The Project

Setting the stage

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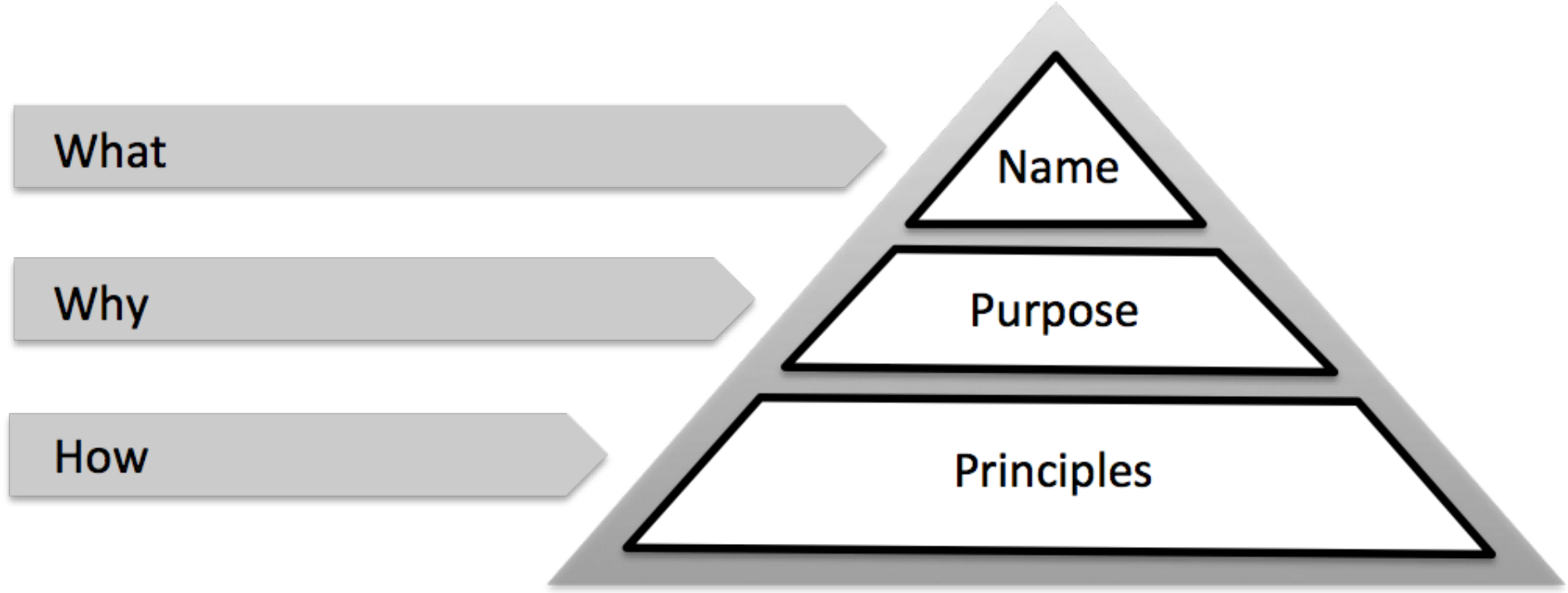
Learning Goals

1. Co-defining the key design requirements for an IoT appliance based on an open-ended design challenge (be justified and precise)
2. Developing a prototyping mind-set (build, learn, re-build)
3. Understand aspects that influence the development of a good product (focus on technology and user experience)

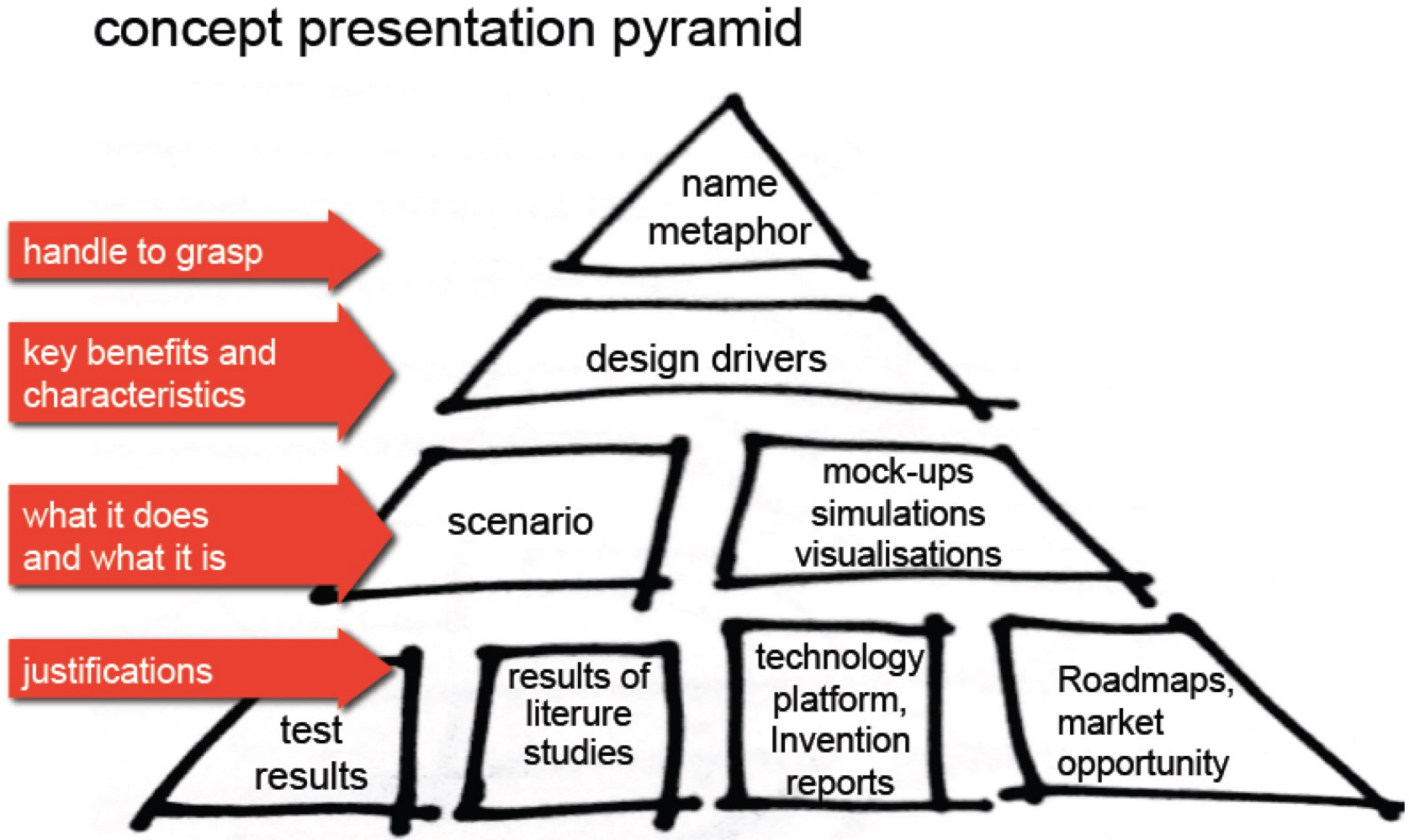
The outcome

- Each team has a booth at the NEXPO´21 – Future of Learning
  - Expo team defines the NEXPO´21 concept
- Presentation/demo of your design concept
  - A mockup is required (can be pre-recorded video/animation)
  - Any actual functionality is a plus
- Key design requirements need to be specified
  - Must be well-justified and based on knowledge on actual users
  - Must be based on existing technology (implementable now)

Minimal Design Concept



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



A more extended version of Design Concept, by Prof. Turkka Keinonen

The Problem

- Design concepts often have unreasonable expectations for technology, and thus, are nothing more than happy ideas.

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.
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 are more detailed than design principles, but less detailed than engineering requirements.

Design Principles?

- Prof. Keinonen talks about “Design Drivers”
- These are fundamental objectives that govern design decisions
  - E.g. “Must be operable by one hand”

Lindholm, C. and Keinonen, T. (2003) Managing the Design of User Interfaces. In Lindholm, C.K.T. and Kiljander, H. (eds), How Nokia Changed the Face of the Mobile Phone, pp. 139–154. McGraw-Hill.

Design Principles

- Design principles are such high-level objectives that enable ***to differentiate*** your design object from the rest.
- These are essentially important in new product innovation.
- They can be about any aspect related to the design outcome.

Engineering Requirements?

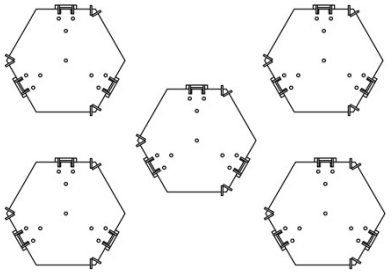
- One-handed mixing tap

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.

NEPPI Hex Machine



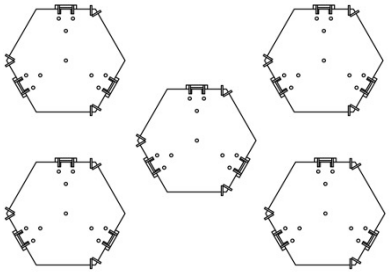
Description (What)

- NEPPI Hex Machine is a modular cloud-connected system that transports a steel ball through a specified route and tracks its whereabouts online.

Purpose (Why)

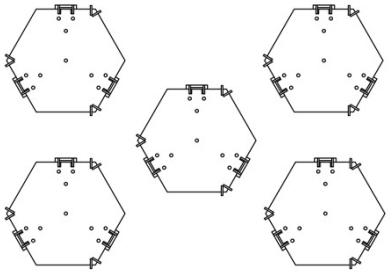
- Hex Machine serves as a hands-on learning tool for university students to learn about IoT systems.

NEPPI Hex Machine



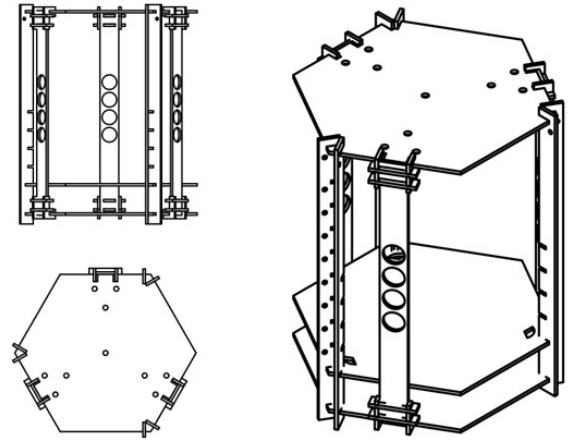
- *Features (How) (core physical requirements)*
  - The machine consists of up to 30 hex modules*, which connect with each other through physical openings (circular holes) on the sides.
  - Each module has up to 16 holes, but only up to four (4) of these can be used in one machine at a time, up to two (2) as inputs and two (2) as outputs.

NEPPI Hex Machine

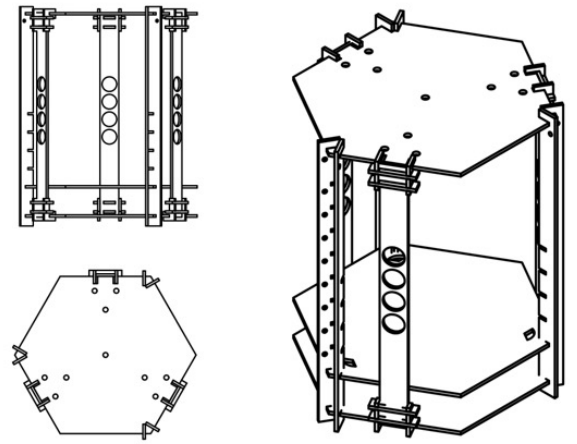


- *Functionality (How)(core functional requirements)*
  - The machine must function without human intervention once launched.
  - The machine must communicate in real-time (as quickly as feasible) with online service that displays where the ball is moving.

NEPPI Hex Module* attachment 1



- *NEPPI hex module*
  - A functioning IoT device that uses the NEPPI hexagon module platform (structure and interfaces, i.e., ‘holes’) and related steel balls (12.7mm balls, provided).
- Physical core requirements
  1. Each module must have one side marked as the side one with the sign ‘I’ on top.
  2. Each module must have up to two active inputs and outputs (in total up to 4 active holes), which need to follow the NEPPI hexagon module platform.
  3. The active inputs and outputs must be co-operational with those of the immediate neighboring hex module, i.e. they must either be able to transport the steel ball to/from the neighboring hex module.



- *Functional core requirements*
  - The module must **transport a steel ball** from a specific entry slot to a specific exit slot without human intervention.
  - *The module must connect to internet via WiFi (Aalto Open) and to the online service once the connection is established. [Provided by NEPPI staff]*
  - The module must automatically detect, when the steel ball has entered the module.
  - The module must identify the hole (either as 0 or 1) that the ball entered from, and is able to send this information to the online service.