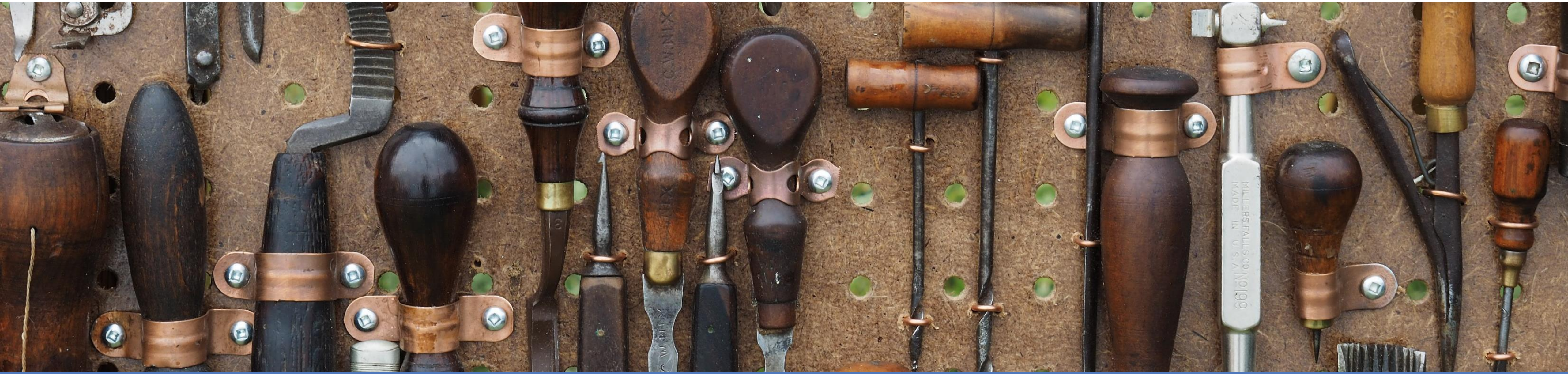

Prototyping

Human-Computer Interaction Lecture

Slides adapted from hci-lecture.org (A. Schmidt, N. Henze, K. Wolf, V. Schwind), Image from: https://pxhere.com/de/photo/669444

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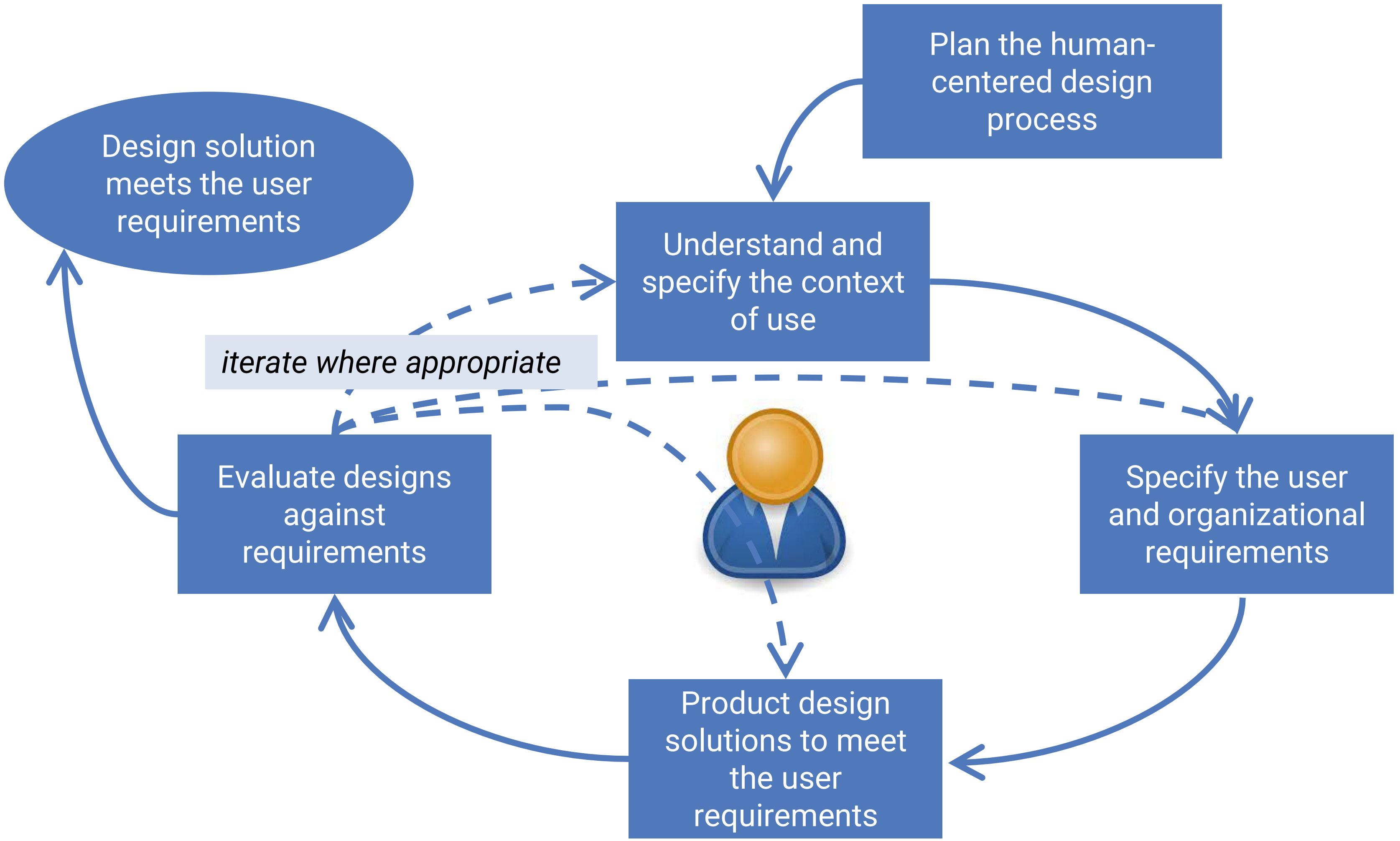
Learning Goals

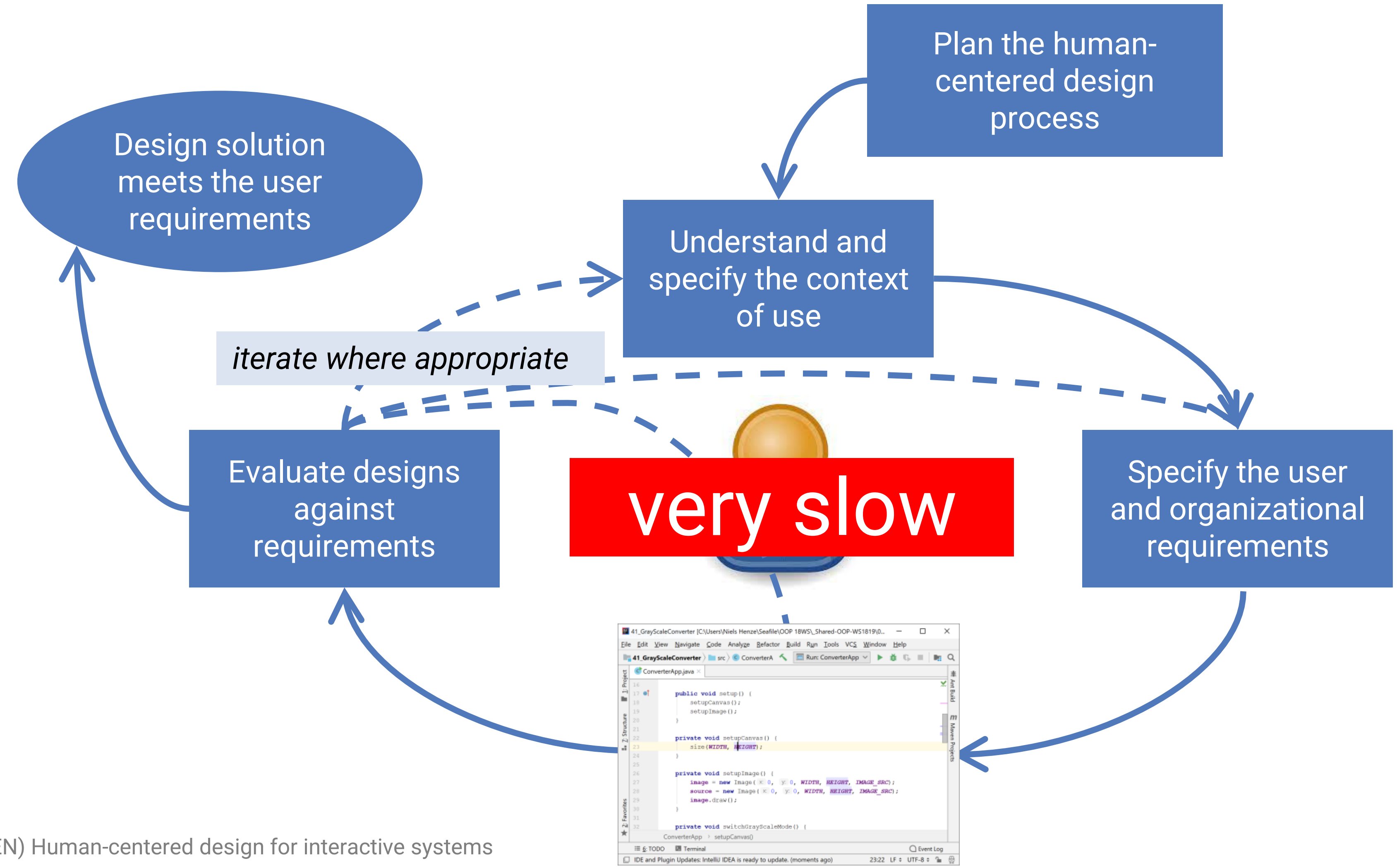
- Understand …
  - the process of prototyping and design approaches in HCI
  - understand why and when prototypes are useful
  - understand how to design prototypes
  - know techniques to develop prototypes with low functionality
- Be able to explain …
  - to put different prototyping techniques into perspective
  - different ways to systemize prototypes
  - discuss user interface designs with regard to these principles
  - be able to select an appropriate prototyping technique

The Human-Centered Design Process



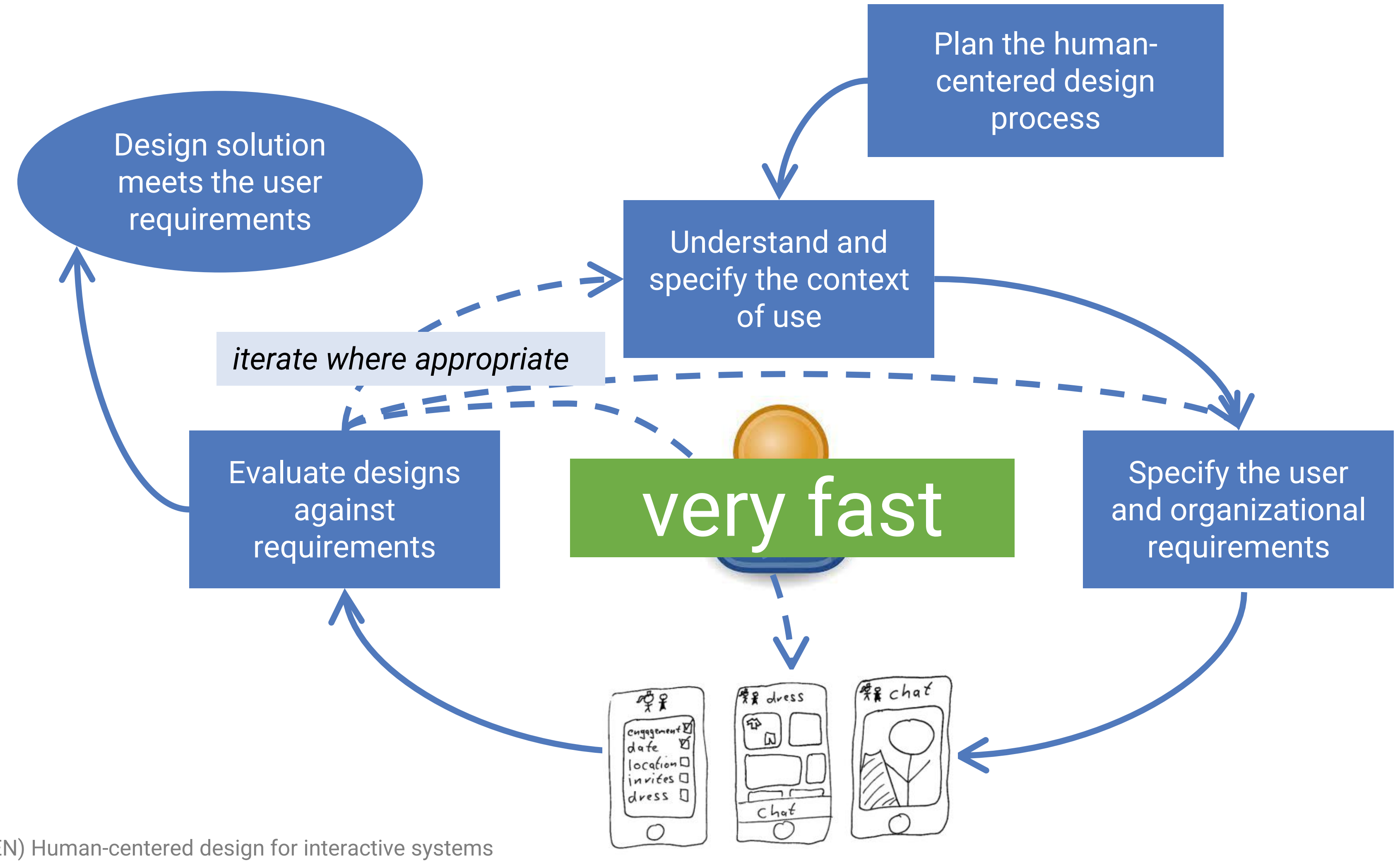
ISO 9241-210:2019(EN) Human-centered design for interactive systems

The Human-Centered Design Process (slow cycle)



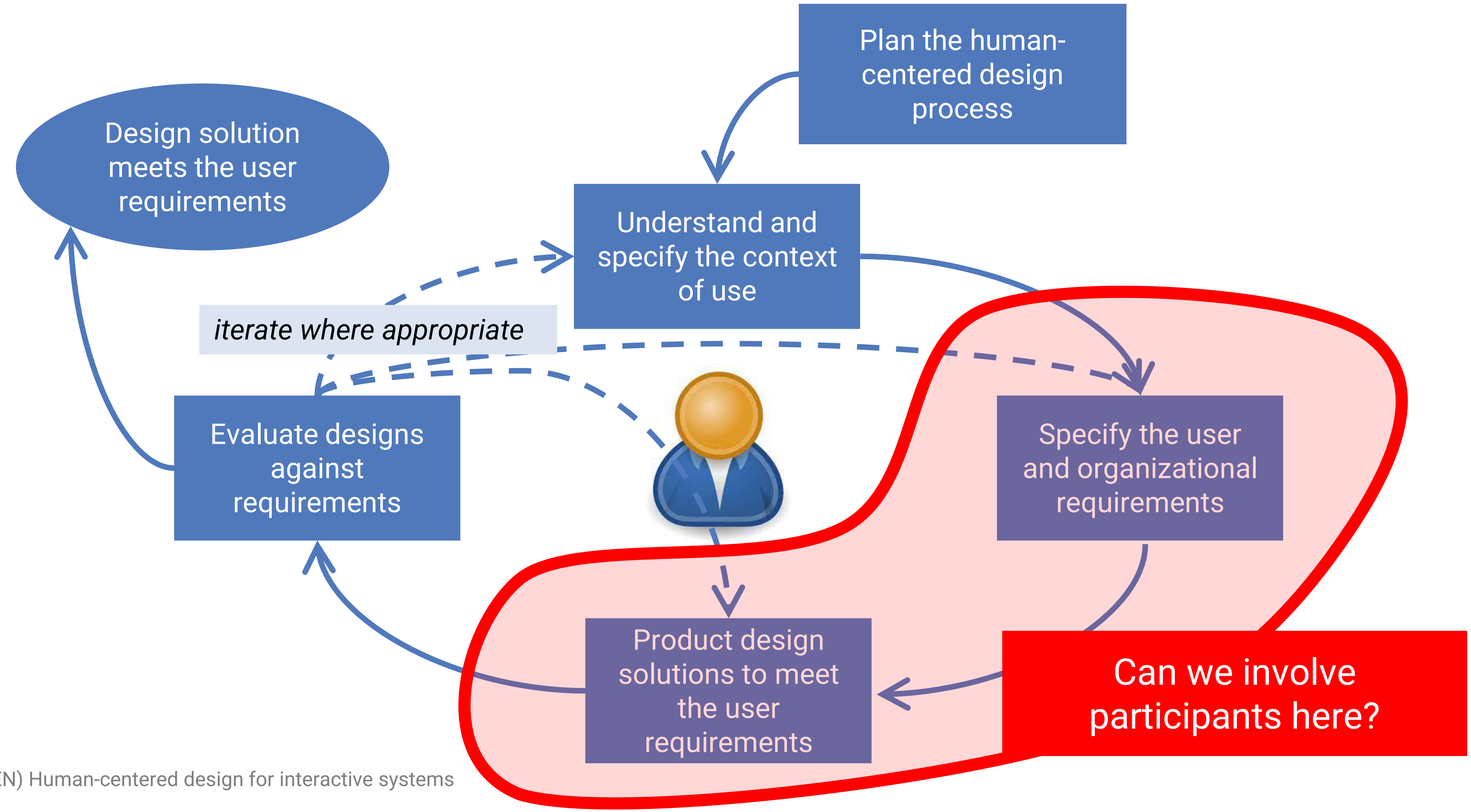
ISO 9241-210:2019(EN) Human-centered design for interactive systems

The Human-Centered Design Process (fast cycle)



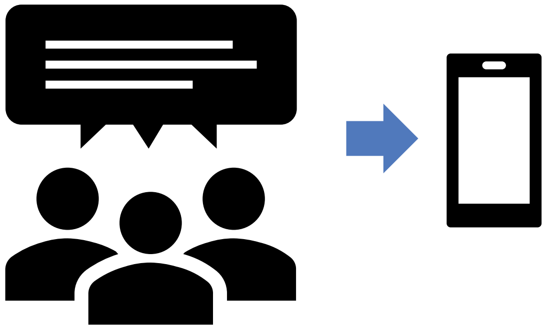
ISO 9241-210:2019(EN) Human-centered design for interactive systems

The Human-Centered Design Process



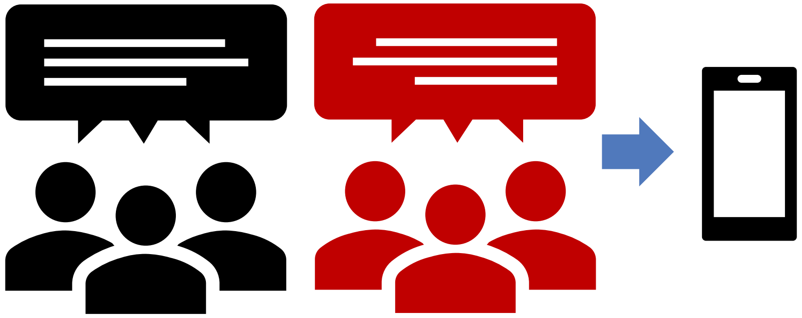
ISO 9241-210:2019(EN) Human-centered design for interactive systems

Prototype Phases



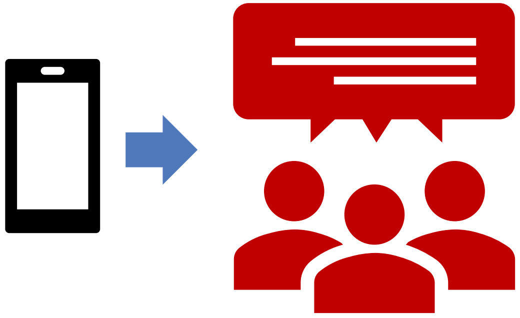
Design/Creation

- Internal prototyping process
  - Fast and efficient
  - Specific/consistent style
  - Only rely on your own feedback



Co-Design/Co-Creation

- You involve users in the design of the prototype
  - Can take a lot of time
  - You get a lot of opinions
  - You need participants
  - Participants can be wrong



Evaluation

- Evaluate your prototype with users
  - You get feedback
  - You can measure the effect of the prototype
  - You need a prototype

Image from Shutterstock.com / ID: 687095556

Prototype Creation

- **Creation Sessions**: Generate ideas and concepts for the design.
- **Design Workshops**: Organize collaborative sessions where all of you actively engage in the prototyping process, contributing ideas and feedback.
- **Card Sorting/Affinity Diagramming**: Organize information into categories, which can be used to inform workflow design.
- **Personas/Journey Mapping**: Requirement analysis and identifying pain points and opportunities for improvement.
- **Task Mapping**: Design your prototype based on the requirement analysis based on the tasks of the users.

} Design Workshops

Prototype Co-Creation with Users

- **Co-creation Sessions**: **Inviting users** to contribute to the creative process of generating ideas and concepts for the design.
- **Participatory Design Workshops**: Organizing collaborative sessions where **users actively engage in the design process**, contributing ideas and feedback.
- **Card Sorting/Affinity Diagramming**: **Asking users to organize information** into categories, which can be used to inform information architecture or workflow design.
- **Custom Journey Mapping**: **Exploring and diagramming the steps users take to interact with a product**, identifying pain points and opportunities for improvement.

} Formative Evaluations

Evaluation of Prototypes

- **User Interviews**: Conducting sessions where users **design and interact with the prototype** while observers (often researcher) take notes.
- **Focus Groups**: Facilitating discussions among **groups of users about the prototype** to gain a broader understanding of user needs.
- **Think-Aloud Protocol**: Asking users to **verbalize their thoughts as they navigate through the prototype**.
- **Contextual Inquiry**: **Observing and interviewing users in their own environment**, which helps in understanding how the design fits into their everyday life and tasks.
- **Remote User Testing**: **Users test the prototype** in their own environment, typically **using their own equipment**
- …there are many more!

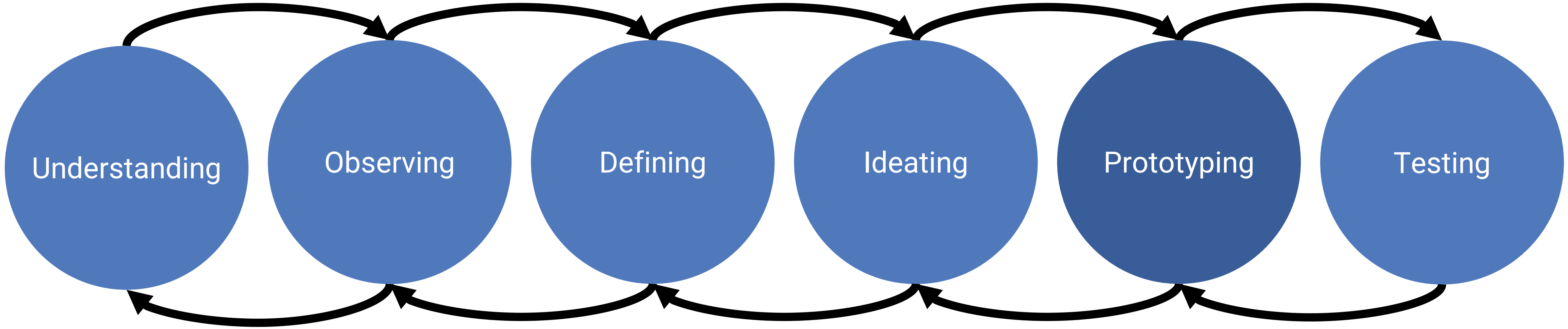
} Summative Evaluation

Exploring Prototypes with Users

- In prototype tests, researchers must often **talk and improvise with participants**
  - They need to explain the nature of the prototype
  - They may need to explain the state of the system
  - They may have to find out whether users are waiting for a response
  - Even with the above necessary interactions between the test facilitator and the user, the test facilitator's ultimate goal should be to quietly observe the person interacting with the design, not to have a conversation with the participant.
- **Tips**:
  - If users click an item for which there is no prepared response yet:
  - **Don't say: "That isn't working."**
  - **Ask: "What were you expecting to happen when you did that?"**

Design Thinking

- A **formative, human-centered design approach** with a set of cognitive, strategic and practical procedures use by designers in the process of designing
- An **iterative**, **non-linear process** including problem finding and framing, context analysis, creative thinking, ideation and solution generating through sketching and drawing, prototyping, and evaluating through user testing.

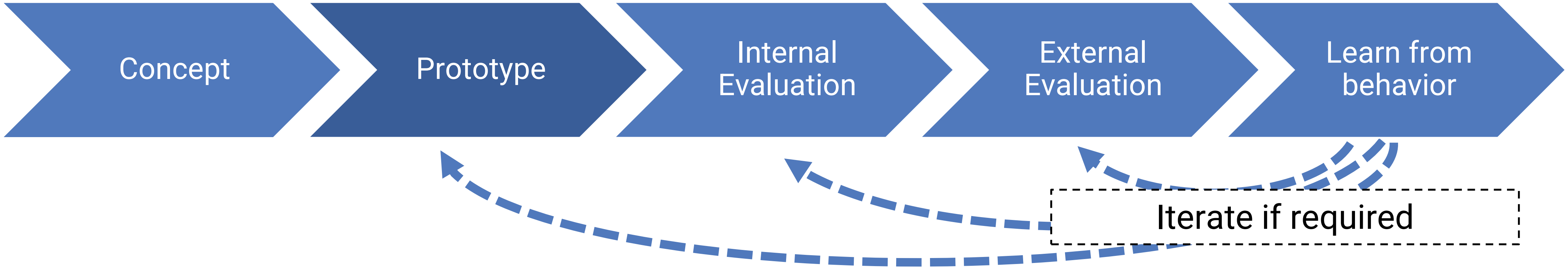


Design Thinking

- **Understanding**: At the beginning, the problem is identified with a team of several people. Getting everyone involved and aware of that problem
  - What should be newly developed? For whom should the development be relevant?
- **Observing**: Observing is about being able to empathize with the user
  - An analysis of the user's will, for example, through an interview or role-playing games
- **Defining**: The results of the first two steps are combined to a point of view
  - Techniques such as personas or task analysis can be used to define the point of view
- **Ideating**: In a brainstorming session, ideas, no matter how crazy or utopian they are, are brought together
  - The results are structured and sorted according to priorities
- **Prototyping**: A prototype is created for demonstration purposes
  - Perfection and completion are typically irrelevant (e.g., paper prototypes). The simpler, the better.
- **Testing**: The prototype will be tested, and feedback evaluated. Users are closely observed.
  - If an idea doesn't work, it can be discarded, and the process reiterated

Lean UX

- Minimal effort to start implementation: the **MVP, minimum viable product**
- When designing an experience, all decisions are made to **maximize the impact of the whole user experience**
- Short, iterative cycles to collect quick feedback from all members
- Collaborative design and evaluation

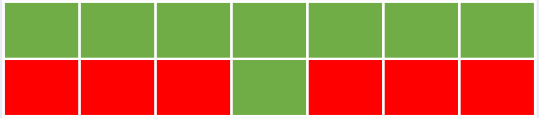


Arguments for not testing a prototype

- In the very early stages of design, **a prototype might be too conceptual** or rudimentary to yield meaningful feedback from users.
- There is **no adjustment to be made to the Waterfall processes** to accommodate UX and iterative design.
- In some cases, **the pressure to be the first** to market **can lead to skipping prototype** testing
- **A team might rely on existing data** or analytics from current users (if the prototype is a revision of an existing product) to inform design decisions instead of direct prototype testing.
- **Testing a prototype**, especially in industries with high competition, **might expose the concept** to potential intellectual propert

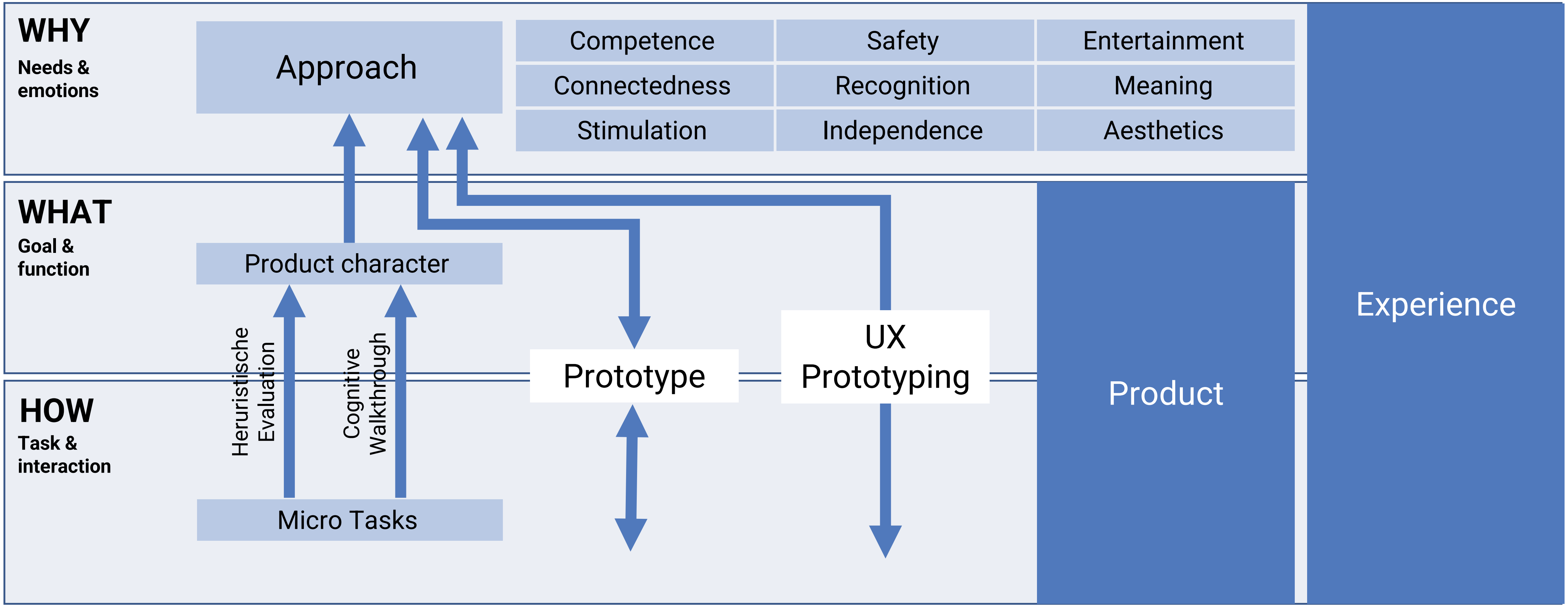
IA-based Testing with Prototypes

- Assumes the information architecture is complete and depends on how much of the features are implemented: **horizontal**, **T**, **M**, and **semi-complete**.

Model		Discoverability	Findability	Usability
Horizontal		People will realize a feature exists	People can navigate and find features	No functionality
T		Testers will learn to go to the prepared parts	Testers will learn to go to prepared areas	Collect feedback for the implemented feature
M		More options in the first few tasks	Difficult for testers to find implemented features	Collect feedback for the implemented feature(s)
Semi-complete		People will realize a feature exists	People can navigate and find features	Collect feedback for the implemented feature(s)

IA-Based View of Prototype Fidelity. (2018, February 21). Retrieved from https://www.nngroup.com/articles/ia-view-prototype

UX Prototyping



Based on Slides from Sarah Diefenbach (https://www.youtube.com/watch?v=0Q1umCBrvU4) and Diefenbach, S., & Hassenzahl, M. (2017). Psychologie in der nutzerzentrierten Produktgestaltung. Springer Berlin Heidelberg.

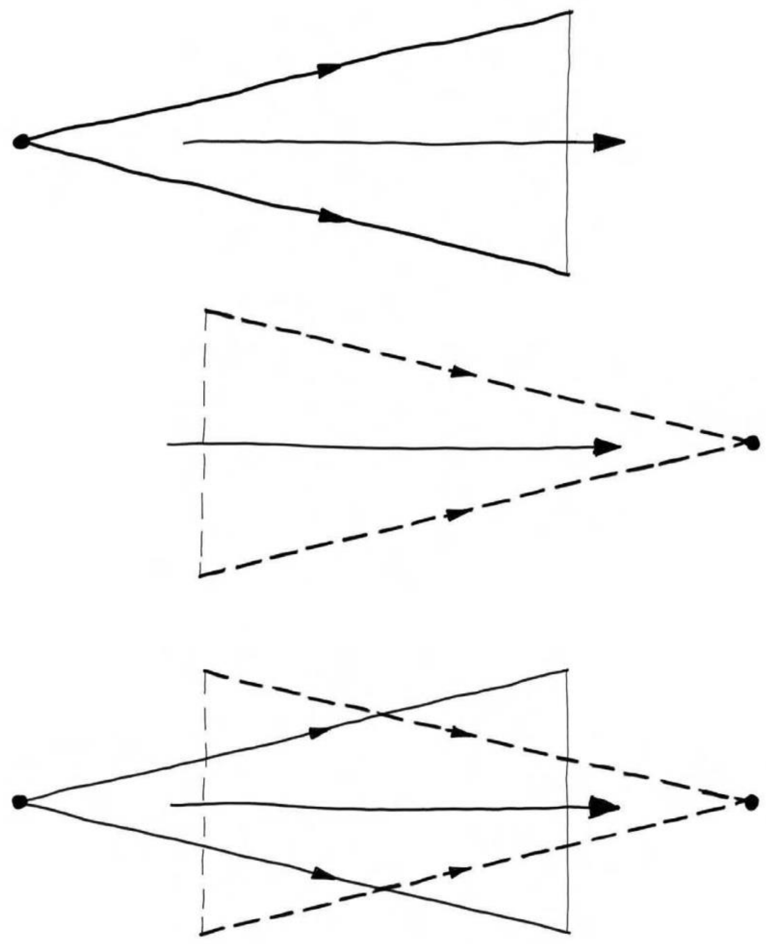
Prototype Definitions

- An **early sample**, **model**, **artifact**, or **release** of a system built to test and to rate a concept or interaction
- A **tool in the design process** that serve to **bridge the gap between theoretical design and practical, functional product**
- It enables you to **explore your ideas and show the intention behind a feature** or the overall design concept to users before investing time and money into development
- Can provide the "look and feel" of the product but do not necessarily include the functional elements
- Can be discarded (throwaway prototypes) or improved (evolutionary prototypes)

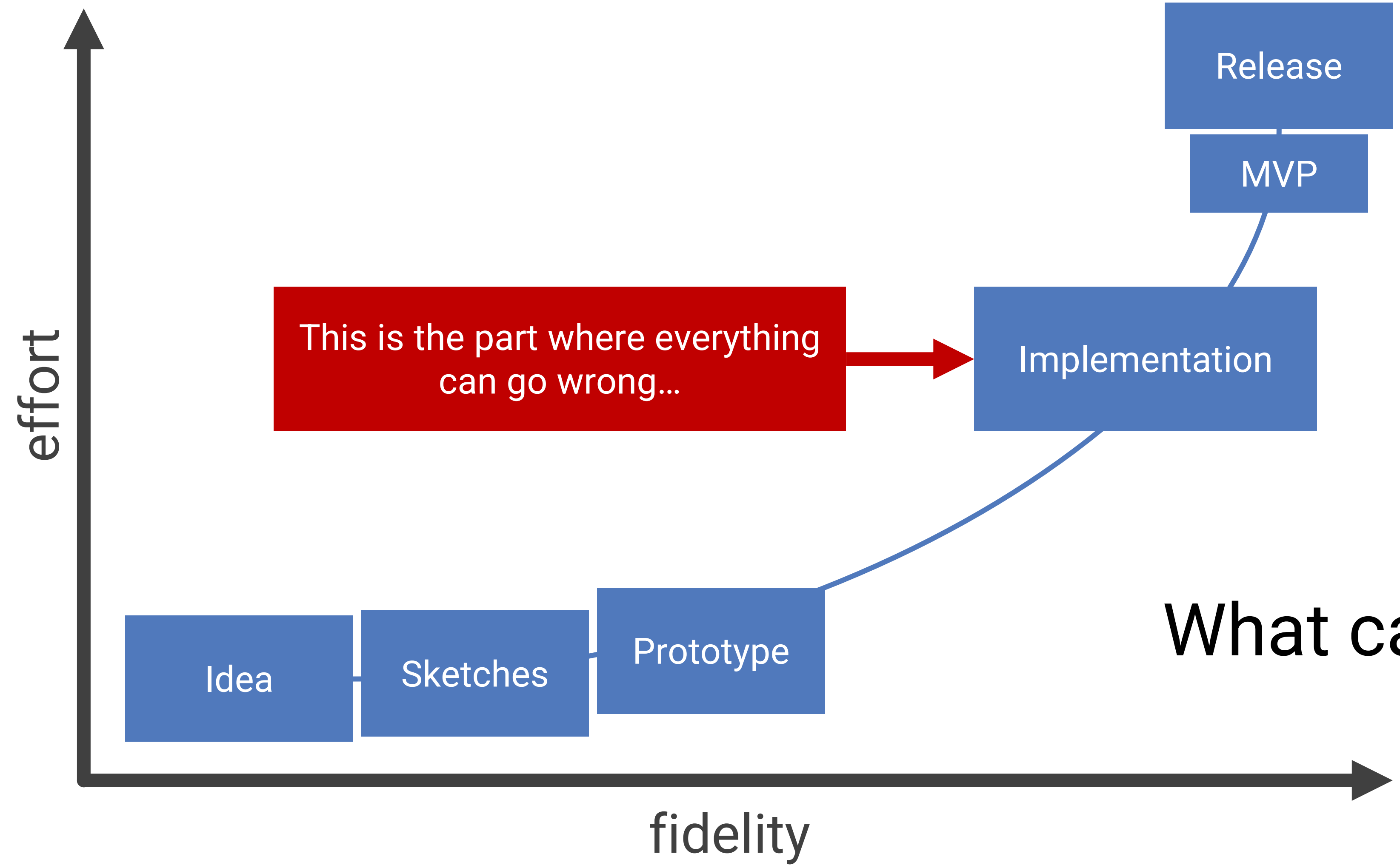
[1] Beaudouin-Lafon, M., & Mackay, W. E. (2009). Prototyping tools and techniques. In Human-Computer Interaction (pp. 137-160). CRC Press.
[2] Horn, J. (1998). The usability methods toolbox handbook. San Jose State University: Industrial and Systems Engineering Department, San Jose, CA.
[3] Connell, J. L., & Shafer, L. (1989). Structured rapid prototyping: an evolutionary approach to software development. Yourdon Press.

Exploring Design Spaces

- **Opportunity-Seeking**:
  - From few to many possibilities
- **Decision making**:
  - From many to few options
- **Overlapping funnels**:
  - The reduction resulting from decision-making is balanced by the constant generation of new, creative ideas.
  - This constantly opens up new possibilities for improving a design.

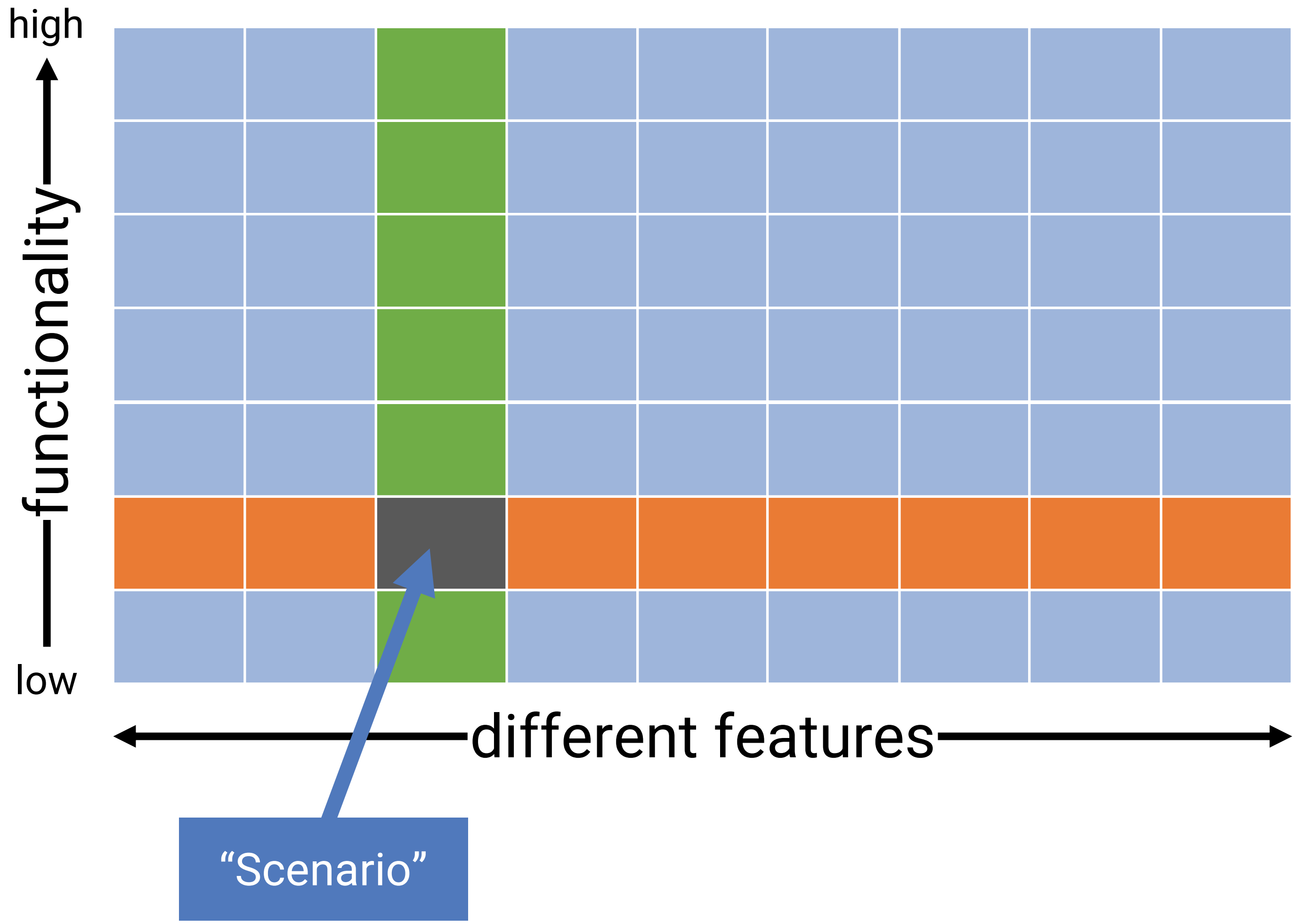


The Problem with Prototypes

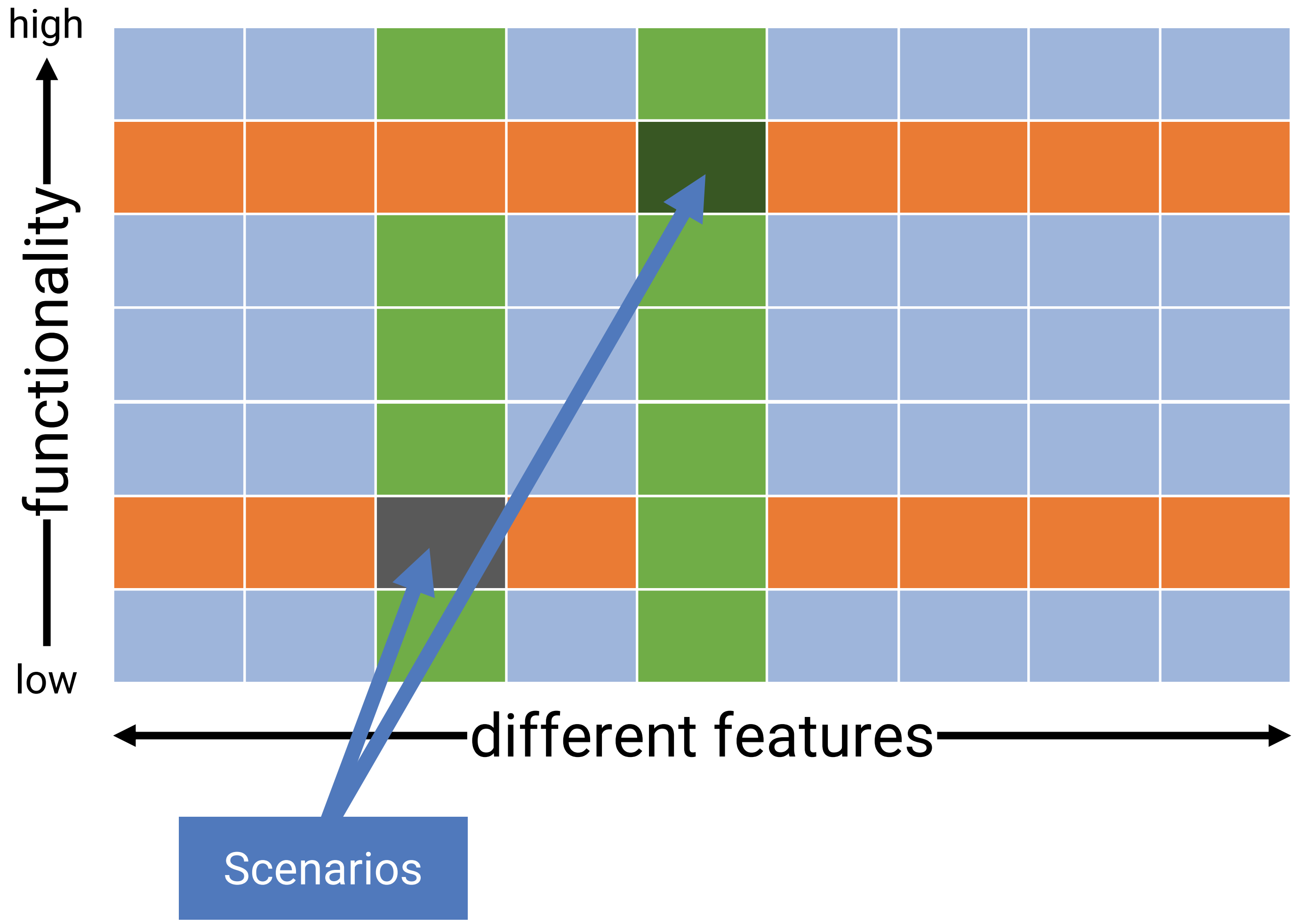


What can we do?

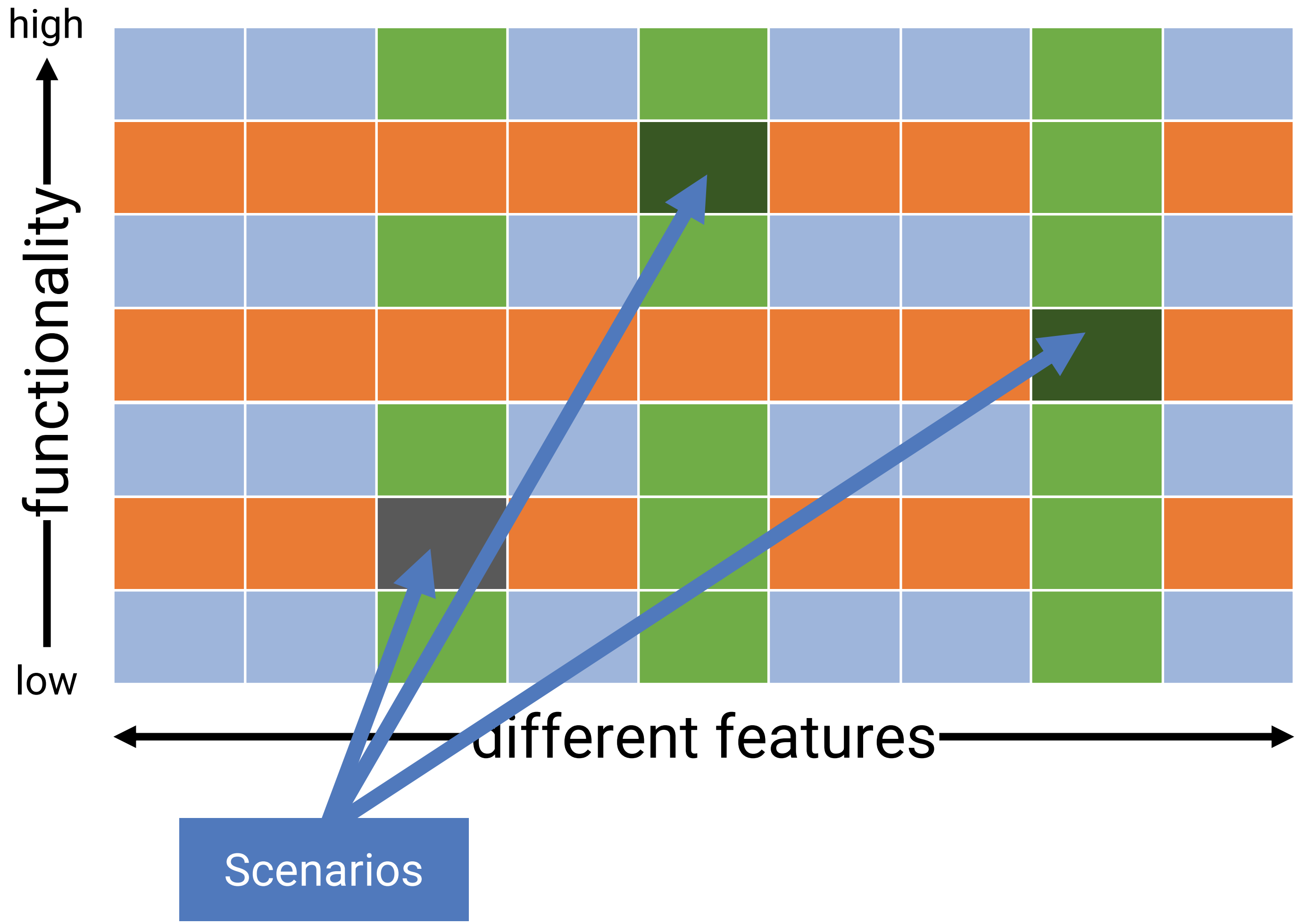
Functionality and Features



Functionality and Features



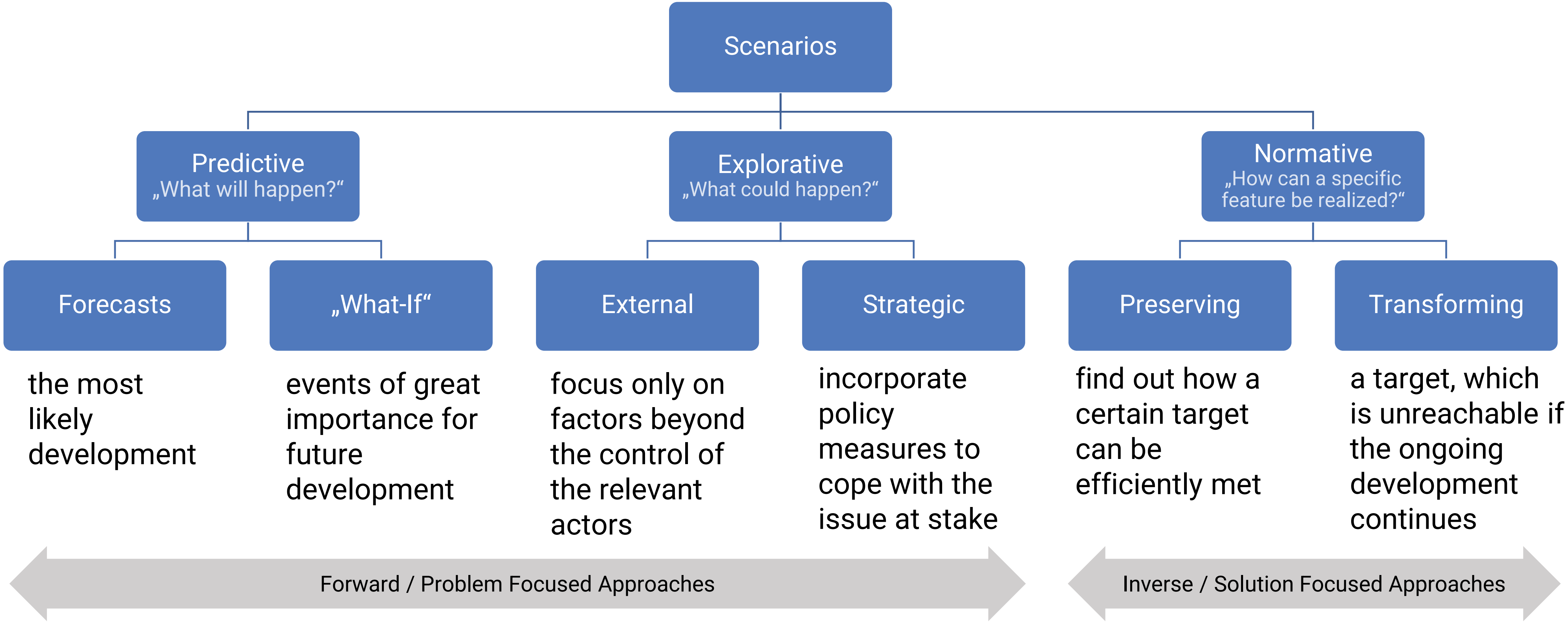
Functionality and Features



Scenarios

- **Scenarios are stories about people using the prototype**. They providing context and meaning to the interactions by outlining specific instances of use.
- **Scenarios are helpful in the prototyping process** for several reasons:
  - **Contextualization**: They ground the design process in real-world situations
  - **Communication**: Scenarios serve as a communication tool among stakeholders, including designers, developers, and users
  - **Guidance**: By outlining specific interactions, scenarios guide the design of the user interface and the system's functionality to support these interactions.
  - **Focus**: They help in maintaining the focus on user needs and experiences throughout the design and development process.
  - **Problem Identification**: They help identify potential problems and challenges in user interactions early in the design process, which can be addressed before costly development efforts are undertaken.

Scenario Development



Börjeson, L., Höjer, M., Dreborg, K. H., Ekvall, T., & Finnveden, G. (2006). Scenario types and techniques: towards a user's guide. Futures, 38(7), 723-739.

Scenario Development Examples

- **We take our personas and tasks to write scenarios** and tell the story of how they use the prototype to accomplish their goals.
- **Scenario Forecast Examples**: “Touchscreen Interface for a Smart Thermostat”
  - **Scenario 1**: *“Emma comes home from work and finds her house too cold. She approaches the smart thermostat and uses the touchscreen interface to raise the temperature. The prototype includes visual feedback showing the temperature change and a timer once the desired temperature is set.”*
  - **Scenario 2**: *“On Sunday evening, Emma programs her heating schedule for the week. She interacts with a graphical interface on the touchscreen, setting different temperatures for different times of the day. The system provides a summary of her settings and asks for confirmation.”*

Prototype Taxonomies

Human-Computer Interaction Lecture

Slides adapted from hci-lecture.org (A. Schmidt, N. Henze, K. Wolf, V. Schwind), Image from: https://pxhere.com/de/photo/437662

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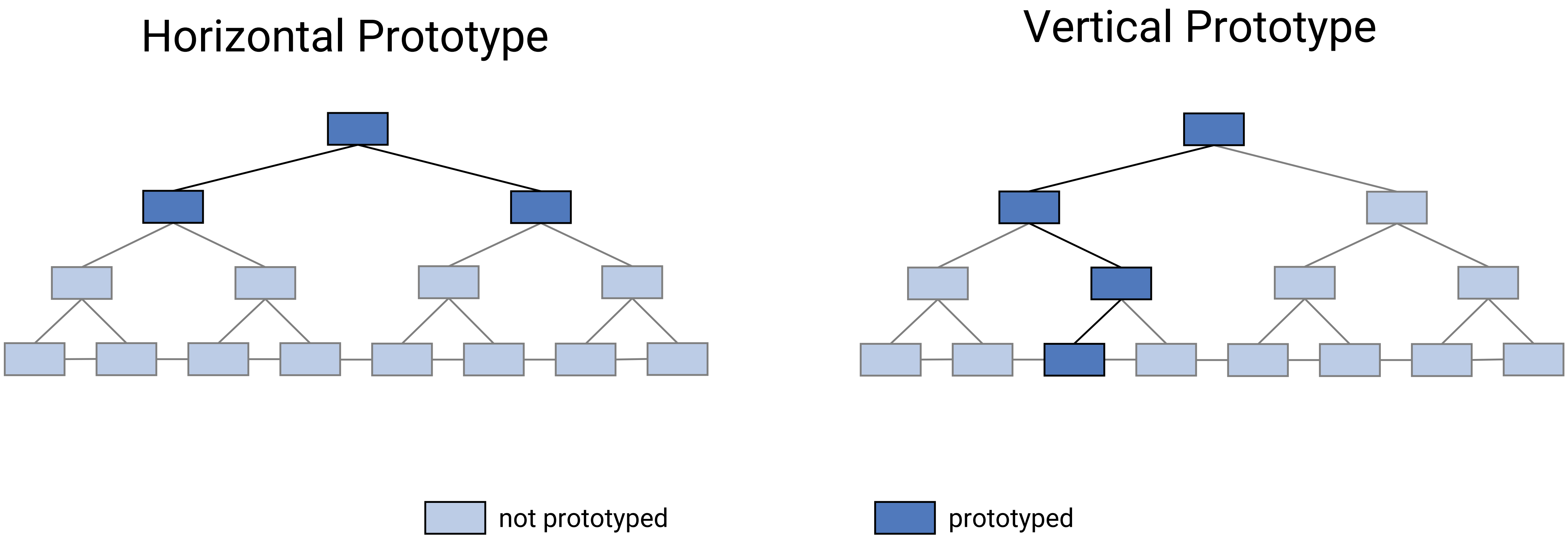
Taxonomies of Prototypes

- Prototypes are commonly categorized based on their **fidelity**, **purpose**, and the **stage of the design process** they are used in
- Common taxonomies:
  - **By representation**: Horizontal vs vertical prototypes
  - **By fidelity**: Low- vs high-fidelity prototypes
  - **By function**: Non-functional vs functional prototypes
  - **By purpose**: Evolutionary prototypes vs throw-away prototypes

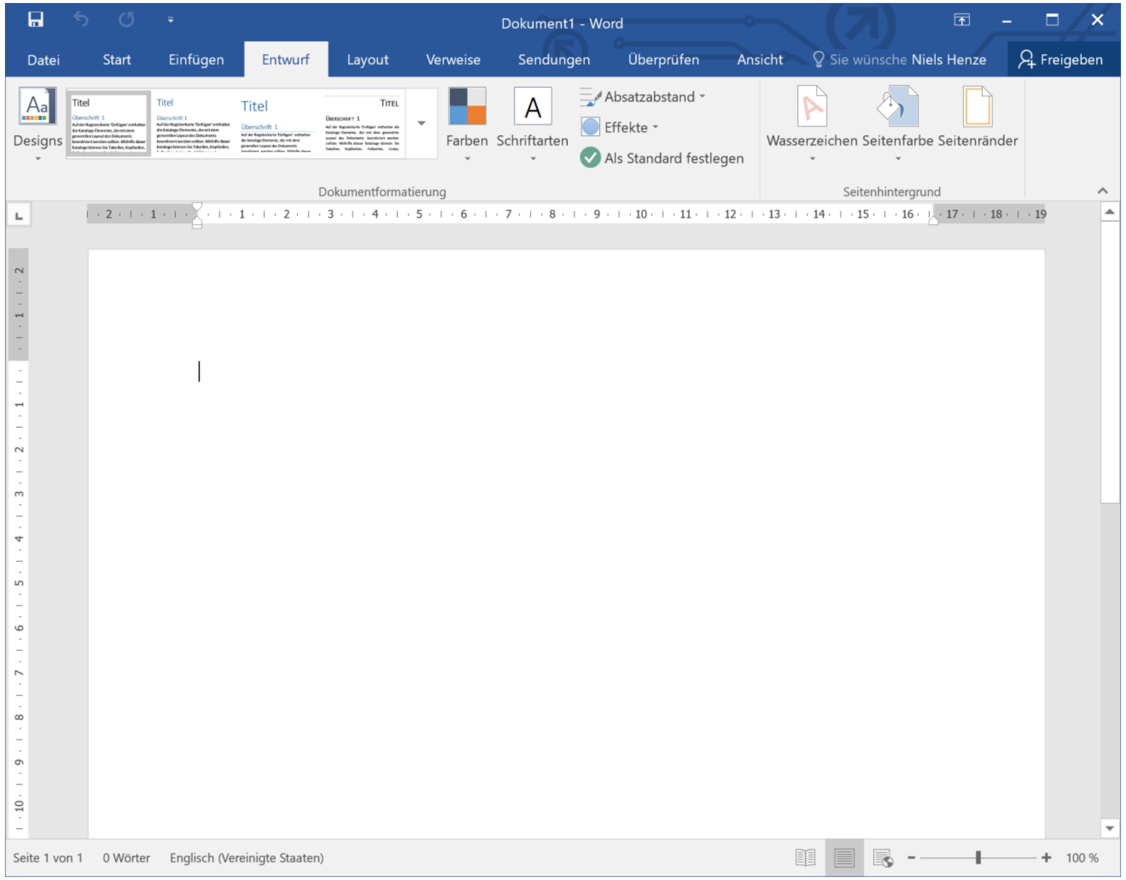
By Representation

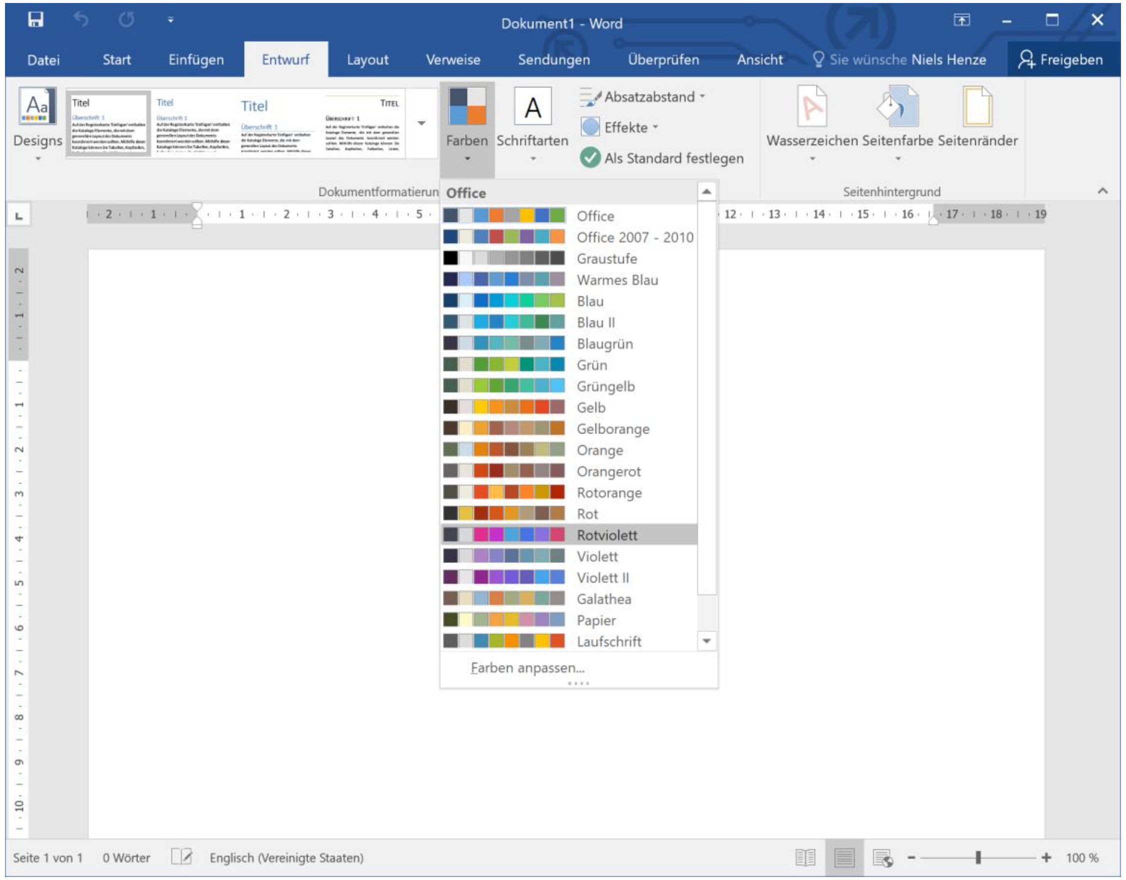


Horizontal Prototype

- Demonstrates the **full feature spectrum** without implementing them
- **Helps to evaluate**/test
  - Navigation (e.g., finding a specific function)
  - Layout options
  - Overall user interface concept
  - Feature placement
  - Accessibility
  - User preferences
- **Applicable in low-fidelity prototyping and high-fidelity prototyping**
- Used in early design stages
  - To determine the set of features to include
  - To decide on the user interface concept

Horizontal Prototype

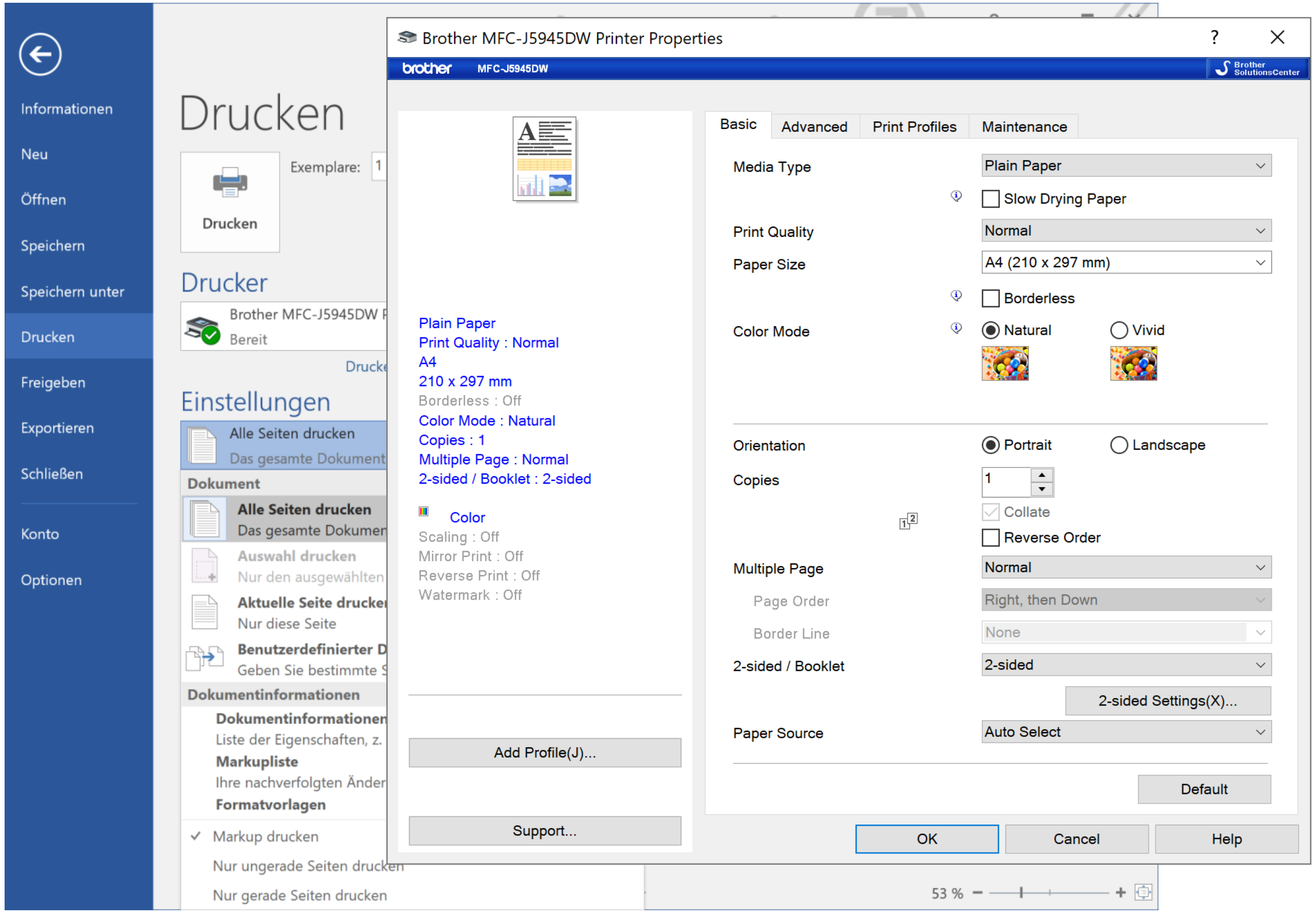




Vertical Prototype

- **Demonstrate a specific feature** and its implemented functionality
- The details of the function/feature are shown/implemented
- Helps to evaluate/test
  - The optimal design for a particular function
  - Optimize the usability of this function
  - User performance for this particular function
- **Applicable in low-fidelity prototyping but mostly used in high-fidelity prototyping**

Vertical Prototype



Based on a photo by cottonbro from https://www.pexels.com/photo/man-using-a-printer-3201783 (PD)

By Fidelity

- **Low-Fidelity Prototypes**
  - Often paper-based or simple digital mock-ups.
  - Quick to create and useful for early-stage design to test broad concepts.
  - Examples: Sketches, paper models, wireframes.
- **Medium-Fidelity Prototypes**
  - More detailed than low-fidelity, often digital, but not fully functional.
  - Used to get a more accurate feel for the final design without extensive coding.
  - Examples: Interactive wireframes, clickable prototypes.
- **High-Fidelity Prototypes**
  - Very close to the final product in terms of detail and functionality.
  - Require more time and resources to create but are used for final testing before launch.
  - Examples: Fully interactive devices or applications, detailed and functional systems.

Low-/Medium/High-Fidelity Prototypes

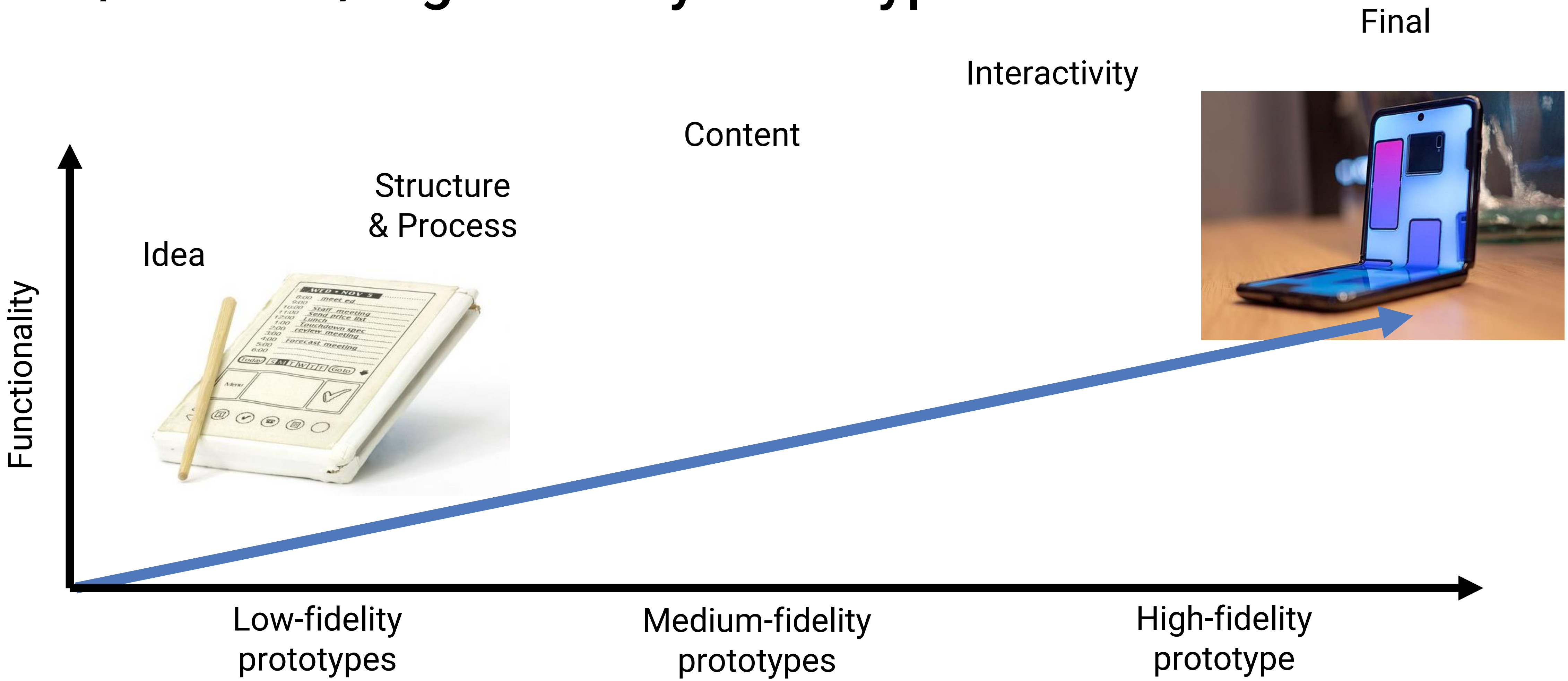


Photo by Mark Richards from https://www.computerhistory.org/revolution/mobile-computing/18/321/1648
Image by Grace R. Samson from https://commons.wikimedia.org/wiki/File:Samsung_Galaxy_Z_Flip_fold.jpg (CC-BY-SA 4.0)

Low-Fidelity Prototype

- **Advantages**
  - Cheap, easy and quick to implement
  - Users are keen to criticise
- **Disadvantages**
  - No real functionality, difficult to identify errors
  - Reuse and extending difficult to impossible
  - Not all ideas can be realized

Photo by Mark Richards from
https://www.computerhistory.org/revolution/mobile-computing/18/321/1648

Photo by Mark Richards from https://www.computerhistory.org/revolution/mobile-computing/18/321/1648

Medium-Fidelity Prototype

- **Advantages**
  - Allow for some level of user interaction, which can yield valuable feedback on the usability
  - Communicate design concepts to stakeholders
  - Flexible enough for changes
- **Disadvantages**
  - They may not fully convey the final look
  - The visual and interactive quality can lead to an attachment to elements that may not be optimal
  - They might give a false sense of completeness

Fig 1. Home screen

Fig 2. Food places

Images by Nick Babich: https://balsamiq.com/learn/articles/mobile-app-wireframing-guide/

Photo by Mark Richards from https://www.computerhistory.org/revolution/mobile-computing/18/321/1648

High-Fidelity Prototype

- **Advantages**
  - Show how the finished product will look and feel
  - Behaves like the final product for selected tasks
  - Allows predicting efficiency
- **Disadvantages**
  - Can be very time-consuming to implement
  - Users can only “use” the implemented functions
  - Feedback centered around look & feel
  - Managers may expect that “the product” is nearly ready

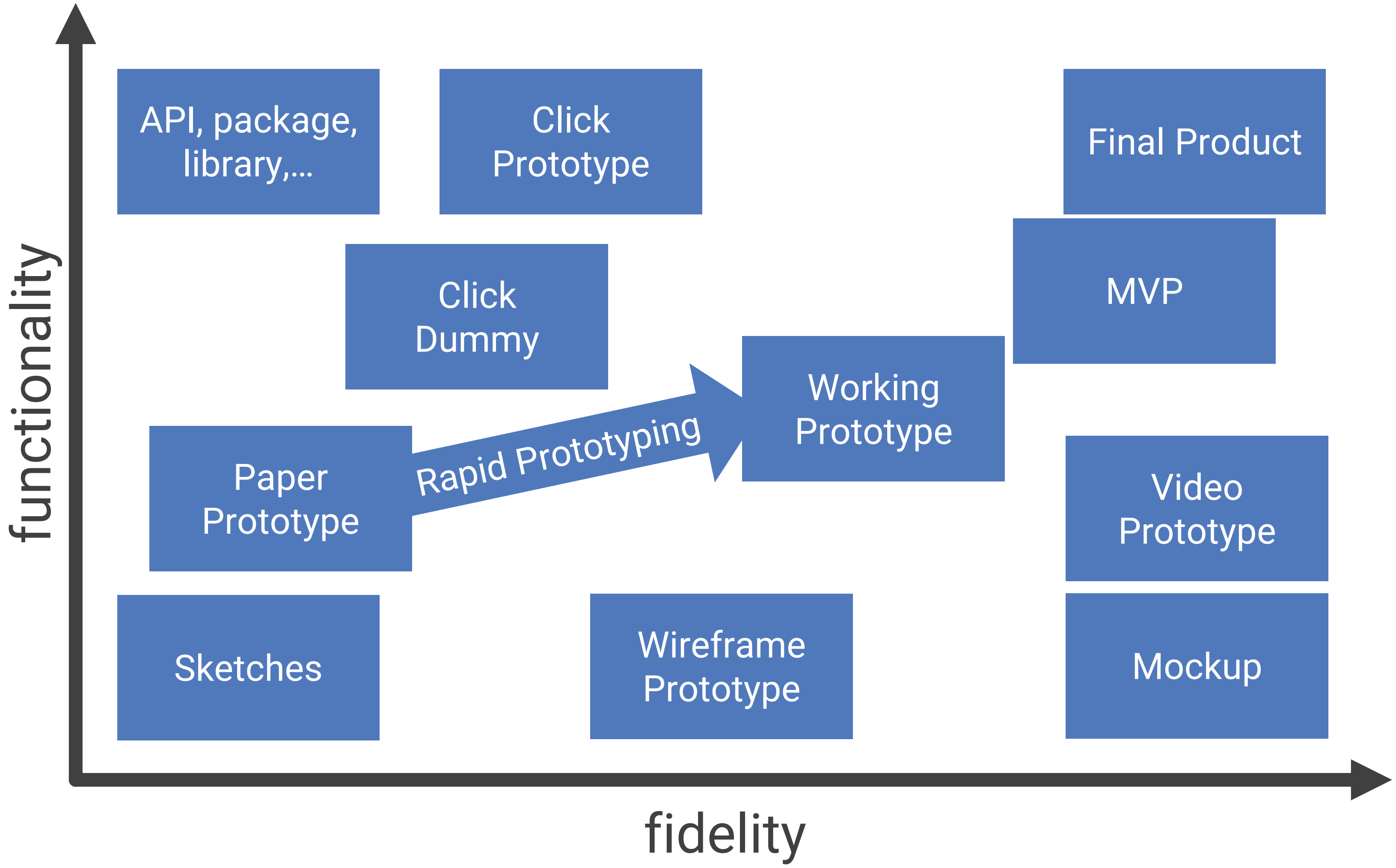
By Function

Images by Lego and CaDA

By Function

Images by Lego and CaDA

By Function and Fidelity



By Purpose

- **Exploratory/rapid prototyping** (rapid/throw-away prototyping)
  - Provides information about the design (capture requirements)
  - not part of the final solution
  - testing certain aspects
- **Incremental Prototype**
  - There is a functional core
  - With each iteration, a new component is added to the core
  - When all components are present, the solution is complete
- **Evolutionary Prototype**
  - The prototype undergoes a series of refinements and can become the solution
  - Useful when the exact requirements cannot be determined in advance
  - Customer / end user are often closely involved in the development

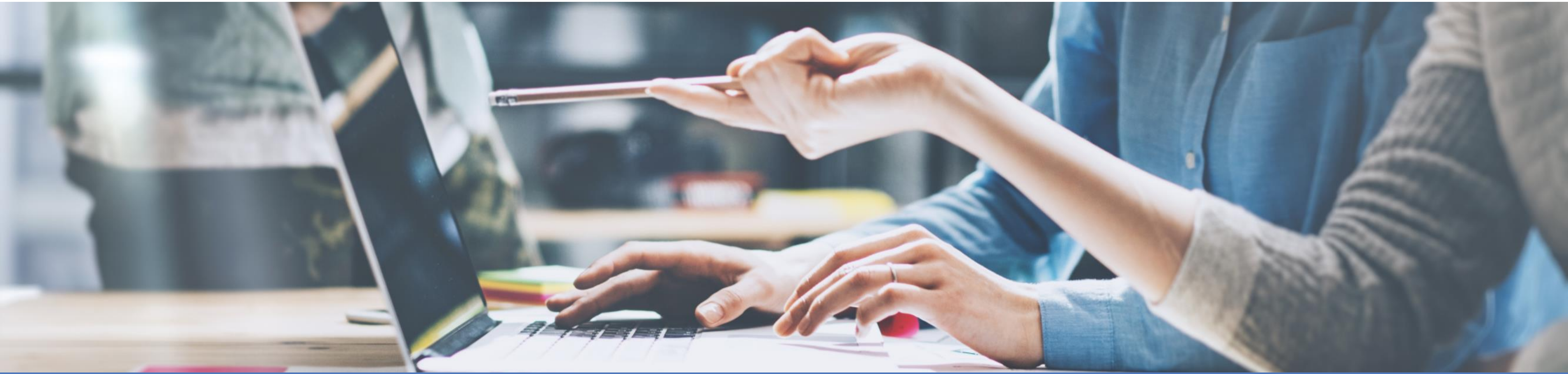
Can lead to an MVP

By Stage of Development

- **Concept Prototypes**
  - Used to validate and develop the initial concept behind a product.
  - Help in communicating the basic idea and main functionality.
- **Functional Prototypes**
  - Include working parts and demonstrate the functionality of the product.
  - Used to test the technical aspects and user interaction with actual working elements.
- **Presentation Prototypes**
  - Created to showcase the product to stakeholders, often resembling the final product in terms of aesthetics.
  - Used for marketing purposes and to gather feedback from a non-technical audience.
- **Production Prototypes**
  - Final stage before mass production.
  - Used to test manufacturing processes and resolve any remaining issues.

Summary

- Which aspect do you want to test?
- Focus on these aspects first
- Horizontal/vertical prototype?
- Low/high fidelity prototype?
- What tools do I want to use for my prototype?
- A prototype is bad if it cannot be tested
- Evaluation does not necessarily mean conducting a user study
- With UX or Lean UX, the focus is on the experience



Designing Prototypes

Human-Computer Interaction Lecture

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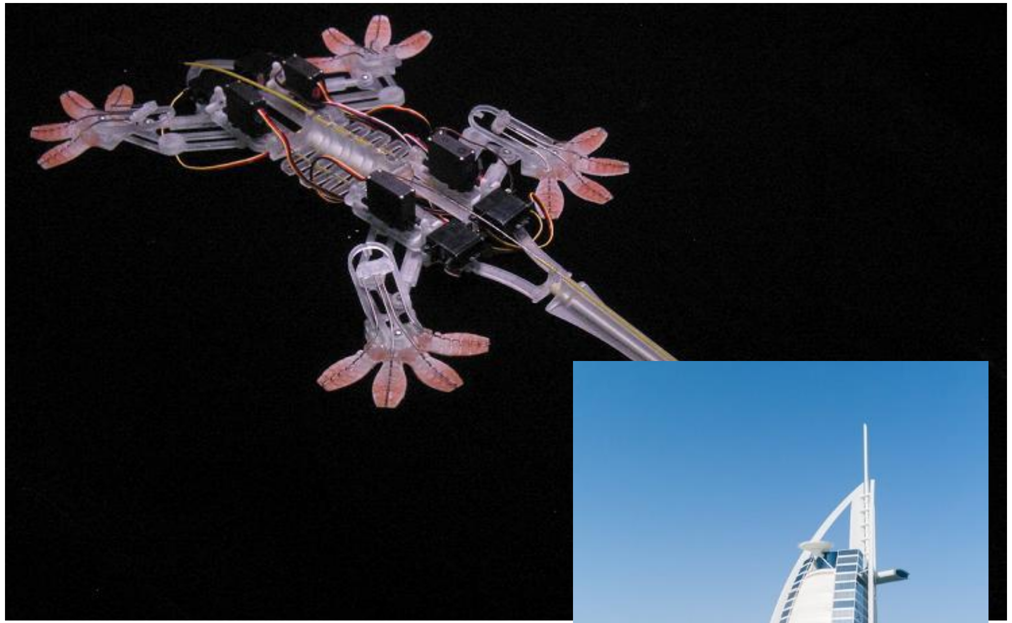
Just do it


just do it
Did you just use a saxophone as a Nike icon
Improvise. Adapt. Overcome

Influence versus Inspiration



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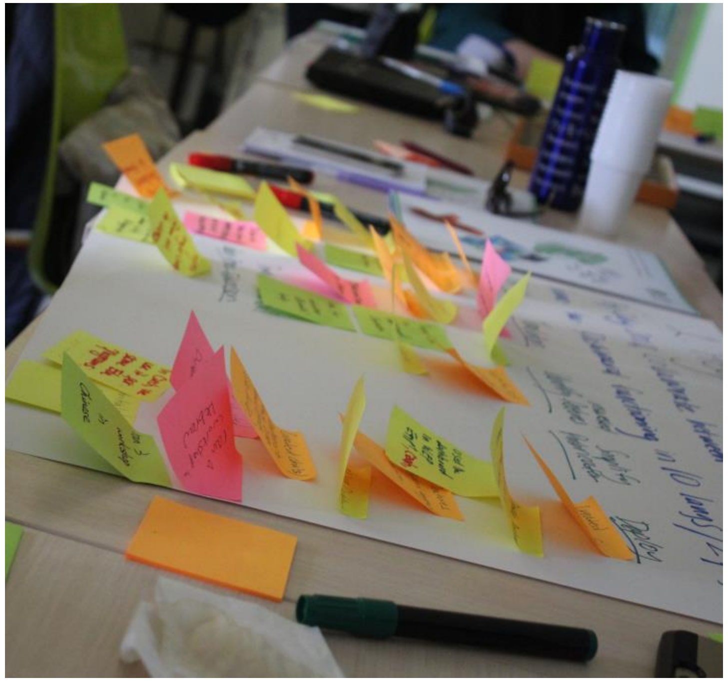
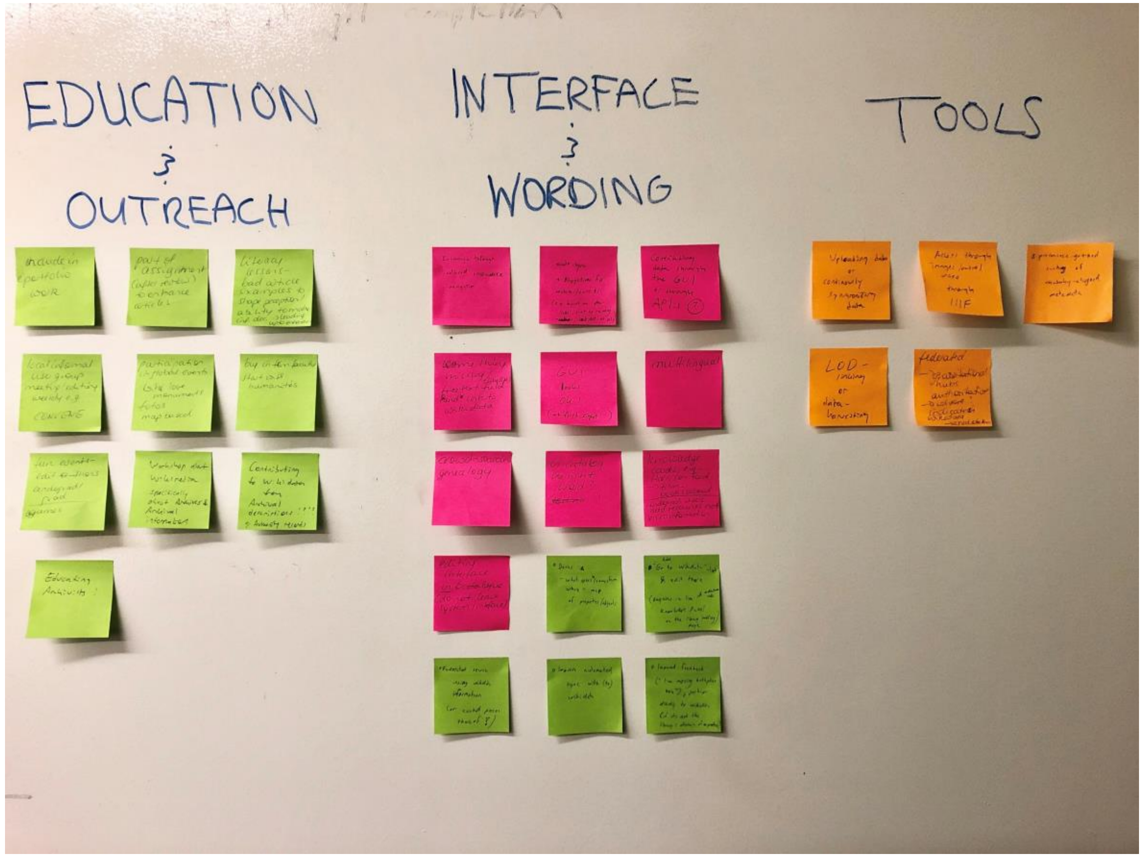
Brainstorming Designs

- **Start with a well-phrased question**, e.g. “How can we help [group] to [benefit]?”
- **Use the 7 rules of brainstorming**:
  1. Defer judgement, engage participants
  2. Encourage wild ideas, allow crazy ideas
  3. Build on others’ ideas
  4. Stay on topic
  5. One conversation at a time
  6. Be visual
  7. Go for quantity
- **Interdisciplinary teams**, select ideas, use simple tools, such as post-its to form idea clusters



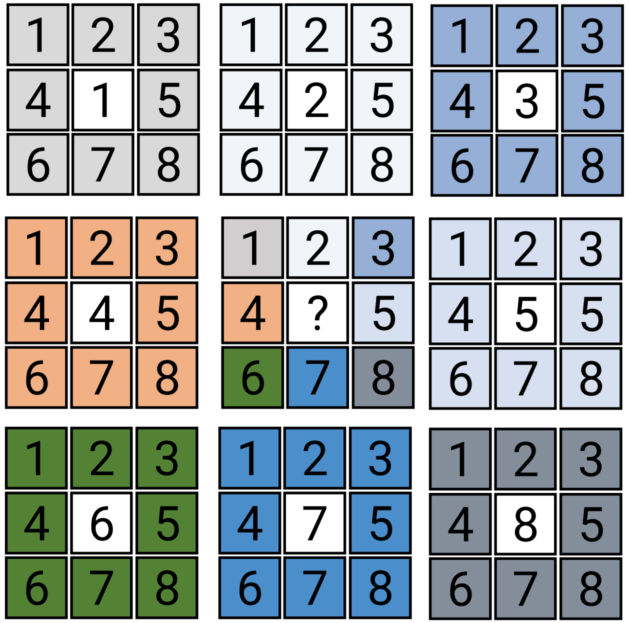
Brain-storming: Organizing & Documenting Designs

- **Identify similar ideas**
- **Identify concepts and themes**
- **Group the ideas** accordingly
- **Conclude design** & implementation concepts
- **Record the process** (take a picture of the grouping result)

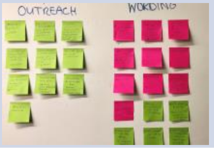
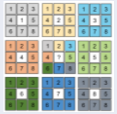
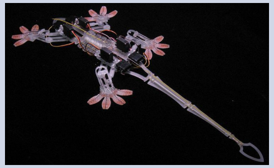


Lotus Flower/Blossom Method

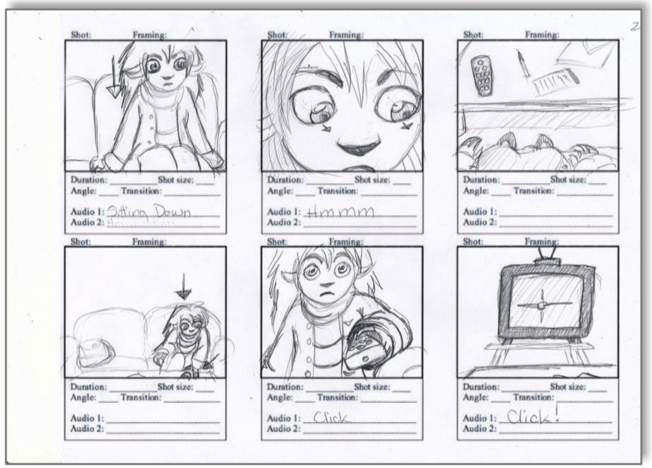
- **Adds structure** & **focus to brainstorming**
- Walk through:
  - **Write down the problem** / question at a card
  - **Search for 8 solutions**
  - **Place the solutions around the 1st card**
  - **Give more ideas more space**
  - **Find 8 more specific or modified descriptions** around each of the 8 solution idea cards

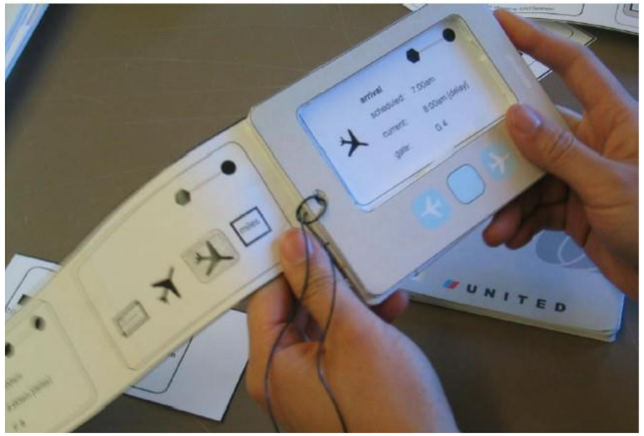


Overview of Ideation Techniques

Technique	Device	Description	Example
Brain-storming	Group interaction	Verbalize thoughts in a groupt so one person's idea prompts others	
Lotus Blossom	Goal setting	Set goals/limits and provide structure	
Input-Output	Translation	Conceptually convert one kind of thing into another	
Focused-Object	Association	Mentally follow associative links among ideas in memory	
Bionics	Analogy	Look for things similar to parts of the problem situation	

Sketches





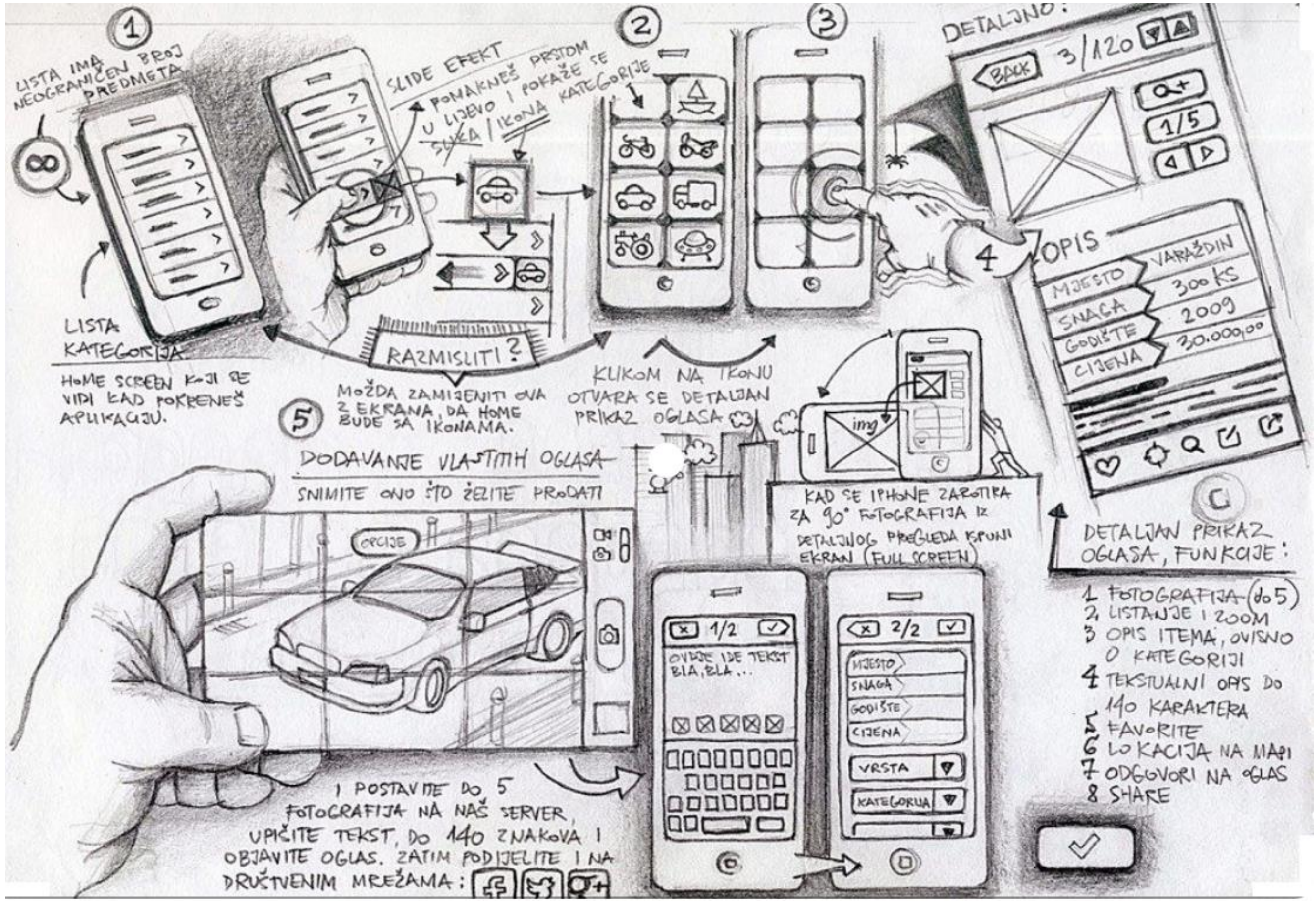


Image by Rosengeist http://rosengeist.deviantart.com/art/hans-Storyboard-page-2-151521853 (CC BY-NC-ND 3.0)
From: Khai N. Truong, Gillian R. Hayes & Gregory D. Abowd: Storyboarding: An Empirical Determination of Best Practices and Effective Guidelines. Proc. DIS, 2006.
https://medium.com/@xinyicui/ui-ux-strategy-a-guide-to-paper-prototype-sketching-3c475ce560f9

Why Sketches?

- **Designers invent while sketching**
  - Many have no design in mind at all and only develop it while sketching
  - Aristotle: “There are things that we must learn before we can do them. And we learn them by doing them.”
- **Sketching supports the invention process**
  - Ideas for solving design problems
  - Anyone can sketch
    - For collaboration and own investigations
- **No “artistic” needs**, just be creative

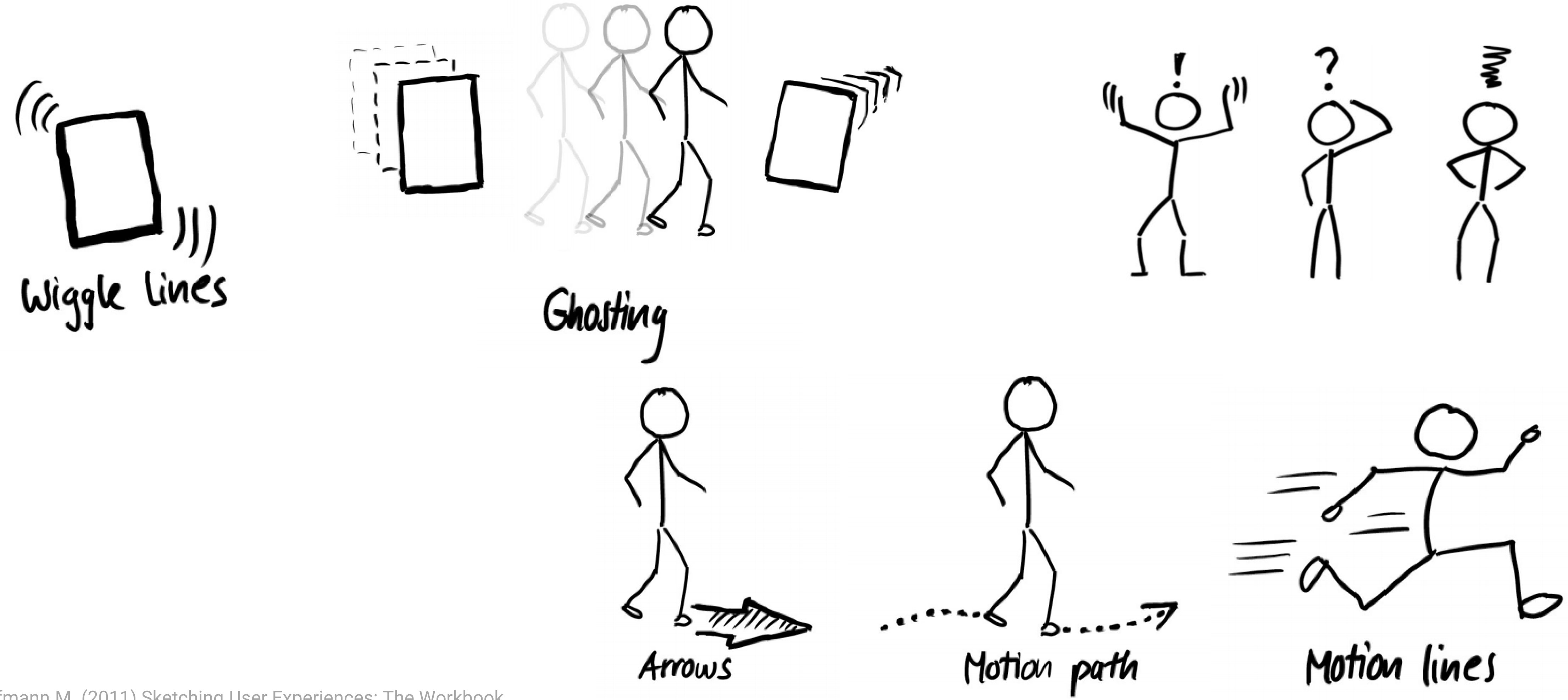
http://www.ideo.com/images/uploads/work/slides/dt_hero_1_626px.png
Pin&Play Meeting, July 2002, Lancaster

About Sketches

- **Quick**: to produce, so can do many
- **Timely**: provided when needed, done “in the moment”
- **Inexpensive**: so doesn’t inhibit exploration early in the design process.
- **Disposable**: no investment in the sketch itself
- **Plentiful**: both multiple sketches per idea, and multiple ideas
- **Clear vocabulary**: informal, common elements
- **Distinct Gesture**: open, free, “sketchy”
- **Constrained Resolution**: no higher than required to capture the concept
- **Appropriate Degree of Refinement**: don’t imply more finished
- **Ambiguity**: can be interpreted in different ways, and new relationships seen within them, even by the person who drew them.
- **Suggest & explore rather than confirm**: foster collaborative exploration

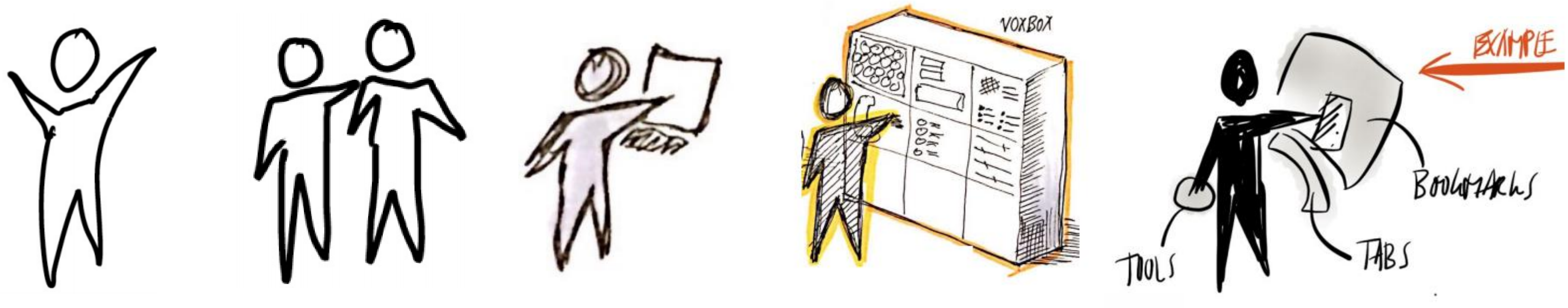
Buxton, B. (2010). Sketching user experiences: getting the design right and the right design.

Sketches with Movements



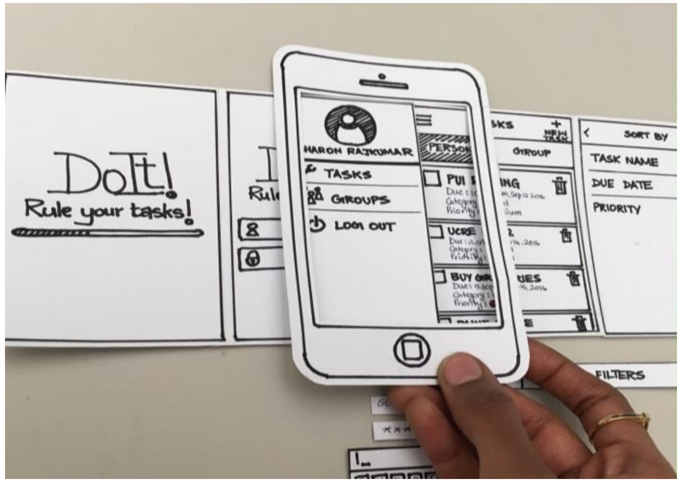
Kaufmann M. (2011) Sketching User Experiences: The Workbook

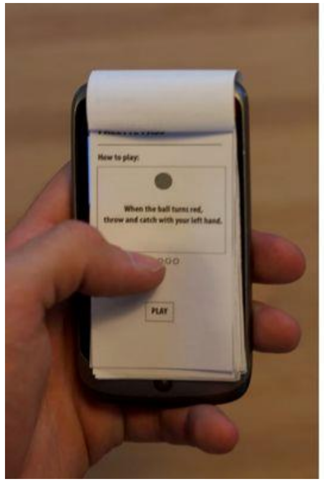
Stick Figures

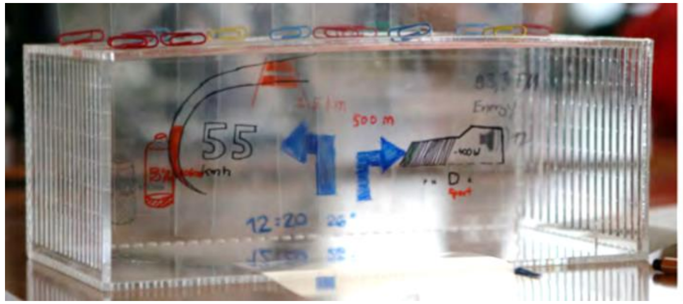


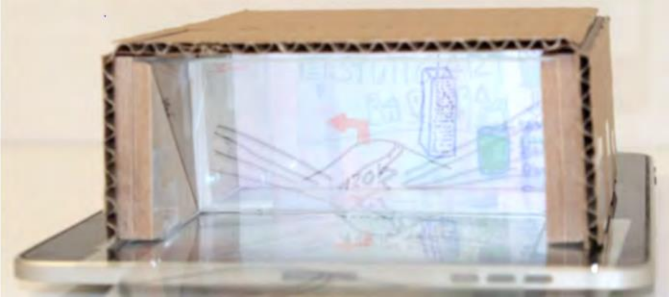
Kaufmann M. (2011) Sketching User Experiences: The Workbook

Paper Prototypes







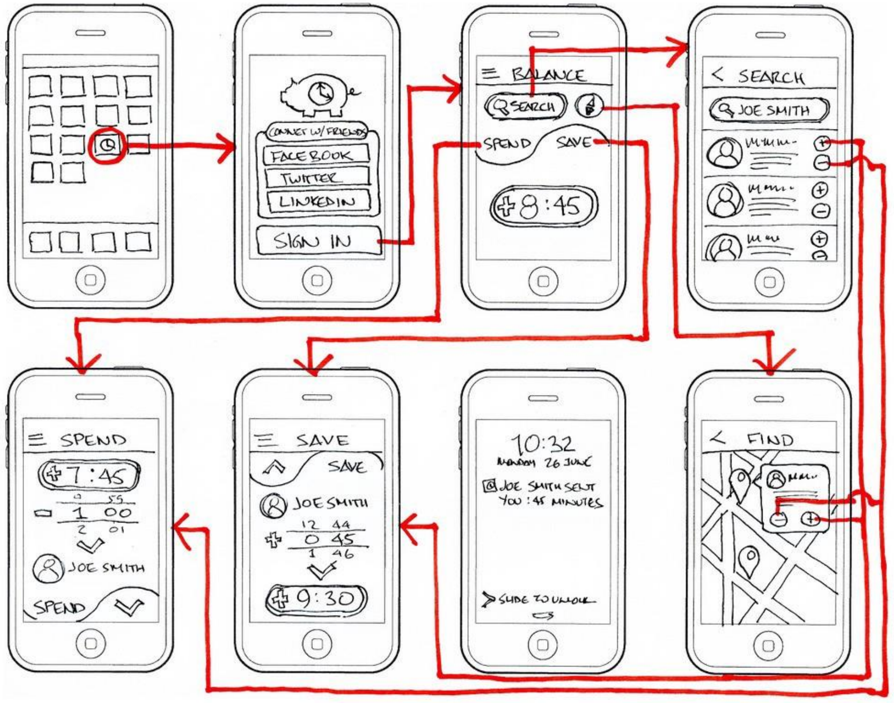


Figures from: Nora Broy, Stefan Schneegass, Florian Alt, and Albrecht Schmidt. 2014. FrameBox and MirrorBox: tools and guidelines to support designers in prototyping interfaces for 3D displays. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14). ACM, New York, NY, USA, 2037-2046. DOI: https://doi.org/10.1145/2556288.2557183

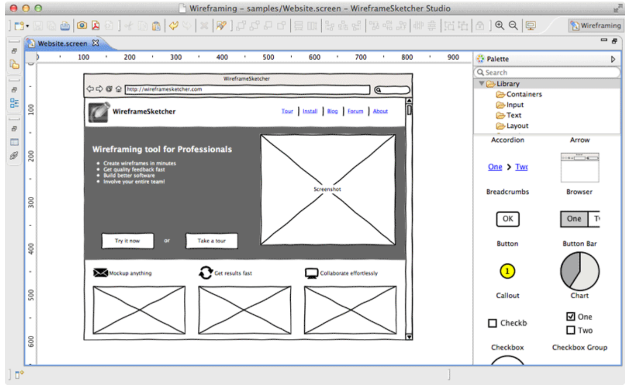
https://www.corehf.com/role-of-paper-prototyping-in-product-development/?doing_wp_cron=1554718467.1168439388275146484375

https://www.nomensa.com/blog/2015/ux-design-5-reasons-use-paper-prototypes

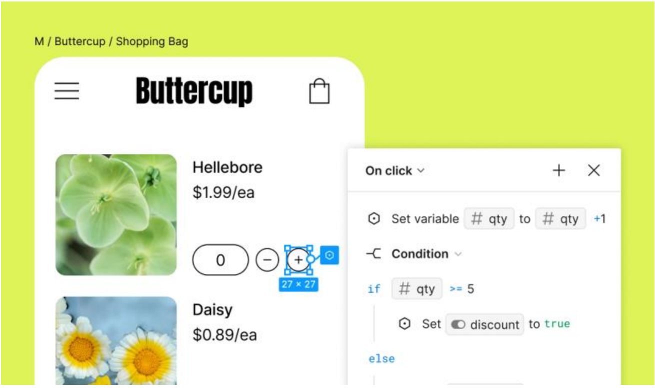
Wireframes



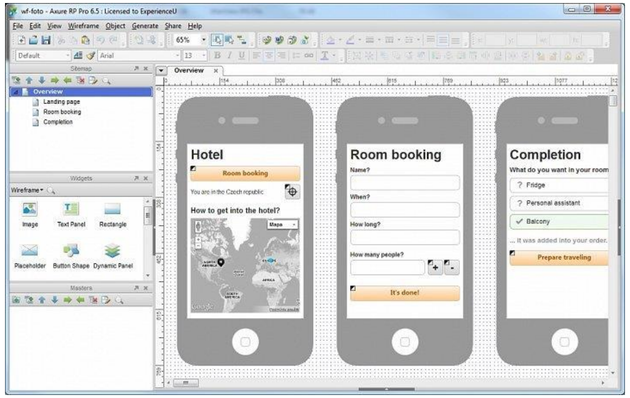
https://medium.com/@ergomania_UX/wireframes-and-colors-541e92401538



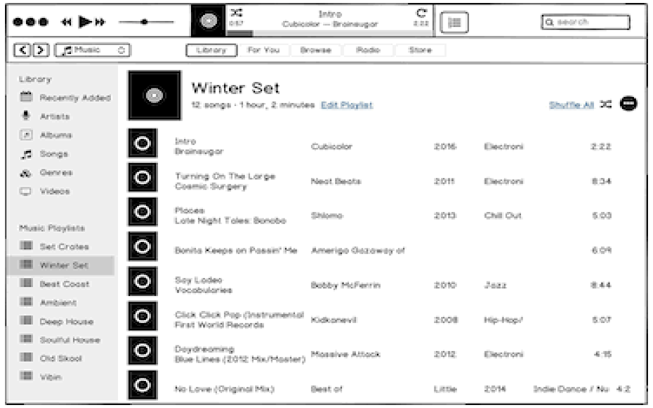
Wireframe Sketcher



Figma



Axure RP

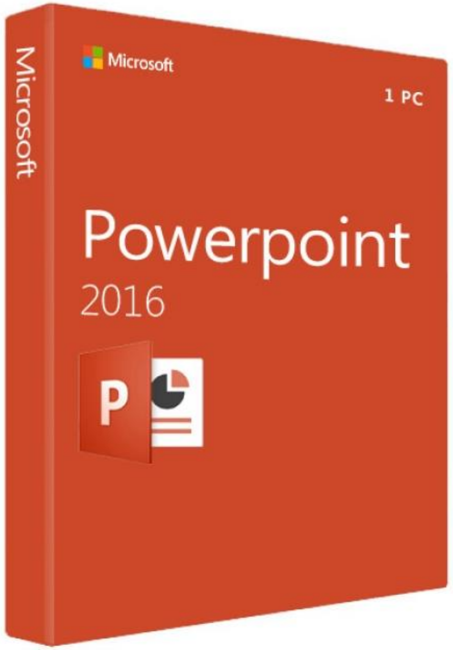


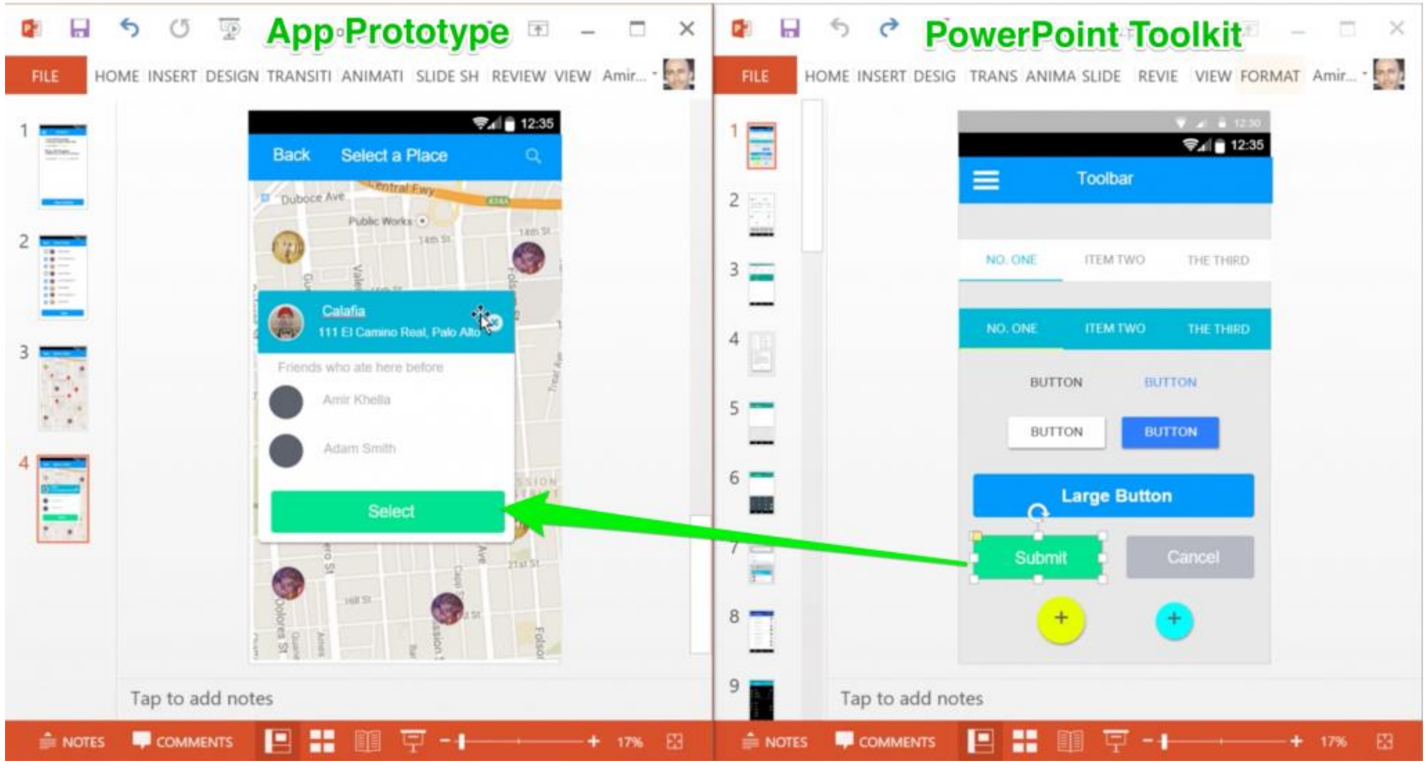
Balsamiq

Paper/Slide Templates

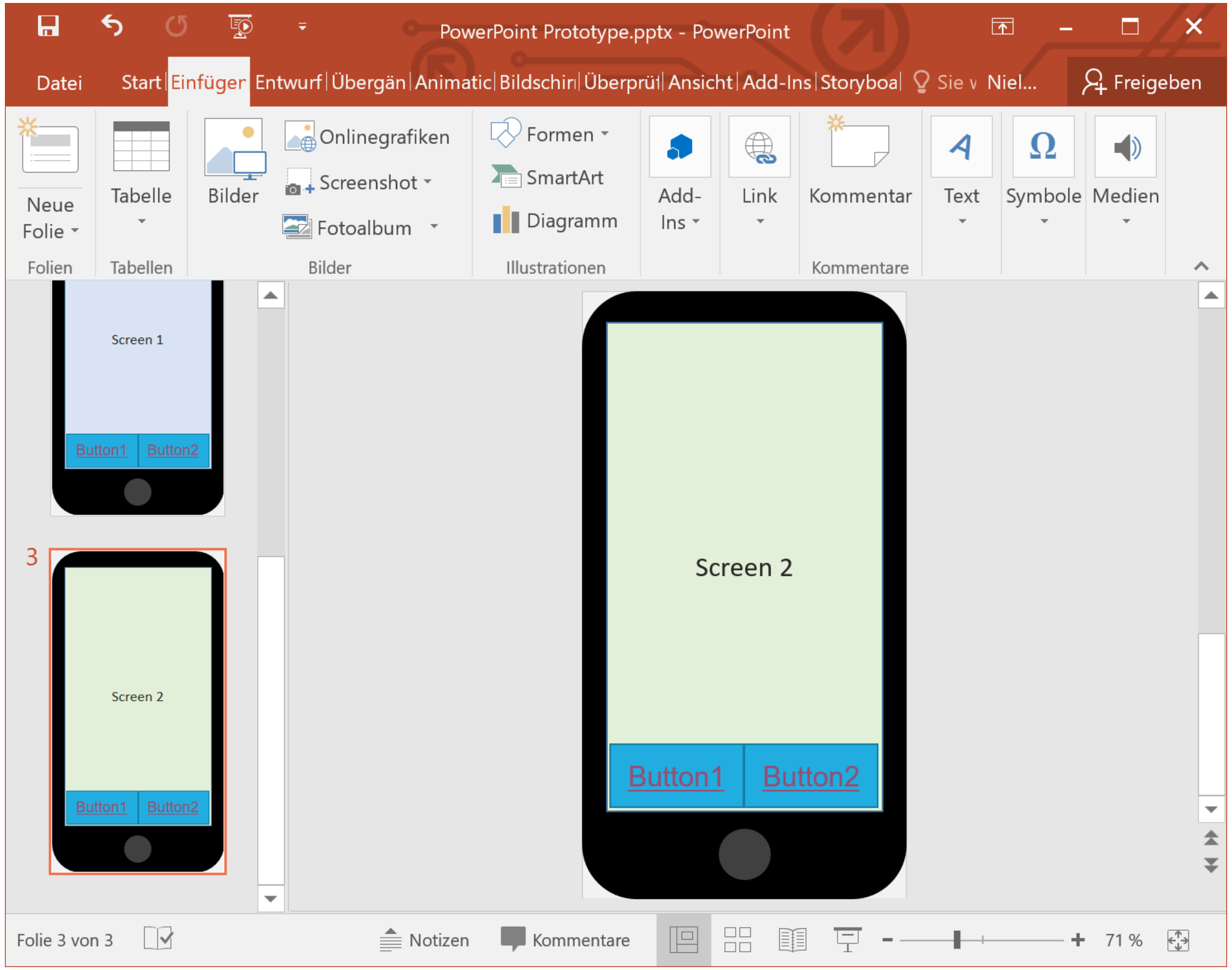
By Betsy Weber from https://www.flickr.com/photos/betsyweber/5516971798 (CC-BY 2.0)

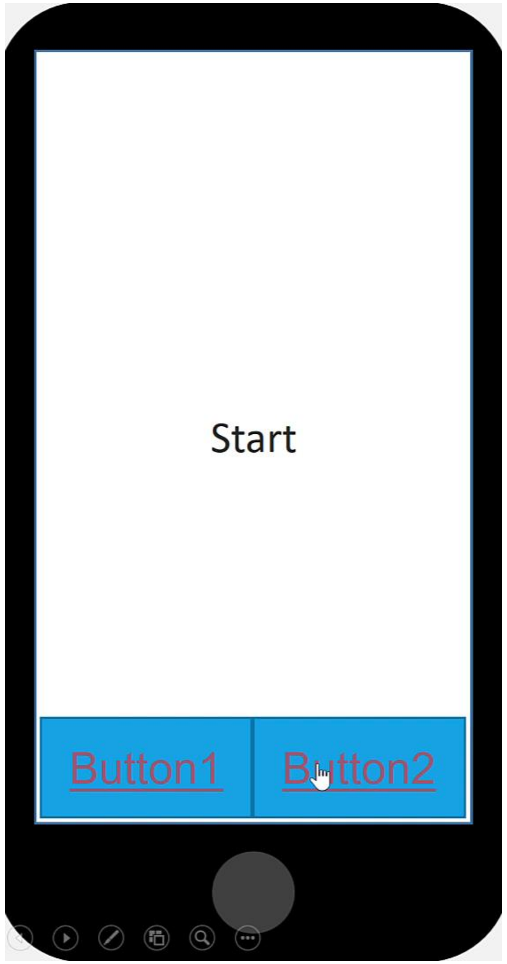
Click Prototypes with Powerpoint



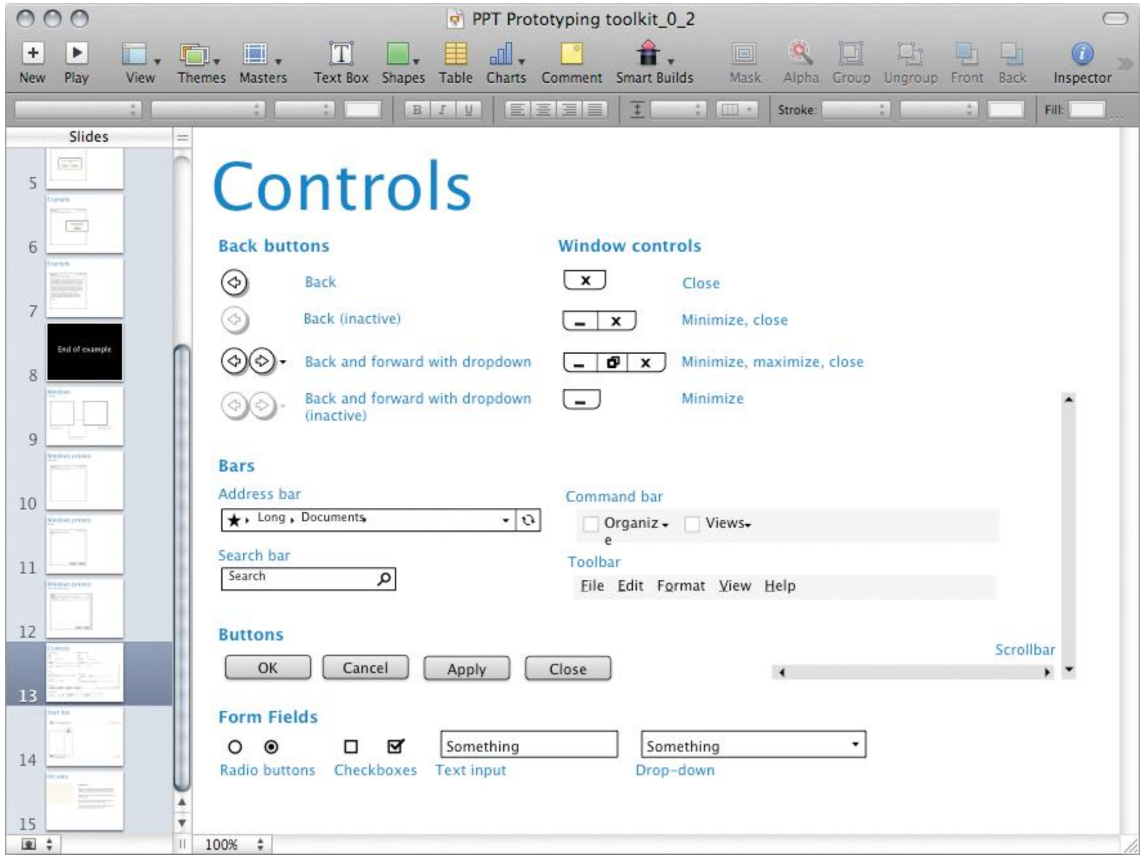


Click Prototypes with Powerpoint





UI Prototyping Elements



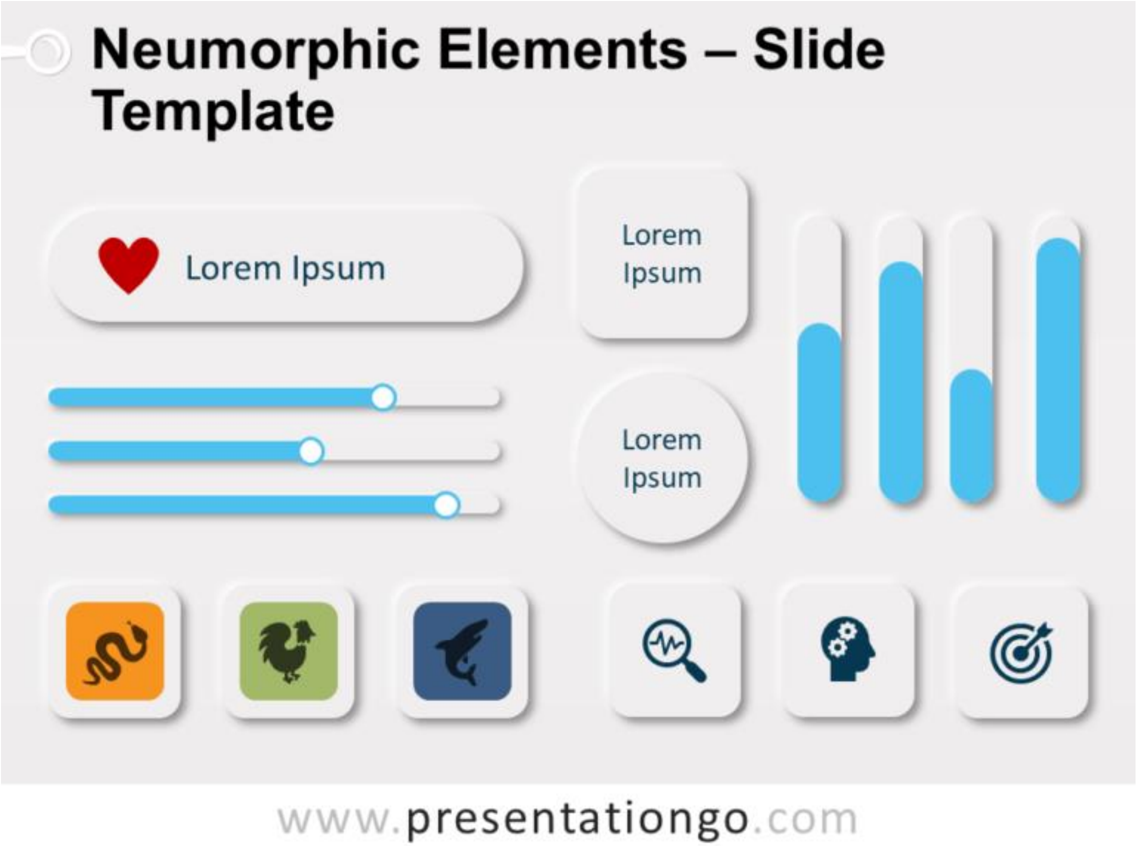
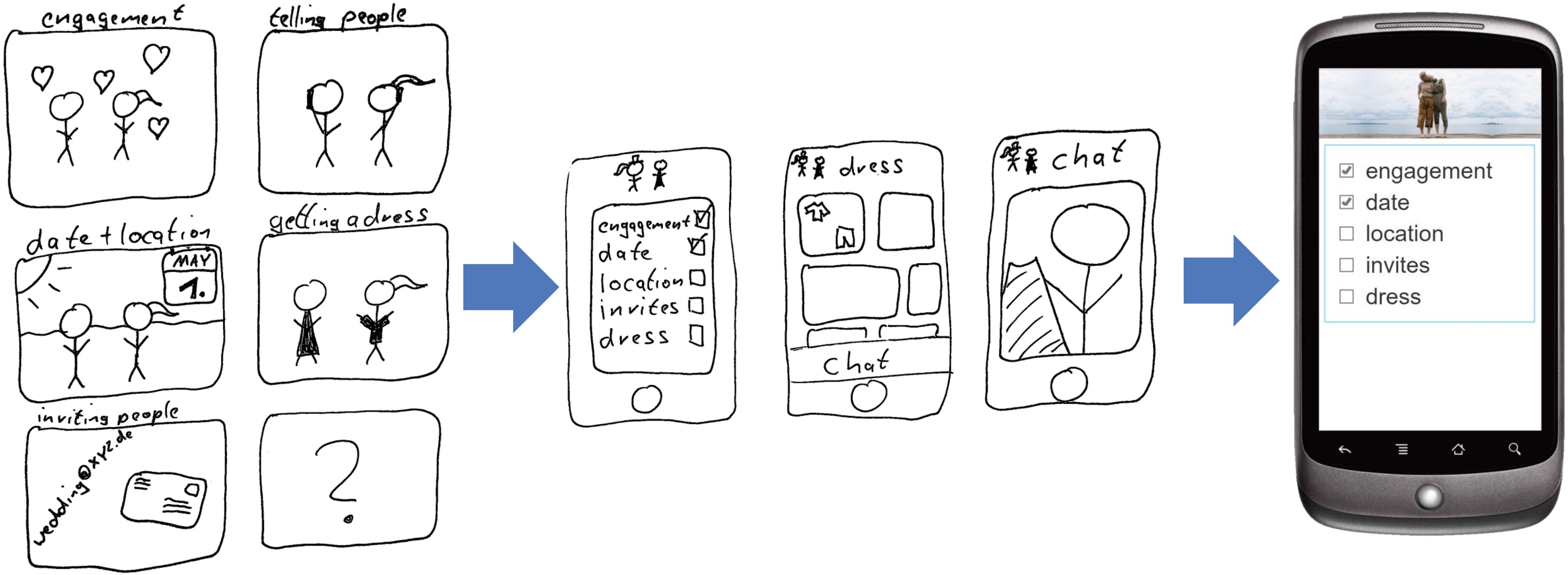


Image by Rosenfeld Media from https://www.flickr.com/photos/rosenfeldmedia/3978127831 (CC-BY 2.0)

From Scenario to App Prototype



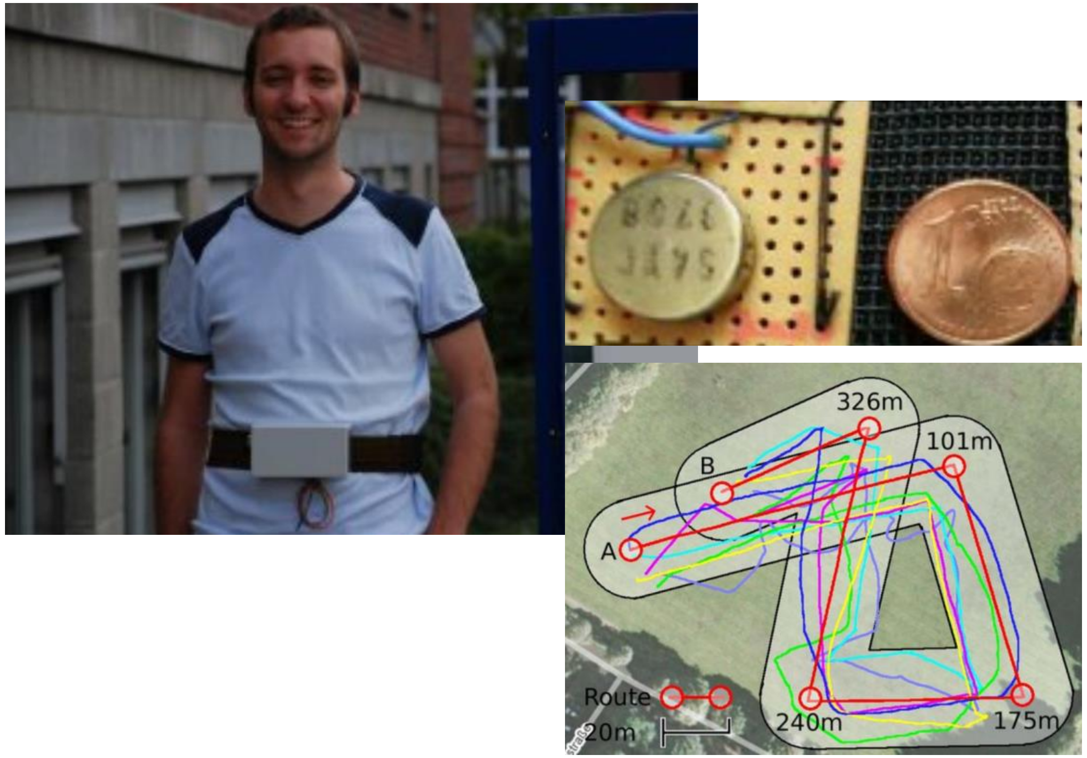
Mock-Up

Images from: https://www.shutterstock.com/image-photo/businessman-city-use-transparent-phone-latest-611026301, BMW iVision Dynamics https://europe.autonews.com, https://www.mockupworld.co/free/holding-a-coffee-cup-mockup/, https://www.archdaily.com/catalog/us/products/11884/3d-rendering-software-lumion

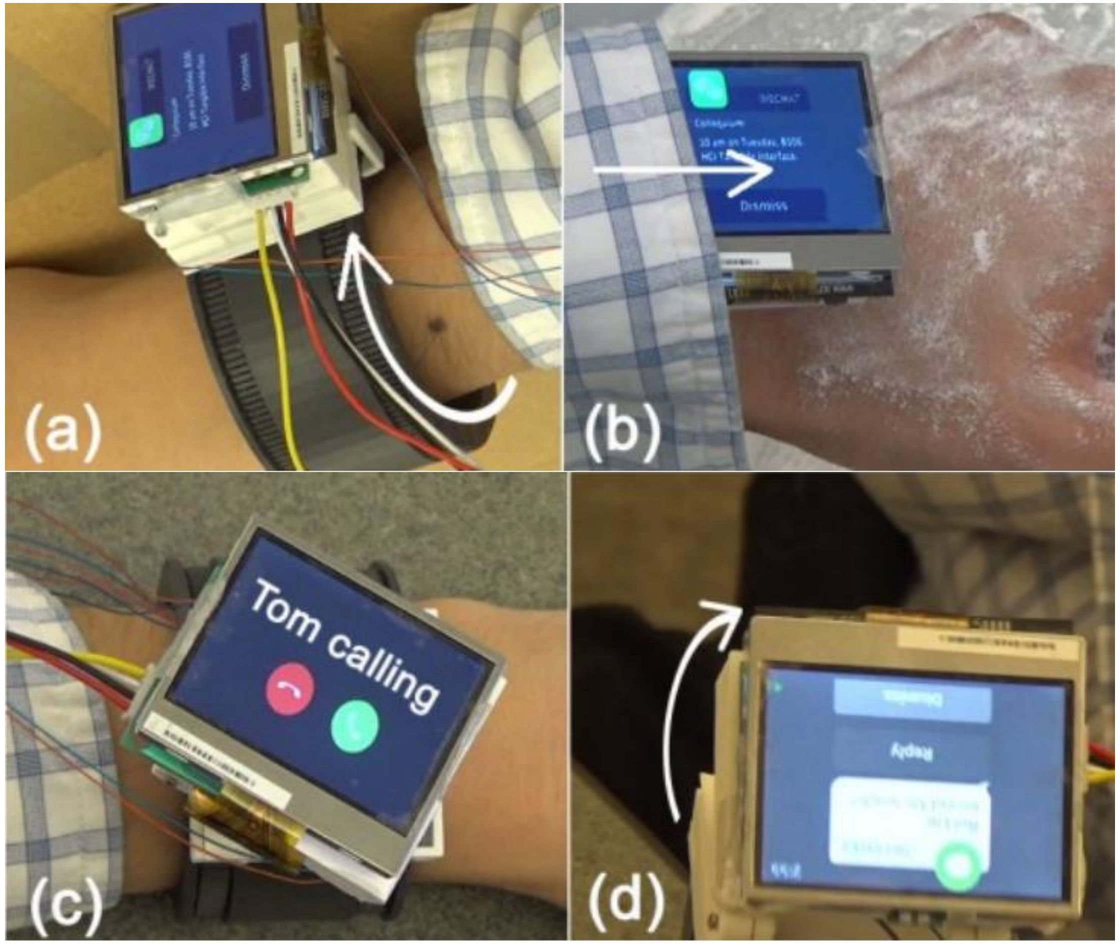
Video MockUp

Video by Judith Amores from https://vimeo.com/76766231 (CC-BY-SA)
The World's First Write and Erase Robot. https://scribit.design/

Hardware Prototypes

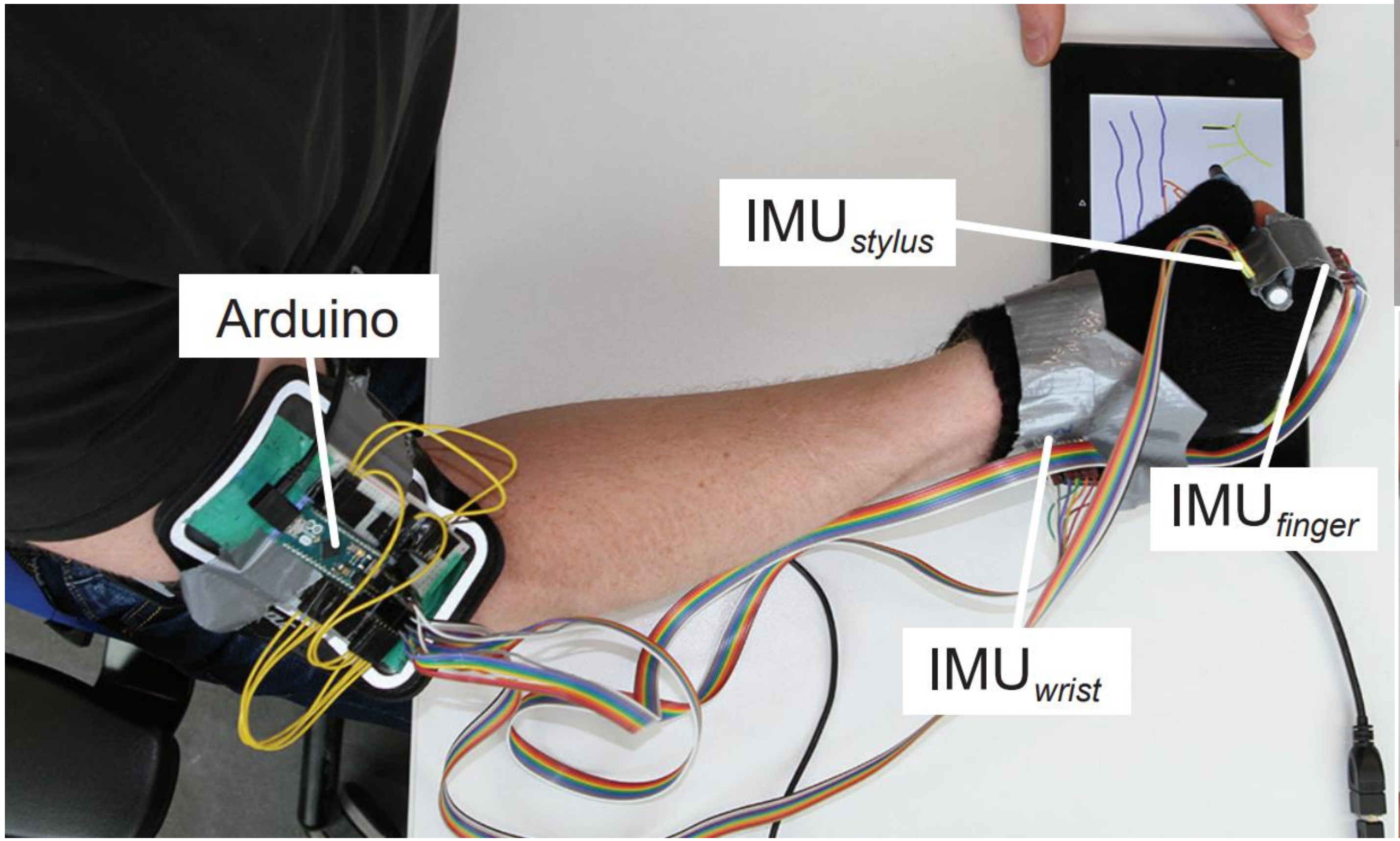


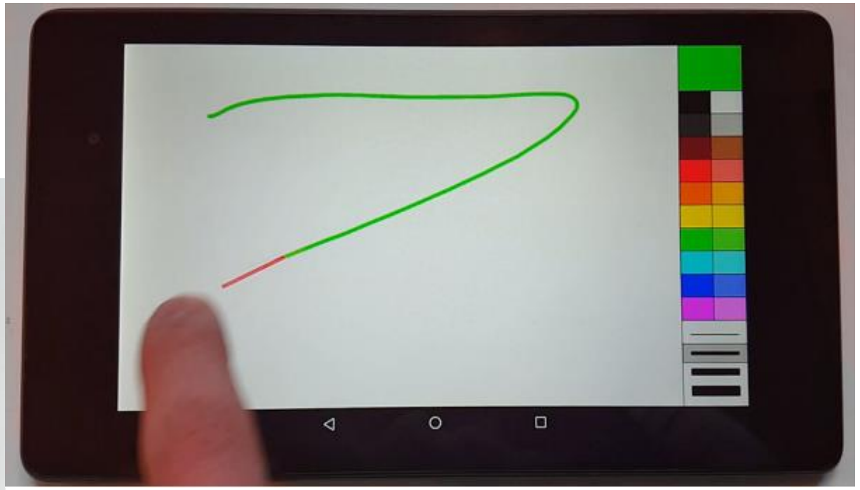
Pielot, Martin & Henze, Niels & Heuten, Wilko & Boll, Susanne. (2008). Evaluation of Continuous Direction Encoding with Tactile Belts. 5270. 1-10. 10.1007/978-3-540-87883-4_1.

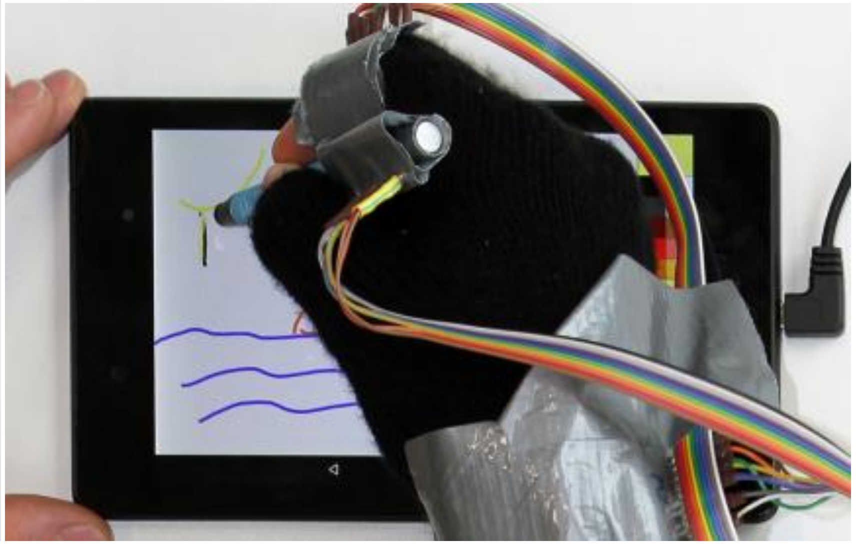


Erik-Oliver Blass, Kaoutar Elkhiyaoui, Refik Molva, Olivier Savry, and Cédric Vérhilac. 2011. Demo: the ff hardware prototype for privacy-preserving RFID authentication. In Proceedings of the 18th ACM conference on Computer and communications security (CCS '11). Association for Computing Machinery, New York, NY, USA, 737–740. https://doi.org/10.1145/2046707.2093481

Sketching with Hardware

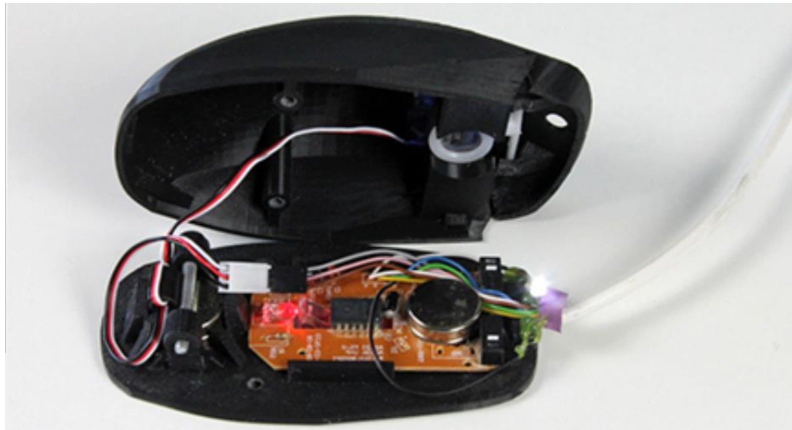


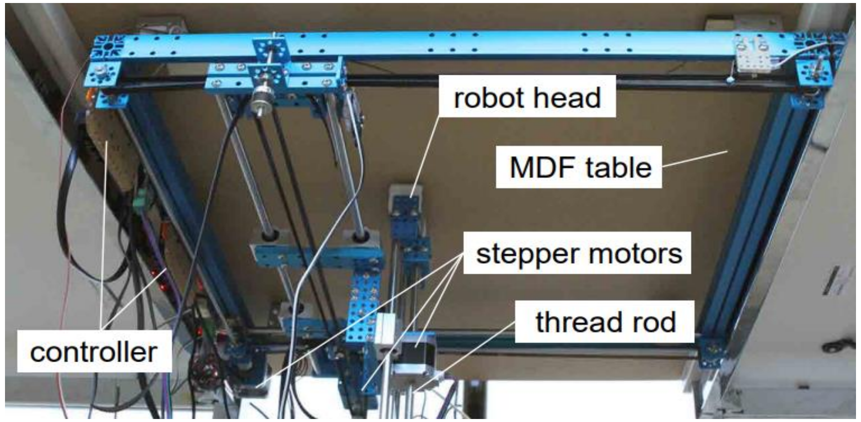


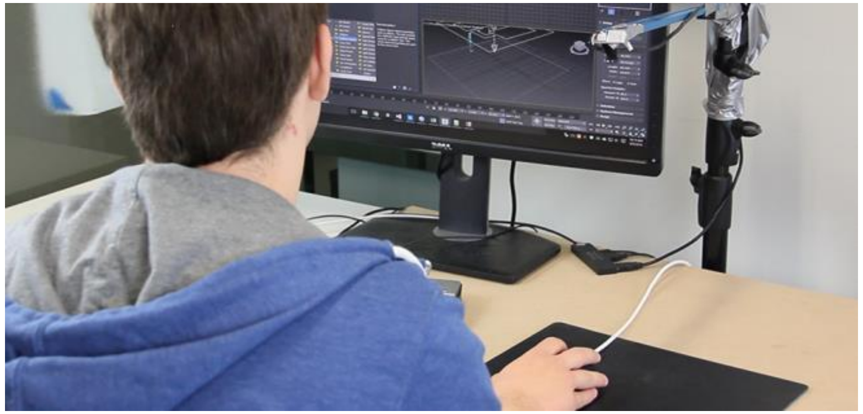


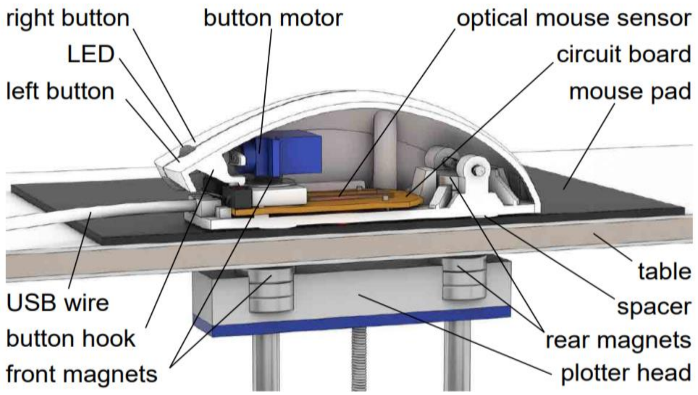
Huy Viet Le, Valentin Schwind, Philipp Göttlich, and Niels Henze. 2017. PredicTouch: A System to Reduce Touchscreen Latency using Neural Networks and Inertial Measurement Units. In Proceedings of the 2017 ACM International Conference on Interactive Surfaces and Spaces (ISS '17). Association for Computing Machinery, New York, NY, USA, 230–239. https://doi.org/10.1145/3132272.3134138

Hardware Prototypes



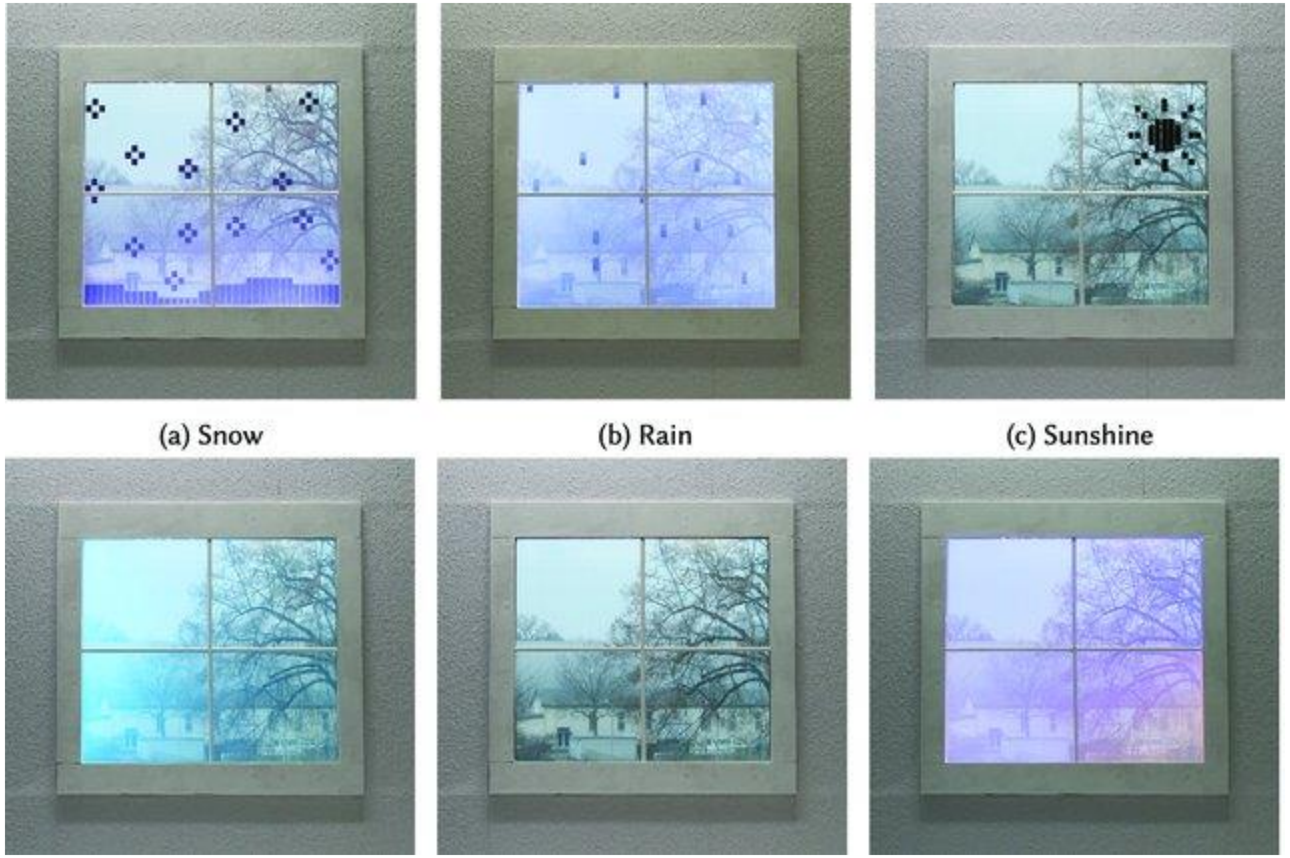


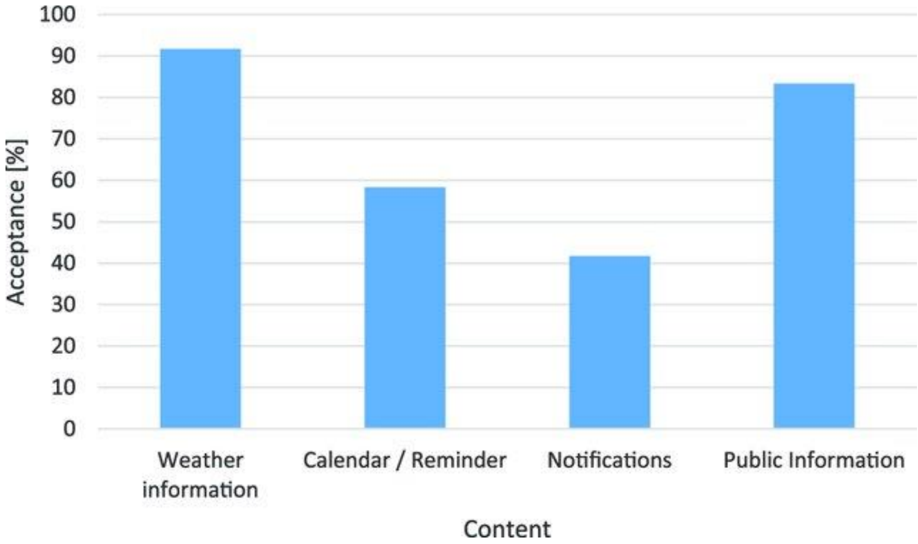


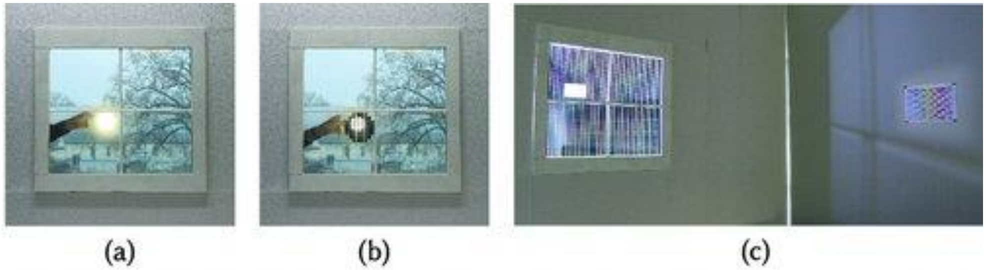


Francisco Kiss, Valentin Schwind, Stefan Schneegass, and Niels Henze. 2017. Design and evaluation of a computer-actuated mouse. In Proceedings of the 16th International Conference on Mobile and Ubiquitous Multimedia (MUM '17). Association for Computing Machinery, New York, NY, USA, 261–271. https://doi.org/10.1145/3152832.3152862

Hardware Prototypes

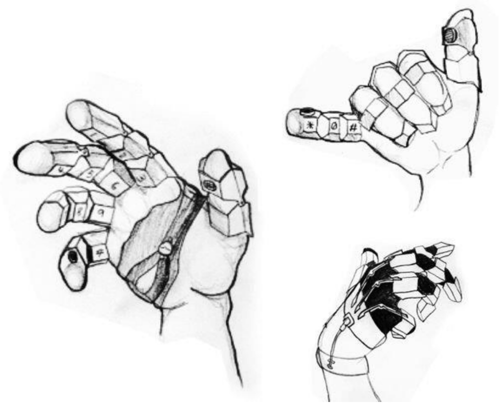
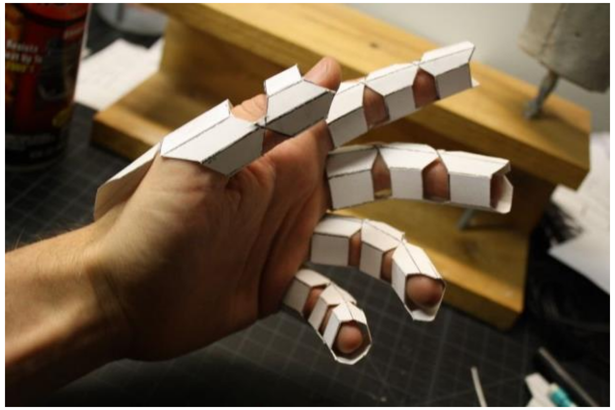






Bader, Patrick & Voit, Alexandra & Le, Huy Viet & Woz´niak, Paweł & Henze, Niels & Schmidt, Albrecht. (2019). WindowWall: Towards Adaptive Buildings with Interactive Windows as Ubiquitous Displays. ACM Transactions on Computer-Human Interaction. 26. 1-42. 10.1145/3310275

Documentation: Prototypes always have value!

https://www.instructables.com/id/Making-Glove-One-a-3D-printed-wearable-cell-p/

http://objest.co
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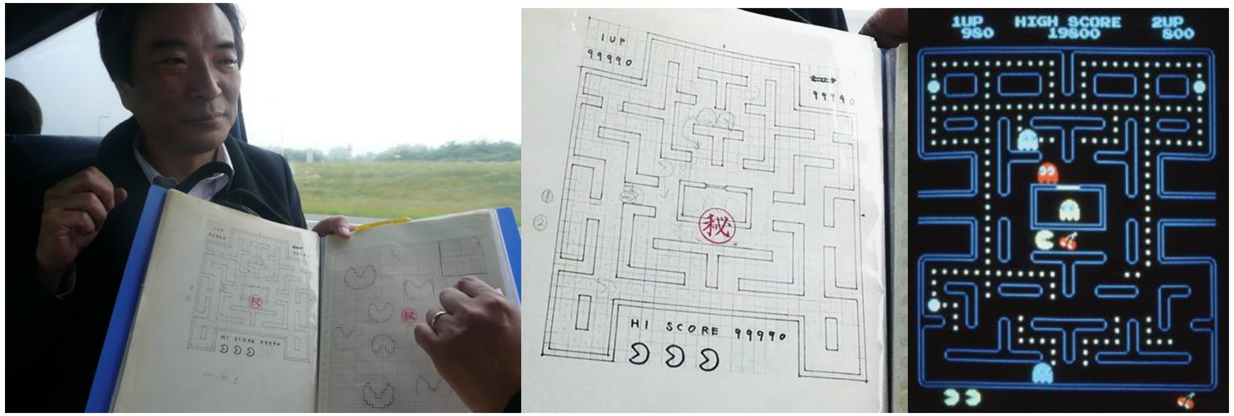

https://www.demilked.com/pac-man-original-drawings-toru-iwatani/

Wizard of Oz Prototypes

Human-Computer Interaction Lecture

Slides adapted from hci-lecture.org (A. Schmidt, N. Henze, K. Wolf, V. Schwind), Image from: https://www.bbc.com/culture/article/20190808-the-subversive-messages-hidden-in-the-wizard-of-oz The Wizard of Oz, Copyright by Turner Classic Movies.

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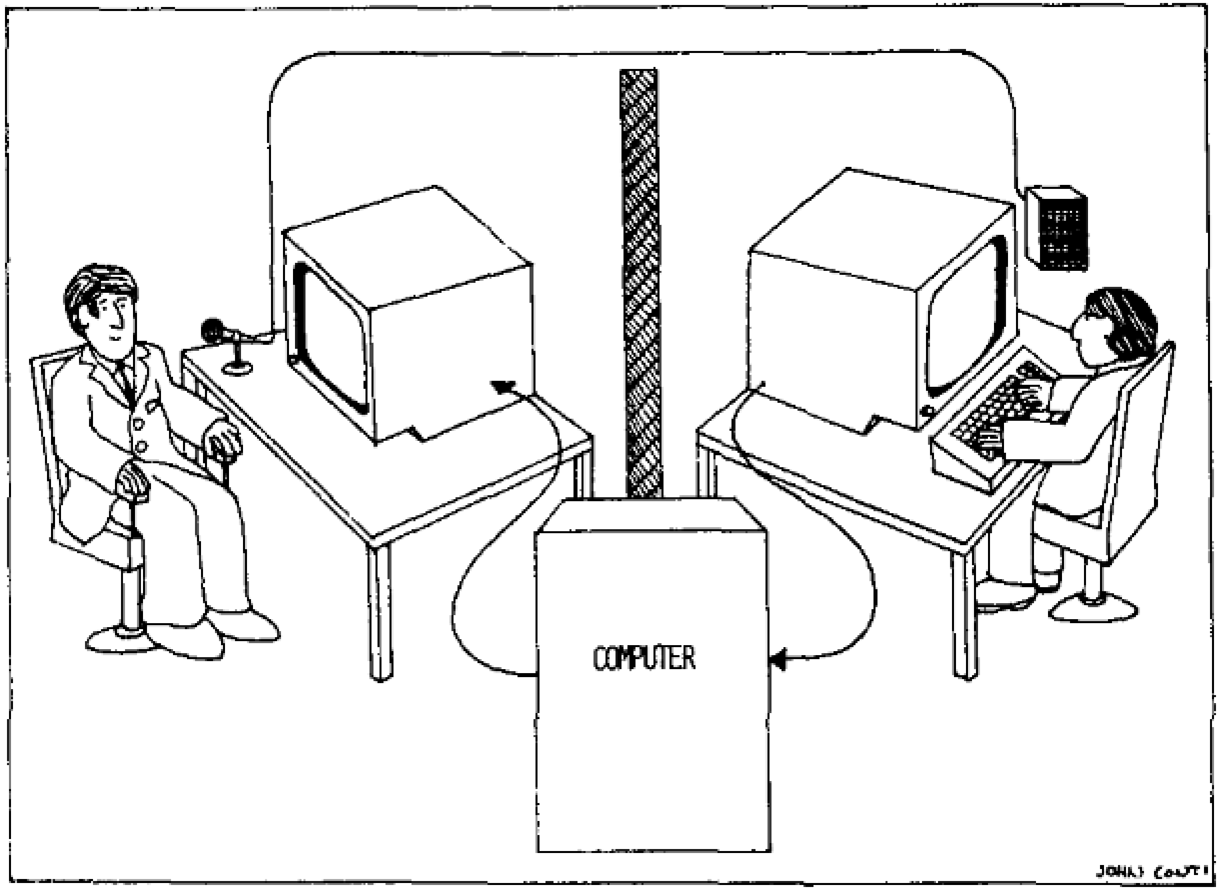
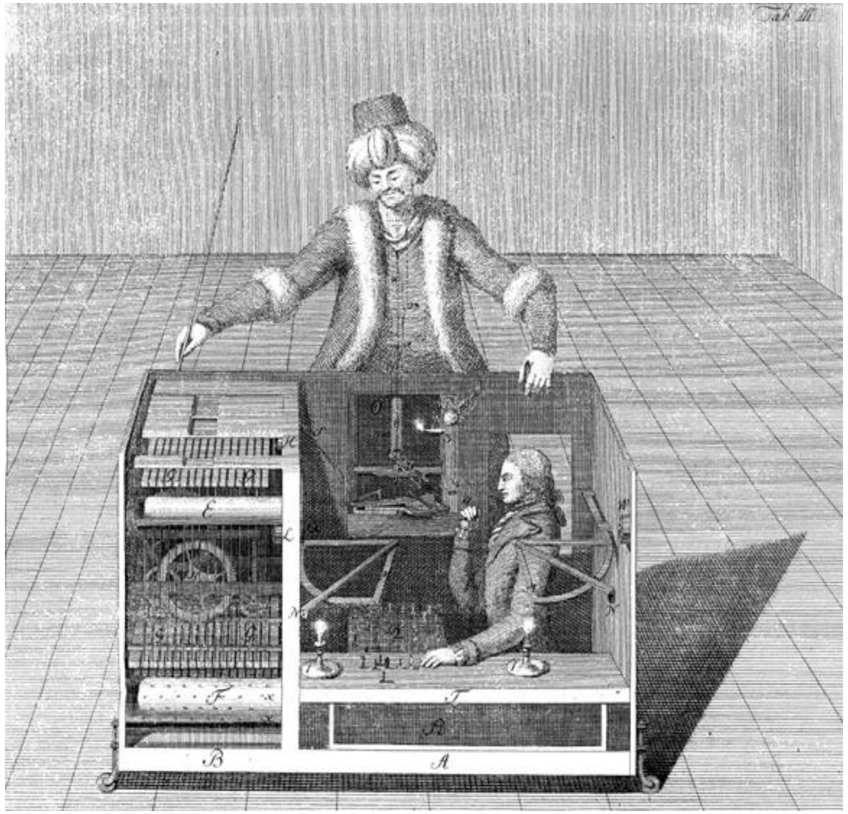
The Wizard of Oz Experiment



Kelley, J. F., “CAL – A Natural Language program developed with the OZ Paradigm: Implications for Supercomputing Systems”. First International Conference on Supercomputing Systems (St. Petersburg, Florida, 16–20 December 1985), New York, ACM, pp. 238–248.

The Mechanical Turk

- **A fake chess-playing machine from the late 18th century**, which was actually concealed a human chess master inside
- The Mechanical Turk was created by Wolfgang von Kempelen in 1770
- A large wooden cabinet with a life-sized model of a human head and torso, dressed in Turkish robes and turban (hence the name "Turk").
- Today, the term "Mechanical Turk" has been repurposed by Amazon for its crowdsourcing internet marketplace called Amazon Mechanical Turk (MTurk)



Engraving from the book: Freiherr Joseph Friedrich zu Racknitz, Ueber den Schachspieler des Herrn von Kempelen, Leipzig und Dresden 1789.

The Wizard of Oz Paradigm

- Users interact with a system they **believe to be autonomous**, but which is actually being operated or partially **controlled by an unseen human operator**
- Allows to **simulate and explore the behavior of a system** that has not yet been fully developed or that may **require complex artificial intelligence (AI)** which is not yet available
- The WoZ paradigm is employed for several purposes:
  - To **study how users interact** with and react to a system before the actual system is built.
  - To **gather user feedback** on the design and functionality of a system without the need for complete backend development.
  - To **explore how users might use and experience** new technologies.

How fast would you build a prototype?

In an hour?

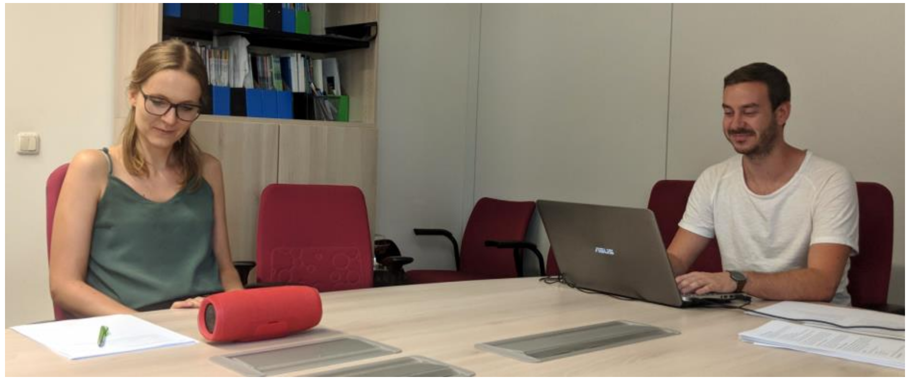
In a day?

In a week?

In a year?

Preferred Voices of Smart Agents

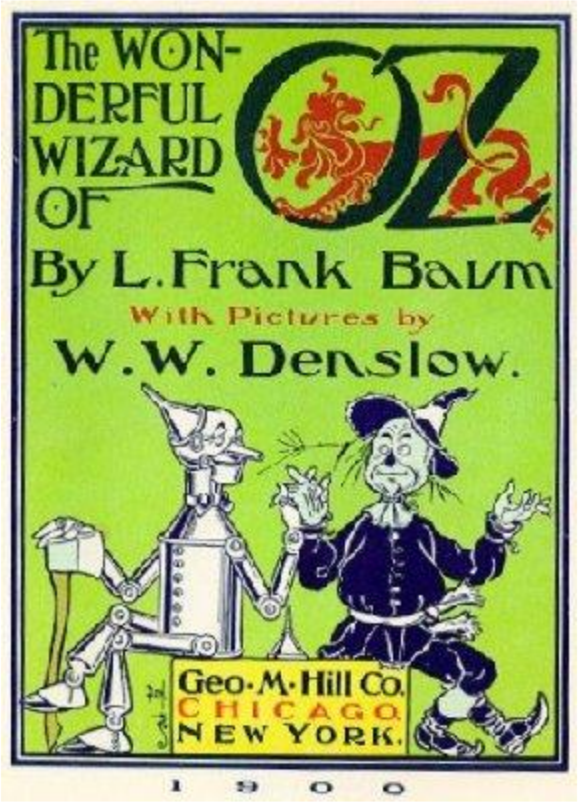
- **Example: We compared different voices and personalities**
  - Participants got a set of tasks (“book a trip to Tokyo”)
  - Experimenter played pre-recorded sound files of humans
  - Participants did not even notice that no speech recognition or reasoning was involved
  - Participants preferred female voices for simple tasks, and male voices for complex tasks



Habler, F., Schwind, V., & Henze, N. (2019). Effects of Smart Virtual Assistants' Gender and Language. In MuC.

Wizard of Oz as a Rapid-Prototyping Technique

- “**Wizard of Oz is a rapid-prototyping method** for systems costly to build or requiring new technology. A human ‘Wizard’ simulates the system’s intelligence and interacts with the user through a real or mock computer interface.”
- “Pay no attention to that man behind the curtain ...," takes on a new meaning when the curtain is replaced by a computer terminal
- Typical areas: Speech recognition, Speech synthesis, Annotation, Reasoning, Computer vision, Gaming, …



Maulsby, D., Greenberg, S., & Mander, R. (1993). Prototyping an intelligent agent through Wizard of Oz. In Proceedings of the INTERACT'93 and CHI'93 conference on Human factors in computing systems.

Wizard of Oz

- **Advantages**
  - You receive early feedback
  - You can compare multiple design and prototype alternatives
  - High ecological validity when the operator's performance can be reached, or the operator can simulate the system' final performance
- **Disadvantages**
  - Even implementing the soft parts requires some effort
  - You must hide the operator
  - Performance depends on the operator
    - Unclear if operator's performance is equal to the system's performance
    - Low external validity (when the operator's performance cannot be reached or is worse)

FRANKFURT UNIVERSITY OF APPLIED SCIENCES

Virtual Prototypes

Human-Computer Interaction Lecture

Slides adapted from hci-lecture.org (A. Schmidt, N. Henze, K. Wolf, V. Schwind), Image from: https://pxhere.com/de/photo/669444

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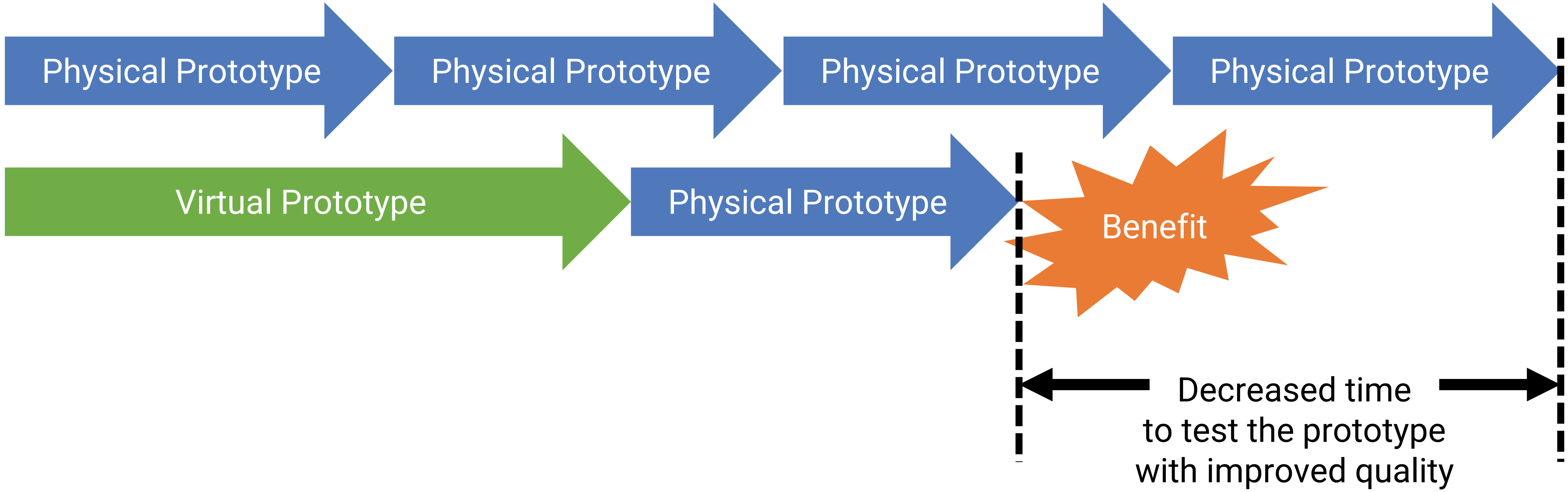
Virtual Prototypes

- **CAD geometry** that is used **to construct the prototype** can be used **to simulate a prototype**
  - 3D Shape and unit function
  - Even interactivity can be realized
  - Identify problems prior to their implementation
  - Quickly test effect of changes
  - Testing behavior under simulated conditions (not part of this lecture)
- A virtual prototype can be **3D-printed** („rapid prototyping“)
  - Efficient and cost-effective
- Requires trained developers in their methodology

Virtual Prototyping

- Used for **design** evaluation, usability **testing**, and to **visualize** how a new **product will look and function before it is built** method in the process of product development.
- It involves using **3D models to validate a design** before committing to making a physical prototype.
  - Done by creating (usually 3D) computer generated geometrical shapes (parts) and either combining them into an "assembly" and testing different mechanical motions, fit and function.
  - The interaction can be simulated in AR/VR/MR
  - Very cheap, fast, and convincing
- **End-to-end prototyping** accounts design decision during prototyping for the final product
- **Eliminate the need for physical materials** and the labor to build them, reducing the cost of the prototyping phase significantly.

Virtual Prototyping



Virtual Prototyping Tools

- MSC Adams/Chassis
- Universal Mechanism
- MatLab
- DyMoLa
- Webots
- Simbad
- ThreeDimWorks
- OpenSim (for humans)
- RoboWorks
- Autodesk Fusion
- Tinkercad (free, web-based)

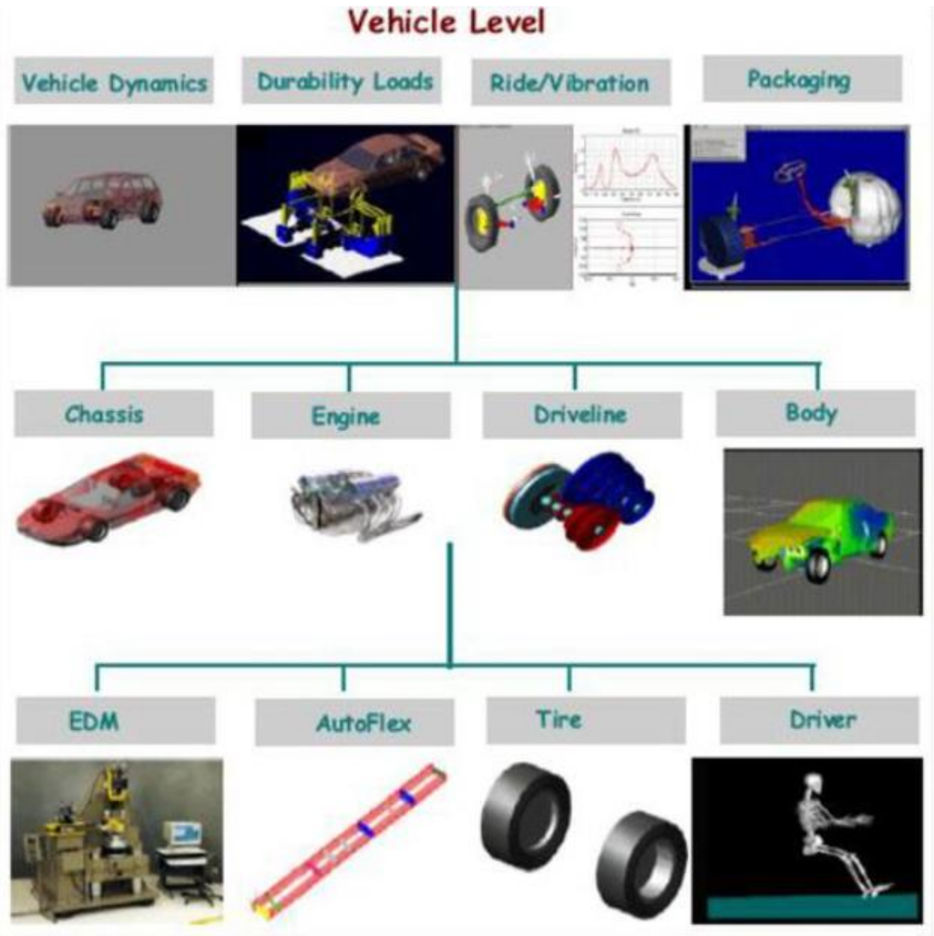
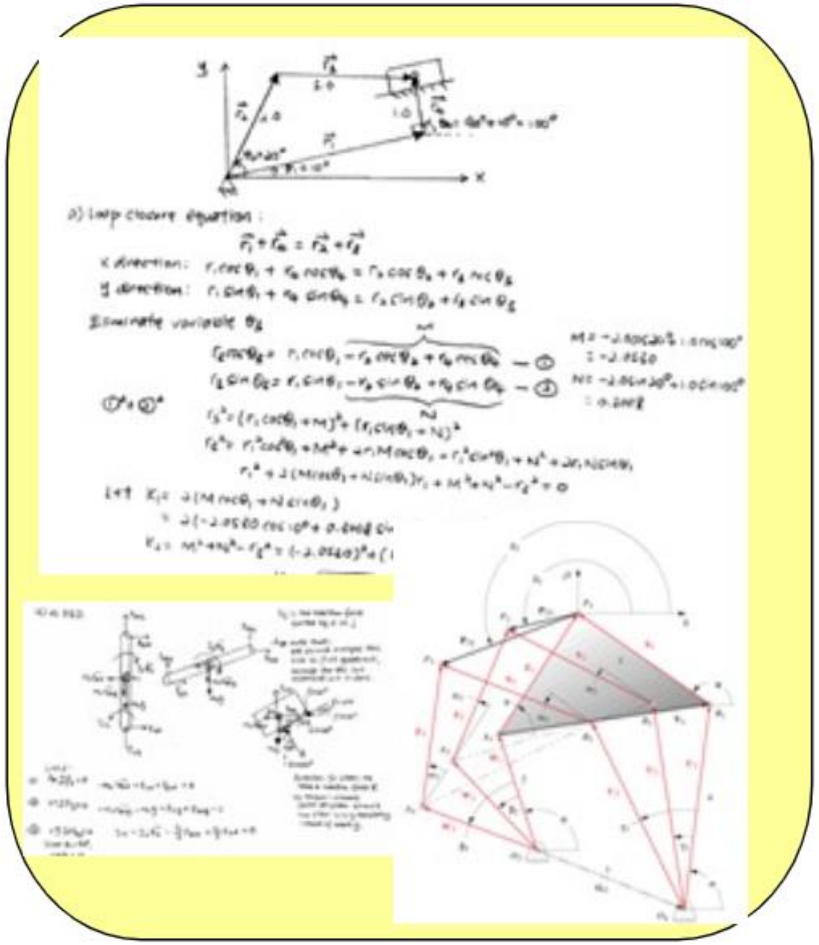
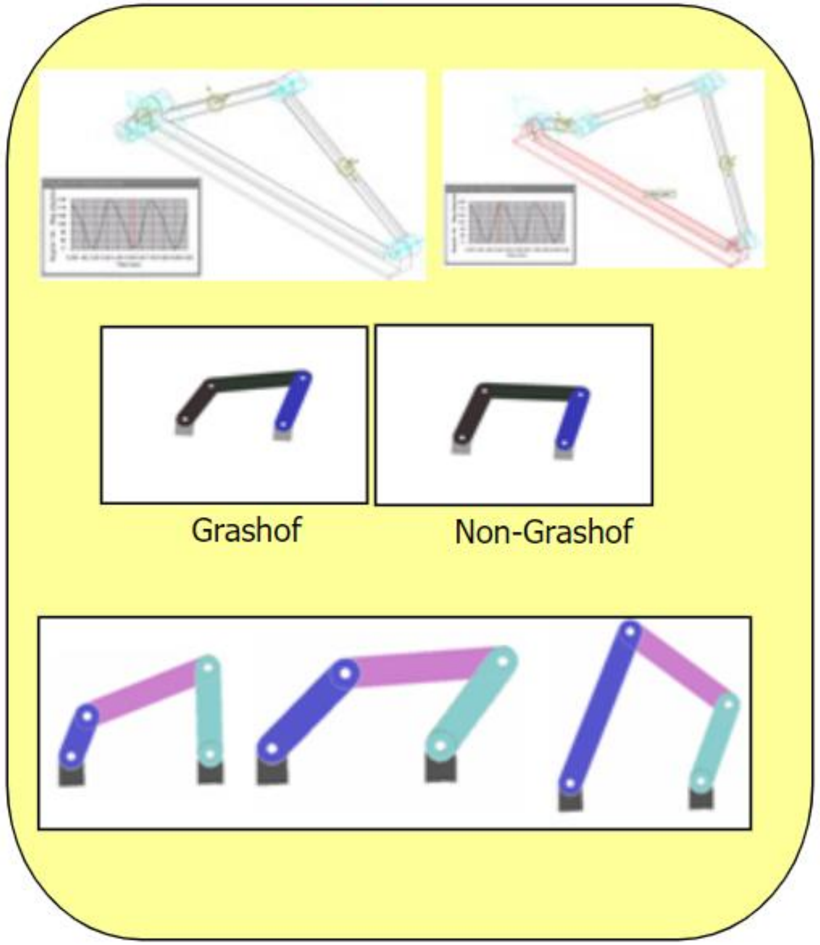


Image from https://slideplayer.com/slide/13314860/

Example: Mechanics





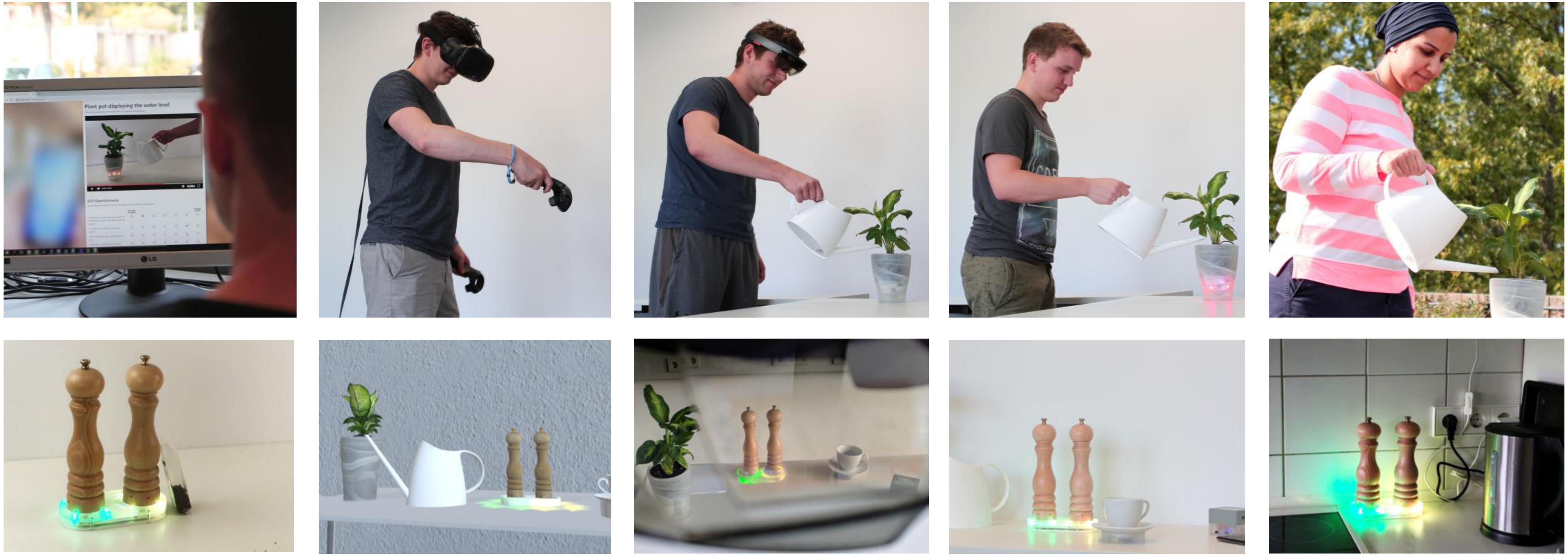
Images from Web-Based Self-Paced Virtual Prototyping Tutorials Rajankumar Bhatt Graduate Student Chin Pei Tang Graduate Student https://slideplayer.com/slide/5013074/

Example: Virtual Prototypes

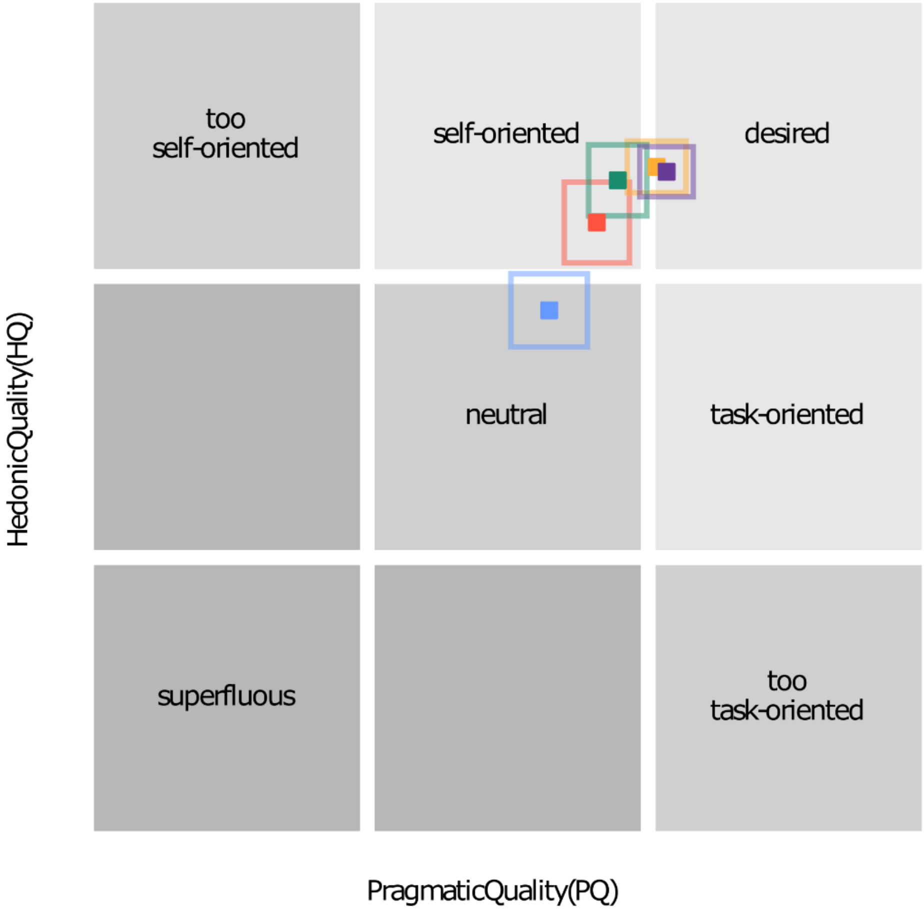
Aromaa, S., Viitaniemi, J., & Leino, S.-P. (2014). Virtual prototyping in human-machine interaction design. ResearchGate. Retrieved from https://www.researchgate.net/publication/275946481_Virtual_prototyping_in_human-machine_interaction_design/figures?lo=1

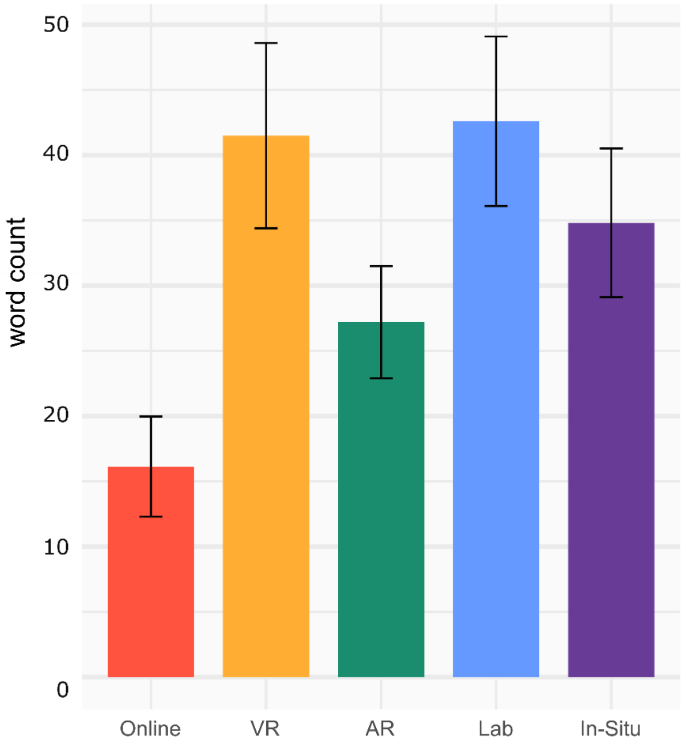
Image from: Frankfurt University of Applied Sciences

Ecological Validity of Virtual Prototyping



Ecological Validity of Virtual Prototyping





Online VR AR Lab In-Situ

Virtual Prototypes

- **Advantages**
  - Cost-effective/Time-efficient: Reduces prototyping expenses and allows for rapid iterations
  - Safe testing: Simulates dangerous scenarios risk-free
  - Advanced visualization: 3D models from any perspective
  - Functional simulation: Tests under various conditions
  - Easily shareable: Facilitates remote collaboration
  - Eco-friendly: Minimizes waste from physical materials
- **Disadvantages**
  - Tactile feedback: Difficult to replicate physical touch
  - Technical limitations: May miss real-world complexity
  - Resource-intensive: Requires high computational power/headsets
  - Potential for overreliance: Could ignore physical prototyping benefits
  - Risk of misinterpretation: May be seen as more complete than they are

Questions?

Prototyping