14: Embedded SW Engineering

Switching to SW engineering

Where we've been

Low-level details of embedded (IO, architecture, clocks, some OS/scheduling)

Where we're going

Bigger picture: software engineering for embedded

What is the difference between software engineering and programming?

People skills

Software engineering involves working with people, to make products that will be used by people

We are not flawless, nor are we machines

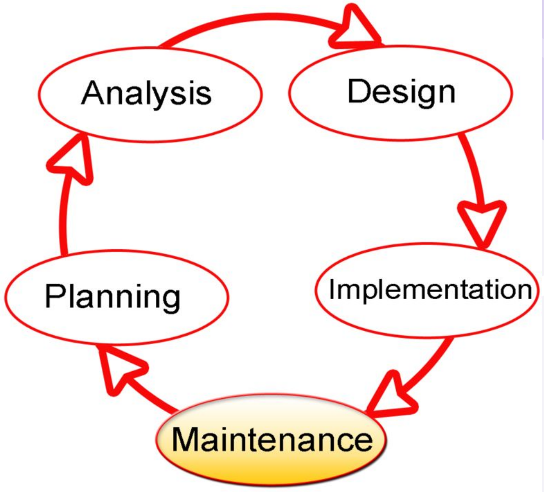
- We have biases, bad days, grudges, weaknesses, but also empathy, collaboration, and diverse viewpoints

What are some ways that sloppy communication or poor management can make for bad code?

System development life cycle

5-10+ stages, may include

- Idea or solicitation by customer
- Marketing
- Planning
- Requirements/analysis
- Design
- Implementation/development
- Testing
- Verification and validation
- Operation/maintenance



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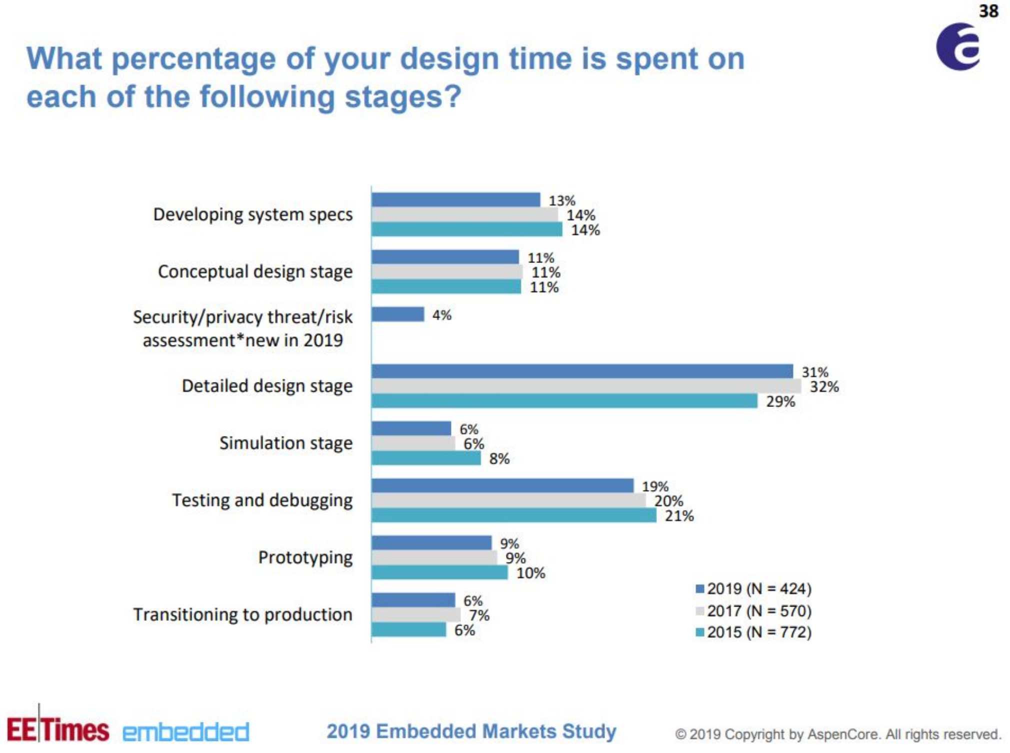
Planning and design makes up majority of SW process



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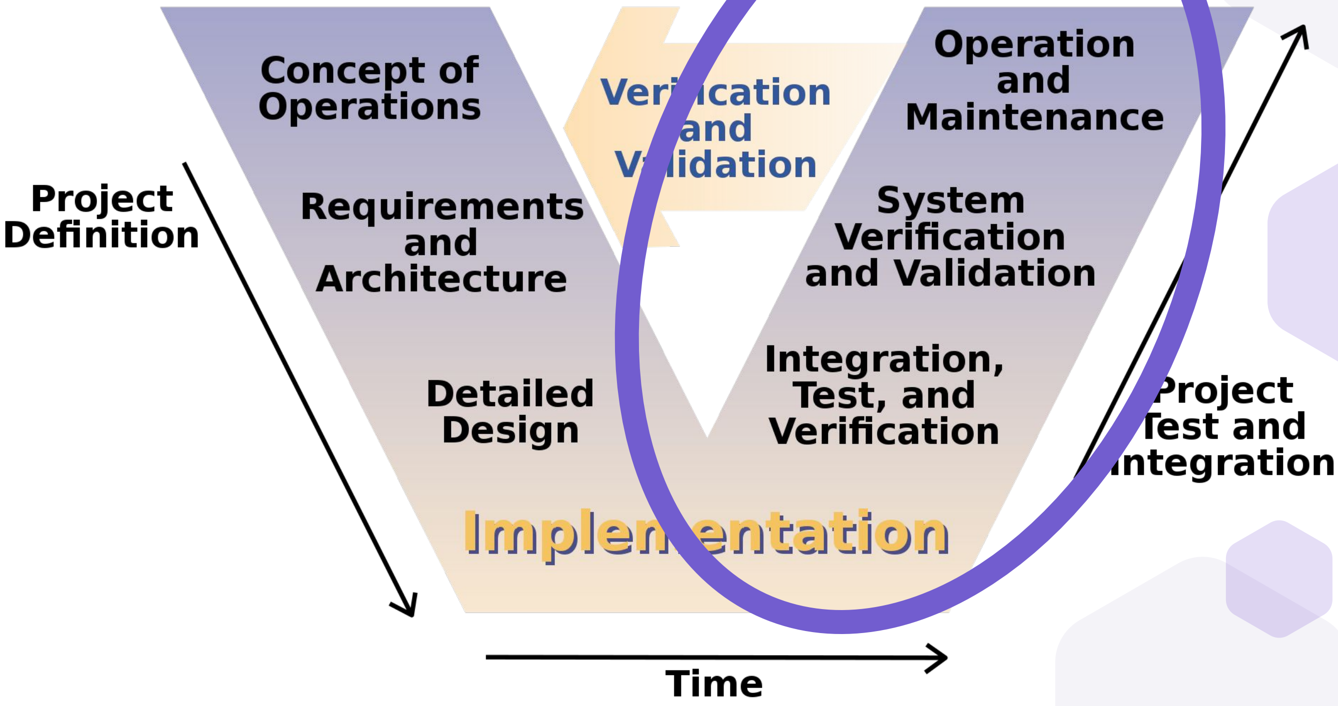
Illustrative example: standing desk

What would it make more sense to do first:

1. *Write standing desk controller requirements*
2. *Unit test standing desk controller*
3. *Write standing desk user requirements*
4. *System test standing desk*

V model

Week after next!



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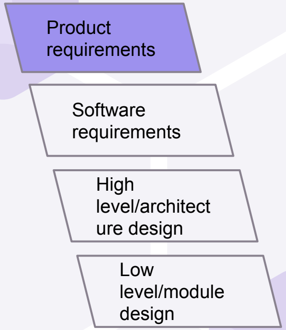
Left side of V model

Product requirements	What the product does from the customer POV
Software requirements	What the product does from the SW POV (high-level, not the "how")
High level/architecture design	What modules there are in the system, which module performs which function, how modules communicate
Low level/module design	Flowcharts, statecharts/finite state machines, algorithms...



Product requirements

Our electric height-adjustable table allows you to easily and effortlessly change from sitting to standing positions throughout your day. Raising and lowering the table is simple, using its ultra quiet, feature-rich electric mechanism. It's an essential tool to any modern workspace.

Details:

- Changing your posture often keeps you more engaged and more comfortable
- Meetings are significantly shorter when standing vs. sitting
- Height-adjustable tables are essential to modern workspaces and prized by office workers everywhere
- Push-button activation with height display readout
- 3 memory positions

Customer-facing
Can be a list of features
Used in marketing

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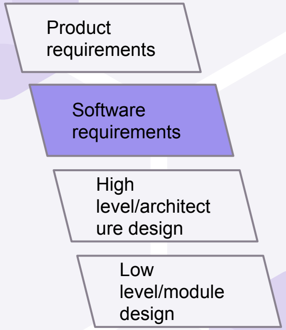
Software requirements



Written with specific wording and format

- “Shall” - the software **must** do this
- “Should” - the software has this goal
- Labeled or numbered (RS-1, RS-2, RS-2.a…)

Precise and measurable

- Quantitative over qualitative
- Can be tested

What the software does, not *how*

Product requirements

Software requirements

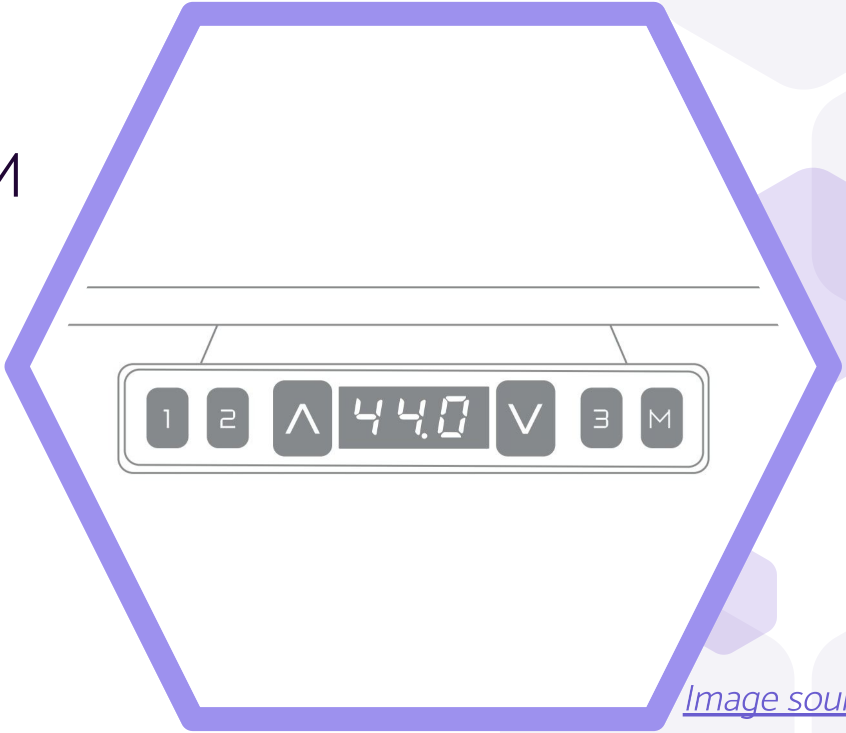
High level/architecture design

Low level/module design

Standing desk inputs

Current height*

Buttons: 1, 2, 3, up, down, M



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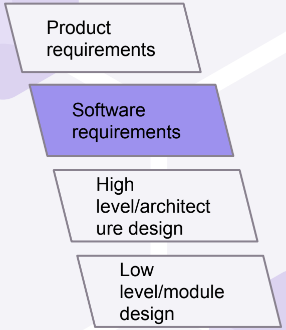
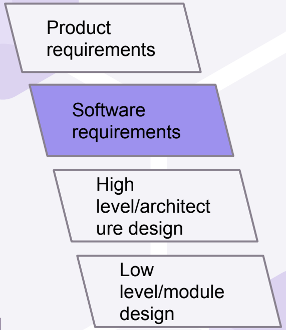


Standing desk outputs

Motor command (stopped, up, down)

Display



Standing desk requirements

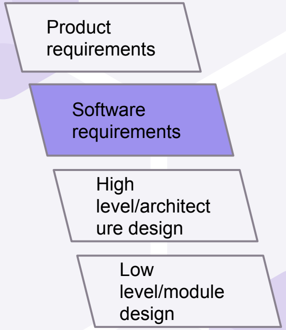
R1: If the desk is not at its maximum height, and the up button is held, the motor shall be commanded UP

R2: If the M button is pressed and released, and one of the numbered buttons [1, 2, 3] is pressed and released within 10 seconds, then the current height shall be stored as a preset for the corresponding numbered button

R3: If one of the numbered buttons [1, 2, 3] is held, the motor should be commanded such that the desk height moves to the corresponding preset height

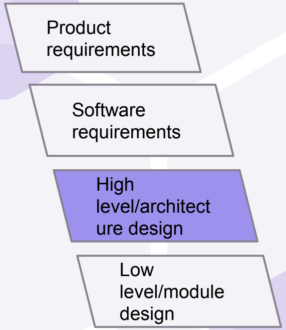
Come up with additional requirement(s) that refine the preset behavior

R3: If one of the numbered buttons [1, 2, 3] is held, the motor should be commanded such that the desk height moves to the corresponding preset height



Refined requirements

High-level/architecture design

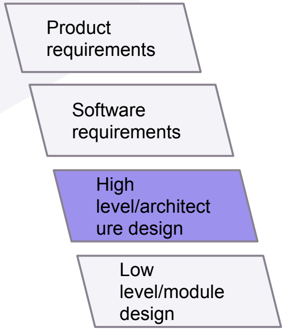


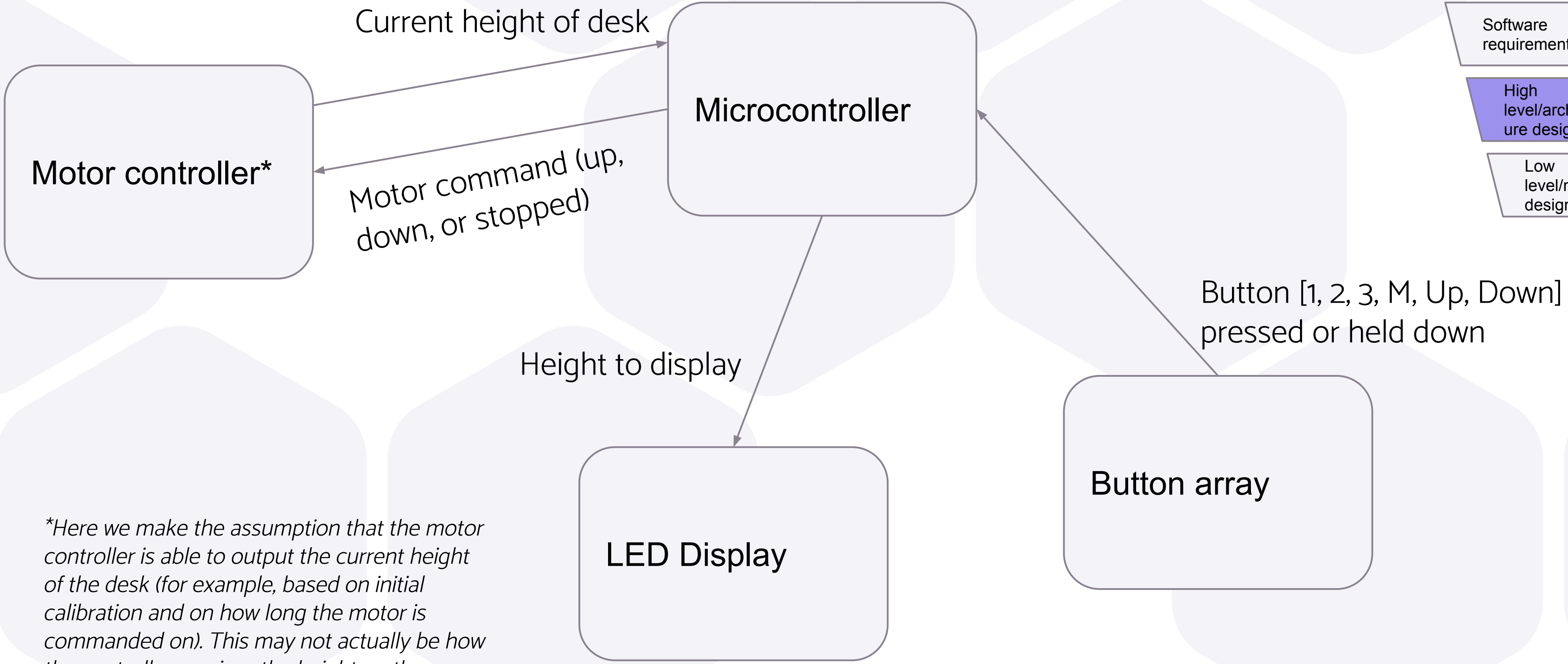
How components fit together and what the interfaces are

- Boxes-and-arrows diagram: **boxes** are components, **arrows** are interfaces

General rule: should fit on one page

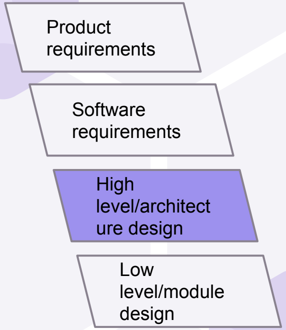
- Details of components are left to detailed design





**Here we make the assumption that the motor controller is able to output the current height of the desk (for example, based on initial calibration and on how long the motor is commanded on). This may not actually be how the controller receives the height on the product, but it's an assumption of how there might be bidirectional communication between two components in a product architecture.*

Boxes-and-arrows for standing desk



Sequence diagrams

Shows interaction between components

Columns: components

Arrows between columns: data sent across interfaces

Temporally arranged (lower is later)

Usually one for each customer **scenario**

- Scenario is variant of a **use case**

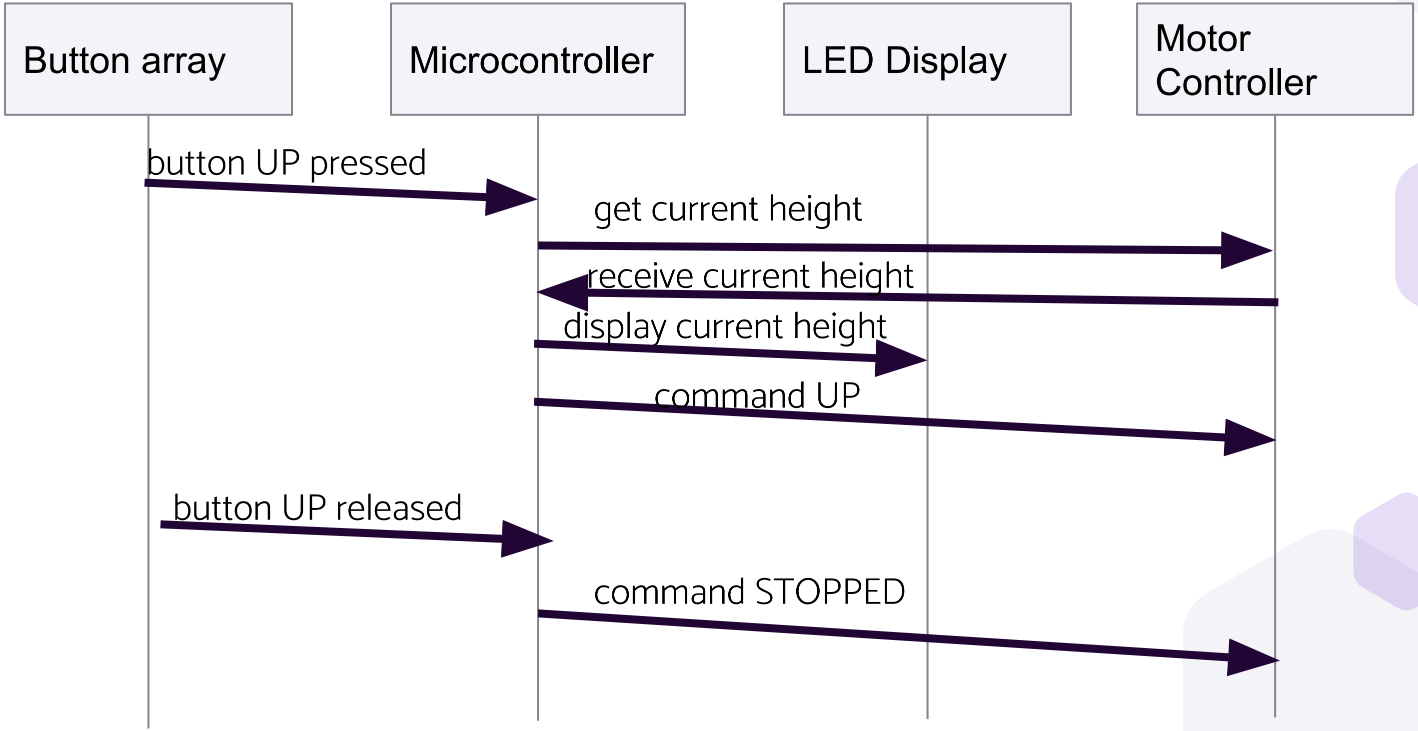
Product requirements

Software requirements

High level/architecture design

Low level/module design

Scenario: user wants to raise desk, presses up button and desk rises



Scenario: store current height as preset 2