ELEC-E9900 Networked Partnering and Product Innovation - NEPPI

Final lecture

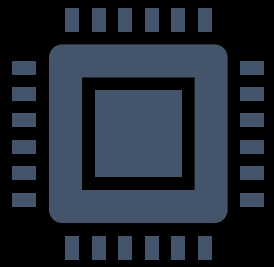
Salu Ylirisku

29.11.2021

Learning Goals

1. To **know Internet of Things (IoT)** from a pragmatic perspective
2. To **design technical concepts** in a user-centred manner
3. To **define key design requirements** of technical applications

Schedule – Two parts



Part I:

Building a complex IoT machine with given design requirements

Event: Show on 12th of November in Väre (13:00-13:30)

Part II:

Defining a design concept with the key design requirements for an IoT application

Event: EXPO on 10th of December in TUAS (15:00-17:00)

Absences

The team is expected to participate in each session throughout the course, i.e., have most of the team actively co-present

If you are absent, please,
1) inform Salu
2) inform your team

Absences are compensated by reading/writing assignments

(due on 17th of Dec)

Absences before the NEXPO´21

- Wed 1st & Fri 3rd of Dec – User tests / Wiz-of-Of
- Wed 8th of Dec – Preparations for NEXPO´21
    - Teaching staff is available at Design Factory
    - You may choose to work elsewhere – just inform Salu up front via e-mail

Evaluation criteria

- IoT machine project (NEPPI hex machine), 20%
- IoT concept project, 20%
- NEXPO, 20%
- Teamwork, 20% (peer grading)
- Exam, 20%

- If you are absent, reading assignments will be assigned to you – and you need to catch up with your team

The IoT machine project grading

- Active participation, 50 %
- Working result (meets the design requirements), 40 %
- Wow effect, 10 %

→ This amounts to 1/5 of the course points. Consider this achieved!

The IoT concept project grading

- Depth of research
  - User study, technology study 20%
- The design approach
  - Iteration, involvement, expression 20%
- Clarity of argumentation of the key requirements
  - Observations, reasoning, decisions 20%
- The quality of the key design requirements
  - Concise, clear, unambiguous 20%
- The presentational quality of the concept
  - Appeal, easy-to-understand, credibility 20%

The IoT concept project grading

- The presentation of your concept in the NEXPO´21 / virtual side needs to address these aspects:
  - Depth of research
    - User study, technology study 20%
  - The design approach
    - Iteration, involvement, expression 20%
  - Clarity of argumentation of the key requirements
    - Observations, reasoning, decisions 20%
  - The quality of the key design requirements
    - Concise, clear, unambiguous 20%
  - The presentational quality of the concept
    - Appeal, easy-to-understand, credibility 20%

The NEXPO grading

- Active participation, 20%
- Audience engagement, 40%
- Presentational design, 20%
- Technical quality in the display of the design concept, 20%

- **NEXPO organising team** needs a member from each project team
  - Makes up half of the project grading for them

Evaluation criteria for the NEXPO team

- IoT machine project (NEPPI hex machine), 20%
- IoT concept project, 10%
- The NEXPO, 30% (of which 1/3 is peer-graded)
- Teamwork, 20% (peer grading)
- Exam, 20%

So, expo team members go through a double peer evaluation. Your project team and the expo team.

Peer grading
– about active participation & contribution

- You will give grade to each one in your team 0-100% (=0-1 in the form)
- You will receive an average score of this

- Default is always 100%, less than 100% means some issues
  - And one gets below 50% then Salu will consider the whole course evaluation for that person

Exam Grading

- Online exam, 17.12 10-12 (ARTS students 16-18)
- 5 questions, 1pt / each

- The answers can be found in the lecture materials

The Exam is about Knowledge

- IoT, Cloud(s), Apps, Devices, Computing, Connectivity
- UX, Prototyping Tools

– what, why, how, and why bother as a design manager

Testing with users

What is a good procedure?

1. Pilot
2. Explain the purpose why you need support
    1. Get people motivated to participate
3. Explain thinking aloud method & documentation
4. Provide clear instructions and the equipment and tools
    1. What is the goal / situation for the user
5. Start with something simple (a simple task for the user)
6. Then test and do observations
7. Thank the participants :)

Do not tell the boss!

Avoid giving hints too early!

[Design Prototype vs. Design Concept]

Learning outcomes

- What are design prototypes
- What are design concepts
- What are design requirements

[Design Prototype
=
Device for Learning]

What is this kind of learning?

- You are learning about an emerging design object
- The learning means that you are developing an ability to judge how your design object works

What does to work mean?

- There are different ways in which design objects (design prototypes / design concepts / design outcomes) work

design for **product development**
- specification for the following design phases
- decision to go ahead with implementation

Concept design for **innovation**
- spin-offs for immediate improvements
- idea bank for future use
- concept directions for technology development investments
- alliances with key partners
- patenting

Concept design for **shared vision**
- specific shared meanings
- vocabulary for communication

Concept design for **competence**
- improving creative problem solving
- improving cross-disciplinary -cooperation
- learning about technology and market opportunities
- improving team spirit

Concept design for **expectation management**
- improving brand image
- influencing consumers' acceptance level
- influencing stakeholders' interest

Keinonen, T. (2006). Introduction to Concept Design. In T. Keinonen & R. Takala (Eds.), *Product Concept Design: A Review of the Conceptual Design of Products in Industry* (pp. 2–31). Springer.

FIGURE 1.7.

The objectives of concept design

IDBM International Design Business Management

[Concepts are Tools]

Language concepts are tools too

- Finnish language has two words for concept:
  - Käsite and konsepti
- Herbert Blumer (1969) argued that scientific concepts are *tools* that
  - 1) enable scientists to gain a new orientation,
  - 2) permit a new organisation for effort, and
  - 3) guide the release of action.

Blumer, H. (1998). *Symbolic Interactionism: Perspective and method (1969)*. University of California Press.

[How do prototypes work for learning?]

What is the simplest prototype you can think of?

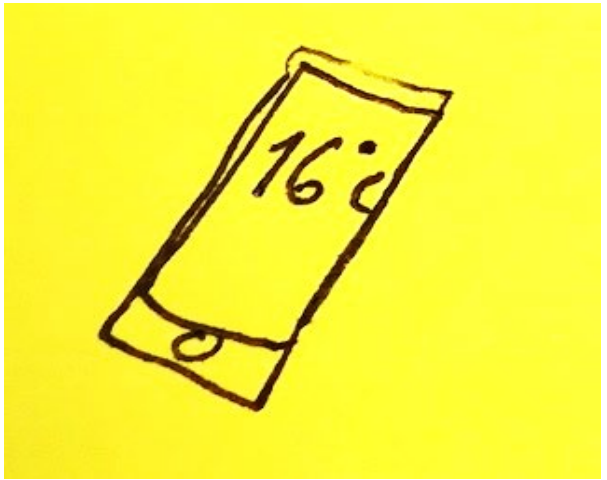
- Idea
  - This gets too deep ☺
- Pic / visualisation / sketch

- Existing object that represents something else
  - “potato theatre”
  - Mock-ups

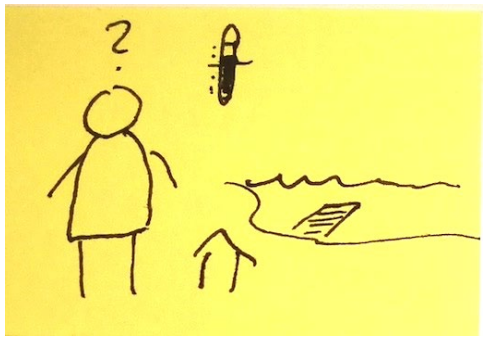
Sketches for learning

What functionalities/features?

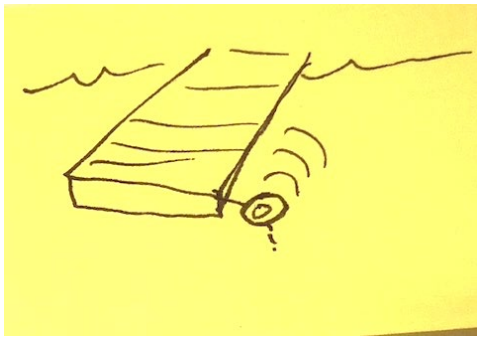
The summer cabin’s water thermometer.



Storyboard / interaction scenario:

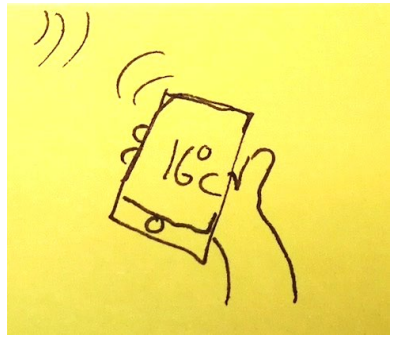


The owner of a summer cabin at a lake, Petra, wants to go swimming. She wants to know, before leaving home, how cold the water is.



She has a wireless thermometer attached to her dock that measures water temperature.

The wireless thermometer sends the temperature data to internet service once a day.



Petra can see the lake temperature on her mobile phone.

Summer cabin's remote water thermometer

Essential requirements?

Measure the water temperature

Show the temperature on a remote mobile device

Weather and water resistant

Battery life at least.. How much?

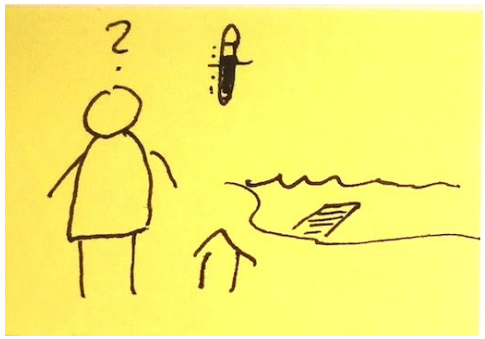
Findings from the users - empathy

User 1: **“**It is enough to know the temperature while at the location, it is just a curiosity. I wouldn’t pay for remote service.**”**

User 2: “I need to know when to remove the ladder from the lake. Water temperature does not decide if I go for swimming or not.”

User 3: “Nice to have. I like to know how things are at the cabin, year round, as it is quite far a way.”

Storyboard / interaction scenario:



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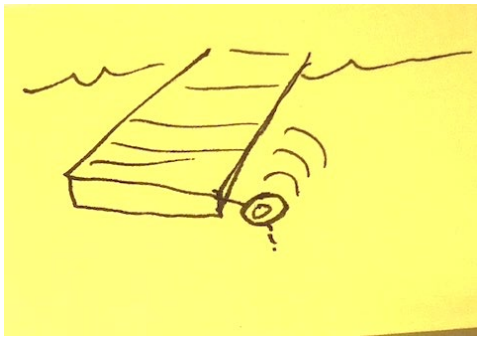

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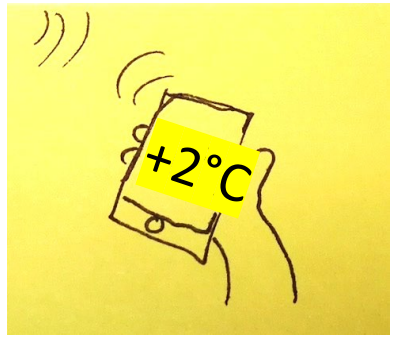
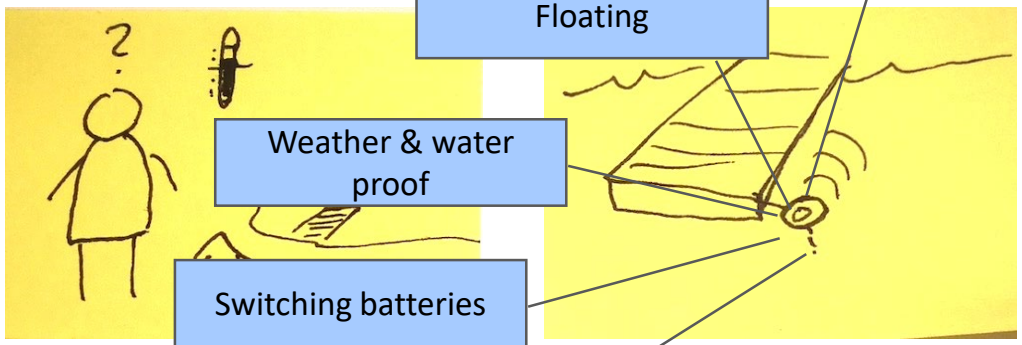
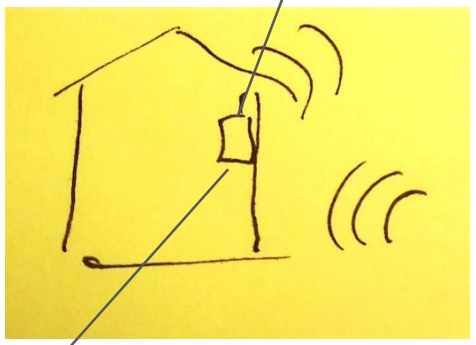


Petra can see the lake temperature on her mobile phone.

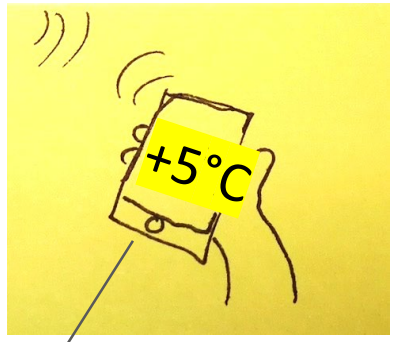
What functionalities/features?



- Attaching
- Floating
- Weather & water proof
- Switching batteries
- Powering on/off
- Indicating that power is on/off
- Computer connection & admin interface needed!
- Metering the temperature
- Connecting to router (LoRaWAN)
- Indicating that connection ok/not



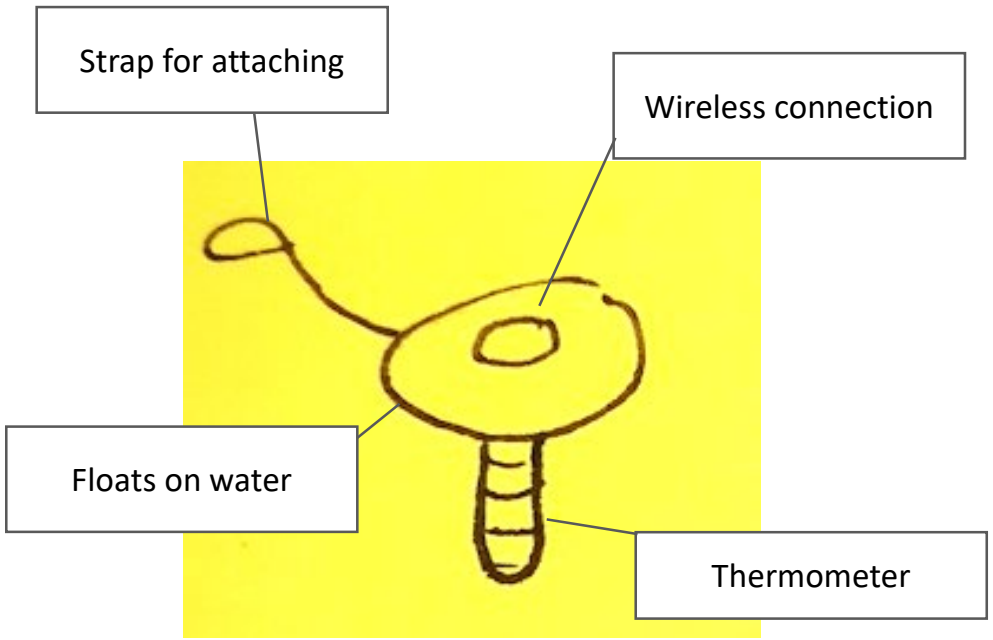
- Mounting
- Connecting to internet
- Setting up access point
- Computer & admin interface needed

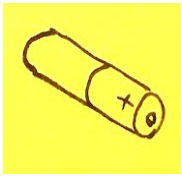


- Installing the app
- Creating an account
- Connecting to user's account
- Showing the measurements

Poster

Wireless Remote Water Thermometer





Safe to use
2 x AA battery
Battery life up to
3 years

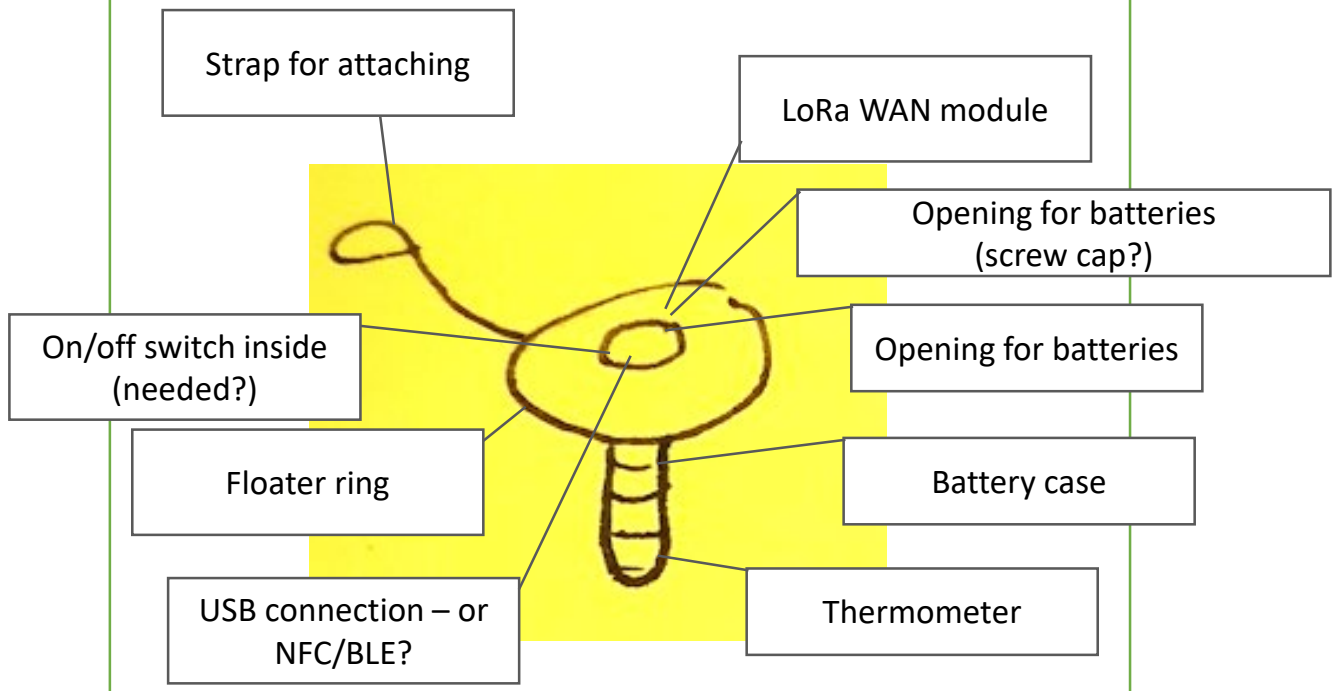
Cloud service
(0.99 €/month)

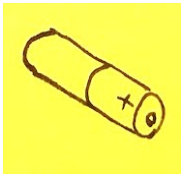
Free Mobile App

Aalto University
School of Electrical
Engineering

Poster

Wireless Remote Water Thermometer





Safe to use
2 x AA battery
Battery life up to
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Cloud service
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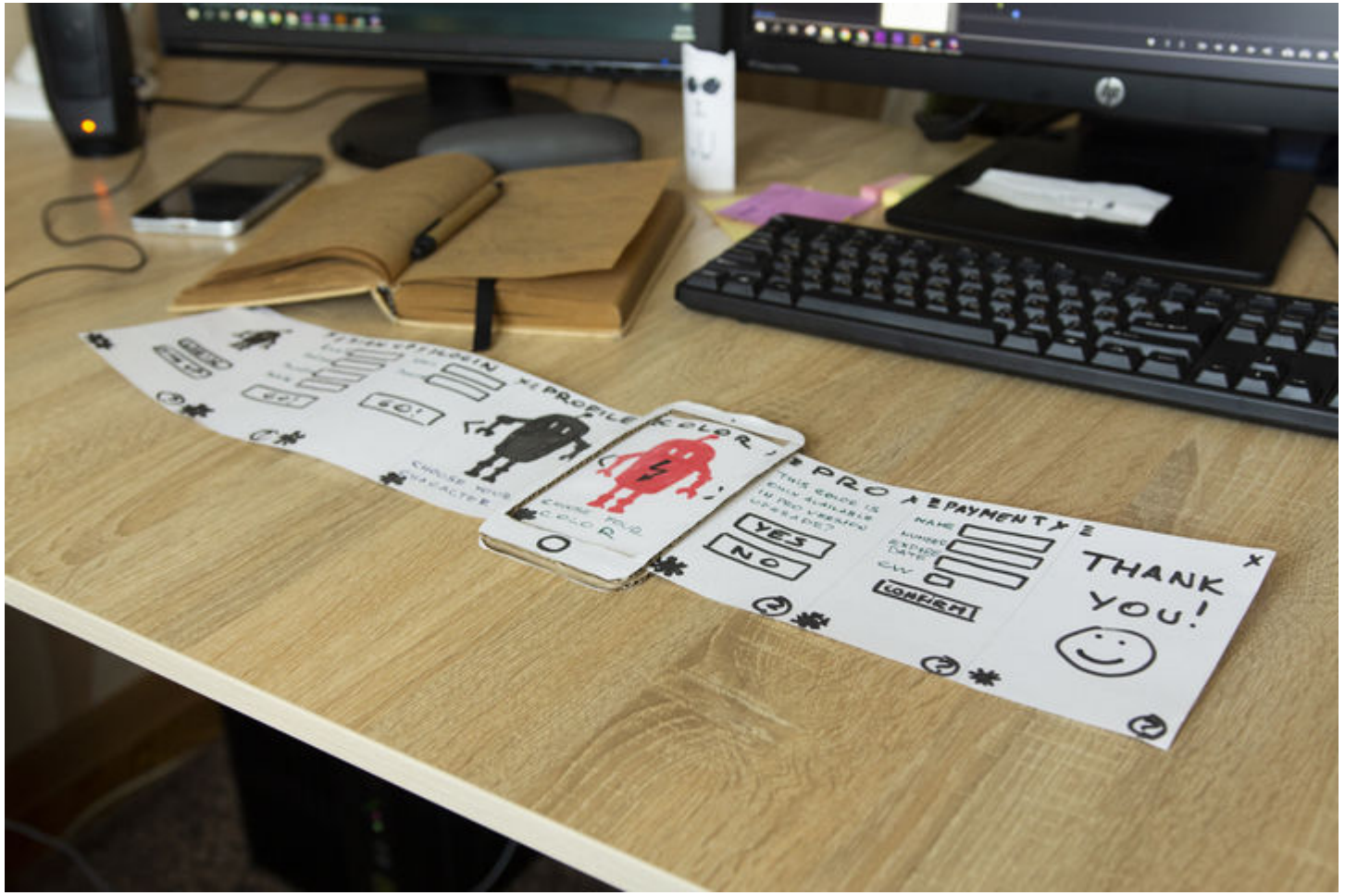
Aalto University
School of Electrical
Engineering

Paper prototypes / Mock-ups



https://www.interaction-design.org/literature/topics/paper-prototyping

E-mail reader

- Field test of the full-scale mock-up and the final poster. Design by Kim Aagaard Holm

Ylirisku, S., & Buur, J. (2007). *Designing with Video: Focusing the user-centred design process* (1st Edition.). Springer.

Creative Design Agency | Creative A

Prototyping & Modelmaking - Marker Maker Creative |...

Industrial Design Agency Bristol - Handmade Foam Models

Design los | Site Design | Branding

Segment Camera

Blond | Segment Camera More

Design Model | Tool Design | Primi

Model Making

Model Making by Barney Mason, via Behance

Sketch | Models | Sketch Drawing

Foamcore - Sketch Models

S Stephen Schock

Sketch Models - Mock Ups

3d Design | Design Model | Icon D

Blue foam...

Design Thinking Process | Design Pr

Simply The Braun Pivo - Yanko Design

Braun Camera foam prototype.

Pop Design | Design Model | Sketc

barber & osgerby: axor one, an interactive shower control

barberosgerby_axor-one_designboom_018

Design Thinking Process | Design Pr

The making of the Twist pitcher for Barrier water...

The making of the Twist pitcher for Barrier water filters

Pen Design | Design Model | User

Mina Bassilious

Been building foam models of an electric screwdriver #modelmaking #idstudent...

Bed Cover Design | Surface Modelin

Portfolio Layout | Portfolio Design

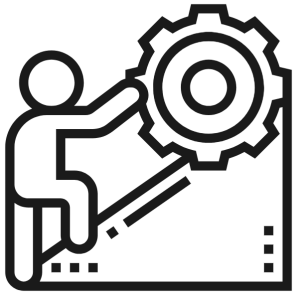
触摸的快感！明基逆向工程鼠标大揭密_-泡泡网

触摸的快感！明基逆向工程鼠标大揭密

Different kinds of tech prototypes

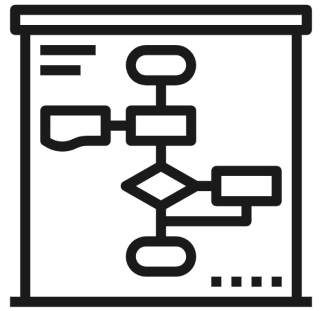
- The physical form/interaction -> Experiential prototype (yes users)
- The components/mechanisms -> Technical prototype (no users)
- The algorithm/processing -> Functional prototype (no users)
- All -> Integrated prototype (yes users)

Technical prototype



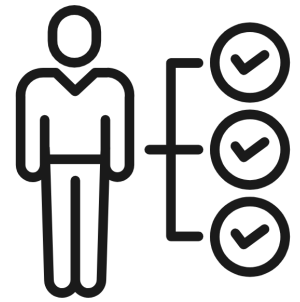
- To test critical components / structures / mechanisms
- With components: Figuring out the price, availability and performance (*for your project*!) may require some research
- With structures: Figuring the needed physical properties, the layout, and size
- With mechanisms: Figuring out how to best do it may require both research (see how others have done similar) and own experimentation

Functional prototype



- To test the critical functionality
- With existing software and modules: Figuring out how well particular software/modules/libraries work for your project, finding reliable sources (in Github check out stars, forks, latest updates, and community)
- With your code: Testing 1) if it works (positive testing), 2) how it breaks (critical testing)

Experiential prototype



- To test how your design fits to users, their activity, or their environment, how it appears and feels to interact with
- With physical forms: Figuring out the location of things for the user, the overall shape, and tactile feel/sensory appeal
- With visual aspects: Figuring out the understandability and appearance
- With interaction: Figuring out how the users are able to use the device, and how they think about it

Integrated prototype

- To test how the whole works (both in the lab as well as with users)

From components back to the whole

[Design Concept = Device for Change]

[Design Concept = Opinionated Learning Outcome]

Design concept as a tool

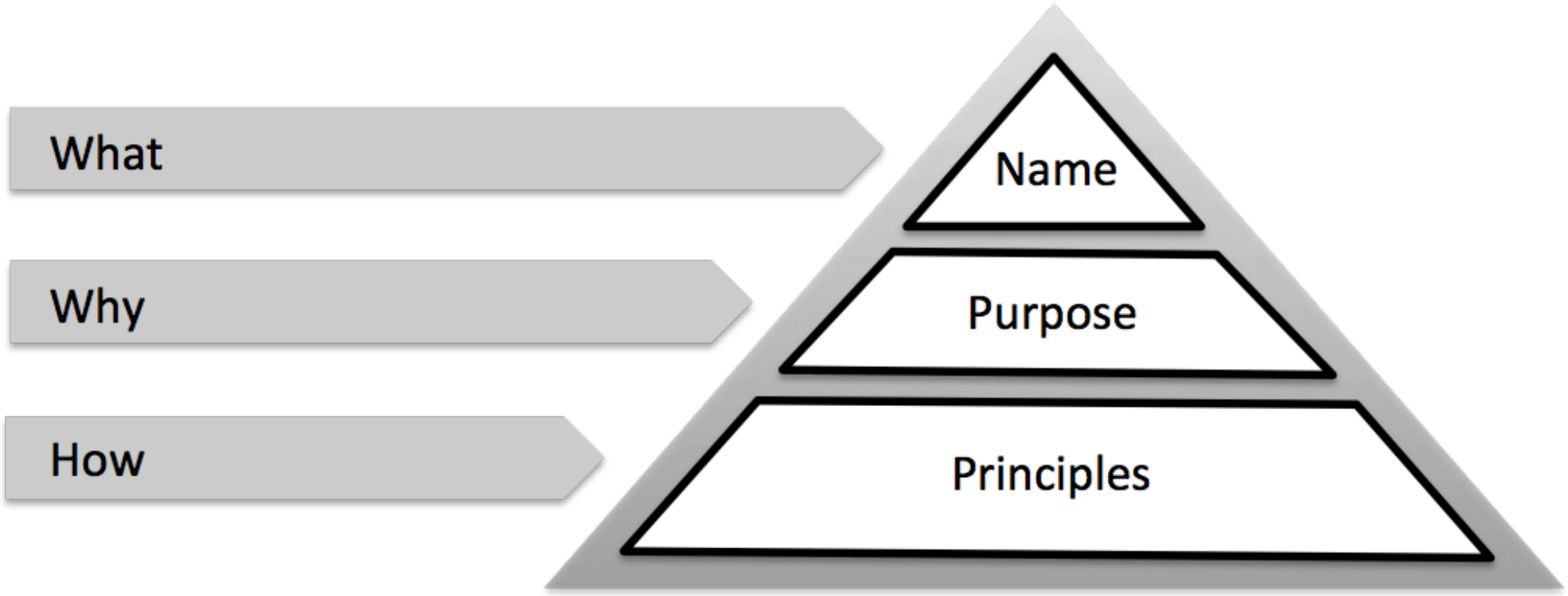
- Persuasion
  - Getting attention and support
  - Getting funding / resources

- Clarification
  - Fostering shared understanding
  - Enabling decision-making

The aim:
To create a design concept that is

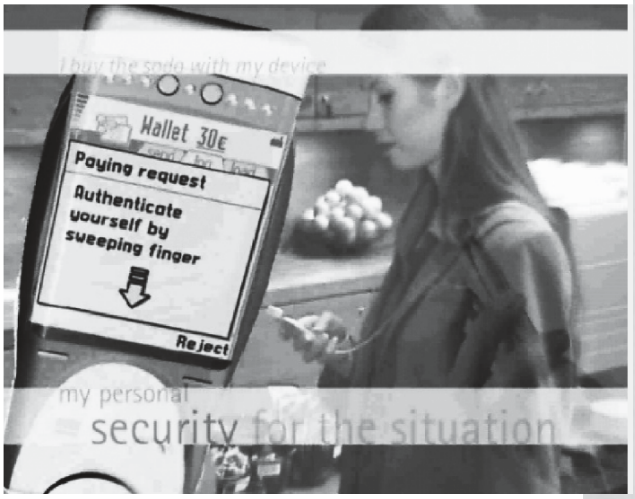
1. …as relevant as possible in terms of effort
2. …as simple as possible in terms of user experience
3. …as clear as possible in terms of design requirements

Minimal Design Concept



Ylirisku, S. (2013). Frame it Simple! Towards a theory of conceptual designing [Doctoral dissertation]. Aalto University.

Nokia in 2003



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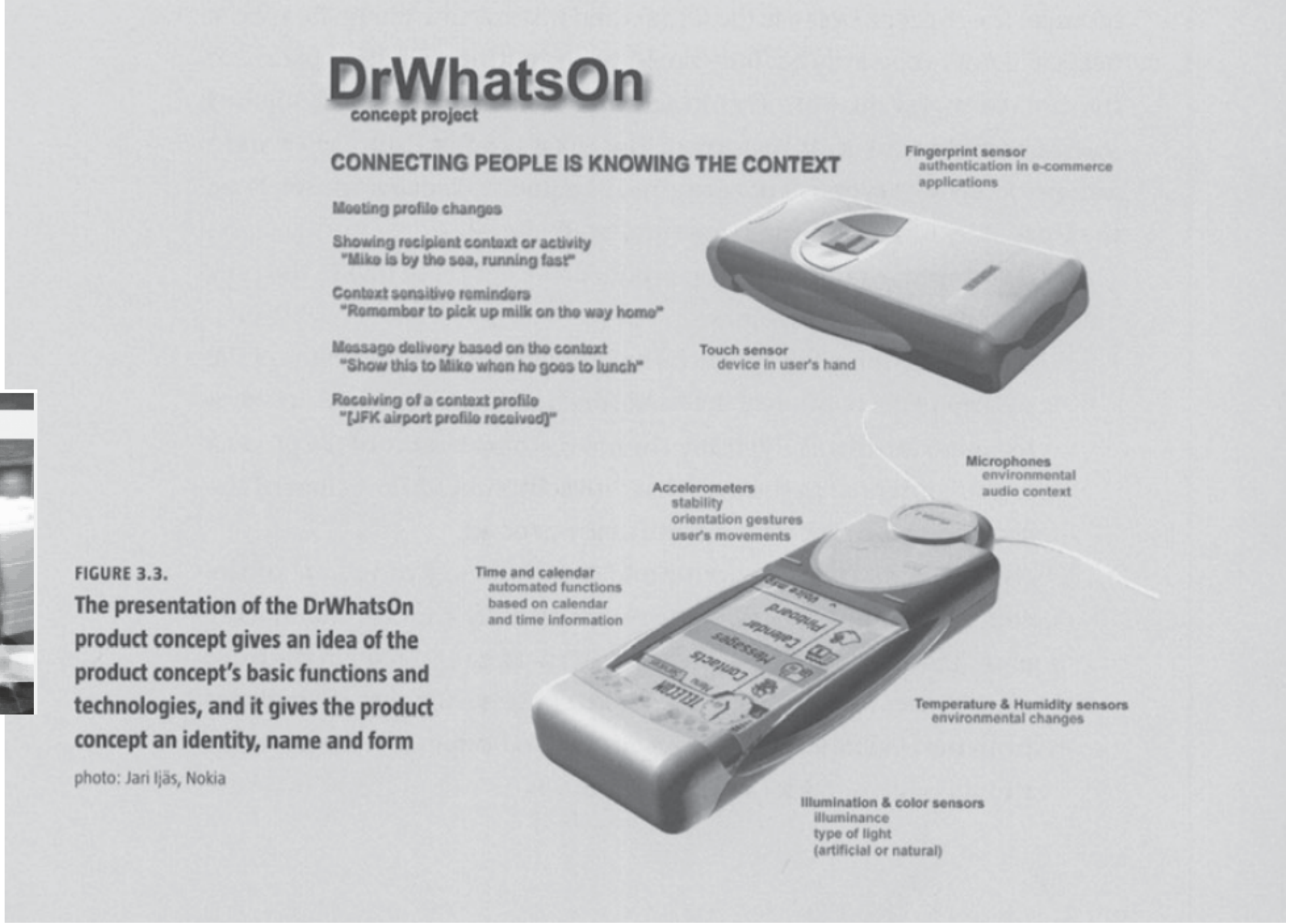

FIGURE 3.3.
The presentation of the DrWhatsOn product concept gives an idea of the product concept's basic functions and technologies, and it gives the product concept an identity, name and form

photo: Jari Ijäs, Nokia

Aalto University

Design Requirements

Key Design Requirements

1. They are overarching statements that define what will be expected of the design outcome.
2. They are grounded in research, justified for their impact, validated with relevant stakeholders, and expressed in a language that is understood by all the stakeholders.
3. They must be stated in a manner, which is independent of a specific implemention, unless there is only one meaningful way to achieve the impact.
4. They can be more detailed than design principles, and they are definitely less detailed than engineering requirements.

Engineering Requirements?

- One-handed mixing tap

TH Darmstadt		Requirements list for one-handed mixing tap	Page 1
Changes	D W	Requirements	Responsible
	D	1 Throughput (mixed flow) max. 10 l/min at 2 bar	KMW
	D	2 Max. pressure 10 bar (test pressure 15 bar as per DIN 2401)	LTMB
	D	3 Temp. of water standard 60 °C, 100 °C (short-time)	
	D	4 Temperature setting independent of throughput and pressure	
	W	5 Permissible temp fluctuation ± 5 °C at a pressure diff. of ± 5 bar between hot and cold supply	
	D	6 Connection 2 x Cu pipes, 10 x 1 mm, l = 400 mm	
	D	7 Single-hole attachment $\varnothing 35^{+2}_{-1}$ mm, basin thickness 0–18 mm (Observe basin dimension DIN EN 31, DIN EN 32, DIN 1368)	
	D	8 Outflow above upper edge of basin, 50 mm	
	D	9 To fit household basin	
	W	10 Convertible into wall fitting	
	D	11 Light operation (children)	
	D	12 No external energy	
	D	13 Hard water supply (drinking water)	
	D	14 Clear identification of temperature setting	
	D	15 Trade mark prominently displayed	
	D	16 No connection of the two supplies when valve shut	
	W	17 No connection when water drawn off	
	D	18 Handle not heated to above 35 °C	
	W	19 No burns from touching the fittings	
	W	20 Provide scalding protection if extra costs small	
	D	21 Obvious operation, simple and convenient handling	
	D	22 Smooth, easily cleaned contours, no sharp edges	
	D	23 Noiseless operation, (≤ 20 dB as per DIN 52218)	
	W	24 Service life 10 years at about 300 000 operations	
	D	25 Easy maintenance and simple repairs. Use standard spare parts	
	D	26 Max. manuf. costs DM 30 (3000 units per month)	
	D	27 Schedules from inception of development	
		conceptual design / embodiment design / detail design / prototype	
		after 2 / 4 / 6 / 9 months	
		Replaces 1st issue of 12.6.1973	

Figure 6.27. Requirements list for a one-handed mixing tap

Pahl, G., Beitz, W., Feldhusen, J., & Grote, K. H. (2007). *Engineering Design: A Systematic Approach* (Third Edition). Springer.

Engineering Requirements?

- One-handed mixing tap

Requirements

1 Throughput (mixed flow) max. 10 l/min at 2 bar

2 Max. pressure 10 bar (test pressure 15 bar as per DIN 2401)

3 Temp. of water standard 60 °C, 100 °C (short-time)

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Engineering Requirements?

- One-handed mixing tap

13 Hard water supply (drinking water)

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24 Service life 10 years at about 300 000 operations

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26 Max. manuf. costs DM 30 (3000 units per month)

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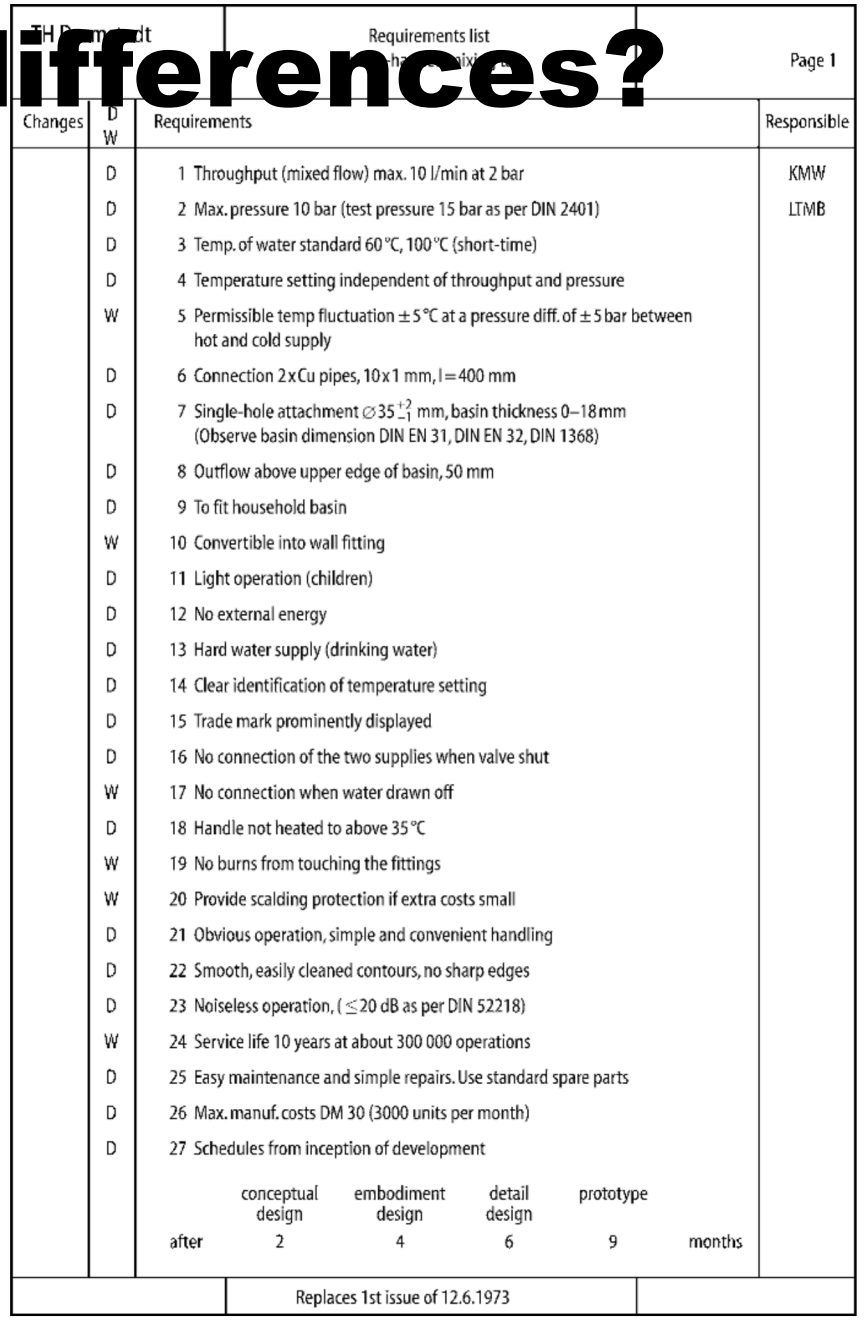
Pahl, G., Beitz, W., Feldhusen, J., & Grote, K. H. (2007). *Engineering Design: A Systematic Approach* (Third Edition). Springer.

The one-handed water mixer

- The water tap must have only one handle for adjusting both the flow and temperature of water.
- Flow is controller by vertical movement of the handle, and temperature by its horizontal movement.
- It must serve as a replacement for an old two-valve water tap.

What are the key differences?

- The water tap must have only one handle for adjusting both the flow and temperature of water.
- Flow is controller by vertical movement of the handle, and temperature by its horizontal movement.
- It must serve as a replacement for an old two-valve water tap.



TH Darmstadt — Requirements list — Page 1

Changes	D W	Requirements	Responsible
	D	1 Throughput (mixed flow) max. 10 l/min at 2 bar	KMW
	D	2 Max. pressure 10 bar (test pressure 15 bar as per DIN 2401)	LTMB
	D	3 Temp. of water standard 60 °C, 100 °C (short-time)	
	D	4 Temperature setting independent of throughput and pressure	
	W	5 Permissible temp fluctuation ± 5 °C at a pressure diff. of ± 5 bar between hot and cold supply	
	D	6 Connection 2 x Cu pipes, 10 x 1 mm, l = 400 mm	
	D	7 Single-hole attachment ∅ 35^{+2}_{-1} mm, basin thickness 0–18 mm (Observe basin dimension DIN EN 31, DIN EN 32, DIN 1368)	
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	D	9 To fit household basin	
	W	10 Convertible into wall fitting	
	D	11 Light operation (children)	
	D	12 No external energy	
	D	13 Hard water supply (drinking water)	
	D	14 Clear identification of temperature setting	
	D	15 Trade mark prominently displayed	
	D	16 No connection of the two supplies when valve shut	
	W	17 No connection when water drawn off	
	D	18 Handle not heated to above 35 °C	
	W	19 No burns from touching the fittings	
	W	20 Provide scalding protection if extra costs small	
	D	21 Obvious operation, simple and convenient handling	
	D	22 Smooth, easily cleaned contours, no sharp edges	
	D	23 Noiseless operation, (≤ 20 dB as per DIN 52218)	
	W	24 Service life 10 years at about 300 000 operations	
	D	25 Easy maintenance and simple repairs. Use standard spare parts	
	D	26 Max. manuf. costs DM 30 (3000 units per month)	
	D	27 Schedules from inception of development	

	conceptual design	embodiment design	detail design	prototype	
after	2	4	6	9	months

Replaces 1st issue of 12.6.1973

Figure 6.27. Requirements list for a one-handed mixing tap

Different kinds of design requirements

https://www.sciencebuddies.org/science-fair-projects/engineering-design-process/design-requirements-examples

Types of Design Requirement for General Products	
A cost target is almost always a design requirement • Cost to purchase • Cost to use • Cost to repair	**Aesthetics** (how it looks) • Style (art deco, Victorian, modern, medieval) • Color • Fit and finish (Is it built with care and attention to detail?)
Geometry • Size, overall dimensions • Curvature	Capacity (how many and how big are the things it can work with)
Physical characteristics • Weight • Density • Melting, boiling point • Color • Transparency • Reflectance • Surface texture (polished, rough) • Elasticity • Hardness • Ductility (ability to be drawn into a wire) • Magnetic properties • Electrical properties (resistance, impedance, etc.) • Impact resistance	Performance characteristics • Accuracy • Strength • Reproducibility, repeatability (Does it always do the same thing given the same input?) • Speed • Acceleration • Deceleration, braking • Rolling resistance • Friction • Adhesion • Absorbency • Permeability (Do things leak through it?) • Resolution

[Questions?]