

Design & Fabrication

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Creativity, Art, and Design

Recapitulation

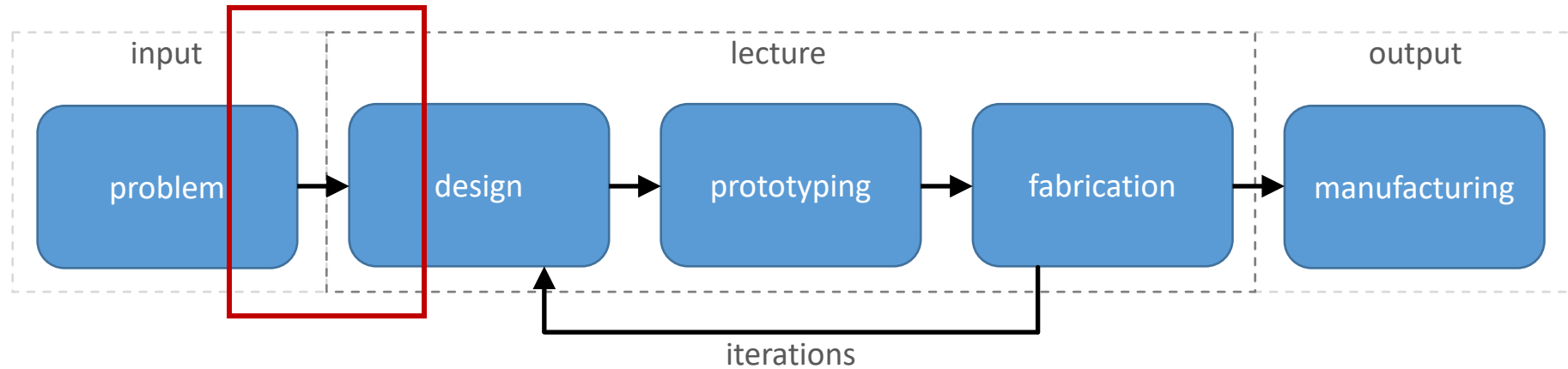
Creativity

- › Creativity Techniques
- › Design Principles
- › Non-/deterministic algorithms
- › Generative AI (supportive tool?)



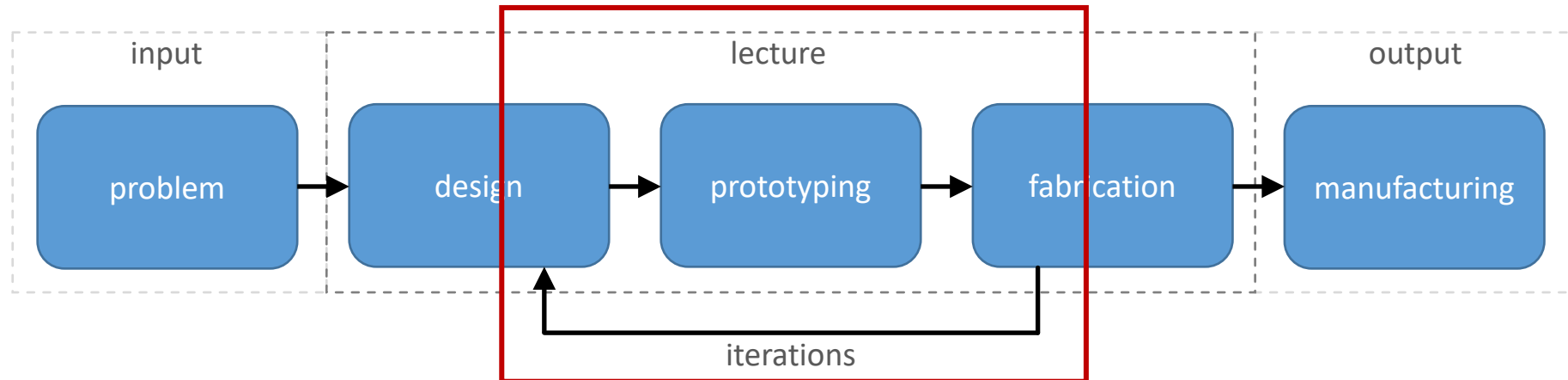
From Design to Fabrication

Recapitulation



From Design to Fabrication

Recapitulation

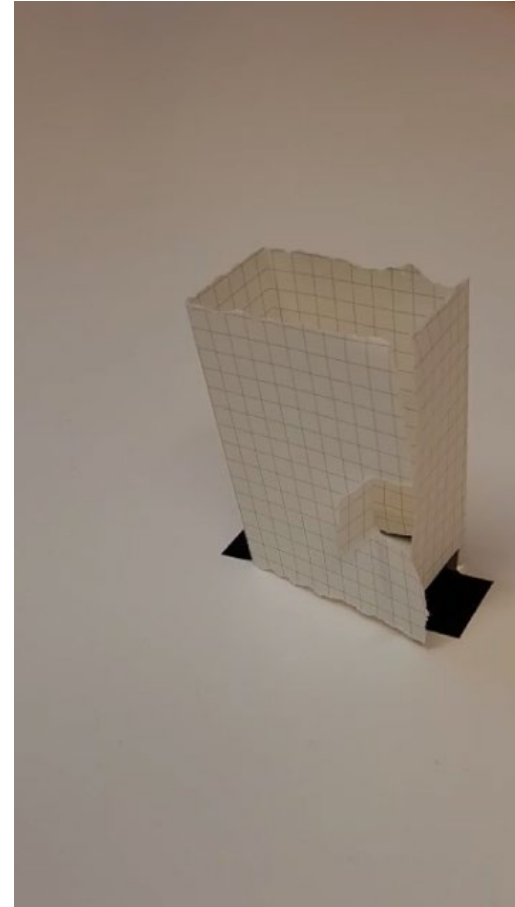


Lecture 3

Prototyping

Prototyping

The Power of Prototyping



Why do we prototype?



Prototyping

The Power of Prototyping

“You can **fix it now on the drafting board** with an eraser or you can **fix it later on the construction site** with a sledge hammer”

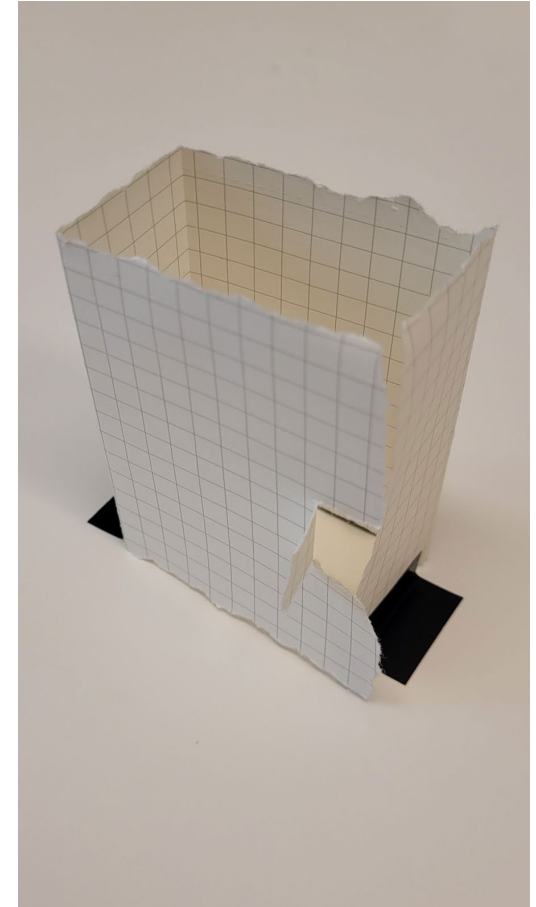
Engineering one-liner

Prototyping

The Power of Prototyping

The Power of Prototyping

- › Evaluation in an early stage
- › Hands-on experience and enhanced collaboration
- › Feedback and informed decision-making
- › Preliminary experiments or studies on feasibility, functionality, and usability
- › Cost-efficient testing before investing money in actual production



Prototyping

The Power of Prototyping

Evaluation Criteria

Framework of Ubiquitous Computing Evaluation Areas (UEAs).

UEA	Metric	Conceptual measures
Attention	Focus	Number of times a user must change focus due to technology; number of displays/actions users need to accomplish, or to check progress, of an interaction; number of events not noticed by a user in acceptable times
	Overhead	Percent of time user spends switching among foci; workload imposed on user attributable to focus
Adoption	Rate	New users/unit of time; user rationale for using the application over an alternative; technology usage statistics
	Value	Changes in productivity; perceived cost/benefit; continuity for user; amount of user sacrifice
	Cost	User willingness to purchase technology; typical time spent setting up and maintaining the technology
	Availability	Number of actual users from each target user group; technology supply source; categories of users in post-deployment
	Flexibility	Number of tasks user can accomplish that were not originally envisioned; user ability to modify as improvements and features are added
Trust	Privacy	Type of information user has to divulge to obtain value from application; availability of the user's information to other users of the system or third parties
	Awareness	Ease of coordination with others in multi-user application; number of collisions with activities of others; user understanding about how recorded data is used; user understanding inferences that can be drawn about him or her by the application
	Control	Ability for users to manage how and by whom their data is used; types of recourse available to user in the event that his or her data is misused
Conceptual Models	Predictability of application behavior	Degree of match between user model and behavior of application
	Awareness of application capabilities	Degree of match between user's model and actual functionality of the application; degree of match between user's understanding of his or her responsibilities, system responsibilities, and the actual situation; degree to which user understands the application's boundary
	Vocabulary awareness	Degree of match between user's model and the syntax used by the application

Prototyping

The Power of Prototyping

Evaluation Criteria

Interaction	Effectiveness	Percentage of task completion
	Efficiency	Time to complete a task
	User satisfaction	User rating of performing the task
	Distraction	Time taken from the primary task; degradation of performance in primary task; level of user frustration
	Interaction transparency	Effectiveness comparisons on different sets of I/O devices
	Scalability	Effectiveness of interactions with large numbers of entities or users
	Collaborative interaction	Number of conflicts; percentage of conflicts resolved by the application; user feelings about conflicts and how they are resolved; user ability to recover from conflicts
Invisibility	Intelligibility	User's understanding of the system explanation
	Control	Effectiveness of interactions provided for user control of system initiative
	Accuracy	Match between the system's contextual model and the actual situation; appropriateness of action; match between the system action and the action the user would have requested
	Customization	Time to explicitly enter personalization information; time for the system to learn and adapt to the user's preferences
Impact and Side Effects	Utility	Changes in productivity or performance; changes in output quality
	Behavior changes	Type, frequency, and duration; willingness to modify behavior or tasks to use application; comfort ratings of wearable system components
	Social acceptance	Requirements placed on user outside of social norms; aesthetic ratings of system components
	Environment change	Type, frequency and duration; user's willingness to modify his environment to accommodate system
Appeal	Fun	Enjoyment level when using the application; level of anticipation prior to using the application; sense of loss when the application is unavailable
	Aesthetics	Ratings of application look and feel
	Status	Pride in using and owning the application; peer pressure felt to use or own the application
Application Robustness	Robustness	Percentage of transient faults that were invisible to user
	Performance speed	Measures of time from user interaction to feedback for user
	Volatility	Measures of interruptions based on dynamic set of users, hardware, or software

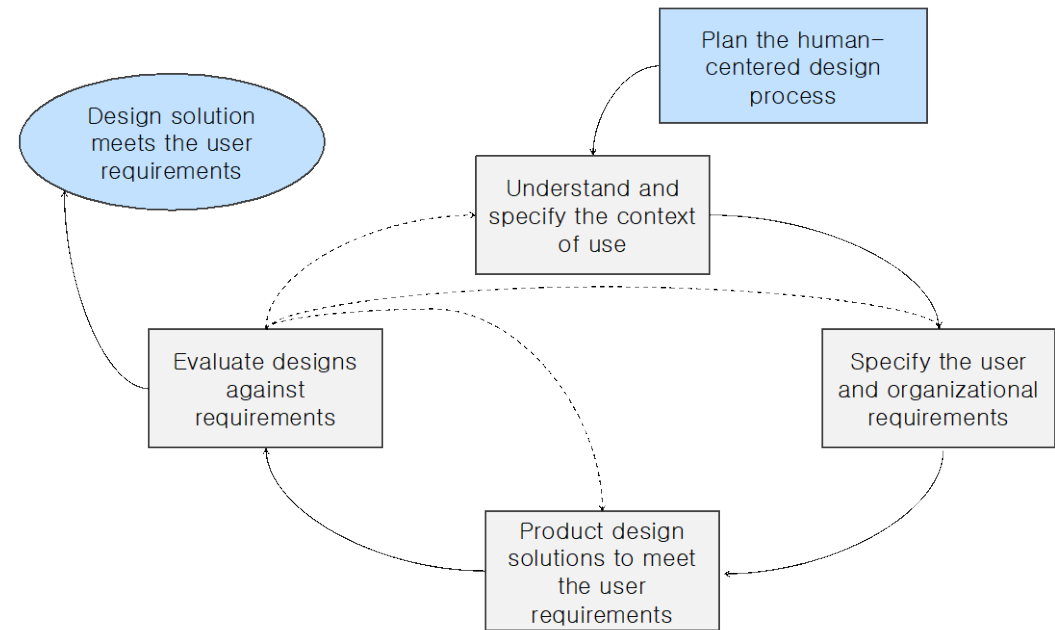
Prototyping

Prototyping Process

Prototyping Process

- › Iterative design process
- › For example ISO 9241-210, Human-Centered Design for Interactive Systems

ISO 9241-210 Human-Centered Design Process



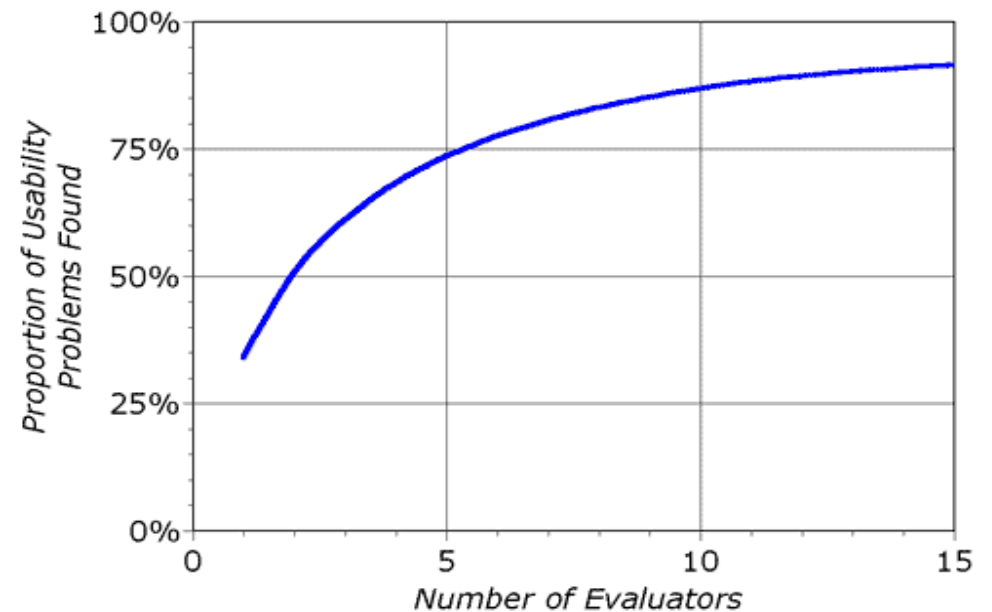
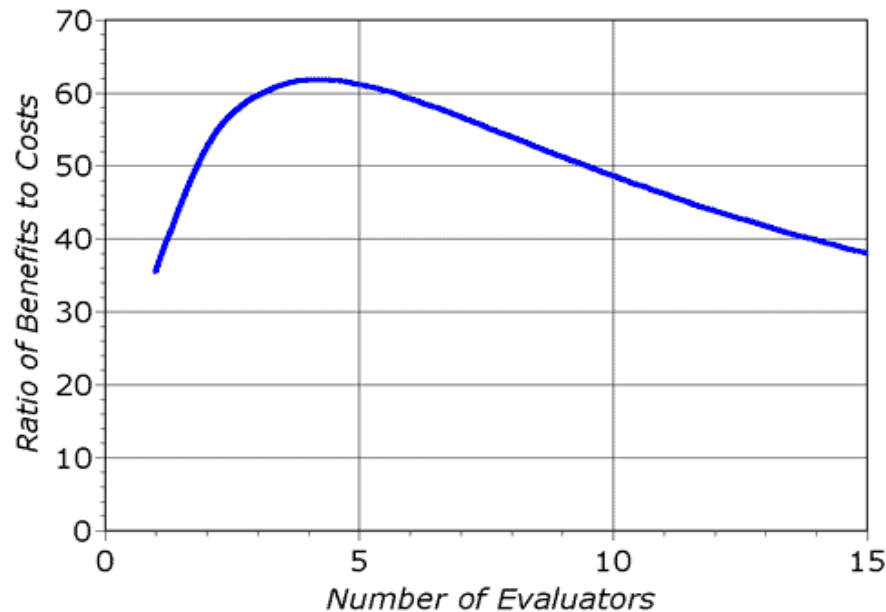
ISO 9241-210:2019 (EN) Human-centered design for interactive systems

Prototyping

Prototyping Process

Evaluation

- › Costs of (heuristic) evaluation vs. problems identified



How do pedestrians interact with autonomous vehicles?

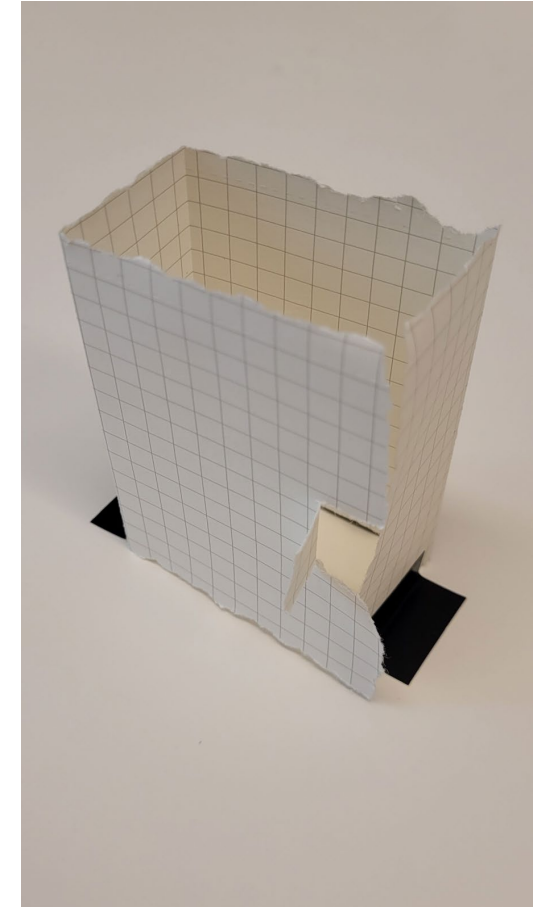


Prototyping

Definition of a Prototype

Definition

- › Preliminary model of a product or system
- › “A concrete representation of part or all of an interactive system”¹ (HCI)
- › Often a tangible representation
- › Implements key functional aspects
- › Used to test feasibility, functionality, and usability
- › Wide variety of complexity and fidelity levels

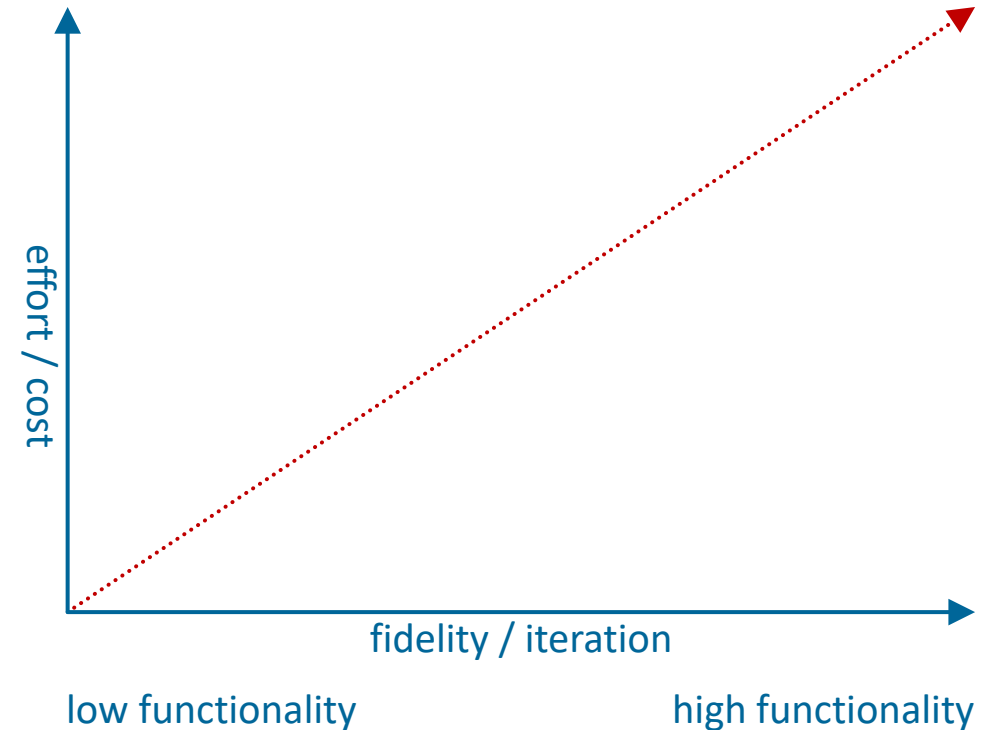


Prototyping

Levels of Prototyping

Levels of Prototyping

- › Diverse prototyping techniques
- › Effort vs. Fidelity
- › Functionality gradually improves
- › Desired process:
 1. Low fidelity & many iterations
 2. High fidelity & few iterations

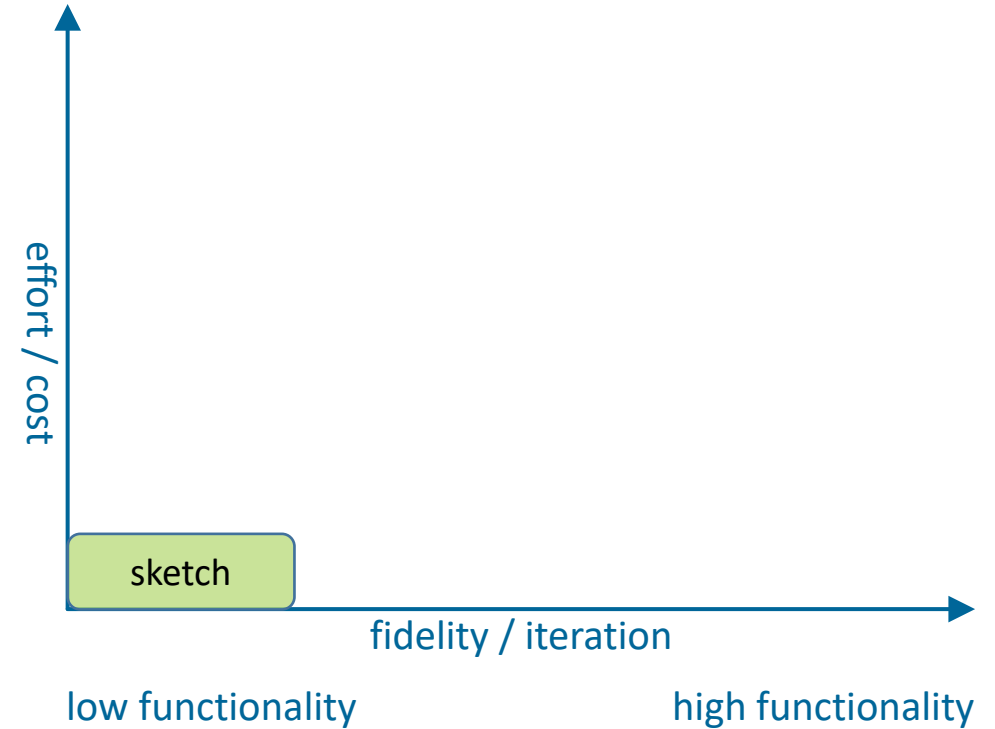


Prototyping

Levels of Prototyping

Sketch

- › Early concept phase
- › Close to the creative process
- › Flowcharts, wireframes, ...

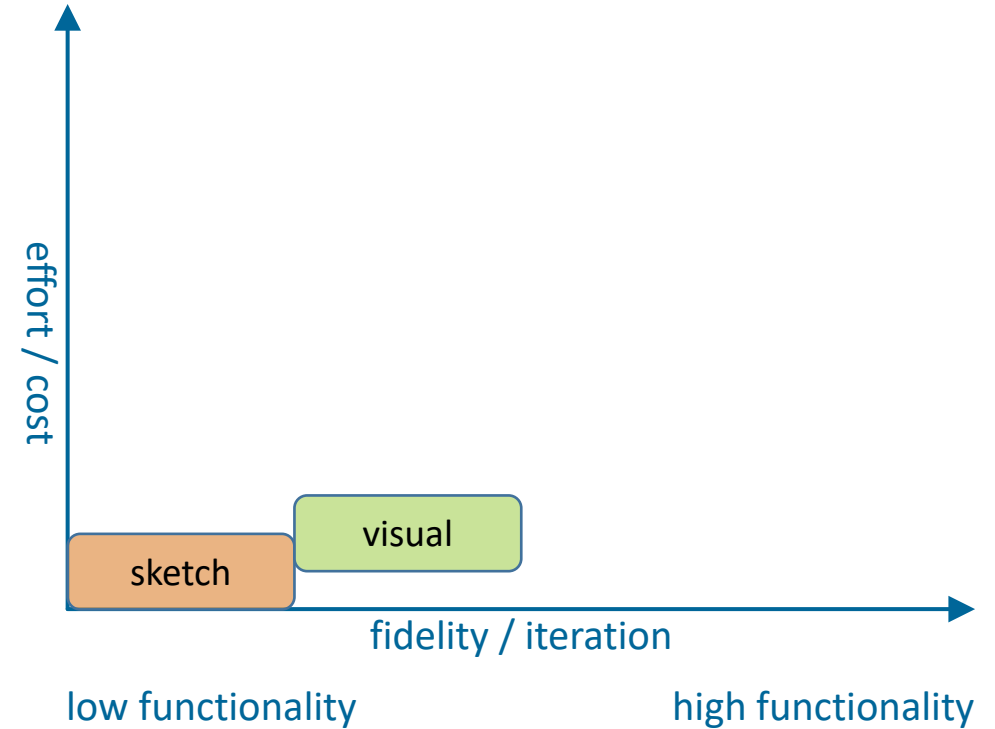


Prototyping

Levels of Prototyping

Visual

- › User experience
- › Analog, e.g., paper prototype
- › Digital in 2D/3D, e.g. **Virtual Reality** (VR) and **Augmented Reality** (AR)

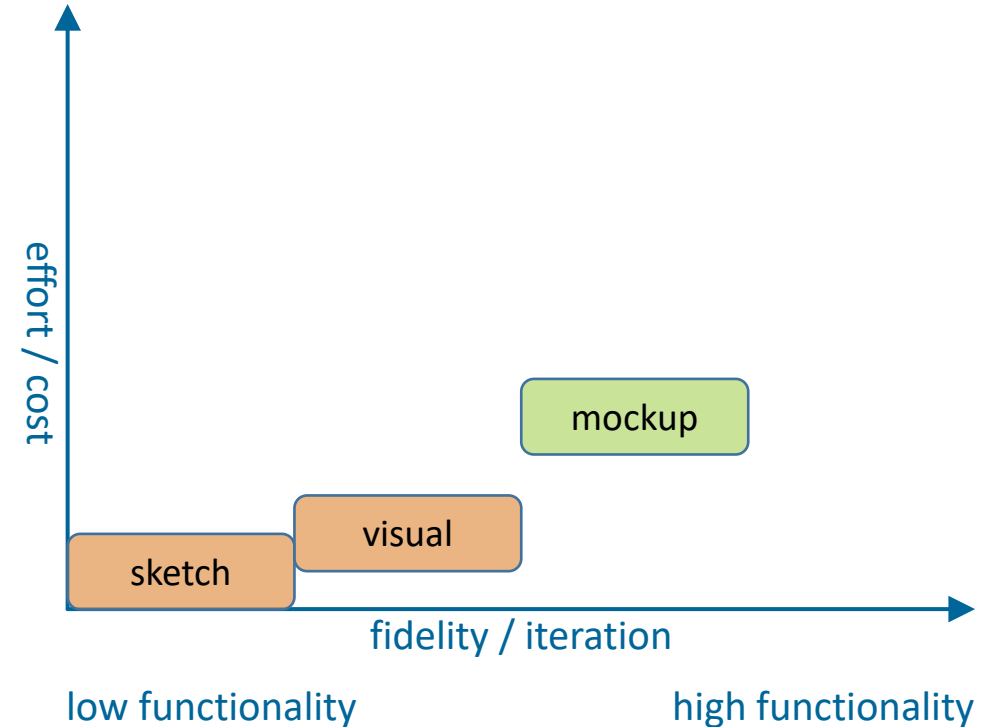


Prototyping

Levels of Prototyping

Mockup

- › Low-fidelity prototype
- › Proof of principle
- › Scaled or full-size model
- › At least part of the functionality and enables testing the design
- › Mainly built for feedback from users

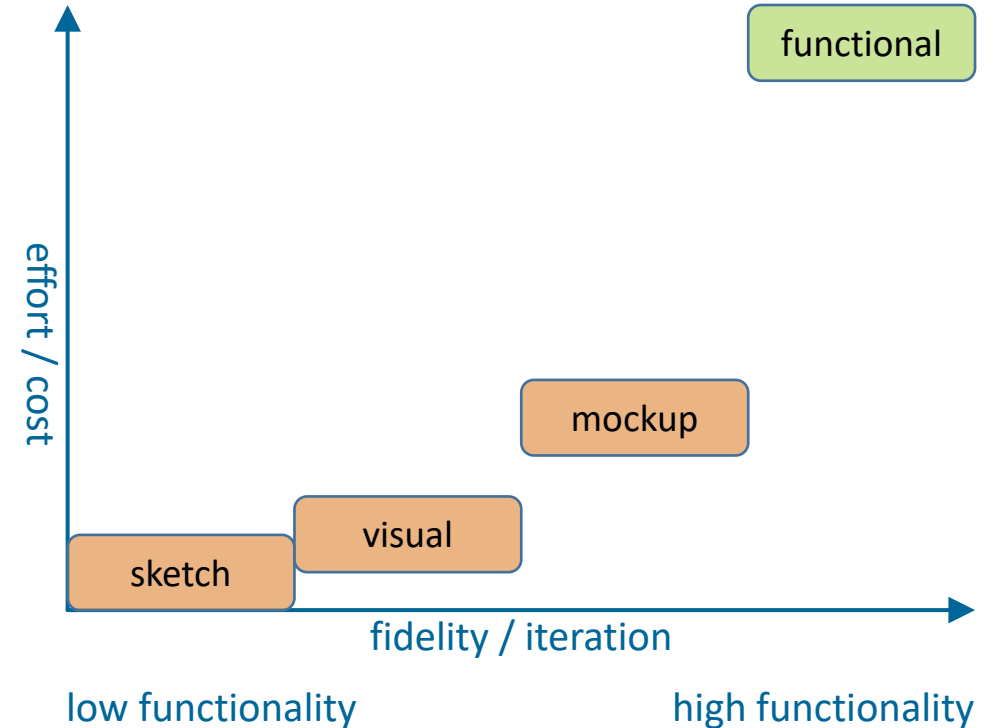


Prototyping

Levels of Prototyping

Functional / Working

- › Highest level of prototyping
- › Focus on functionality
- › Often 3D printed physical objects
- › Off-the-shelf components, link to bulky, outlying electronics
- › For user studies and final testing

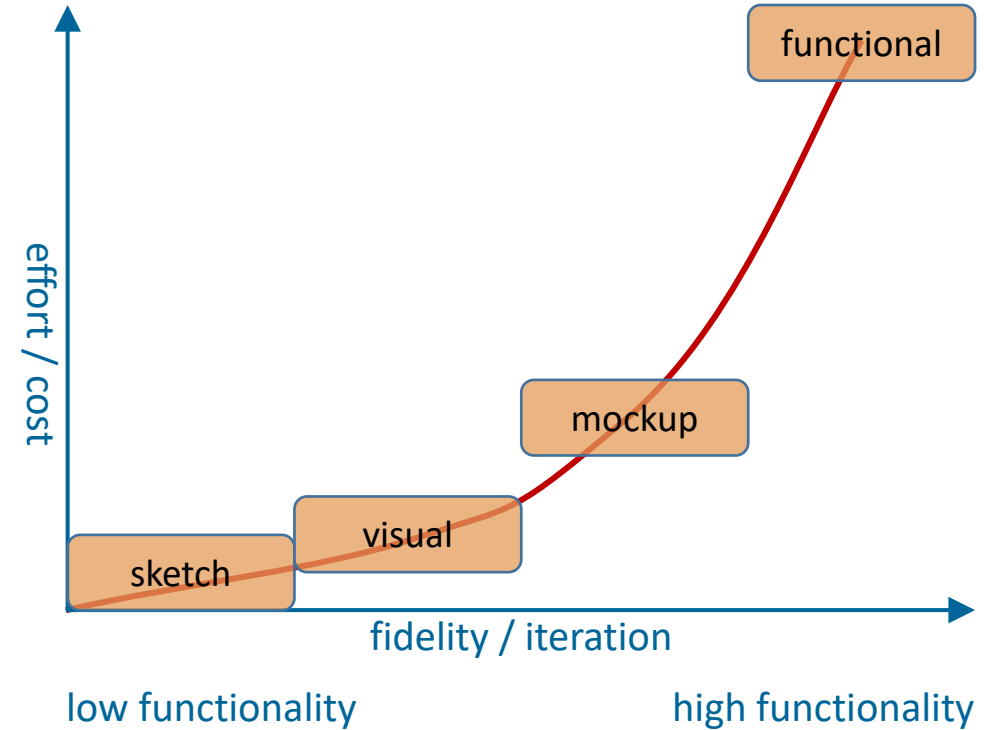


Prototyping

Levels of Prototyping

Virtual vs. Haptic Prototypes

- › Still not an equal substitute
- › Hands-on and tangible experience
- › Virtual prototypes are inexpensive
- › Functional prototypes are expensive
- › Physical prototypes still superior

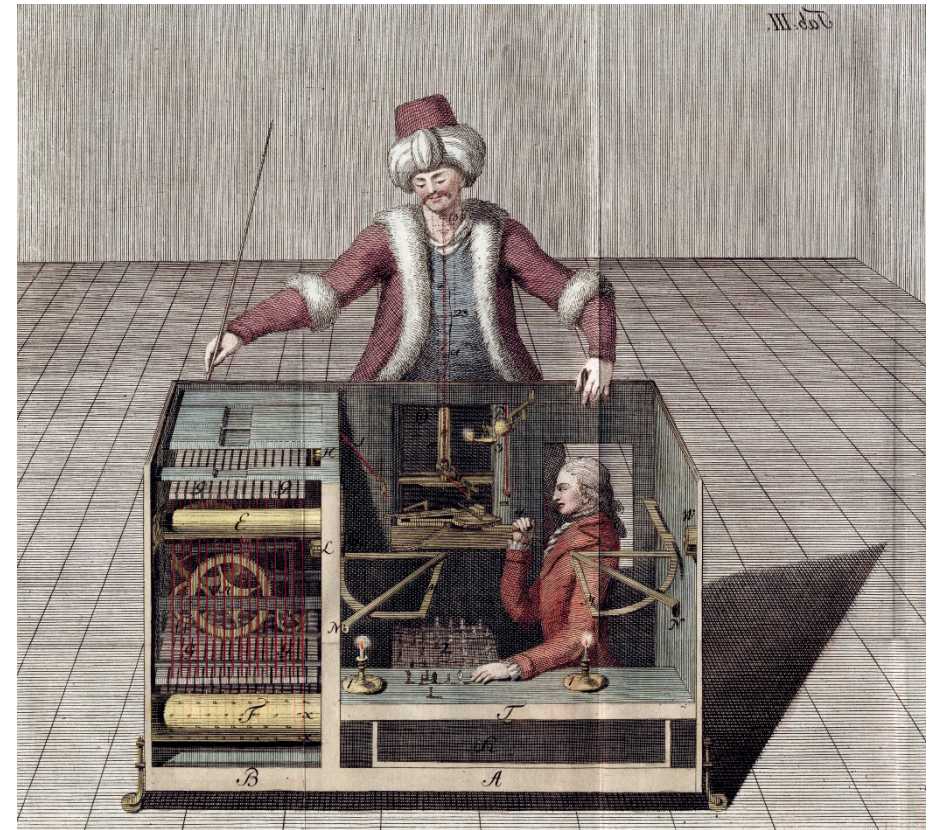


Prototyping

Levels of Prototyping

Mechanical Turk

- › 1770 – 1854
- › By Wolfgang von Kempelen
- › To impress Maria Theresa of Austria
- › “**Wizard of Oz**” prototypes
- › Simulate / **mimic** functionality



Did anyone hear about
Rapid Prototyping?

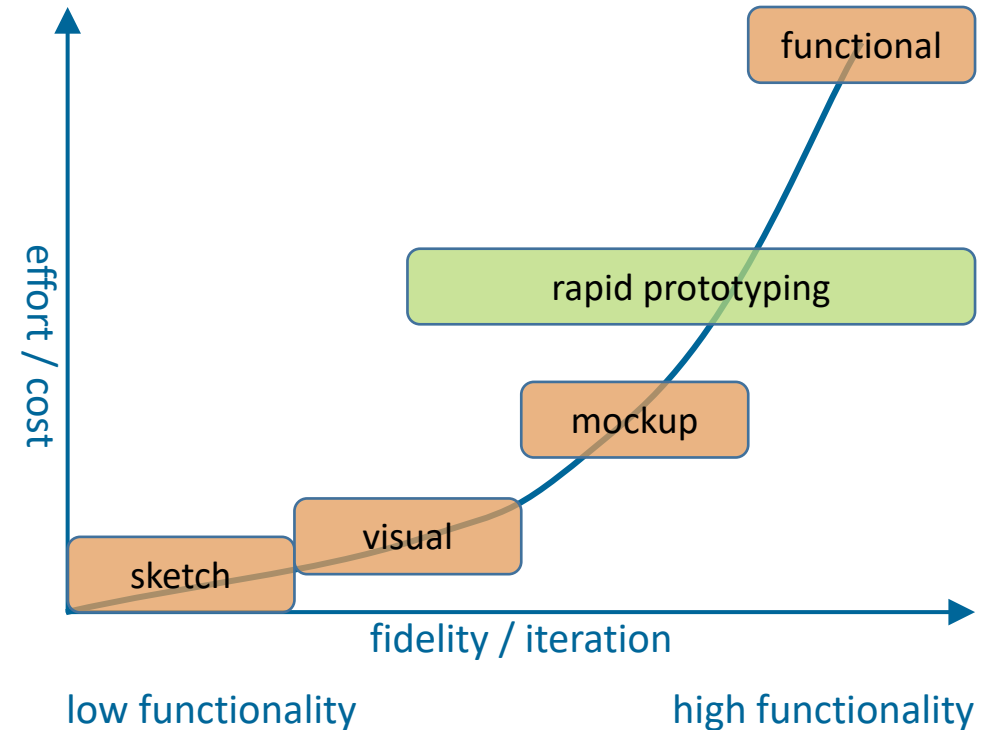


Prototyping

Rapid Prototyping

Rapid Prototyping

- › Early stage of project development
- › Fast fabrication of **physical parts**
- › **Quick iterations** toward initial design
- › Testing form, fit, and function
- › Only necessary, **essential features**
- › All about **testing** and user **feedback**
- › **Minimum Viable Product (MVP)**

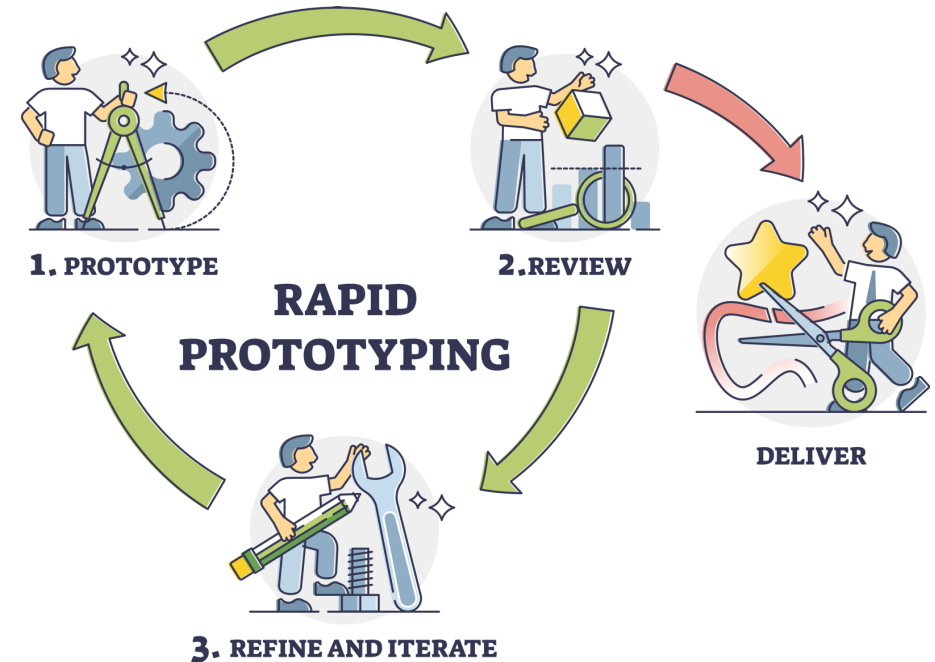


Prototyping

Rapid Prototyping

Rapid Prototyping Techniques

- › Paper prototypes
- › Building blocks (e.g., Lego)
- › **Mockups** (e.g., cardboard)
- › Subtractive manufacturing, e.g. CNC machining, laser cutting, ...
- › Additive manufacturing, e.g. **3D printing** (most common)



What are your questions?



Tutorial

Creativity Techniques

Creative Thinking Techniques

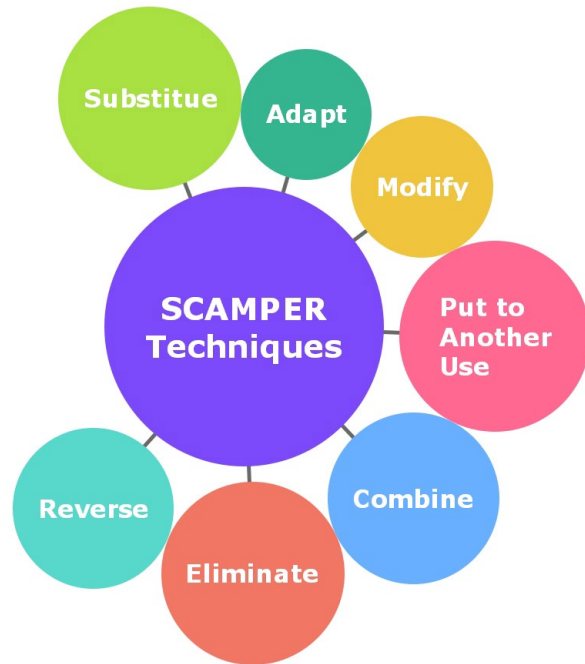


SCAMPER



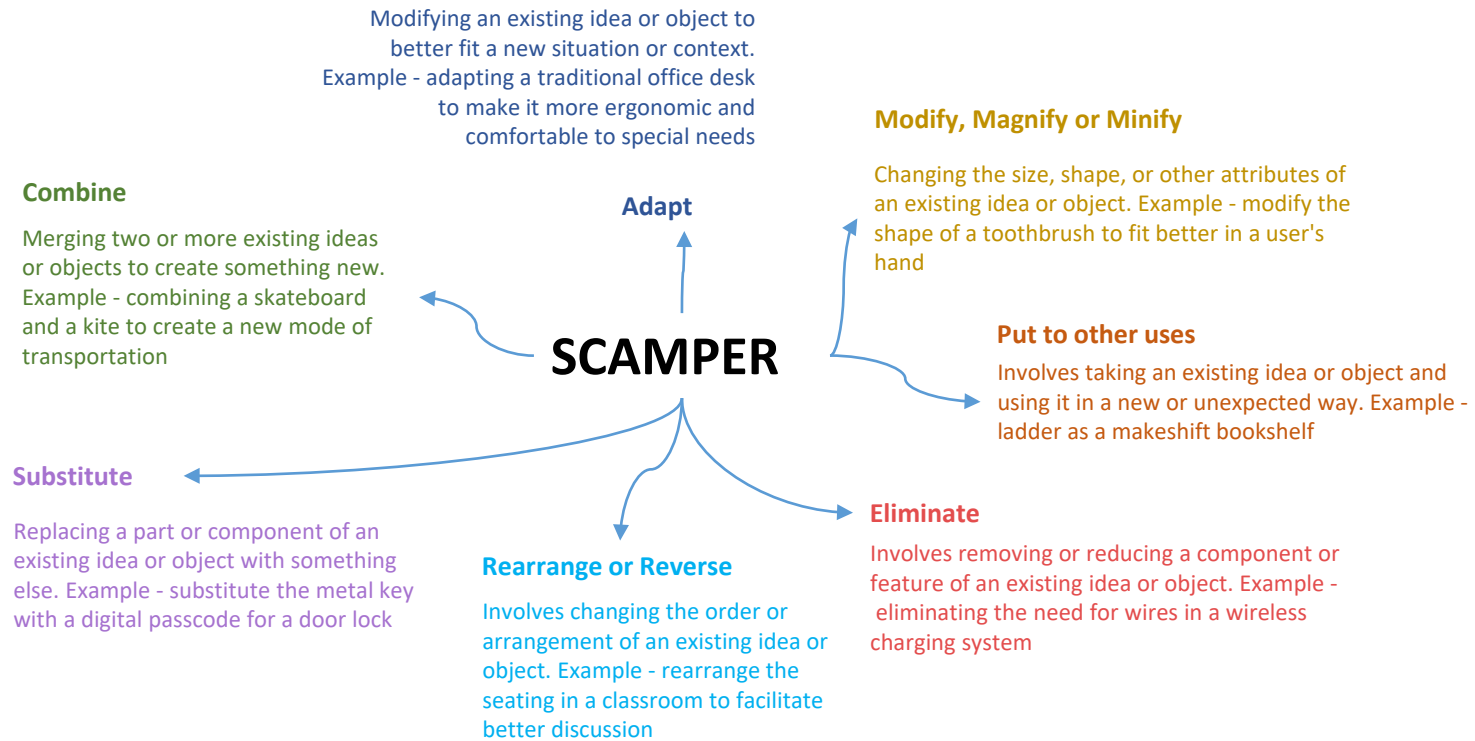
SCAMPER

Brainstorming technique

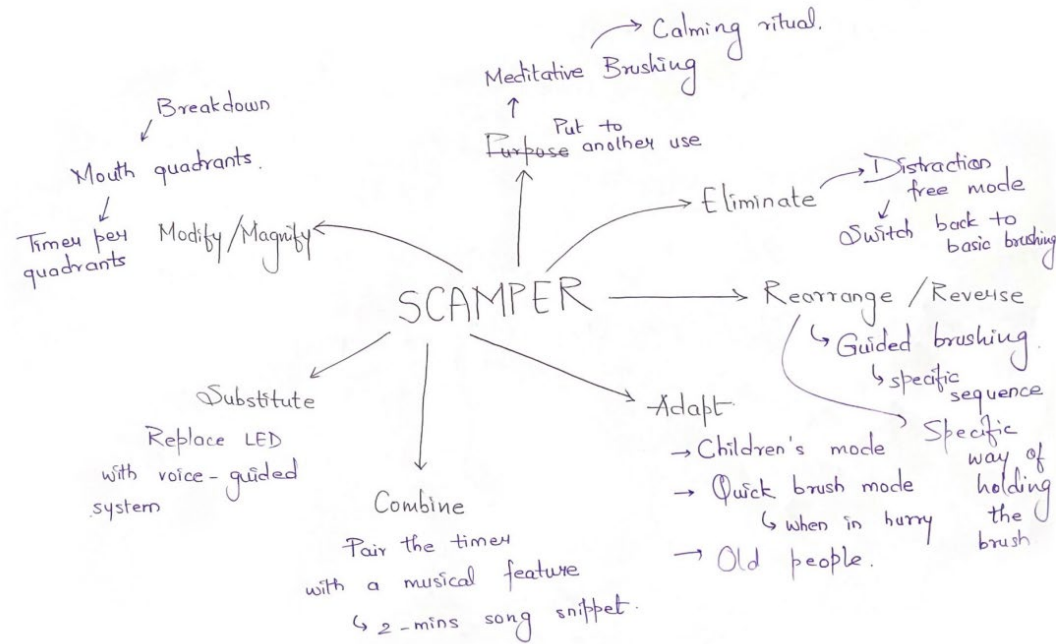


- Exploring different ways to modify or improve an existing product, service, or idea
- SCAMPER stands for Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, and Rearrange
- Follow the rules of brainstorming

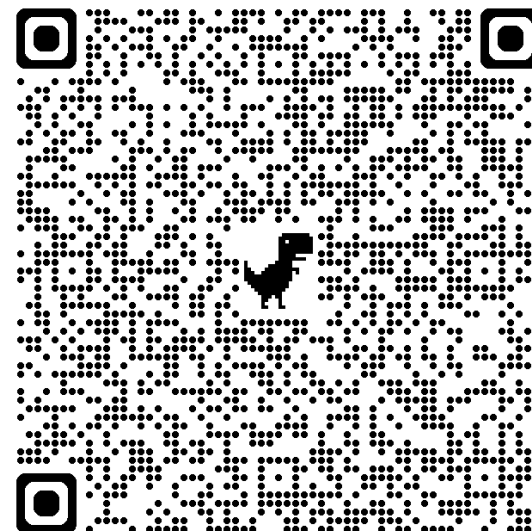
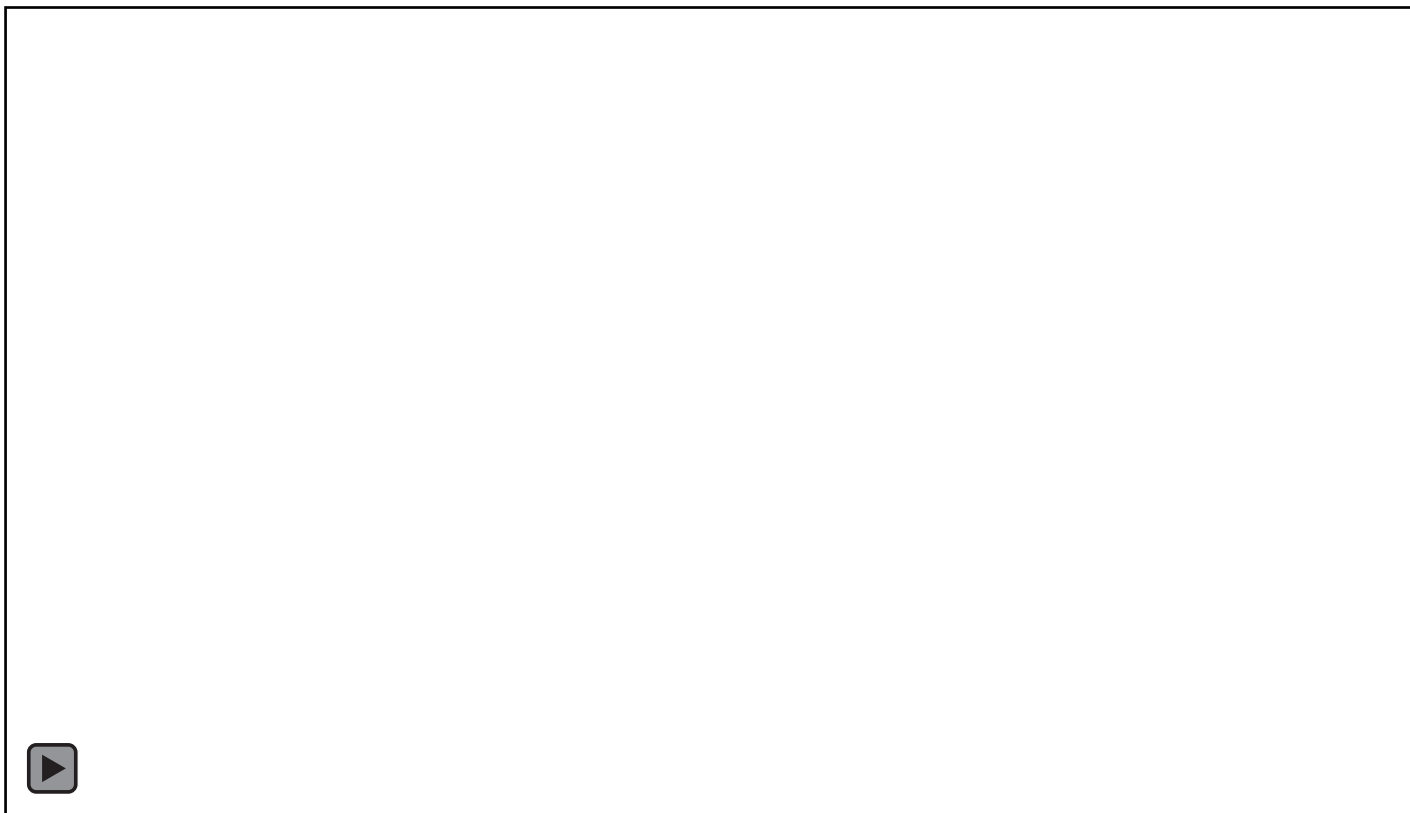
Details



Example



Timer



Scan to navigate to the online
whiteboard



Verplank Sketching Framework

Beyond craft to design

Sketchbook



IDEA



METAPHOR



MODEL



DISPLAY



ERROR



SCENARIO



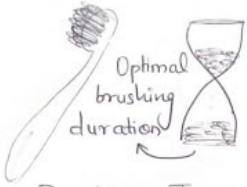



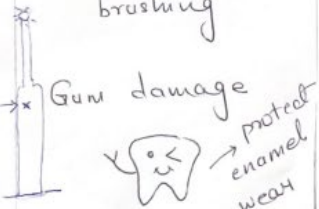



TASK



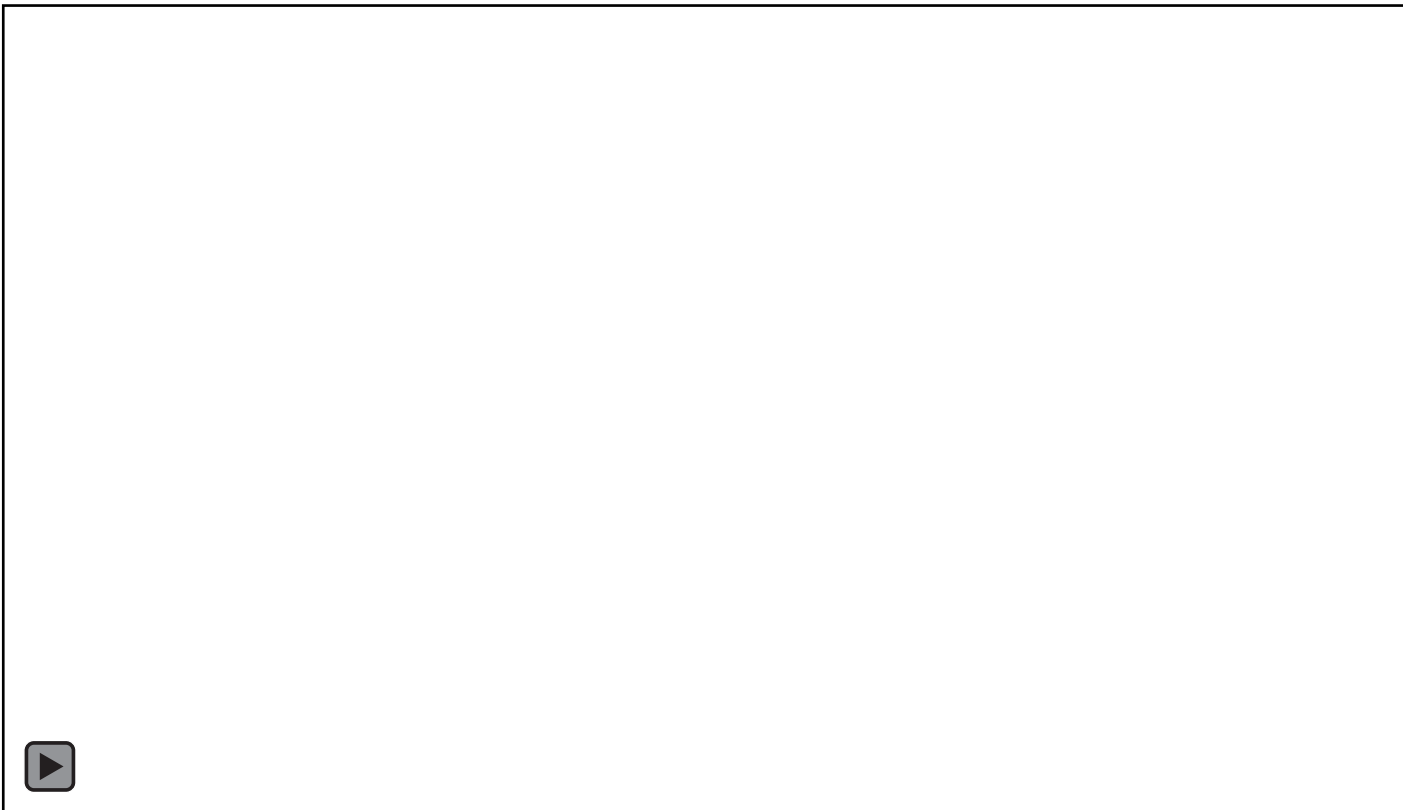
CONTROL

- » Idea: Core concept behind a product.
- » Metaphor: Familiar concept aiding user understanding.
- » Model: Underlying system logic.
- » Display: User feedback.
- » Error: Potential mistakes and corrections.
- » Scenario: User interaction narrative.
- » Task: User's goals with the product.
- » Control: Interfaces for user interaction.

Example

<p>IDEA</p>  <p>Brushing Timer</p>	<p>METAPHOR</p> <p>POACHED EGG</p> 	<p>DISPLAY</p> <p>Set of LED indicators</p> <ul style="list-style-type: none">● → GUM CARE● → Whitening● → Standard brushing 	<p>MODEL</p> <p>Built-in-timer.</p> <p>→ Sensors → track active brushing.</p> <p>Timer pause → inactive toothbrush.</p> 
<p>ERROR</p> <p>Prevent over / under brushing</p> 	<p>SCENARIO</p> <p>☺ → Sarah</p> <p>↓ morning routine</p> <p>→ Distracted by notifications on phone</p> <p>→ Toothbrush blinks when brushed right amount of time</p>	<p>TASK</p> <ol style="list-style-type: none">1. Dentist recommended 2-minutes2. Prevent potential damage. 	<p>CONTROL</p> <p>Control button.</p> <p>press.</p>  <p>Automatic pause after 2 mins</p> <p>Overridden by users</p> 

Timer

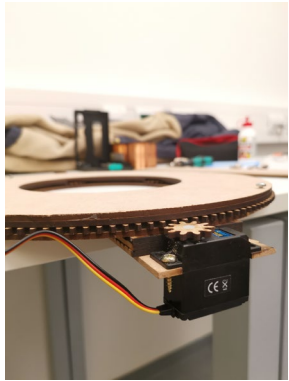


Thank You!

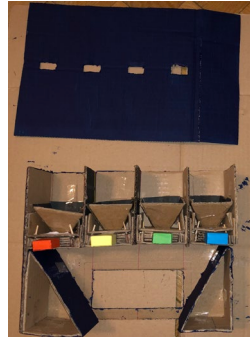


Project Examples

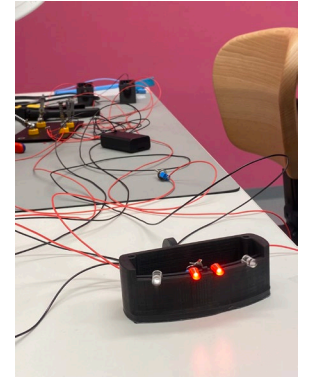
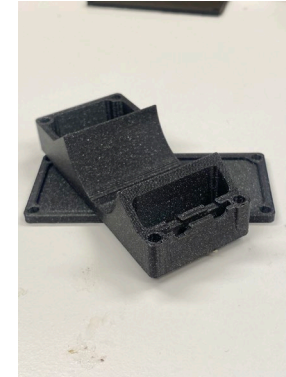
Project Examples (2023)



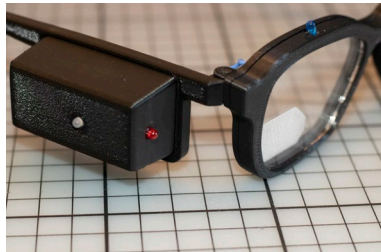
EchoLid: Voice command activated assisted cooking



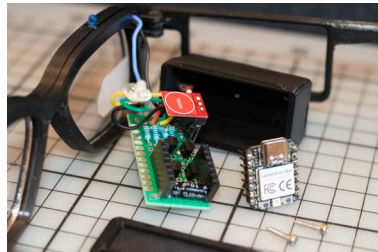
PillPal: Smart Pill Dispenser



Safe rider: Traffic safety bike indicators



Smart Glasses with AI supported zoom in/ out features



Espico: Automatic nutrition delivery



Smart bottle cap: Combines bottles and measuring cups

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