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Exercise for

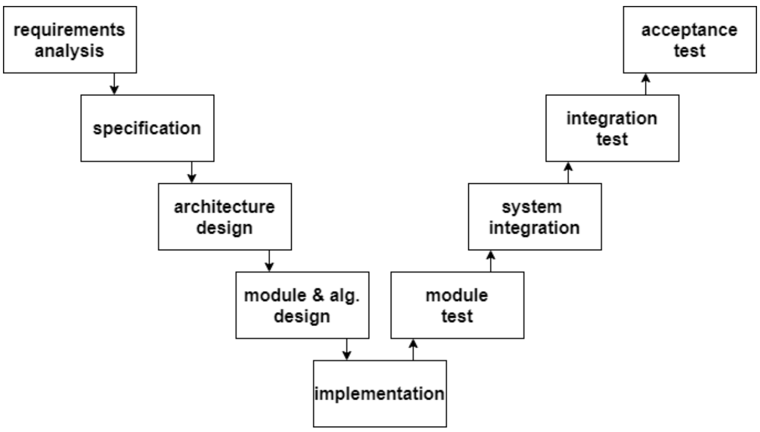
Embedded Systems

Summer Term 2025

Sheet 5: Embedded Software Dev. & Design

Exercise 1: V-Model
Name the missing steps of the V-Model, denoted by A-E in the following graphic:

Solution:



For the remaining three exercises imagine the following scenario:
You are a startup that wants to manufacture an innovative luxury car. However, you are limited in budget and thus cannot afford an assembly line for the production of your vehicle as well as the required parts. Since you firmly believe in the success of your car and want to be able to scale easily with higher demand you start looking for alternative production line designs (Referred to as "System" further on).

Exercise 2: Types of Requirements
To find the optimal design for your production you start by writing down requirements for it. This yields the following ten requirements.
For each requirement decide whether they are functional or non-functional. If they are non-functional, choose the correct category from the quality tree. (A copy of the quality tree is attached to the end of this exercise)

- The System must fit in an area of 20x20m.
  Solution: **Mounting Space**
- The Assembly-System should not require an up-front payment higher than 3 million$.
  Solution: **Cost**
- Switching the production to a different vehicle model should take less than 24 manhours and no additional capital investment.
  Solution: **Configurability**
- Increasing the Systems capacity twofold should not exceed 100 manhours.
  Solution: **Scalability**
- Reducing the Systems footprint to an area of 10x10m at the cost of a 60% lower production rate should be doable with less than 100 thousand$ in capital investment.
  Solution: **Adaptability**
- The Assembly of a car chassis should take at most 60 minutes.
  Solution: **Performance**
- The System must be able to produce parts out of Titanium and Aluminium.
  Solution: **Functional**
- The incorporation of further types of metal alloys into your production line should be doable in less than 80 manhours.
  Solution: **Extendability**
- The assembly should have tolerances of less than 0.05 millimeters.
  Solution: **Reliability**
- The System must be able to assemble a chassis, all mechanical parts and all body panels of a car.
  Solution: **Functional**

Exercise 3: Good Requirements

A big automative manufacturer is interested in your development and is willing to fund part of its development if the system will also meet their requirements. You ask the manufacturer to send you these and receive the following ten requirements.

For each requirement decide whether there are issues with them. Use the ”Basic requirement issues” discussed in the lecture as a guideline. If there is an issue with a requirement choose one of the following reasons:

(The requirement proposes a solution / the requirement is not checkable / the requirement is not understandable by an average programmer).

- The Assembly-System should use 4 robotic arms.
  Solution: **Proposes Solution**
- The System should be able to produce parts meeting the ISO 134866-1:1999 standard.
  Solution: **Not Understandable**
- The System should be able to adapt to other metals.
  Solution: **Not Checkable**
- The System should be able to be sold as a product.
  Solution: **Not Checkable**
- The Systems operation should not require human interaction 99.99% of time.
  Solution: **Good**
- The metal parts should be 3D-printed.
  Solution: **Proposes Solution**
- The Levy should be less than half of the liquid assets available.
  Solution: **Not Understandable**
- Production should take less than a week.
  Solution: **Not Checkable**
- The parts should be assembled in the center of the machine, one piece at a time.
  Solution: **Proposes Solution**
- The System should be operational in temperatures between -10°C and 50°C as well as humidities between 10% and 60%.
  Solution: **Good**

Qualitytree: