cursor movement destination
  - PD - Pen Down              **PD [ X, Y [...] ] [ ; ]**
    - X; X coordinate of the cursor movement destination
    - Y; Y coordinate of the cursor movement destination
  - PA - Plot Absolute         **PA [ X, Y [...] ] [ ; ]**
    - X; X coordinate of the cursor movement destination
    - Y; Y coordinate of the cursor movement destination

## Software

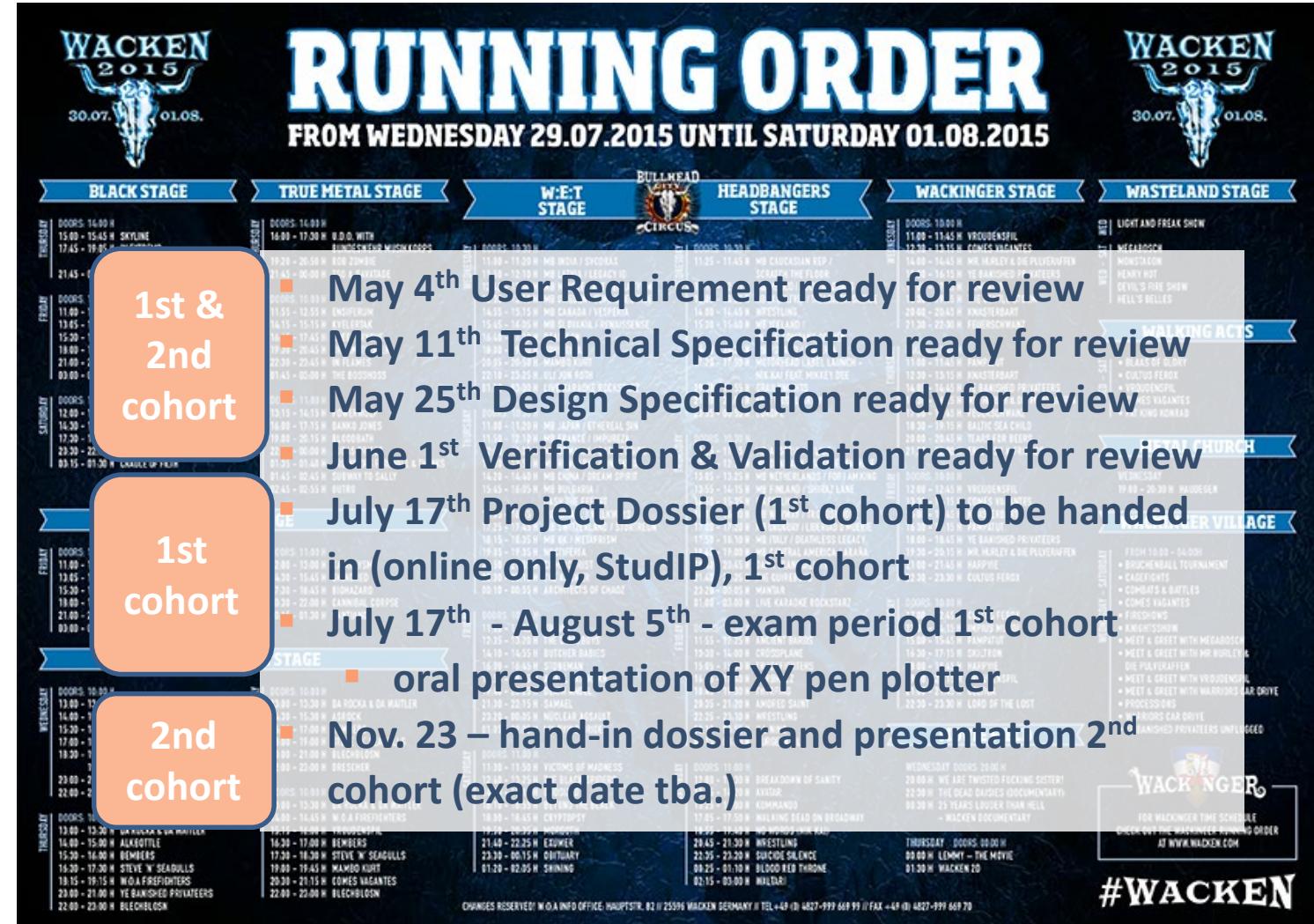
- Microsoft Visual Studio Community Edition
- X- and Y-Position as long-Variable
- The first point the development of the Functions for single steps X-, Y- and X-Y-direction. This function should control at first only the variables of the positions.
- Later this variable of the position will be used for the control of the step motors.
- Furthermore, it is necessary, to create and test an algorithm for the approximation of a given line ( $X_1, Y_1$ ) – ( $X_2, Y_2$ ) with single steps in X-, Y-direction or X-Y-direction. This approximation has to guarantee, that a straight line can be plotted.

# Orga Stuff

# Running Order

Date	Time	Room	Content
April, 6 <sup>th</sup>	2.00 pm	BBB	Getting Started, Introduction
April, 20 <sup>th</sup>	2.00 pm	BBB	User Requirement
April, 27 <sup>th</sup>	2.00 pm	BBB	Introduction to Additive Manufacturing
May, 4 <sup>th</sup>	2.00 pm	BBB	Review User Requirement, From User Requirement to Technical Specification
May, 11 <sup>th</sup>	2.00 pm	BBB	Review Technical Specification, From Technical Specification to Implementation (Design Specification)
May, 25 <sup>th</sup>	2.00 pm	BBB	Review Design Specification, Module Verification, How to verify SW, HW, Mech, Validation
June, 1 <sup>st</sup>	2.00 pm	BBB	Review Verification & Validation
June 8 <sup>th</sup>	2.00 pm	BBB	Consultation

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# Team Folder

- each team is provided by team folder in StudIP
- folder only accessible by team members and lecture staff
- the work files, dossiers, assignments have to be uploaded in the corresponding team folder only
- **NB: Do not send files to my personal mail address!**
- no print-out hardcopy is needed to be handed in



The screenshot shows a user interface for managing team folders. At the top, there's a decorative banner with the HSS logo and a small photo of a person. Below it is a sidebar with 'Aktionen' (Actions) containing 'Neuer Ordner' (New Folder) and 'Datei hinzufügen' (Add File). The main area has a 'Dateien hochladen' (Upload Files) section with a 'Drag & Drop' placeholder. A 'Ansichten' (Views) section at the bottom has 'Ordneransicht' (Folder View) selected, highlighted with a yellow bar. On the right, a list of folder entries is shown:

<input type="checkbox"/>	Dateiordner der Gruppe: Team 12
<input type="checkbox"/>	Dateiordner der Gruppe: Team 13
<input type="checkbox"/>	Dateiordner der Gruppe: Team 14
<input type="checkbox"/>	Dateiordner der Gruppe: Team 15
<input type="checkbox"/>	Dateiordner der Gruppe: Team 16
<input type="checkbox"/>	Dateiordner der Gruppe: Team 17
<input type="checkbox"/>	Dateiordner der Gruppe: Team 18
<input type="checkbox"/>	Dateiordner der Gruppe: Team 19
<input type="checkbox"/>	Dateiordner der Gruppe: Team 20
<input type="checkbox"/>	Dateiordner der Gruppe: Team 21
<input type="checkbox"/>	Dateiordner der Gruppe: Team 22
<input type="checkbox"/>	General - Docs, Infos, Templates

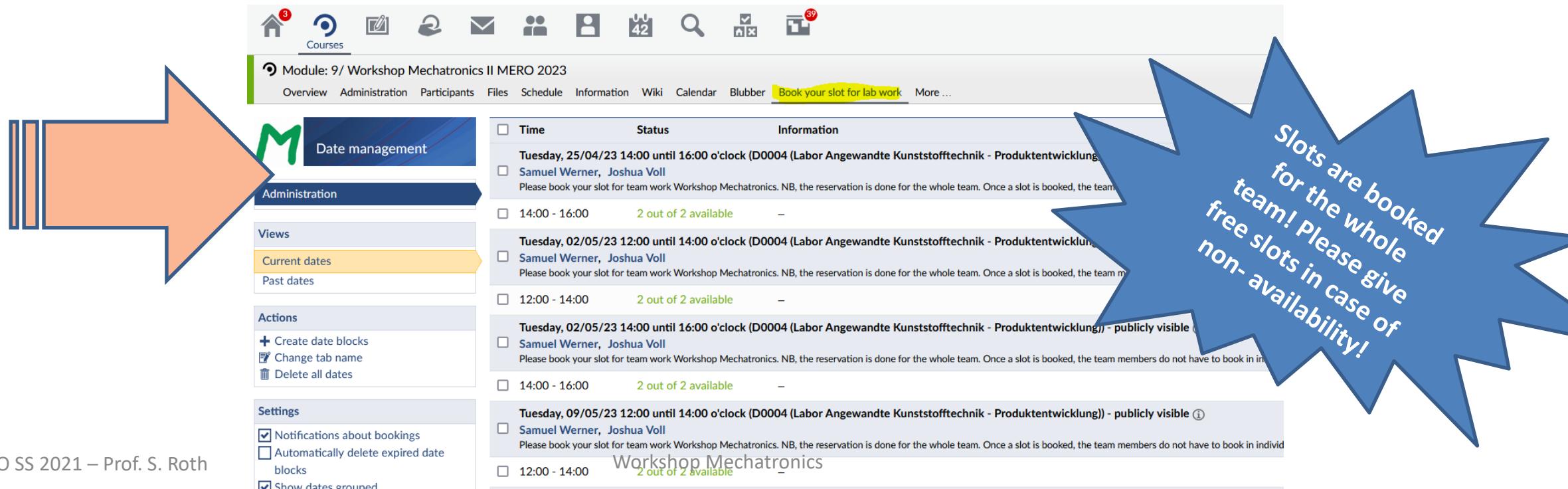
At the bottom right are buttons for 'Herunterladen' (Download), 'Verschieben' (Move), 'Kopieren' (Copy), and 'Löschen' (Delete).

# How we will proceed....

- **Lecture online Thursdays , 2.00 pm for all groups**
  - basic principles of development by V-model
  - documentation
  - set-up user requirement
  - system specification
  - verification and validation → test protocol and test report

- **Open lab sessions**

- Tuesday, 8 am – 2 pm & Wednesday 8 am – noon
- work in the lab F2F
- consultation for 3D-printing
- question, discussion of project
- 3D printing and assembly of parts
- slots for consultation to be booked via StudIP:



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Module: 9/ Workshop Mechatronics II MERO 2023

Overview Administration Participants Files Schedule Information Wiki Calendar Blubber Book your slot for lab work More ...

**Date management**

**Administration**

**Views**

Current dates Past dates

**Actions**

+ Create date blocks  Change tab name  Delete all dates

**Settings**

Notifications about bookings  Automatically delete expired date blocks  Show dates grouped

**Information**

Tuesday, 25/04/23 14:00 until 16:00 o'clock (D0004 (Labor Angewandte Kunststofftechnik - Produktentwicklung))

Samuel Werner, Joshua Voll  
Please book your slot for team work Workshop Mechatronics. NB, the reservation is done for the whole team. Once a slot is booked, the team members do not have to book in individually.

14:00 - 16:00 2 out of 2 available —

Tuesday, 02/05/23 12:00 until 14:00 o'clock (D0004 (Labor Angewandte Kunststofftechnik - Produktentwicklung))

Samuel Werner, Joshua Voll  
Please book your slot for team work Workshop Mechatronics. NB, the reservation is done for the whole team. Once a slot is booked, the team members do not have to book in individually.

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Please book your slot for team work Workshop Mechatronics. NB, the reservation is done for the whole team. Once a slot is booked, the team members do not have to book in individually.

14:00 - 16:00 2 out of 2 available —

Tuesday, 09/05/23 12:00 until 14:00 o'clock (D0004 (Labor Angewandte Kunststofftechnik - Produktentwicklung)) - publicly visible ⓘ

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Please book your slot for team work Workshop Mechatronics. NB, the reservation is done for the whole team. Once a slot is booked, the team members do not have to book in individually.

12:00 - 14:00 2 out of 2 available

Workshop Mechatronics

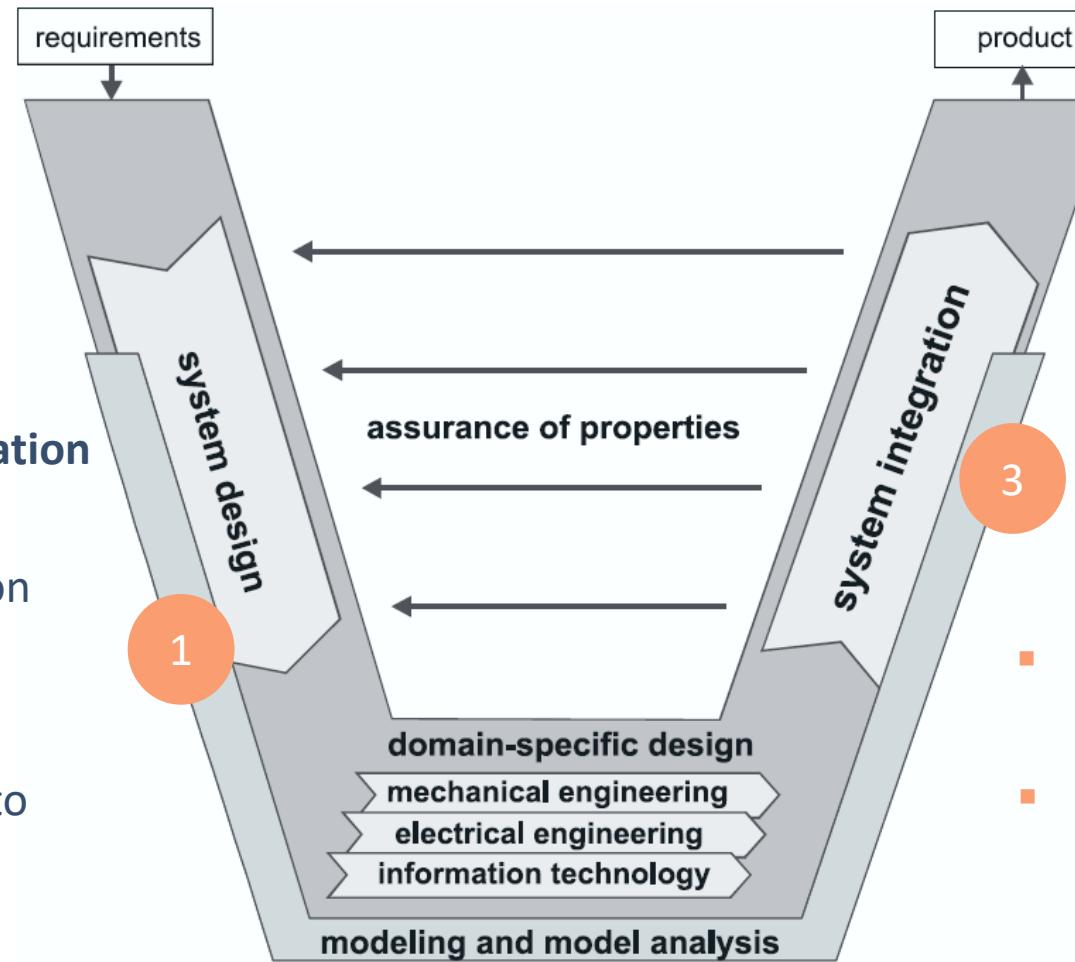
# V-Model

# “V – model”

- describes the approach for product development in mechatronic systems

## system design - specification

- user requirement → technical specification
- definition of overall solution concept
- split up of system into domains



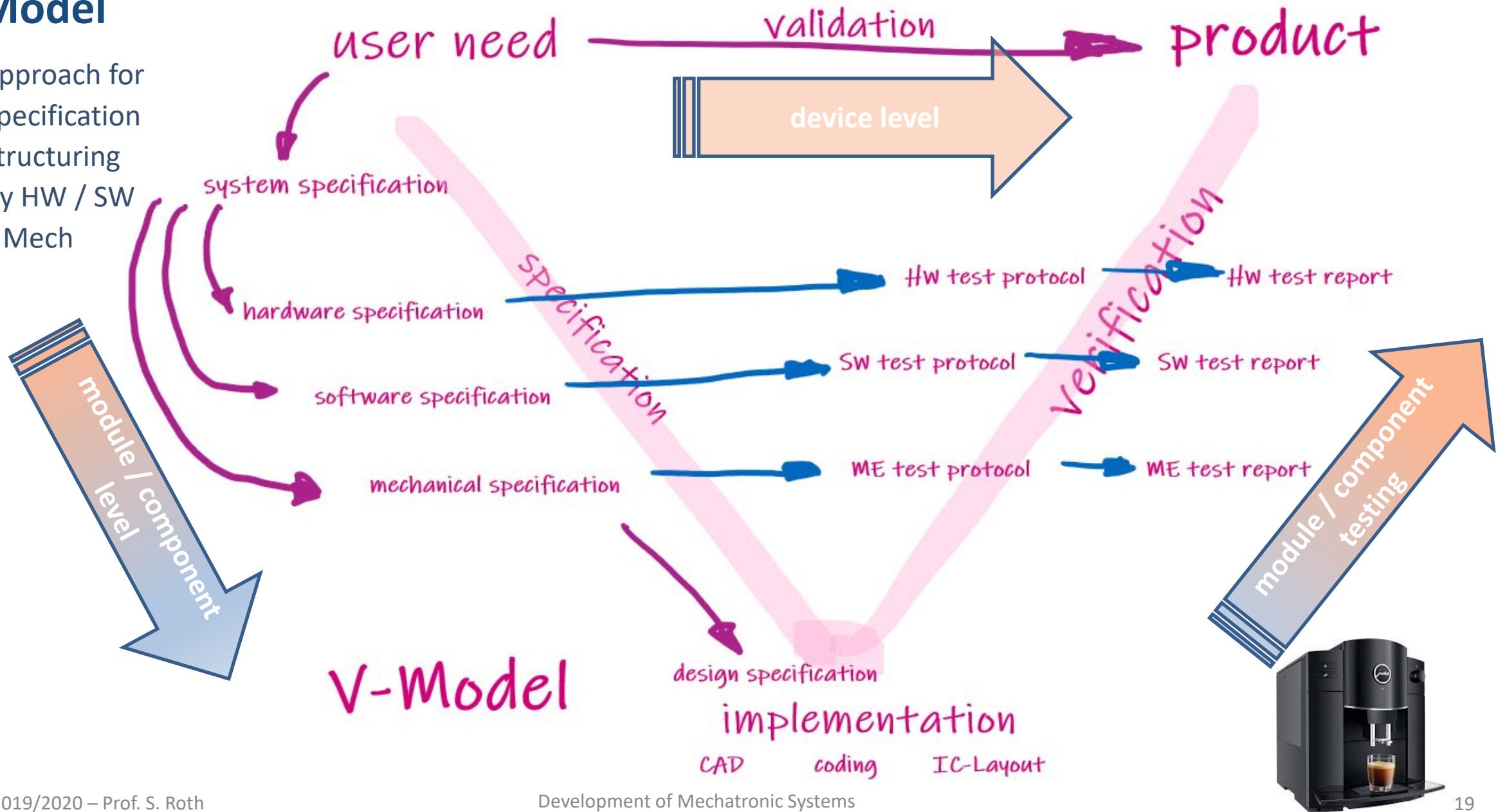
## design - implementation

- domain wise realisation of design

ref: VDI 2206 (2004)

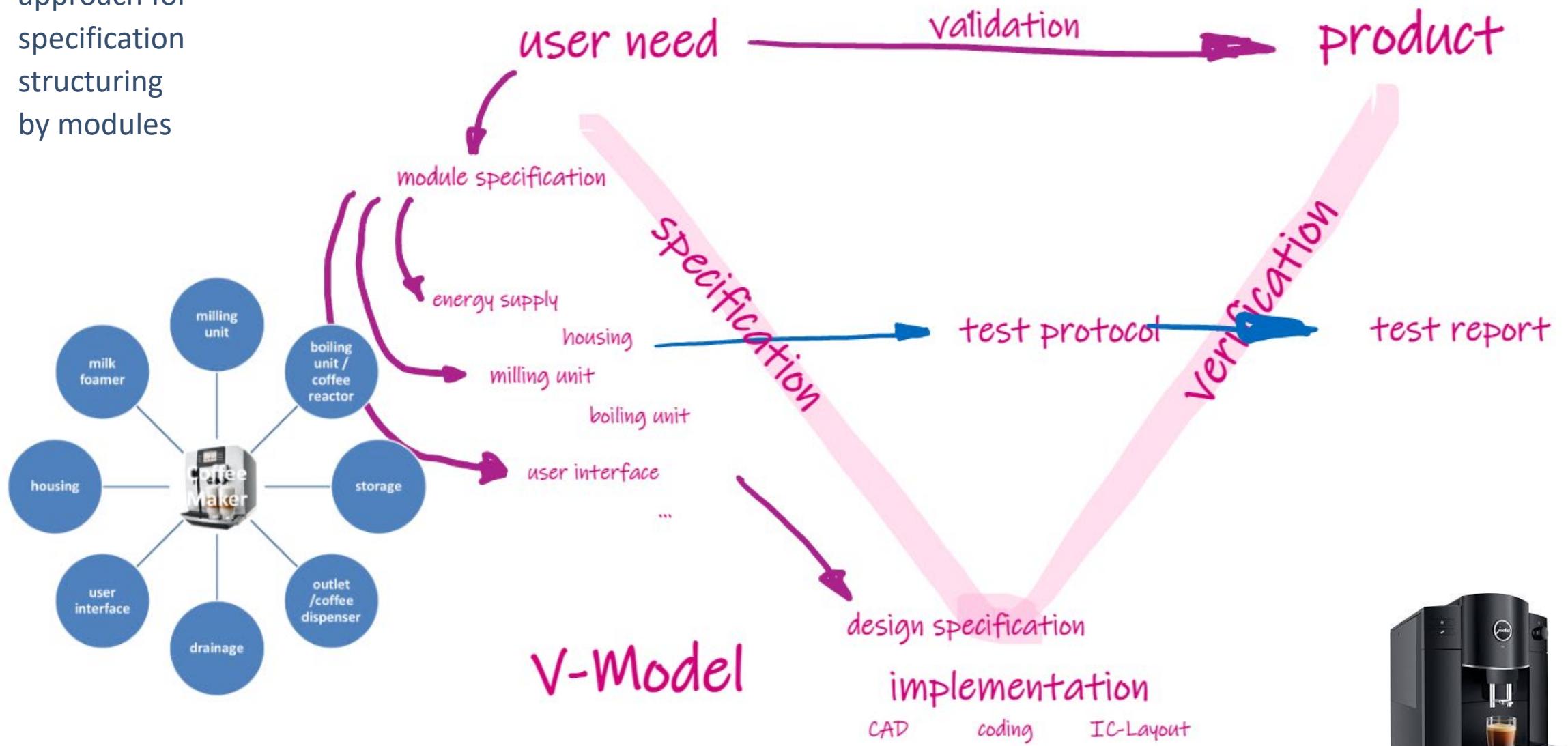
# V-Model

- approach for specification structuring by HW / SW / Mech



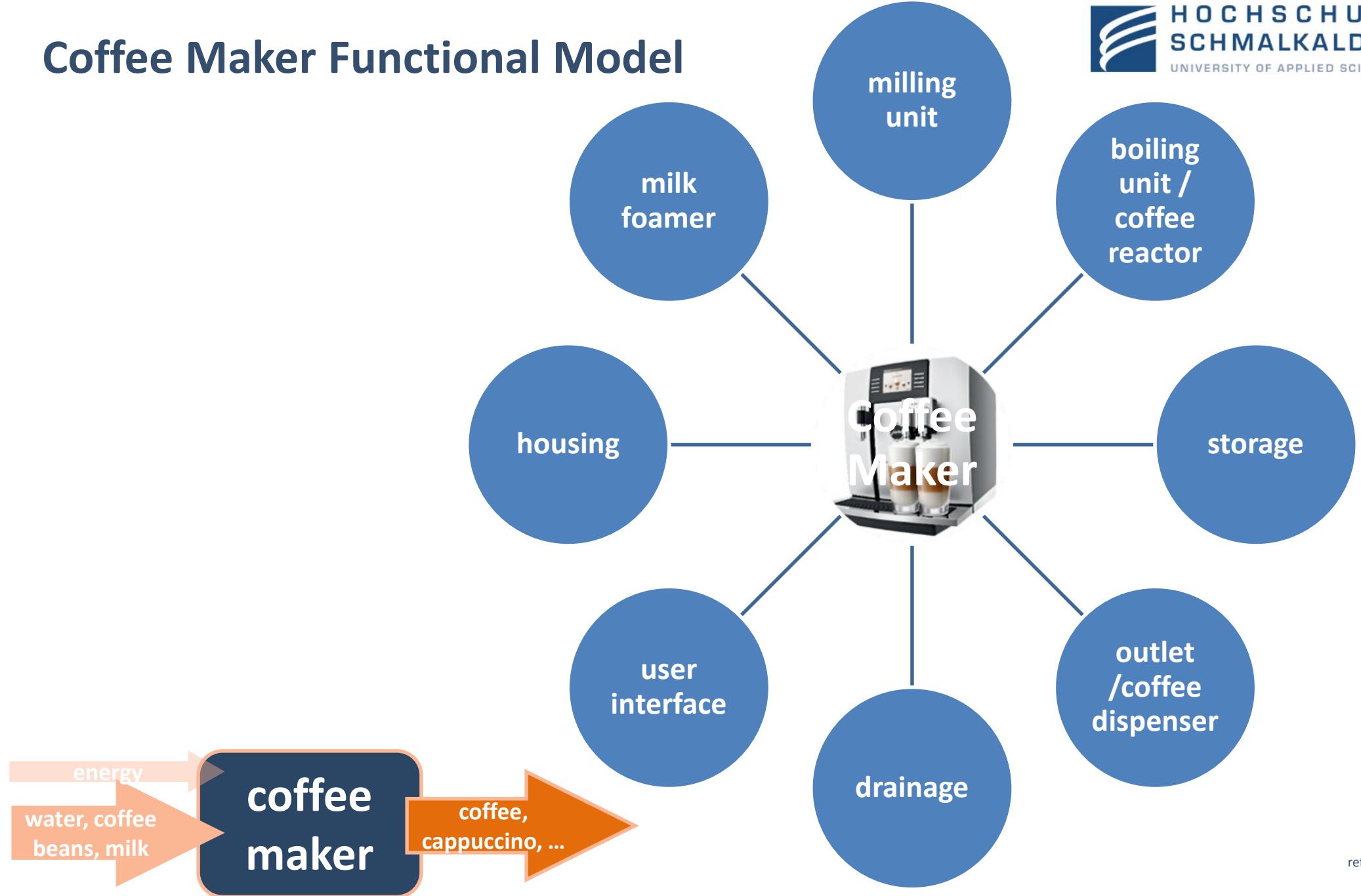
# V-Model

- approach for specification structuring by modules



# Development of Mechatronic Systems - Exercise

## Coffee Maker Functional Model



# User Requirement



**Customer's voice:**  
What is needed?  
For what purpose?

ref.: B.Braun Melsungen AG

## Structure

- preamble
  - motivation, market situation, competitors
- intended use
- focus group (user and client)
- focus application: use cases
- application site (i.e. industrial, home, etc..)
- functional requirements
  - general function (lifetime, cleaning,...)
  - specific functions (routines, features,...)
- market requirements
  - product concept, i.e. layout, portfolio
  - target markets
  - target costs (production, sales price, etc.)
- other non-functional requirements
  - service concept
  - logistic requirements, etc...
- regulatory requirements and standards
- appendices, miscellaneous

# User Requirement



application

- intended use
- focus group (user and client)
- focus application: use cases
- application site (i.e. industrial, home, etc..)
- ...



## focus group

- used by people between 14...80 yrs.
- used by male/female
- to be used without any skills (no training, no educational background necessary)
- self explaining use
- focus customer: hotel owner, public authorities, companies, middle-class families

## application site

- offices, enterprises (shop floor), schools, authorities restaurants & coffee shops, train stations, airport, domestic (home use)
- indoor environment
- 10....45°C, 0....100% r.H.

## use case

- primary operating function: preparation of coffee
- secondary operating functions
  - serving hot water (for tea)
  - preparation of espresso
  - preparation of cappuccino (with milk foam)

# Intended Use – Coffee maker



IMPRESSA C50 Instructions for Use



The Instructions for Use has been awarded the seal of approval by the independent German Technical Inspection Agency, TÜV SÜD, due to its easy-to-understand style, its thoroughness and coverage of safety aspects.

## intended use

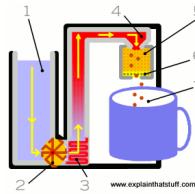
- Coffee Maker Model X is intended to be used for preparation of hot beverages, i.e. coffee beverages and hot water for tea. It can be used indoor in commercial sites as well as private homes by all people from 14 to 80 years.

## Important information

### Proper use

The machine is designed and intended for private domestic use. It should only be used for coffee preparation and to heat milk and water. Use for any other purpose will be deemed improper. JURA Elektroapparate AG cannot accept any responsibility for the consequences of improper use.

# User Requirement



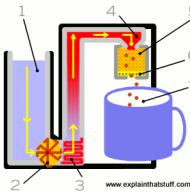
### functional requirements

- general functions for product
- module functions



### general functions

- cleaning procedure: cleaning by wiping using soapy water
- cleaning by bleach (i.e. Clorox) possible
- lifetime 10 years
- max. lifecycles 800.000 runs (cups)
- max dimensions 40 x 50 x 80 cm<sup>2</sup>
- max. weight 10 kg
- preparation time for coffee max 15 sec.
- modern “apple”-like styling
- ....



### functional requirements

- general functions for product
- module functions

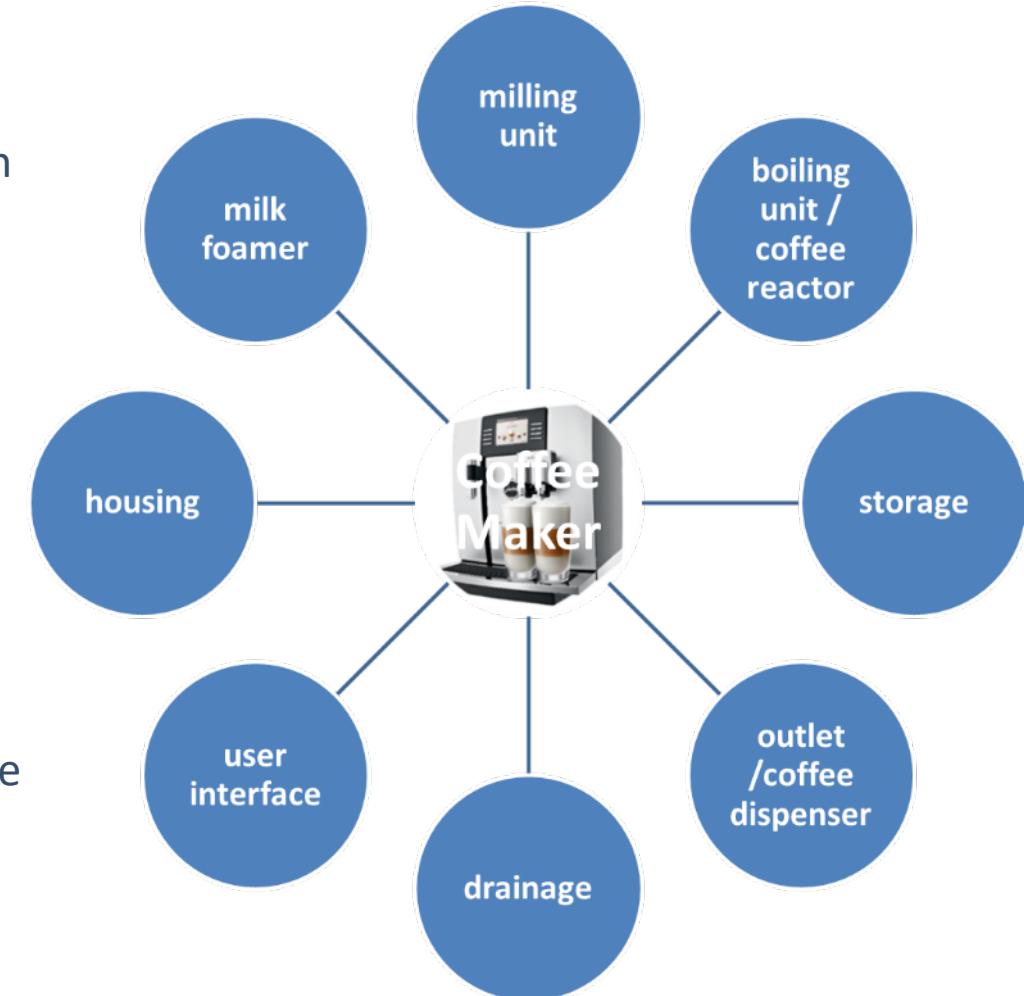


### milling unit

- powder size 50...150 µm
- milling time max. 5 sec
- use of coffee beans length 2...5 mm, max. 6 mm dia
- low noise → max. 70 dB
- stainless steel blades
- blades designed for life-time → no sharpening necessary

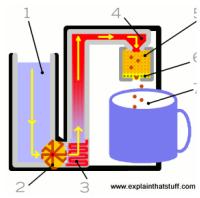
### coffee reactor

- boiling volume 200 ml
- boiling temperature coffee 100°C
- boiling time 20 sec
- hot steam for espresso → max. 120 °C, 6 bar



### functional requirements

- general functions for product
- **module functions**



## User Requirement

### storage

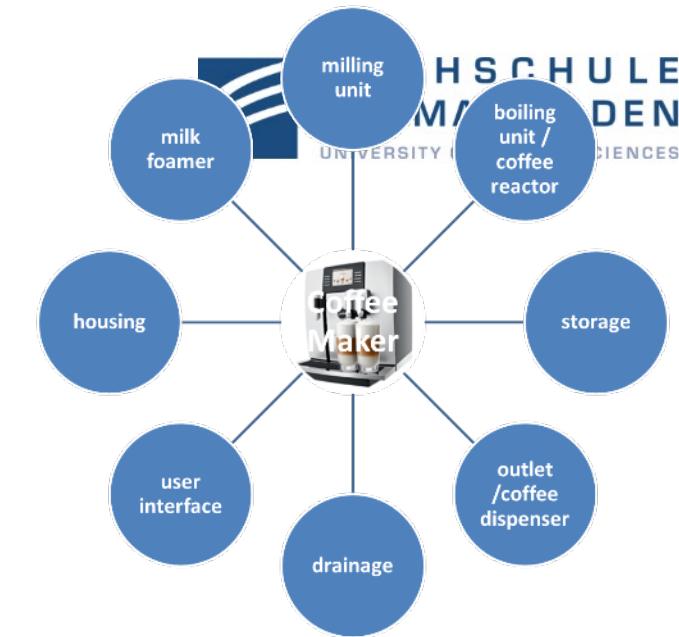
- milk storage for 50 cappuccino → 2 l volume
- coffee storage for 200 cups → 2 l volume
- water for 200 cups → 5 l volume
- connection to water tap
- water storage tank removable for filling
- each storage tank should have a handle for carrying
- filter unit for water filtration installed on tank

### outlet/dispenser

- should have two taps for parallel filling
- cups of up to 250 mm height to be filled
- filling height adjustable 50...250 mm

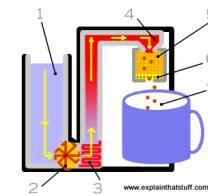
### drainage

- drainage volume sufficient for 8 h use w/o change → 500 ml volume
- drainage sink to be removable for clearance



### user interface

- readable by all users in 50 cm distance → minimum display size 7 x 13 cm, resolution 200 dpi minimum
- readable under sunny conditions → brightness 200 lux
- input by touch display
- color display → 256 colours
- cleanable by alcoholic wipes



### functional requirements

- general functions for product
- **module functions**

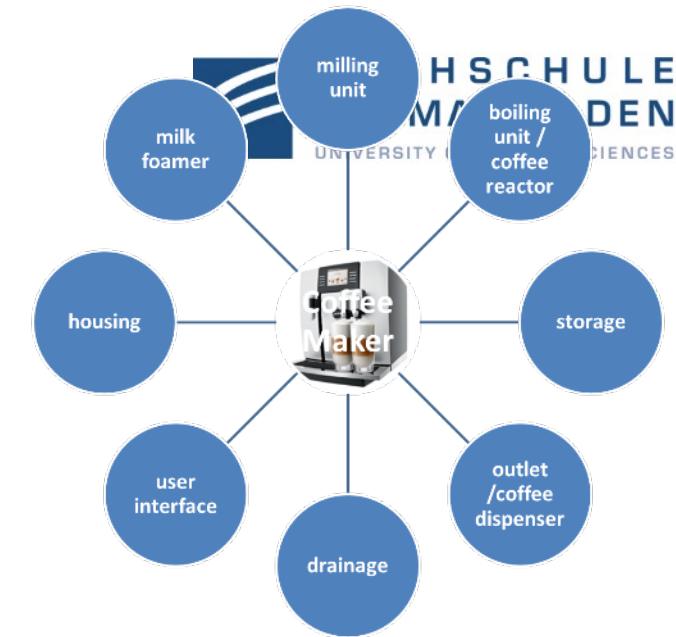


### housing

- different colors possible
- scratch-free surfaces → acc. to ISO test
- impact strength → should withstand drop by 20 cm height w/o damage
- water/dust tightness → acc. to IP 46 (EN 60529 standard)

### milk foamer

- preparation time 10 sec
- foam volume for one cup → 10 cm<sup>3</sup>
- low noise → 60 dB
- milk from cows and goats usable
- milk with fat content 1,5...5% usable
- to be cleaned by hot water 100°C
- parts to be removed and can be cleaned in dish washer



# User Requirement



## market requirements

- target market
- costs
- sales price
- product concept

### market

- EU countries
- Asia: India, Pakistan, Bangladesh
- NAFTA

### sales

- product launch September 2021
- 4 yrs. production period
- production cost max. 1500 €
- production site: Germany
- sales price 2999,- € (standard), 3999,- € (deluxe)
- production #: 10.000 units/yr.
- sales path: by licensed retailer, online shop
- private label optional

### product concept

- two model strategy
  - deluxe: with milk foamer
  - standard: w/o milk foamer
- accessories: customized cups  
brand logo



# User Requirement



non-functional requirements

- logistic concept
- service concepts
- ....

## logistic concept

- primary packaging should withstand drop of 1 mtr. height w/o damage of product
- dimensions of primary packaging acc. that fits 8 units/EURpalette
- primary packaging should withstand rainy shower → 20 min, 25mm total precipitation
- secondary packaging: EUR-palette, 8 primary units fixed
- sea shipping by container
- air freight possible
- transport conditions -15...80 °C, 0...90 % r.H.

## service concept

- online webinar for installation
- installation guide given by instruction for use
- hotline 8-20 pm/daily accessible
- repair service on the spot and at retailer
- replaceable spare parts: functional units (housing, display, ...)
- spare parts provided up to 3 yrs. after expiration of product





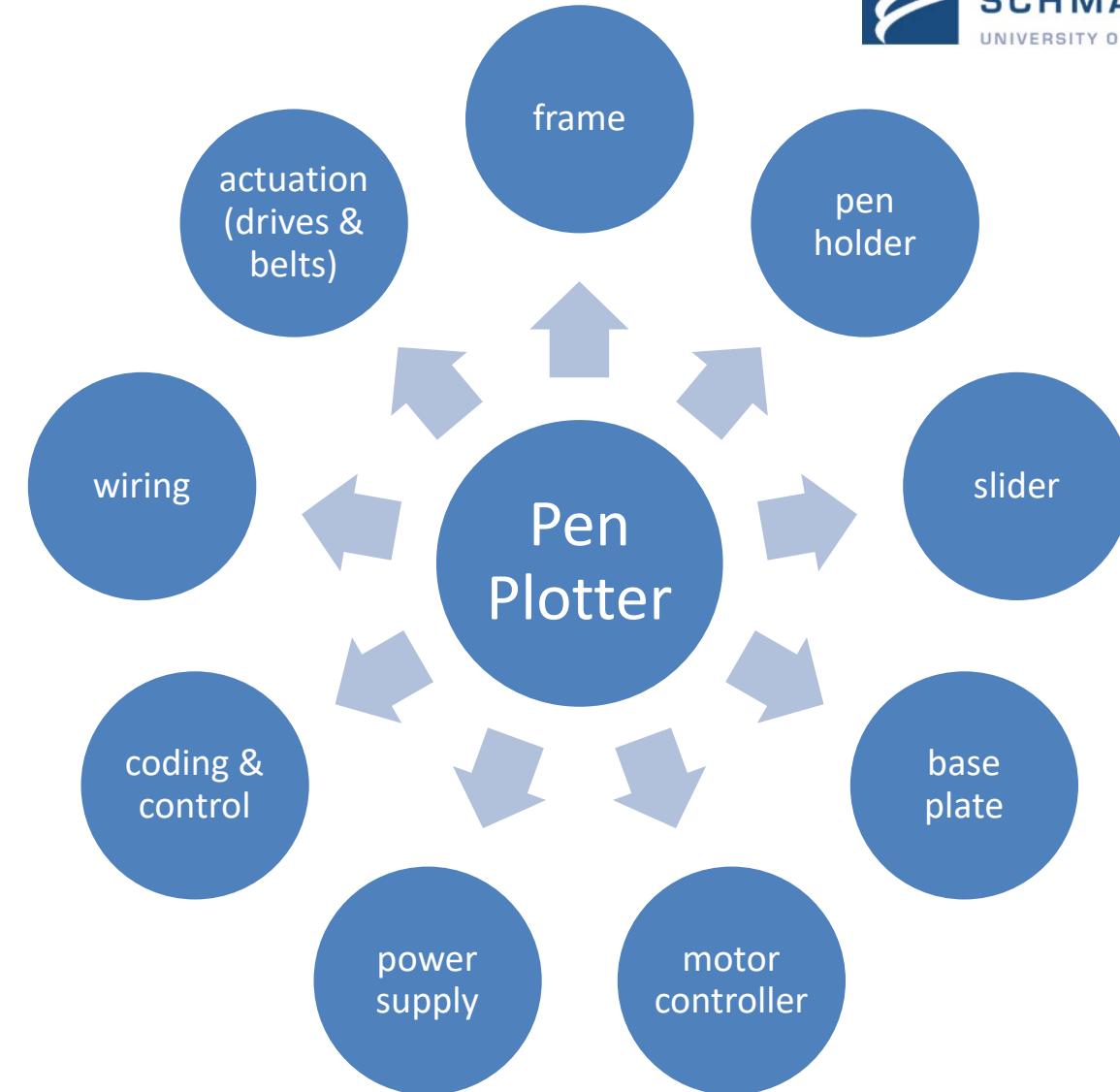
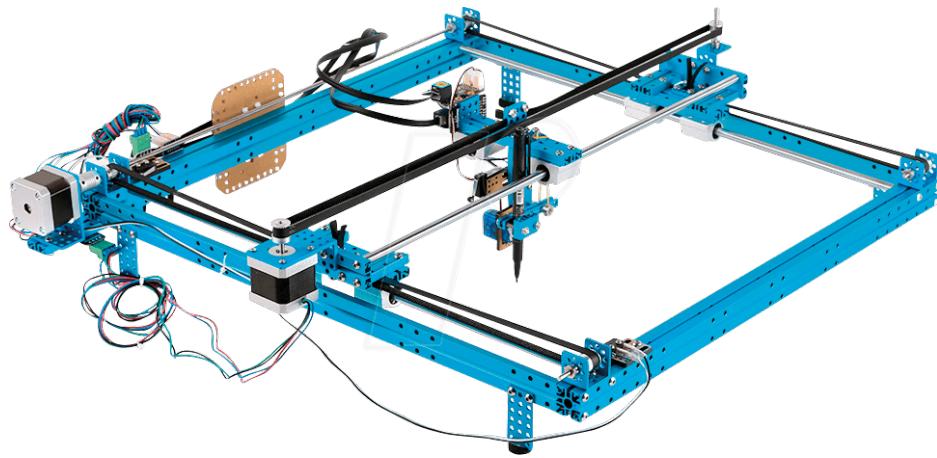
### applicable standards and conformities

- CE conformity
- EU 2006/95/EC – Low Voltage Directive
- EU 2004/108/EC – Electromagnetic Compatibility
- EU 2009/125/EC – Ecodesign Directive
- EU 2011/65/EU – Restriction of hazardous substances (RohS)
- standards valid in NAFTA and Asian countries specified for sale of product
- ...



# Modules – Pen Plotter

- What are logical modules?



ref.: leil.de/di/pics/haus\_vom\_nikolaus.jpg, reichelt.de

# User Requirement - Now it is your turn!

- <https://padlet.com/stefanalbertroth/7ynagby8g4ci04wa>

**MERO 21 - User Requirement Pen Plotter**  
What are our modules? What are customer's wishes?

**Focus & General Functions**

- Stefan Roth 7T.  
lifetime/cycle  
pen plotter should run for 5 demonstration cycles, i.e. at presentation w/o fault
- Stefan Roth 7T.  
size  
pen plotter should fit in transport box
- Stefan Roth 7T.  
weight  
pen plotter should be carried by single student

**frame**

- Anonym 7T.  
lightweight and strong enough to do specific work.
- Anonym 7T.  
Give support and does not move when it's working
- Anonym 7T.  
installed and stable at every side with pen moving in the middle

**pen holder**

- Anonym 7T.  
adjustable for different kinds of pens.
- Anonym 7T.  
It should hold firmly.
- Anonym 7T.  
should support easy change of pen from the holder

**slider**

- Anonym 7T.  
Movement should be linear, smooth and free of noise.
- Anonym 22h  
moving speed should be enough to draw accurately.
- Anonym 7T.  
long rail rod with slider and the pen installed on the slider

**base plate**

- Anonym 7T.  
should be stable enough to hold all the components and perform the required task
- Anonym 7T.  
moveable plate in X direction while the pen moves on y direction and Z
- Anonym 7T.  
should contain gripper at corner to hold paper
- Anonym 7T.  
Suitable Base area to accomodate the total frame

**motor controller**

- Anonym 7T.  
smooth controlled movement in application area
- Anonym 7T.  
No jerks



# V-Model

Make me a coffee!

User test: start machine run, prepare a cup of coffee, use of 15 focus users, criteria: intuitive handling w/o introduction

User test run report: criteria: intuitive handling w/o introduction → passed: coffee prepared by all focus users successfully w/o introduction

ERALDEN  
APPLIED SCIENCES

user need

validation

product

SYS Spec: preparation procedure: 200 ml of coffee, temperature of 75°C, total preparation time 30 sec by use of grinded beans

system specification

HW Spec: boiling unit: heat up 200 ml of water from 12° to 80° in 15 sec.

hardware specification

SW Spec: boiling unit: start-end cycle 15 sec.

software specification

ME Spec: boiling unit: boiling reservoir of 300 ml , withstand 80°C, media tap water

mechanical specification

V-Model

SYS test: Preparation procedure: 200 ml of coffee, temperature of 75°C, total preparation time 30 sec by use of grinded beans, repeat 1000 x, criteria: 1000 x run w/o fault, prescribed temp. and time kept

HW test: boiling unit: heat up 200 ml of water in 15 sec. from 12° to 80°C, repeat 1000 x, test criteria: time kept and temp. reached, 1000 x runs w/o problems

SW test: check sw-routine, run time signal start – signal end 15 sec., criteria: 15 sec. kept, emergency stop successful, ready signal given

ME test: boiling unit: boiling reservoir of 300 ml , 250 ml heat up to 80°C, test criteria: 15 min w/o distortion of tank, no occurring cracks

SW impl.: coding, start-stop cycle, ready signal, emergency stop

HW impl.: use of 800 W heating coils from supplier XYZ

Development of Mechatronic Systems

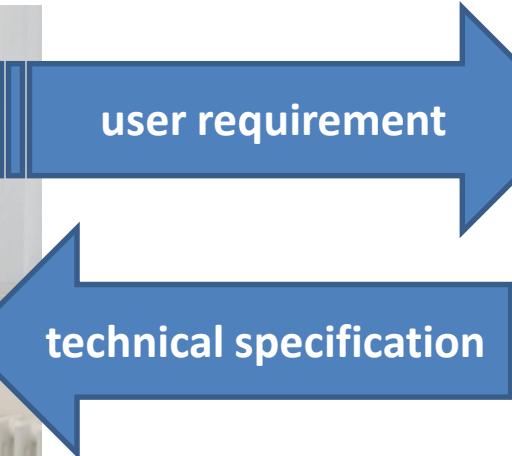
CAD

coding

IC-Layout



# User Requirement ↔ Technical Specification



Customer's voice:  
**What** is needed?  
For what purpose?



Technical Translation:  
**How** it can be realised?  
By what technical  
feature/principle etc.?

- description of needs from customer's viewpoint
- origin: market surveillance and review, customer feedback
- input: strategic company's interests
- → bundled and edited by marketing

- technical understanding/ translation of customer needs
- specific/quantifiable / measurable / verifiable / testable requirements
- edited by R&D

ref.: B.Braun Melsungen AG

# Technical Specification ↔ Design Specification

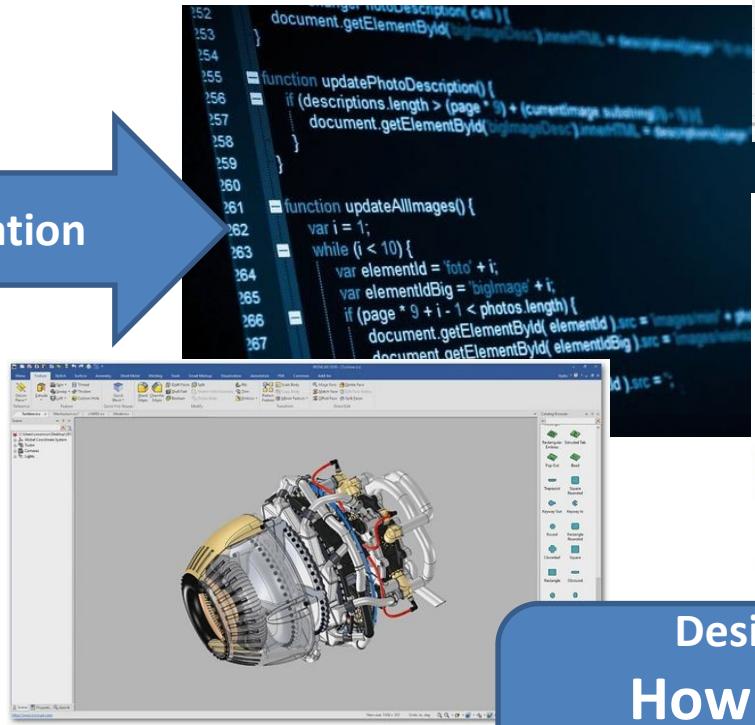


**Technical Specification:**  
How it can be realised?  
By what technical  
feature/principle etc.?

- technical understanding/  
translation of customer needs
- quantifiable / measurable
- edited by R&D

NB:  
The **technical specification** describes the technical conditions and general solution approach. It is measurable and testable by verification (i.e. module verification). The **design specification** represents the implementation, namely how/by what components the solution is realised in the product.

implementation



**Design Specification:**  
How it is implemented?  
By what technical component, HW,  
software, design?

- realisation of the specification by CAD, coding, HW-Layout, component description
- to be verified
- output of R&D-work

# Transfer User wish → Technical requirements

- translate product needs into technical specification
- one-to-one: only one spec per phrase/term
- needs to be prioritized (must /wish)



## origin of needs for requirements

- customer needs
- regulatory issues (law, directives etc.)
- standards
- measures from risk analysis
- marketing

The device has  
to be robust!

Mechanical  
Requirement

**Must:** housing has to withstand drop height of 1,80 m to hospital floor w/o parts coming off

**Must:** impact strength of housing material has to be > 25 kJ/m<sup>2</sup> acc. ISO 179 Charpy A

**Wish:** housing has to withstand drop height of 1,80 m to hospital floor w/o any damage

Electronic  
Requirement

**Must:** Electronic board has to withstand drop height of 1,80 m to hospital floor w/o parts coming off

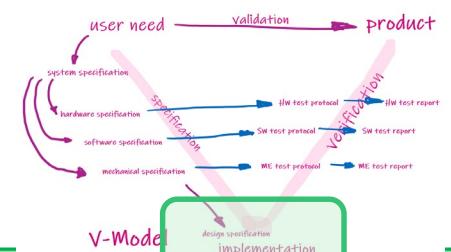
**Wish:** electronic works after drop height of 1,8 m free of error

Software  
Requirement

**Must:** drops of height >0,2 m has to be detected by electronic sensor

**Must:** drops of height >0,2 m has to be processed for alarming

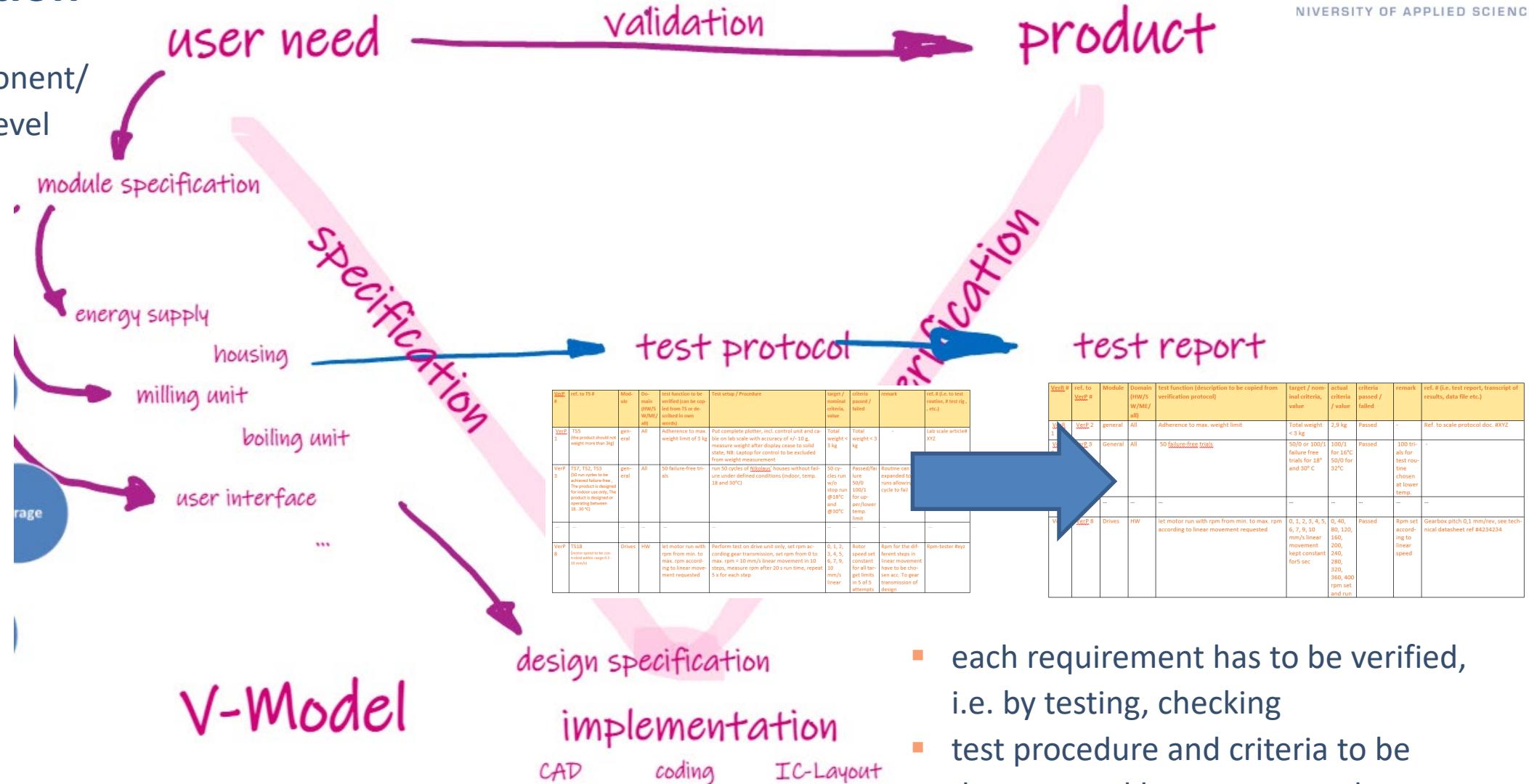
# Implementation – Design Specification



Technical Specification			Technical Requirement	Remark	Domain (HW/SW/ ME/all)	Must / Wish	Design Specification			Reference (# bill of materials, article # supplier part, ref. doc # etc.) to implementation	Remark	Domain (HW, SW, ME, all)
TS #	ref. to UR #	Title					DS #	ref. to TS #	Description			
TS4	UR4	focus group	The XY-plotter is operated by students of Master course MERO, male/female, 20...30 years old.									
<b>General Functions</b>												
TS5	UR5	portability	the product should not weight more than 3kg.		all	m	DS3	TS5	total weight of parts <3 kg, sum of all parts' weight	bill of materials (doc.# 01_MERO_BOM)	total weight 2.9 kg	all
TS6	UR6	dimensions	Designing should be taken care to fit the dimensions 56*39*42 cm <sup>3</sup>		all	m	DS4	TS6	Ground board dimensions 305 X 305 X 12mm	bill of materials (doc.# 01_MERO_BOM)		ME
							DS12	TS6	Overall dimensions 305 x 305 x 200 mm <sup>3</sup>	CAD Model (model name PP_MERO_CAD_ASSY.sldasm)		all
TS7	UR7, UR11	life time	50 run cycles to be achieved failure-free		all	m						
TS8	UR8	flexibility	Operation of plotter should be manageable by focus		all	w						
TS18	UR12	Movement in X and Y direction	motor speed to be controlled within range 0.1 - 10 mm/s		ME	M	DS10	TS18	DC geared motor V-TEC 6V Micro 10x12mm DC Motor Getriebe Motor Stirnradgetriebe 80 rpm	part# see bill of materials (doc.# 01_MERO_BOM) , technical datasheet supplier	supplier Eckstein	HW
TS19	UR17	pen unit	Schwan Stabilo fineliner, 0,5 mm thickness has to be used.		ME	M	DS11	TS19	Schwan Stabilo fineliner 88, 0,5mm thickness	<a href="https://www.stabilo.com/de/shop/17/Fineliner-STABILO-point-88/kaufen?cmsbc=431">https://www.stabilo.com/de/shop/17/Fineliner-STABILO-point-88/kaufen?cmsbc=431</a>	all colors possible	all

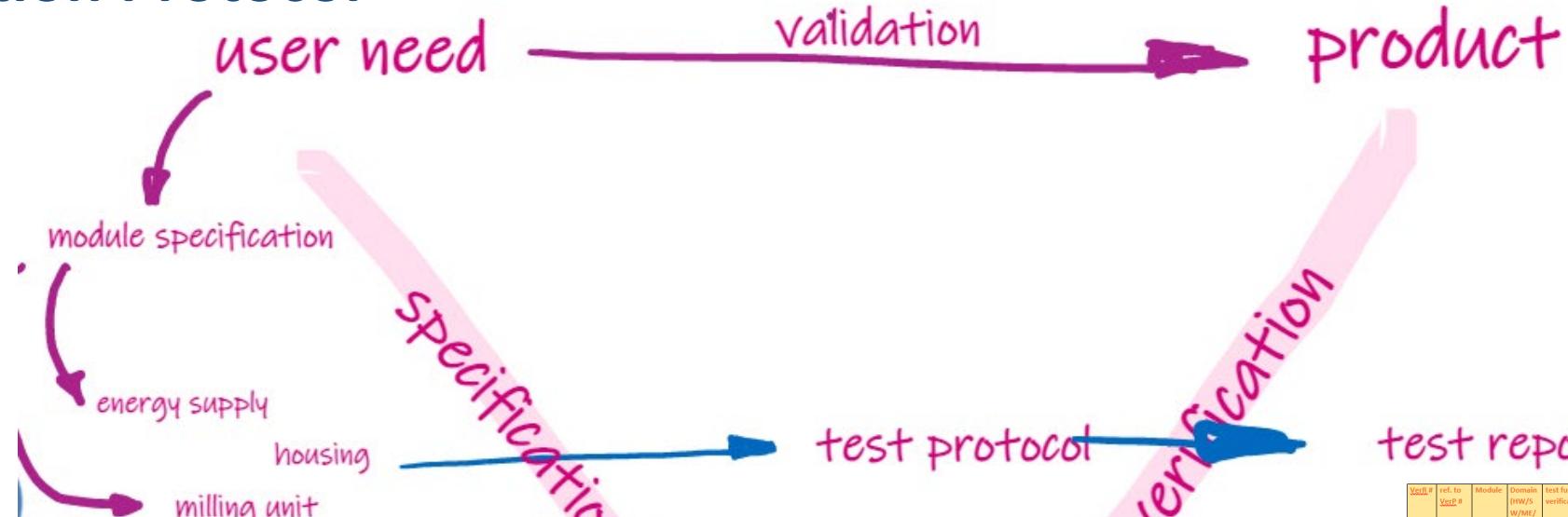
# Verification

- on component/module level



- each requirement has to be verified, i.e. by testing, checking
- test procedure and criteria to be documented by test protocol
- result documented by test report

# Verification Protocol

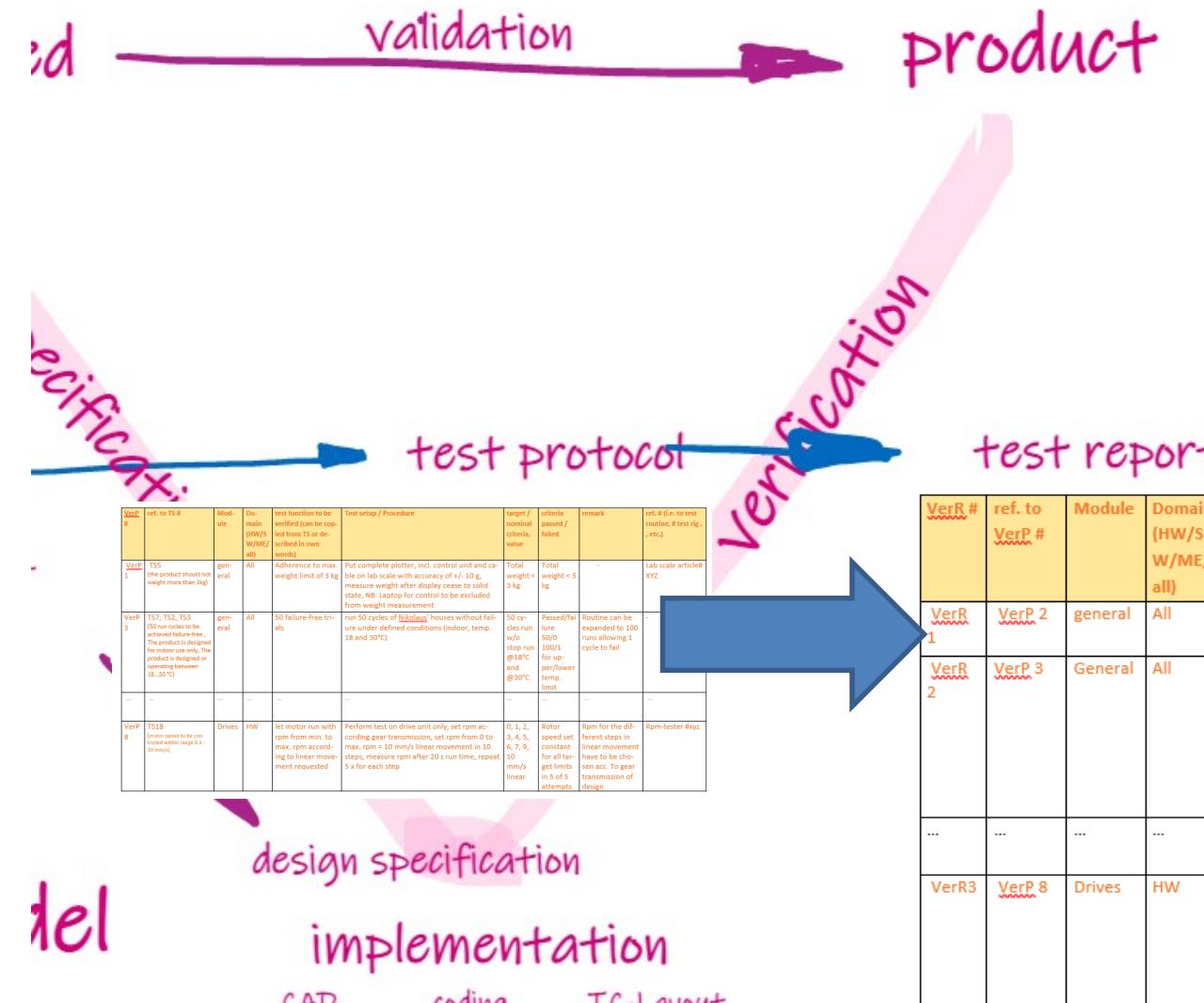


VerP #	ref. to TS #	Mod- ule	Do- main (HW/S W/ME/ all)	test function to be verified (can be copied from TS or described in own words)	Test setup / Procedure	target / nominal criteria, value	criteria passed / failed	remark	ref. # (i.e. to test routine, # test rig, etc.)
VerP 1	TS5 (the product should not weight more than 3kg)	gen- eral	All	Adherence to max. weight limit of 3 kg	Put complete plotter, incl. control unit and cable on lab scale with accuracy of +/- 10 g, measure weight after display cease to solid state, NB: Laptop for control to be excluded from weight measurement	Total weight < 3 kg	Total weight < 3 kg	-	Lab scale at XYZ
VerP 5	TS7, TS2, TS3 (50 run cycles to be achieved failure-free, The product is designed for indoor use only, The product is designed or operating between 18...30 °C)	gen- eral	All	50 failure-free trials	run 50 cycles of <u>Nikolaus'</u> houses without failure under defined conditions (indoor, temp. 18 and 30°C)	50 cycles run w/o stop run @18°C and @30°C	Passed/fail 50/0 100/1 for upper/lower temp. limit	Routine can be expanded to 100 runs allowing 1 cycle to fail	-
...	...	...	...	...	...	...	...	...	...
VerP 8	TS18 (motor speed to be controlled within range 0.1 - 10 mm/s)	Drives	HW	let motor run with rpm from min. to max. rpm according to linear movement requested	Perform test on drive unit only, set rpm according gear transmission, set rpm from 0 to max. rpm = 10 mm/s linear movement in 10 steps, measure rpm after 20 s run time, repeat 5 x for each step	0, 1, 2, 3, 4, 5, 6, 7, 9, 10 mm/s linear	Rotor speed set constant for all target limits in 5 of 5 attempts	Rpm for the different steps in linear movement have to be chosen acc. To gear transmission of design	Rpm-tester #xyz

VerP #	ref. to VerP #	Module	Domain (HW/S W/ME/all)	Test function (description to be copied from verification protocol)	target / nominal criteria, value	actual criteria / value	criteria passed / failed	remark	ref. # (i.e. test report, transcript of results, data file etc.)
VerP 1	VerP 2	general	All	Adherence to max. weight limit	Total weight < 3 kg	2.9 kg	Passed	-	Ref. to scale protocol doc. XYZ
VerP 2	VerP 3	General	All	50 failure-free trials	50/0 or 100/1 failure free trials for 18° and 30°C	Passed	100 trials for test routine chosen at lower temp.	-	
...	...	...	...	...	...	...	...	...	...
VerP 8	VerP 8	Drives	HW	let motor run with rpm from min. to max. rpm according to linear movement requested	0, 1, 2, 3, 4, 5, 6, 7, 9, 10 mm/s linear movement kept constant for sec	0, 40, 80, 120, 160, 200, 240, 280, 320, 360, 400 rpm set and run	Passed	Rpm set according to linear speed	Gearbox pitch 0.1 mm/rev, see technical datasheet ref #4234234

- reference to technical specification
- test procedure, test critieria/target value
- reference to further documents, i.e. defined test procedures optional

# Verification Report



- reference to test report
- test function and criteria (to be copied from test protocol)
- documentation of actual value
- documentation of passed / failed criterai
- reference to further documents, i.e. transcripts, data files etc.

VerR #	ref. to VerP #	Module	Domain (HW/S W/ME/all)	test function (description to be copied from verification protocol)	target / nominal criteria, value	actual criteria / value	criteria passed / failed	remark	ref. # (i.e. test report, transcript of results, data file etc.)
VerR 1	VerP 2	general	All	Adherence to max. weight limit	Total weight < 3 kg	2,9 kg	Passed	-	Ref. to scale protocol doc. #XYZ
VerR 2	VerP 3	General	All	50 failure-free trials	50/0 or 100/1 failure free trials for 18° and 30° C	100/1 for 16°C 50/0 for 32°C	Passed	100 trials for test routine chosen at lower temp.	-
...	...	...	...	...	...	...	...	...	...
VerR3	VerP 8	Drives	HW	let motor run with rpm from min. to max. rpm according to linear movement requested	0, 1, 2, 3, 4, 5, 6, 7, 9, 10 mm/s linear movement kept constant for 5 sec	0, 40, 80, 120, 160, 200, 240, 280, 320, 360, 400 rpm set and run	Passed	Rpm set according to linear speed	Gearbox pitch 0,1 mm/rev, see technical datasheet ref #4234234

# Approach for Pen Plotter

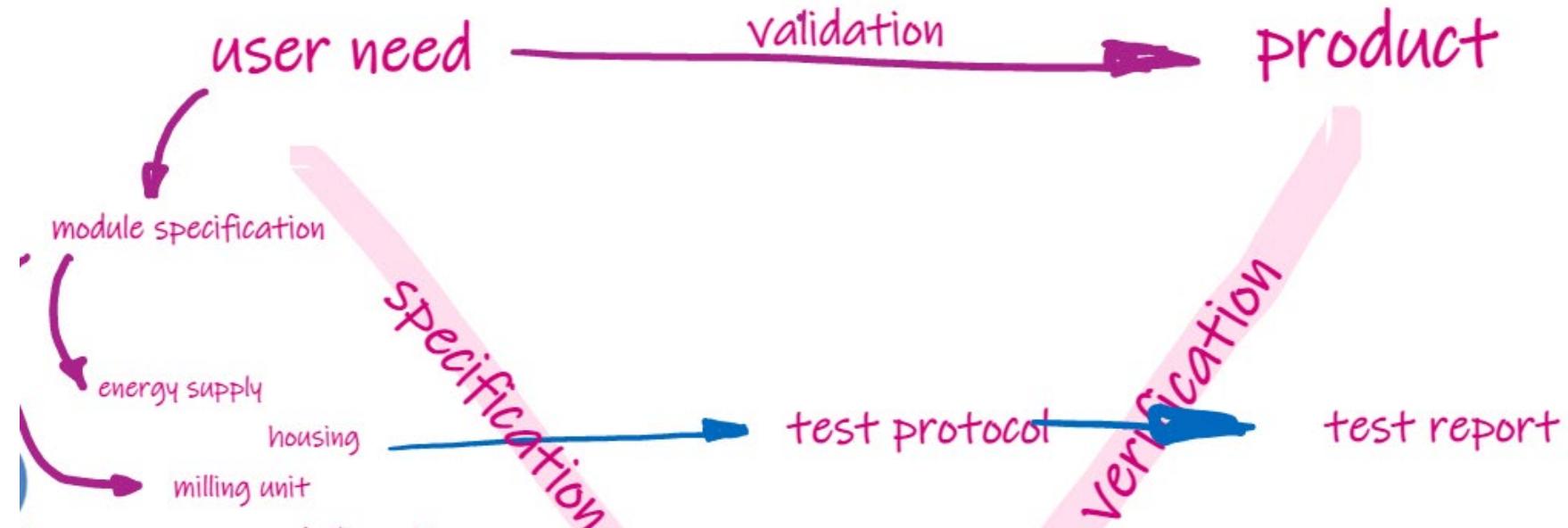
- you can create separate documents for test protocol and report
- also, you can use the requirement engineering matrix to be filled up with your test protocol and

i	Verification Protocol					Verification Report					Validation Protocol								
	Ver P #	ref. to TS	test procedure (description of routine)	verification criterion	ref. # (i.e. test protocol,etc.)	Domain (HWIS WIME)	VerR #	ref. to VerP #	test function (to be copied from verification protocol)	verificatio n criterion	actual value	criterion passed / failed	remark	ref. # (i.e. test report etc.)	Domai n (HW)	ValP #	ref. to UR #	validation (descrip)	
<b>General Functions</b>										<b>General Functions</b>									
VerP1	TS5	proof total weight by scale	weight <3 kg	test protocol doc # 02_MERO_VerP	all	VerR1	VerP1	proof total weight by scale	weight <3 kg	2,9 kg	P		Print out scale, see test report 05_MERO_Ve		all				
VerP2	TS6	put total pen plotter into SAMLA-box 45l	has to fit in box with lid closed	test protocol doc # 02_MERO_VerP	ME	VerR2	VerP2	put total pen plotter into SAMLA-box 45l	has to fit	fits	P		test report handling see test report 05_MERO_Ve		all				
VerP3	TS7, TS2, TS3	run 50 cycles of Nikolaus' houses without failure under defined conditions (indoor, temp. 18 and 30°C)	50 failure-free trials at high/low temperature	test protocol doc # 02_MERO_VerP	all	VerR3	VerP3	run 50 cycles of Nikolaus' houses without failure under defined conditions (indoor, temp. 18 and 30°C)	50 runs @18°C, 50 runs @ 30°C	55 runs @ 16°C, 63 runs @31C, who failure	P		test report handling see test report 05_MERO_Ve		all				
VerP4	TS8, TS4	focus group (3 members) should manage to run Nikolaus' house drawing cycle after 5 min oral introduction to plotter	3 runs done successfully after introduction	focus group test protocol 03_MERO_UseTestP	all	VerR4	VerP3	focus group (3 members) should manage to run Nikolaus' house drawing cycle after 5 min oral introduction to plotter	3 runs	8 runs	P		focus group test report 06_MERO_Us eTestR		all				
<b>Module Function - Mechanics</b>										<b>Module Function - Mechanics</b>									
VerP5	TS9	draw line of 50 mm length by use of Schwan Stabilo 0,5 mm, repeat 5 x	thickness range 0,45...0,55 mm	test protocol doc # 02_MERO_VerP	ME	VerR4	VerP5	draw line of 50 mm length by use of Schwan Stabilo 0,5 mm, repeat 5 x	thickness range 0,45...0,55 mm	thickness range 0,48...0,52 mm	P		test report handling see test report 05_MERO_Ve		ME				

# Validation

- to be carried out on device level
- refers to validation of application (intended use, use case,...)
- to be documented by validation protocol → validation report analogue to verification
- alternatively: documentation in requirements engineering matrix

Validation Protocol					Validation Report			
ValP #	ref. to UR #	validation procedure (description of routine)	ref. # (i.e. validation protocol, customer test, etc.)	validation criteria	ValR #	ref. to ValP #	criteria passed / failed	ref. # (i.e. test report, etc.)
<b>Application</b>								
ValP 1	UR 1, UR 2, UR 3, UR 4	set-up pen plotter at University's lab, start pen plotter by student, draw Nikolaus' house	validation protocol doc.# 07_MERO_ValP	Nikolaus house plotted in one run	ValR 1	ValP 1	passed	validation report doc.# 08_MERO_ValR



# Project Dossier

# Project Dossier

to be provided by team

- written project dossier (ca. 20...30 pages)
- use template provided for master thesis:

[https://studip.hschmalkalden.de/dispatch.php/institute/files/index/6a6766b29dfd0a20cb9a1a891595f979  
?cid=abd13090707bd4d737a878cf96fc8eab](https://studip.hschmalkalden.de/dispatch.php/institute/files/index/6a6766b29dfd0a20cb9a1a891595f979?cid=abd13090707bd4d737a878cf96fc8eab)

## content/structure of dossier

- description of task
- development documentation acc. V-model
  - user requirement
  - technical specification
  - test protocol
  - test report

→ you can use the excel spreadsheet to file your requirements and verification actions
- presentation of technical solution
  - design
  - function
  - IC-layout & principle
  - software / hardware / coding
- appendices: CAD-data, bill of materials, coding,... (provided by e-files)



Aktionen	
<input checked="" type="checkbox"/> Ordner bearbeiten	
<input checked="" type="checkbox"/> Neuer Ordner	
<input checked="" type="checkbox"/> Datei hinzufügen	

Ansichten	
<input checked="" type="checkbox"/> Ordneransicht	
<input type="checkbox"/> Alle Dateien	

/ Formulare und Hinweise für Praktikum/ Abschlussarbeit/ Anerkennung Studienleistungen /  
Abschlussarbeit / Leitfaden Erstellung von Abschlussarbeiten, Wordvorlage und Aufgabenstellung - Guide  
for Bachelor/Master Thesis & Templates  
Ein Ordner für Materialien, welche nur zum Download zu Verfügung gestellt werden sollen.  
Den Inhalt des Ordners können nur Lehrende und TutorInnen verändern.

Guideline for Master Thesis and Templates  
Leitfaden und Wordvorlage für das Erstellen von Abschlussarbeiten

Anmerkung: Für Abschlussarbeiten aus dem Bereich Maschinenbau entfernen Sie bitte das AKT-Logo aus den Vorlagen

Type	Name	Größe	Autor/-in	Datum	Aktiv
<input type="checkbox"/>	Aufgabenstellung BA MA AKT Template.docx	2.2 MB	Roth, Stefan	vor 1 Monat	
<input type="checkbox"/>	BA-MA_HSM_Word - Formatvorlage V3.0_05-2020.dotx	652.0 kB	Roth, Stefan	vor 1 Jahr	
<input type="checkbox"/>	Guideline MasterThesis Seul_Beneke_Roth_Himmel-Saar 2021-06 V3.0e.pdf	1.5 MB	Roth, Stefan	vor 9 Monaten	
<input type="checkbox"/>	Leitfaden Erstellen von Abschlussarbeiten Seul_Beneke_Roth_2020-05 V3.0.pdf	2.4 MB	Roth, Stefan	vor 1 Jahr	
<input type="checkbox"/>	Master Thesis - Information MERO WS 20-21.pdf	929.1 kB	Roth, Stefan	vor 9 Monaten	
<input type="checkbox"/>	Thesis Outline Master MERO Template.docx	2.2 MB	Roth, Stefan	vor 2 Monaten	



# Project Presentation

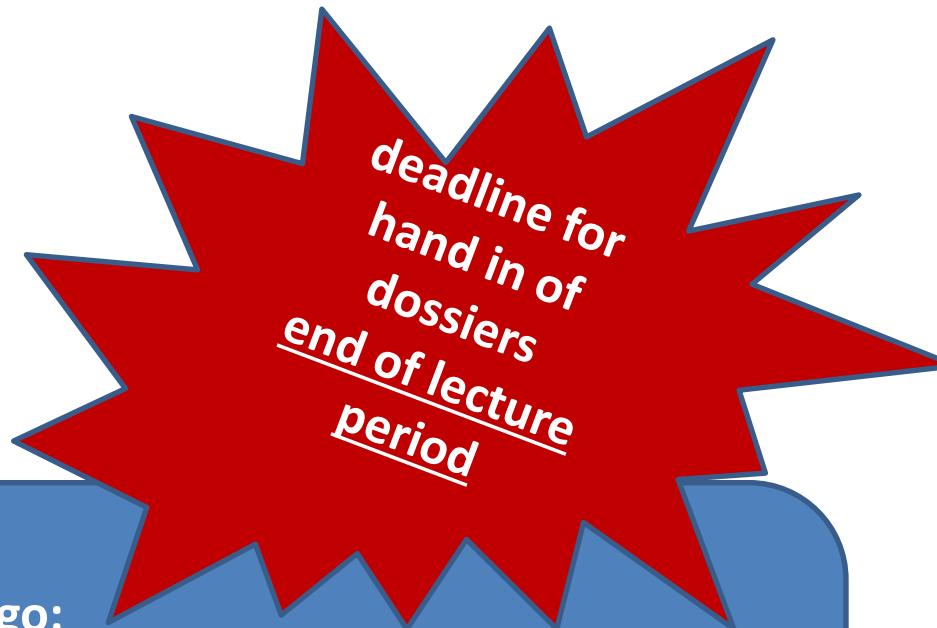
- oral presentation of workshop project
  - 10 min presentation + 10 min demo run pen plotter + 10 min Q & A
- keep the time limits!

## content/structure of presentation

- introduction/description of task
- presentation of technical solution
- live demonstration: test run Nikolaus' house



<https://legogradstudent.tumblr.com/post/177558645356/serving-as-a-discussant-the-grad-student-lobs>



## Steps to go:

1. Prepare project dossier
2. hand in as e-file to team folder in StudIp
3. announcement of date for presentation by supervisor
4. presentation and final mark

# Thank you for your attention!



ref.:www.din.de/resource/blob/320522/b8d972c9f576fb8d3a0d7c1f69c64015/roboter-schach-data.jpg

## Contact

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