



School of Professional and  
Continuing Education  
(SPACE)

## Chapter 06 (Design)

# Design, Prototyping and Construction (Part 1)

- 
- 01** PROTOTYPING
  - 02** CONCEPTUAL DESIGN
  - 03** CONCRETE DESIGN
  - 04** GENERATING PROTOTYPES
  - 05** CONSTRUCTION

# Designing with or for People?

- Is stakeholder engagement one-way?
- Co-design
  - Emphasises creativity and mutual learning
  - Often multidisciplinary
- Participatory design (Scandinavian version)
  - Stakeholders are design partners
  - Co-operative prototyping is important
- Community-based design
  - Scale in terms of numbers and diversity

# PROTOTYPING

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# Prototyping

- What is a prototype?
- Why prototype?
- Different kinds of prototyping
  - **Low fidelity** (Paper-based)
  - **High fidelity** (software-based)
- Compromises in prototyping
  - Vertical
  - Horizontal
- Final product needs to be engineered

# What is a prototype?

- One manifestation of a design that allows **stakeholders** to **interact** with it
- In other design fields, a prototype is a **small-scale model**:
  - a miniature car
  - a miniature building or town
  - the examples here come from a 3D printer



Source: PalmPilot wooden model © Mark Richards

# What is a prototype?

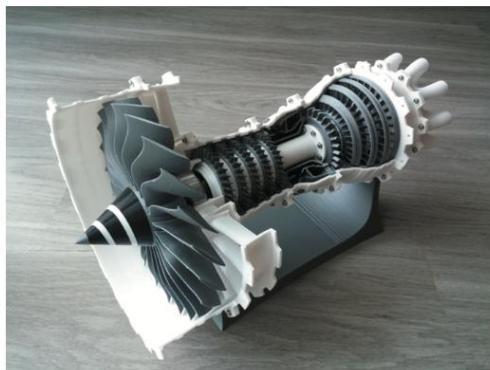


(a)

**Figure 11.1** (a) Color output from a 3D printer: all the gears and rods in this model were ‘printed’ in one pass from bottom to top, and when one gear is turned, the others turn too.

Source: (a) The Computer Language Company, Inc., courtesy of Alan Freedman

# 3D Printing Examples



(a)



(b)



(c)

**Examples of 3D printing:** (a) model jet engine, (b) Synapse Dress by Anouk Wipprecht: embedded with sensors, the wearer can control the dress's lighting pattern, and (c) custom-made climbing shoes based on a scan of the wearer's feet

**Source:** (a) CatiaV5ftw / MakerBot Industries, LLC / CC BY-NC 4.0, [www.thingiverse.com/thing:392115](http://www.thingiverse.com/thing:392115). Licensed under CC-BY-3.0, (b) ANOUK WIPPRECHTSYNAPSE DRESS created for Intel in 2014, [www.niccolocasas.com/ SYNAPSE-DRESS](http://www.niccolocasas.com/ SYNAPSE-DRESS), and (c) Photo Credits: ATHOS

# 3D Printing Examples



(c)

(c) A teddy bear 'printed' from a wireframe

design <http://www.disneyresearch.com/project/printed-teddy-bears/>

(c) Courtesy of Scott Hudson, Human–Computer Interaction Institute, Carnegie Mel- lon University.

Watch video: <https://www.youtube.com/watch?v=qc-tGbMN9Ms>

# What is a prototype Interaction Design (ID)?

In interaction design it can be (among other things):

- a series of screen **sketches**
- a **Storyboard**, i.e. a cartoon-like series of scenes
- a Powerpoint **slide show**
- a video **simulating** the use of a system
- a **lump** of wood (e.g. PalmPilot)
- a **cardboard** mock-up
- A loosely connected set of **electronic elements**
- An **animation** of product use
- a piece of software with **limited functionality** written in the target language or in another language

# What to prototype?

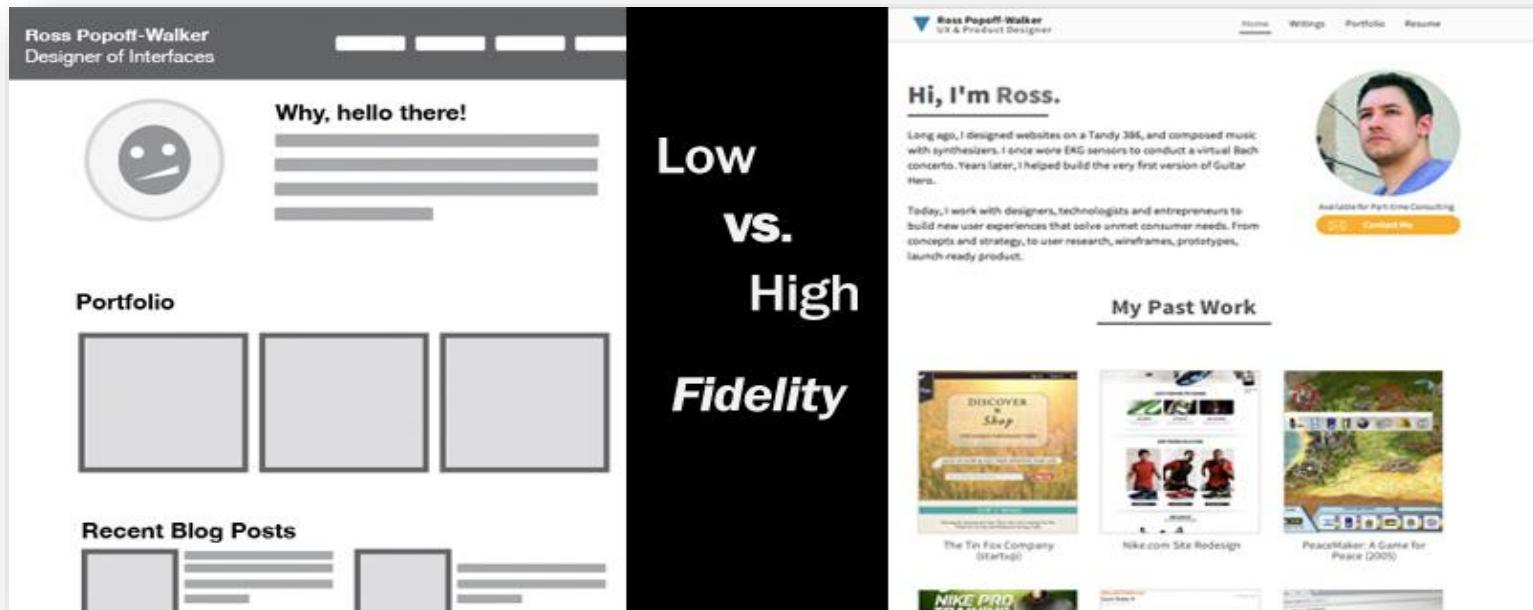
- Technical issues
- Work flow, task design
- Screen layouts and information display
- Difficult, controversial, critical areas

# Why prototype?

- Evaluation and **feedback** are central to interaction design
- Stakeholders can **see, hold, interact** with a prototype more easily than a document or a drawing
- Team members can **communicate** effectively
- You can **test out** ideas for yourself
- It encourages **reflection**: very important aspect of design
- Prototypes answer questions, and support designers in **choosing between alternatives**

# Fidelity in Prototyping (FP)

- Fidelity refers to the level of detail
  - Low fidelity
    - artists renditions with many details missing
  - High fidelity
    - prototypes look like the final product



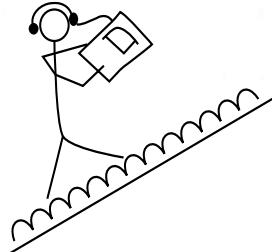
# Low-fidelity Prototyping (LFP)

- Uses a medium which is **unlike** the final medium, e.g. paper, cardboard
- Is **quick, cheap and easily changed**
- Examples:
  - sketches of screens, task sequences, etc
  - Index cards or sticky notes
  - card-based
  - ‘post-it’ notes
  - storyboards
  - ‘Wizard-of-Oz’

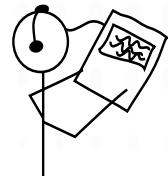
# Examples of LFP: Storyboards

- It is a series of **sketches** showing how a user might **progress** through a **task** using the device
- Often used with **scenarios**, bringing more detail, and a chance to **role play**
- Used early in design

# Example 1 LFP : Storyboards



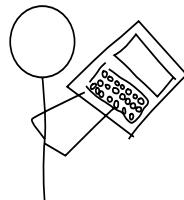
Christina walks up hill; the product gives her information about the site



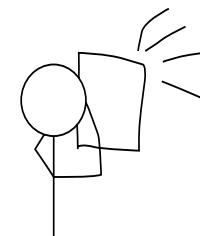
Christina adjusts the preferences to find information about the pottery trade in Ancient Greece



Christina scrambles to the highest point



Christina stores information about the pottery trader's way of life in Ancient Greece



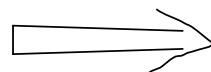
Christina takes a photograph of the location of the pottery market

# Examples 2 LFP: Sketching

- Sketching is important to low-fidelity prototyping



- Don't be inhibited about drawing ability. Practice simple symbols



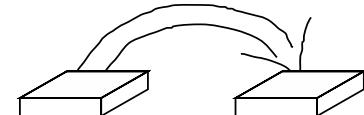
Give



Receive



People



Transfer



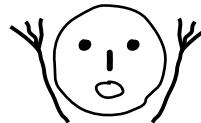
Digital devices



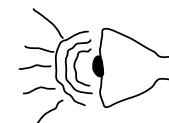
happy



Upset



Surprise



Sound



Light

# Examples 2 LFP: Sketching

ACTIONS

AUTHOR EDIT / VIEW MODE

REJECT

ACCEPT

INSERT

STRIKE OUT

MOVE

ADD COMMENT

ITALICS

BOLD

CAPITALIZE

SWAP WORDS

VIEWS

SUMMARY

DOCUMENT

ZOOMED

B

How does technology help our education? Well, the items that are probably used the most that have to do with technology are computers. A computer allows students to go on the Internet, and look up research, and while we gather information, we have fun! Can you believe it? We can have fun while we learn. That's not what I expected when I started school. I thought technology would be tedious while I learned. Boy, was I wrong! To tell you the truth, I like school and I'm glad we have technology to help us. It makes learning a lot more fun!

My example of technology is a computer. It helps my education a lot.

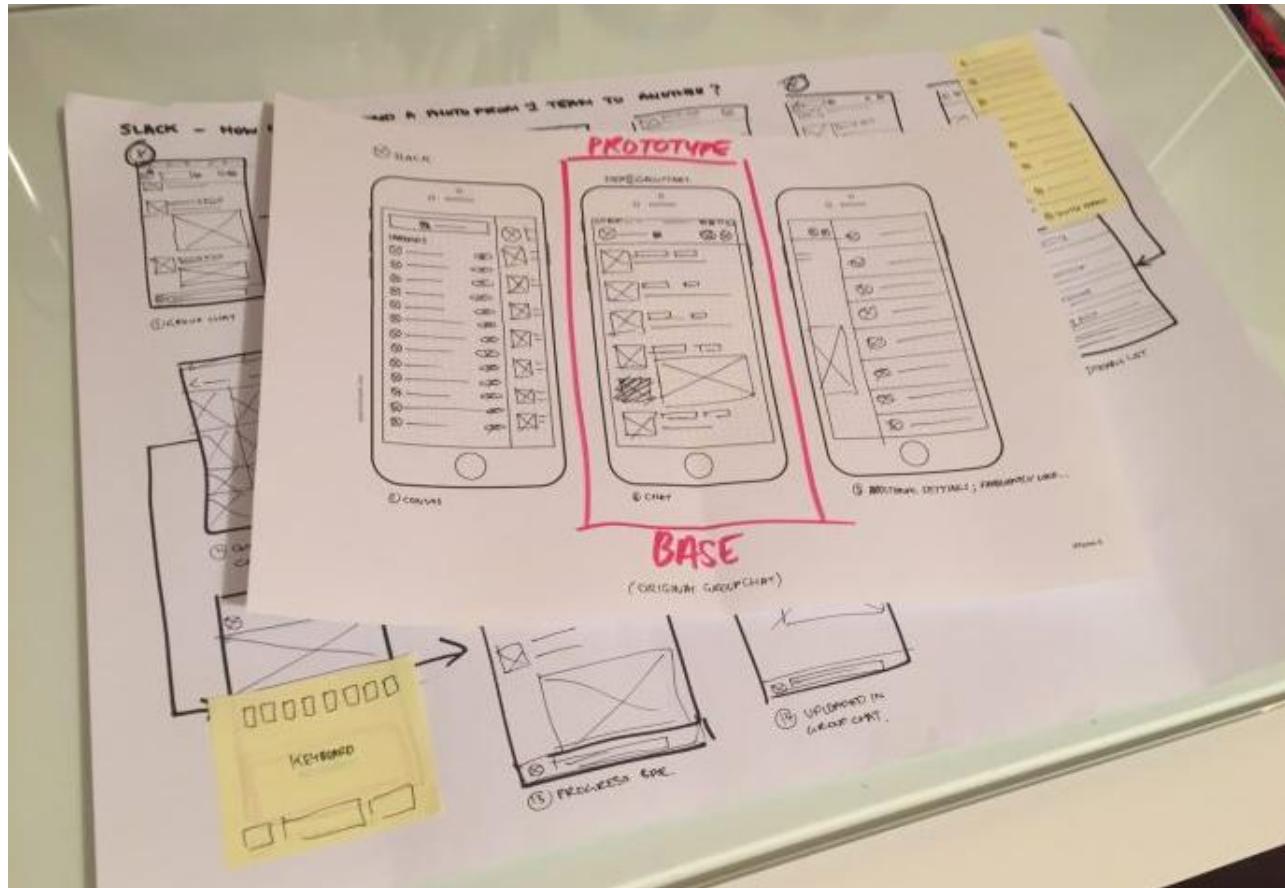
Another person who thinks the same as I do is my teacher. She enjoys the technology of today that develops computers. She is always finding out new assignments to give us. Some of them are easy and some of them are not.

Another item that has to do with technology that helps our education is a digital camera. We use the digital camera to make books with pictures of our class. It is very enjoyable to take pictures with the digital camera, but sometimes it gets complicated. When it does, I ask Mr. Williams, (our computer and camera whiz), to help me. Then after he assists me I have learned something new. So if you think about it, I learn something that is good to know, and while I learn, I have fun. I am very glad we have technology so we are able to have computers and digital cameras to help our education.

Technology is a big part of my education. If we didn't have technology, it would take ten times as long to look up information about a subject than with

UNDO HELP SEARCH DONE REVIEWERS

# Examples 2: Sketching / paper prototypes



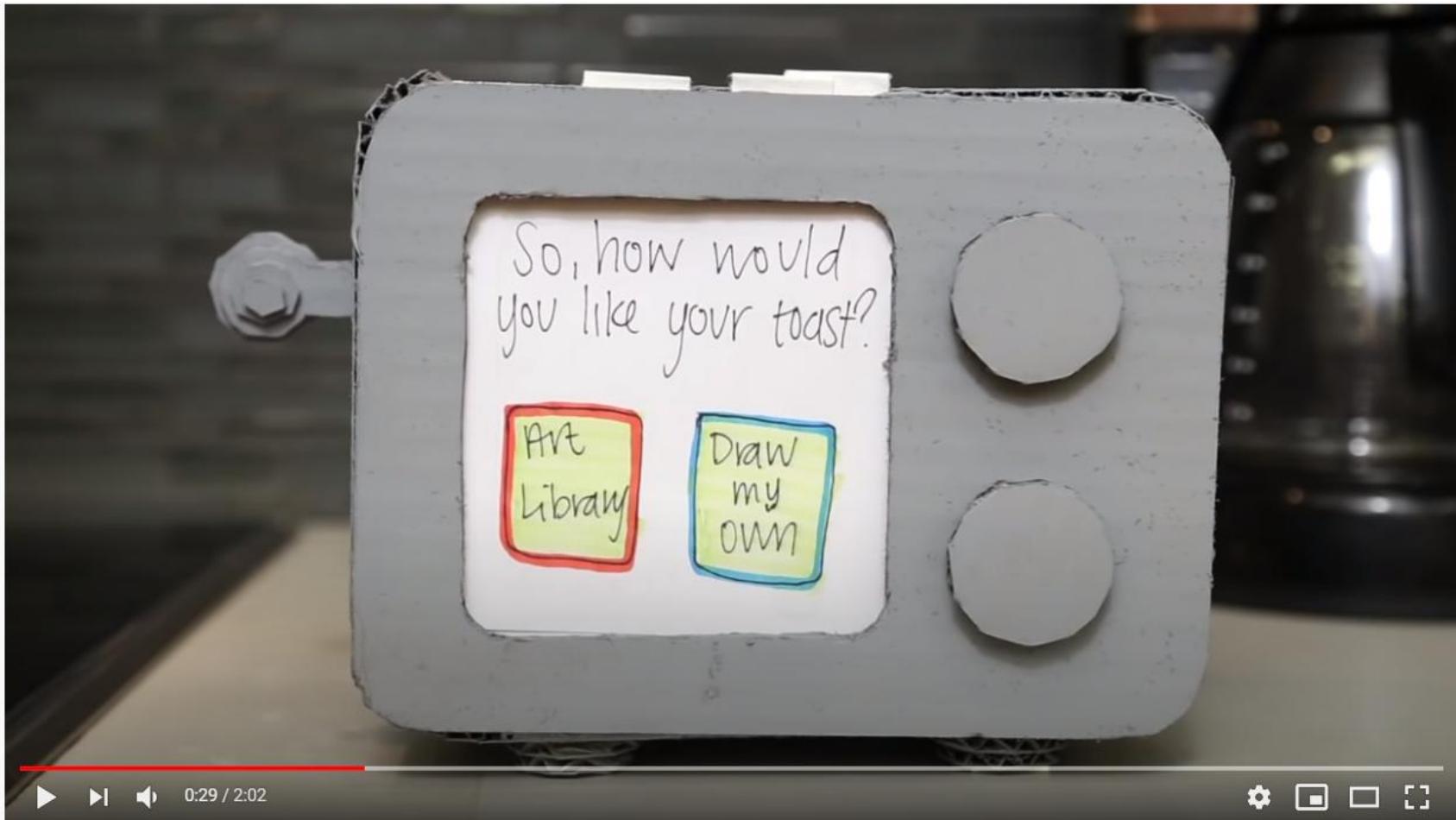
Paper prototypes can assist in documentation. Notes and revisions will support designers and developers when they will create an actual product. Image source: inesnorman

# Examples 3 LFP: Index Cards prototypes



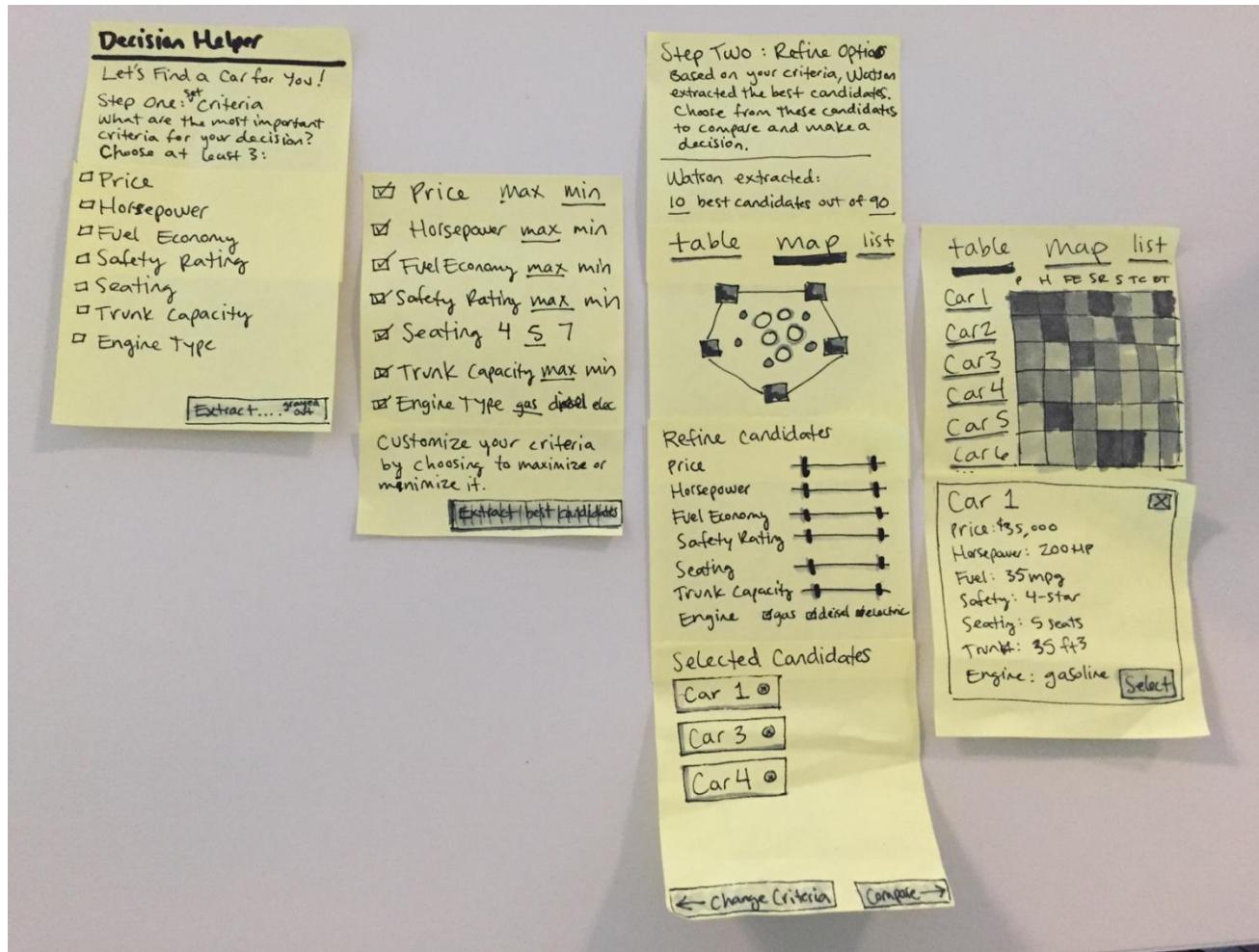
- Index cards (3 X 5 inches)
- Each card represents one screen or part of screen
- Often used in website development
- In evaluation, can step through the cards

# Examples 3 LFP: How to make a Card-based prototypes



[https://www.youtube.com/watch?v=k\\_9Q-KDSb9o](https://www.youtube.com/watch?v=k_9Q-KDSb9o)

# Examples 4 LFP: 'Post-it' notes



Low-fidelity paper prototypes don't look like the final product

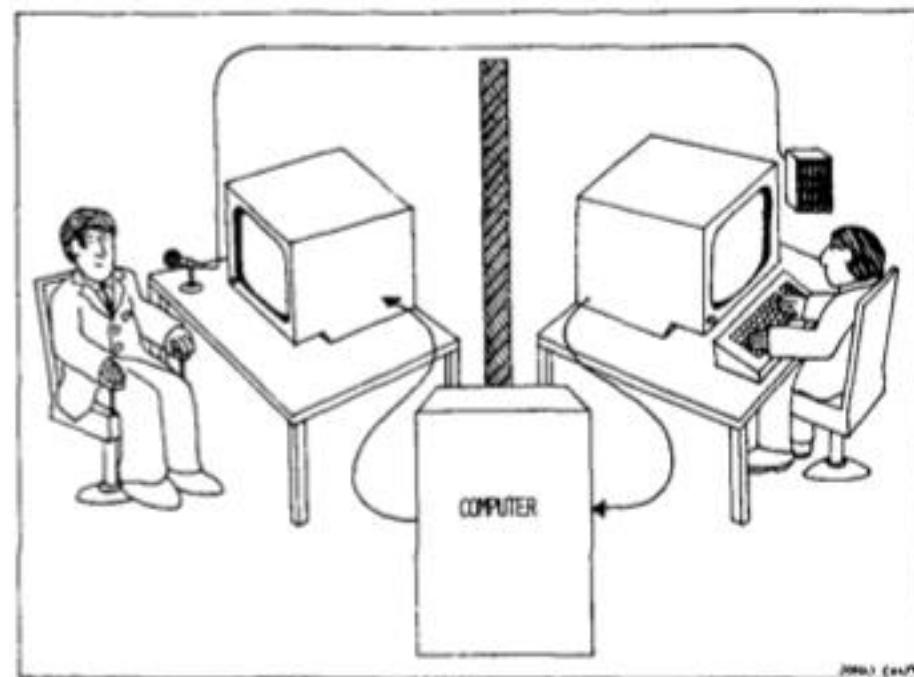
Source: <https://www.oreilly.com/ideas/prototyping-physical-digital-products>  
www.id-book.com

# Examples of LFP: Storyboard and Paper Prototype

- GMail Art
  - <https://www.youtube.com/watch?v=MDr5Vclw38U>
- Paper Prototype Angry Bird
  - <https://www.youtube.com/watch?v=ZwWq7zldBwQ>
- UA&P Portal Storyboard (with scenario example)
  - <https://www.youtube.com/watch?v=Z6UUH5CtQP4> –
- Order Food on Train Storyboard (with scenario example)
  - <https://www.youtube.com/watch?v=k7gxq0IRHQk>
- UA&P Usability Test for Portal Paper Prototype
  - [https://www.youtube.com/watch?v=G\\_oOmk-1TAw](https://www.youtube.com/watch?v=G_oOmk-1TAw)

# Examples 5 LFP: ‘Wizard-of-Oz’ prototyping

- The users **thinks** they are **interacting** with a computer, but a **developer** is **responding** to output rather than the system.
- Usually done early in design to understand users' expectations



# Examples 5 LFP: ‘Wizard-of-Oz’ Prototyping



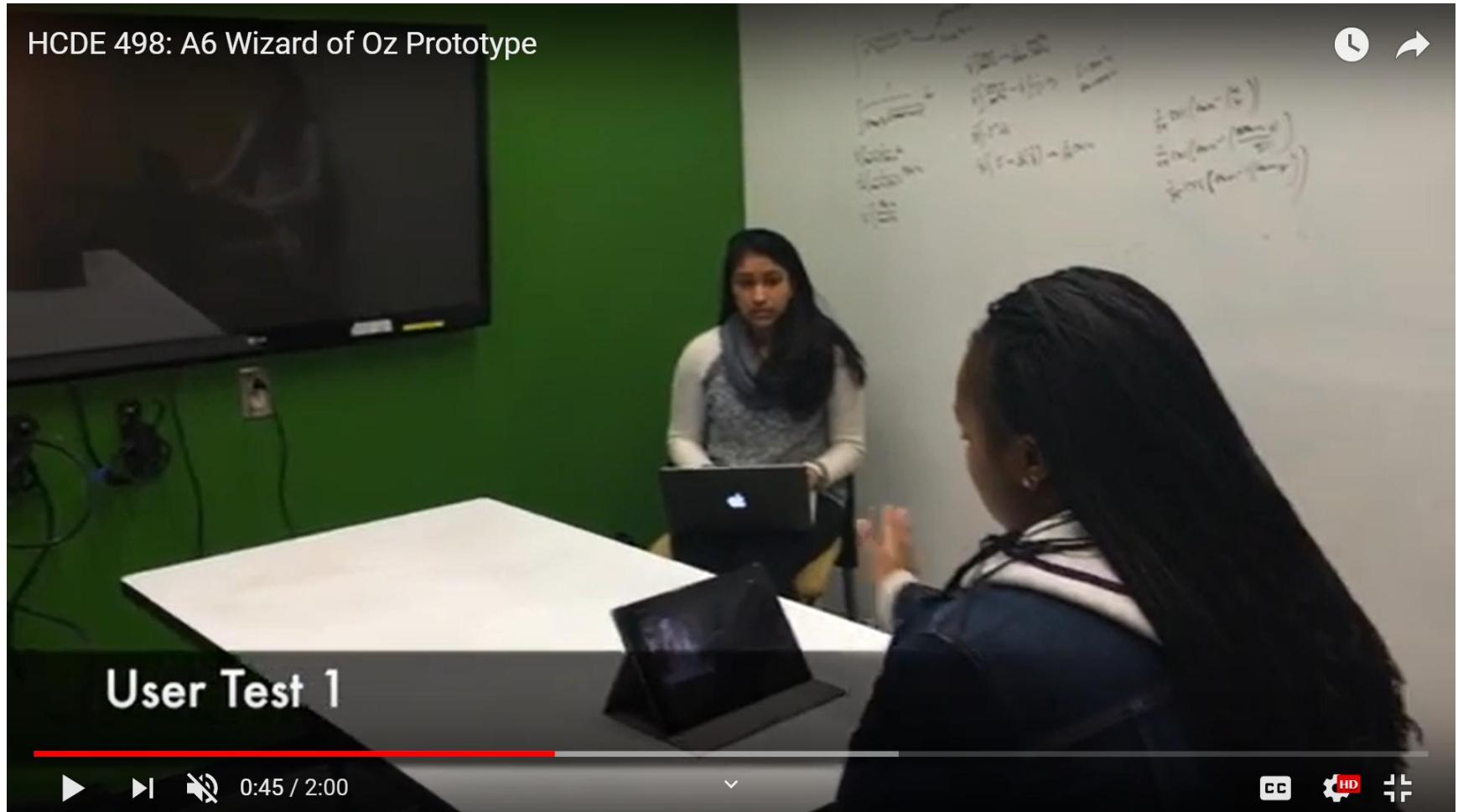
Source: <https://www.youtube.com/watch?v=QX9cjsYBihc>

# Examples 5 LFP: 'Wizard-of-Oz' prototyping



Source from [https://www.youtube.com/watch?v=WtrO6b\\_oUYI](https://www.youtube.com/watch?v=WtrO6b_oUYI)

# Examples 5 LFP: 'Wizard-of-Oz' prototyping



Source: <https://www.youtube.com/watch?v=mDRq9LisRn0>

# High-fidelity prototyping (HFP)

- Uses materials that you would expect to be in the **final product**
- Prototype **looks more like the final system** than a low-fidelity version
- High-fidelity prototypes can be developed by integrating existing hardware and software components
- Danger that users think they have a complete system.....see compromises

# From : Low-Fidelity Prototype(LFP)

About  
Our  
Company

News

Contact  
Info

Locate  
ATM

# WELCOME !

ACCOUNT # 0235126-8

show  all transactions  Filter last  transactions

TOTAL BALANCE \$ 7770.47

DATE ▾	PLACE ▾	AMOUNT ▾	TOTAL ▾
10/15/00	amazon.com	-\$ 168.20	\$ 6000.00
10/18/00	Good Guy's	-\$ 67.61	7932.39
11/02/00	Safeway	-\$ 39.02	7893.37
11/10/00	Border's	-\$ 50.00	7843.37
11/30/00	Max's	-\$ 29.73	7813.64
12/01/00	Safeway	-\$ 52.83	7760.81
12/01/00	Valero	-\$ 17.96	7742.85
12/06/00	DEPOSIT	+\$ 500.00	8242.85
12/10/00	Target	-\$ 18.94	8223.91
12/24/00	FAO Schwartz	-\$ 293.02	7930.89
12/24/00	Macy's	-\$ 108.91	7821.98
12/24/00	Sharper Image	-\$ 205.09	7616.89
12/24/00	Safeway	-\$ 61.93	7554.96
12/26/00	Fry's	-\$ 87.65	7467.31
12/30/00	RadioShack	-\$ 19.81	7447.50
01/04/01	DEPOSIT	+\$ 500.00	7947.50
01/14/01	Safeway	-\$ 62.71	7884.79
02/14/01	Godiva's	-\$ 114.32	7770.47

Yourbank.com

Sign-in!

Social Security number

password

Open a New  
Online Account

LFP also called as a wireframe design

# Convert to: High-Fidelity Prototype(HFP)

YourBank.com - Microsoft Internet Explorer - [Working Offline]

File    Address C:\Documents and Settings\Administrator\My Documents\ExptResearch\hifi2bkup\frameset1.htm

## ACCOUNT#0235126-8

Show: all transactions

Filter last  transactions.

Total Balance: \$7770.47

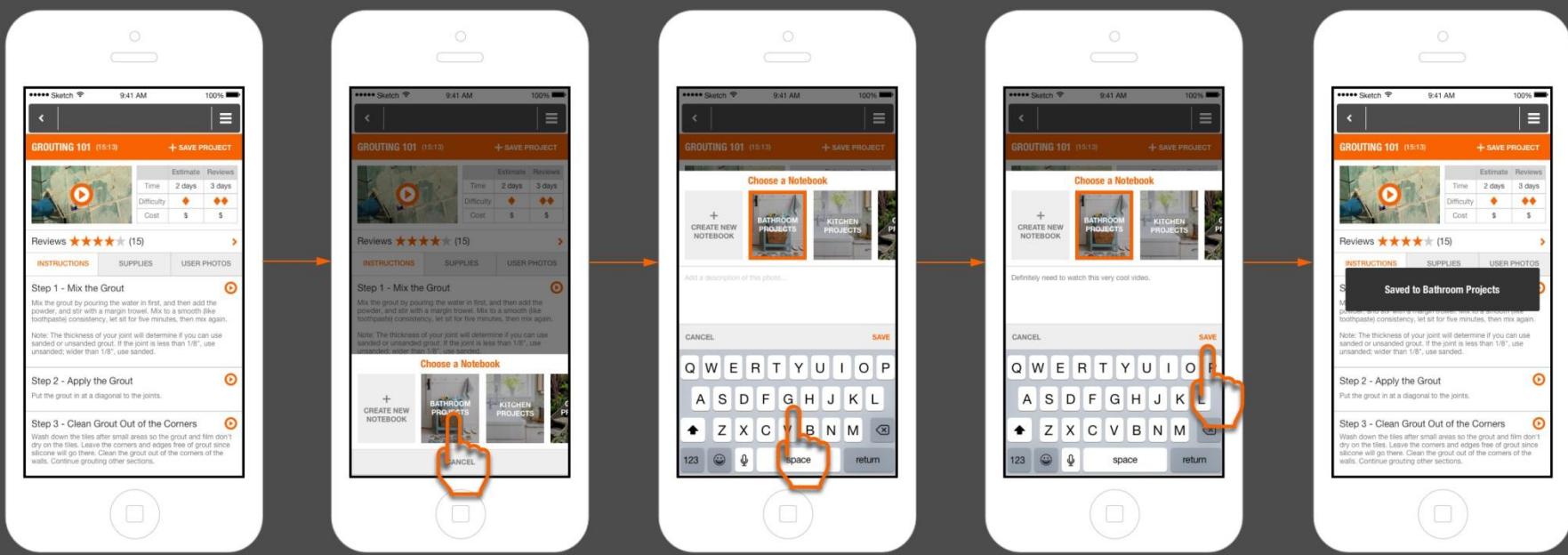
DATE	PLACE	AMOUNT	TOTAL
10/15/00	amazon.com	-\$168.20	\$8000.00
10/18/00	Good Guy's	-67.61	7932.39
11/02/00	Safeway	-39.02	7893.37
11/10/00	Borders	-50.00	7843.37
11/30/00	Max's	-29.73	7813.64
12/01/00	Safeway	-52.83	7760.81
12/01/00	Valero	-17.96	7742.85
12/06/00	DEPOSIT	+500.00	8242.85
12/10/00	Target	-18.94	8223.91
12/24/00	FAO Schwartz	-293.02	7930.89
12/24/00	Macy's	-108.91	7821.98
12/24/00	Sharper Image	-205.09	7616.89
12/24/00	Safeway	-61.93	7554.96
12/26/00	Fry's	-87.65	7467.31
12/30/00	RadioShack	-19.81	7447.50
01/04/01	DEPOSIT	+500.00	7947.50
01/14/01	Safeway	-62.71	7884.79
02/14/01	Godiva's	-114.32	7770.47

**YOUR BANK**  
2201 Sherwood Way or  
4206 College Hills Blvd.  
San Angelo, TX 76901  
(915) 949-3721  
1-800-700-9603

Accounts  
Transfers  
Bill Payer  
Services  
E-mail  
Exit

My Computer

# Examples of HFP: Mobile App



In the design process of high-fidelity prototyping, you need to work closely with the interaction designers to design a product as simple and easy to use as possible

Source: <https://www.mockplus.com/blog/post/different-stages-of-prototyping>

# Evolution of Prototypes

The image displays three versions of the Nielsen Norman Group website side-by-side, showing the progression of design from basic wireframes to high-fidelity visual mockups.

- Left Version:** Shows a grid of 15 small, low-resolution thumbnail images representing various content pieces like articles, videos, and training modules. Each thumbnail includes a title, a brief description, and a small preview image.
- Middle Version:** Shows the same grid of thumbnails, but each one is enclosed in a larger, rounded rectangular frame, giving it a more polished and professional look.
- Right Version:** Shows the same grid of thumbnails, but each one is enclosed in a large, detailed visual mockup of a website page. This includes a header with the Nielsen Norman Group logo and navigation links, a main content area with a large image and text, and a footer section.

Iterative design process evolved from **black-and-white wireframes** for content planning to multiple versions of **high-fidelity visual mockups** created with cloud-based prototyping tools.

Source: <https://www.nngroup.com/articles/case-study-iterative-design-prototyping/>

# Evolution of Prototypes (Low to High Fidelity Prototype)

- **Example :** iPhone ColorMood Designer from Low Fidelity to High Fidelity Prototype.
  - <https://www.youtube.com/watch?v=V8LNDqMIapY>

# Advantages & Disadvantages

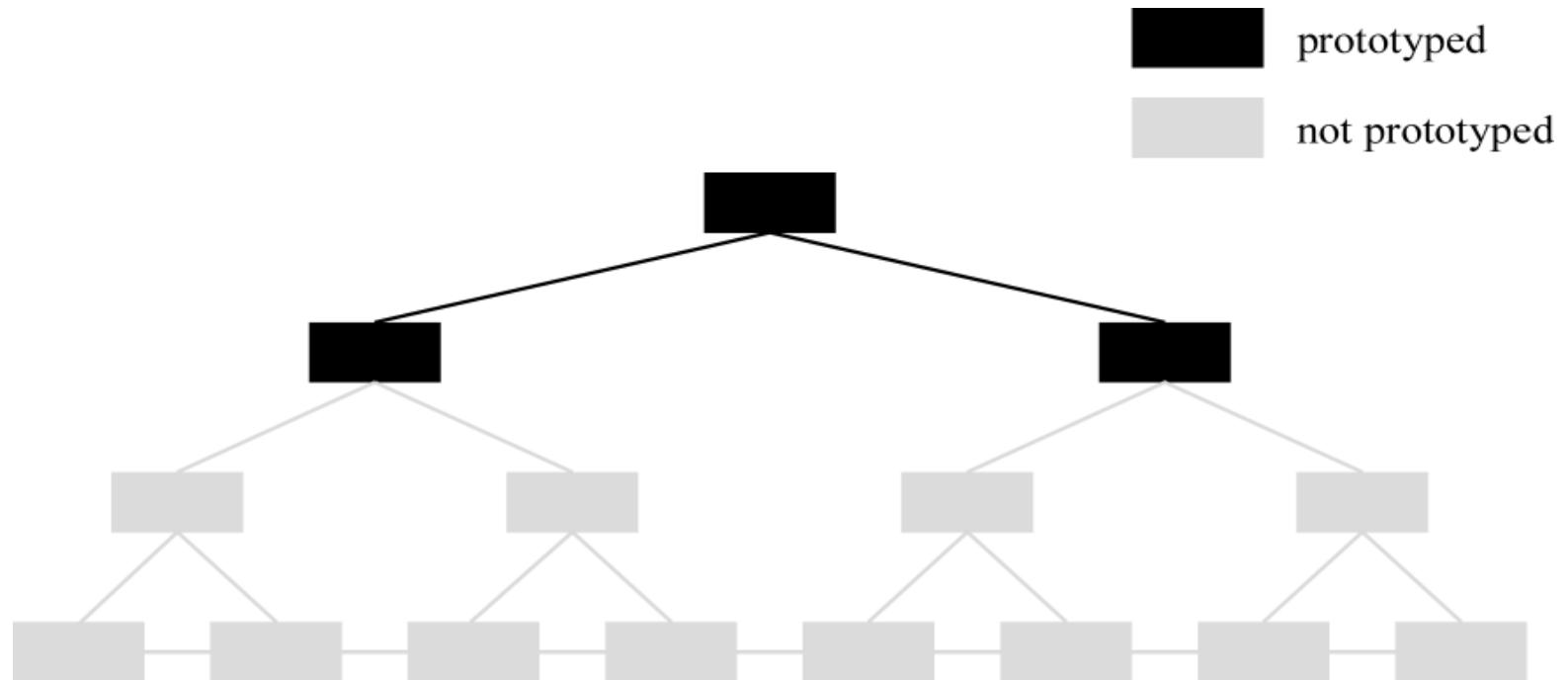
Type	Advantages	Disadvantages
Low-fidelity prototype	<p>Lower development cost</p> <p>Evaluates multiple design concepts</p> <p>Useful communication device</p> <p>Addresses screen layout issues</p> <p>Useful for identifying market requirements</p> <p>Proof of concept</p>	<p>Limited error checking</p> <p>Poor detailed specification to code to</p> <p>Facilitator-driven</p> <p>Limited utility after requirements established</p> <p>Limited usefulness for usability tests</p> <p>Navigational and flow limitations</p>
High-fidelity prototype	<p>Complete functionality</p> <p>Fully interactive</p> <p>User-driven</p> <p>Clearly defines navigational scheme</p> <p>Use for exploration and test</p> <p>Look and feel of final product</p> <p>Serves as a living specification</p> <p>Marketing and sales tool</p>	<p>More resource-intensive to develop</p> <p>Time-consuming to create</p> <p>Inefficient for proof-of-concept designs</p> <p>Not effective for requirements gathering</p>

Table 11.3 Advantages and disadvantages of low- and high-fidelity prototypes

# Compromises in prototyping

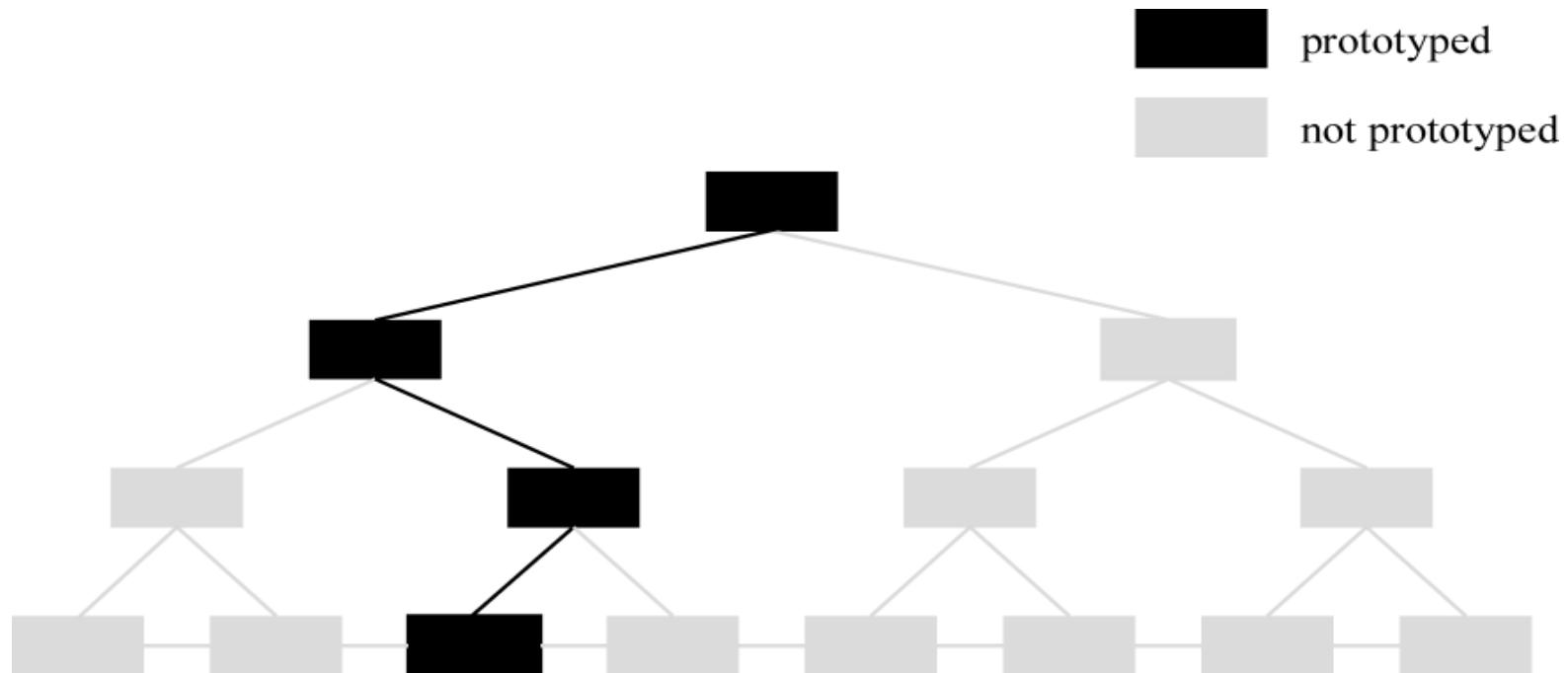
- All prototypes involve compromises
- For software-based prototyping maybe there is a slow response? sketchy icons? limited functionality?
- Two common types of compromise
  - **horizontal**: provide a **wide range** of functions, but with **little detail**
  - **vertical**: provide a lot of **detail** for only a **few functions**
- Compromises in prototypes mustn't be ignored. Product needs engineering

# Horizontal Prototype: Broad but only Top-Level



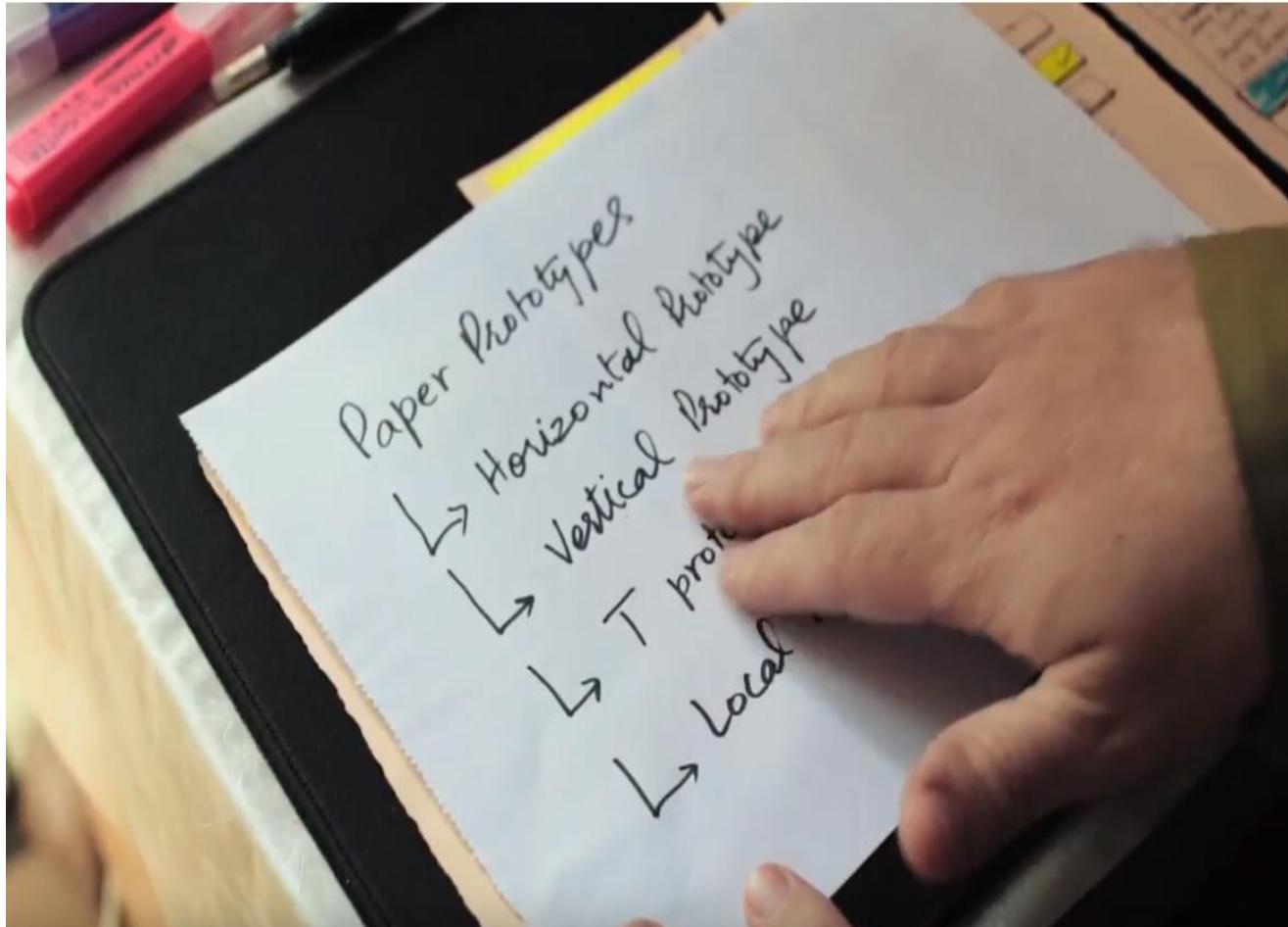
provide a **wide** range of functions, but with **little detail**

# Vertical Prototype: Deep, but only Some Functions



full functionality and performance of a “slice” or small part of the system

# Examples of compromises: Horizontal and vertical



Source: [https://www.youtube.com/watch?v=HJmK\\_wuZWp4](https://www.youtube.com/watch?v=HJmK_wuZWp4)

# **CONCEPTUAL DESIGN**

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# Conceptual design

- Transform user **requirements/needs** into a **conceptual model**
- A **conceptual model** is an outline of what people can do with a product and what concepts are needed to understand and interact with it
- Mood board may be used to capture feel
- Consider alternatives: prototyping helps

# Choosing an Interface Metaphor

- **Interface metaphors** combine familiar knowledge with new knowledge in a way that will **help the user understand the product**.
- Three steps: understand functionality, identify potential problem areas, generate metaphors
- Evaluate metaphors:
  - How much structure does it provide?
  - How much is relevant to the problem?
  - Is it easy to represent?
  - Will the audience understand it?
  - How extensible is it?

# Considering interaction and interface types

- Which interaction type?
  - How the user invokes actions
  - Instructing, conversing, manipulating or exploring
- Do different interface types provide insight?
  - shareable, tangible, augmented reality, etc.

# Expanding the initial conceptual model

- What functions will the product perform?
  - What will the product do and what will the human do (task allocation)?
- How are the functions related to each other?
  - Sequential or parallel?
  - Categorisations, e.g. all actions related to privacy on a smartphone
- What information is needed?
  - What data is required to perform the task?
  - How is this data to be transformed by the system?

# **CONCRETE**

# **DESIGN**

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# Concrete design

- Difference between conceptual and concrete is emphasis
- Many aspects to concrete design
  - Color, icons, buttons, interaction devices, and so on
- User characteristics and context
  - Inclusiveness, input, and output modes
- Accessibility
  - Web Content Accessibility Guidelines
- Localisation and internationalisation
  - Language, navigation, icons, and metaphor
  - Indigenous knowledge and perspectives

# **GENERATING PROTOTYPES**

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# Generating Prototypes

- Generate a storyboard from a scenario
  - Break down scenario into steps
  - Create a scene for each step
- Sketching out a storyboard prompts designers to think about design issues
- Generate a card-based prototype from a storyboard or from a use case
  - Consider each step in the use case – what interaction element is needed
  - Draw a card that captures it

# Generate storyboard from scenario

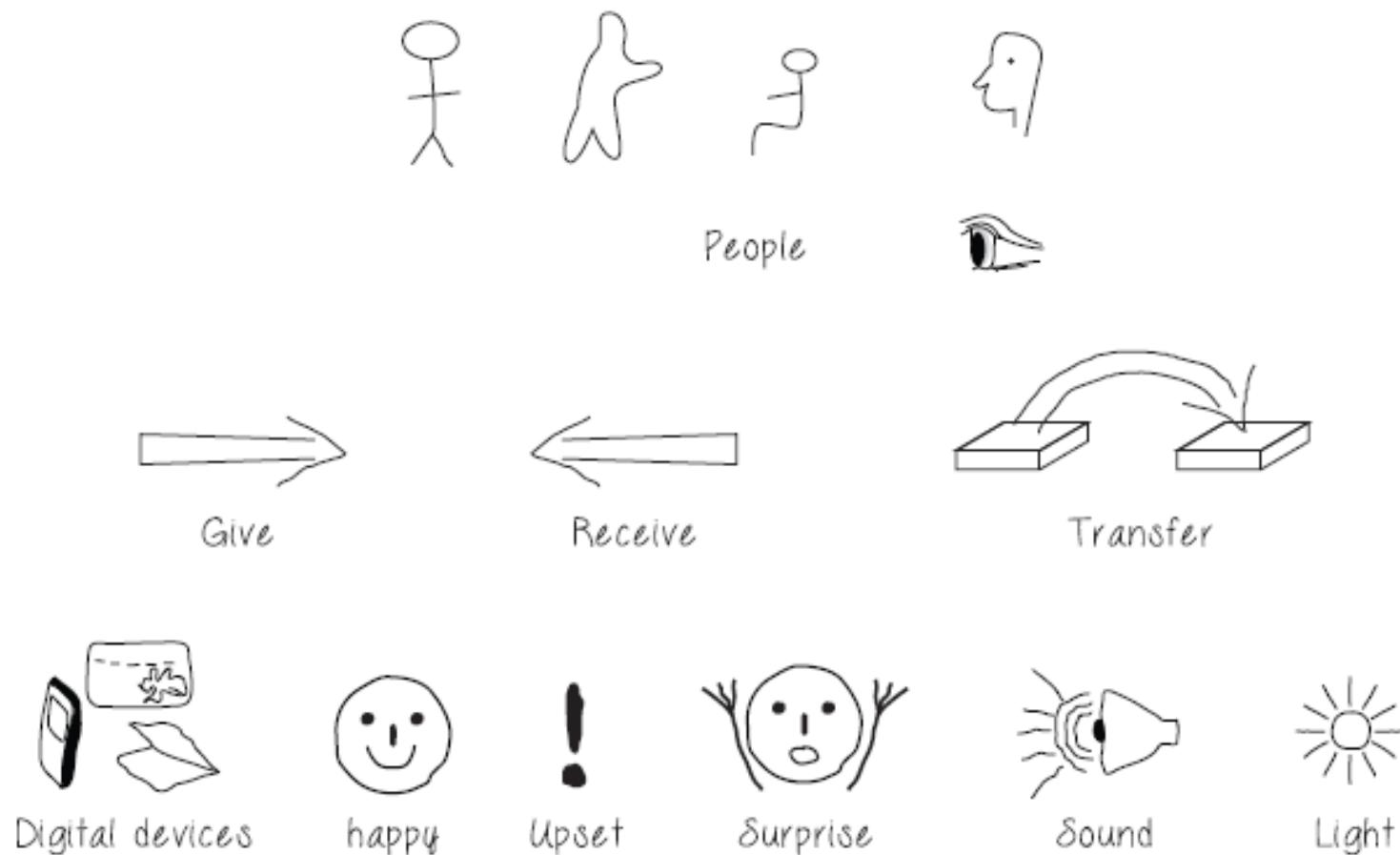
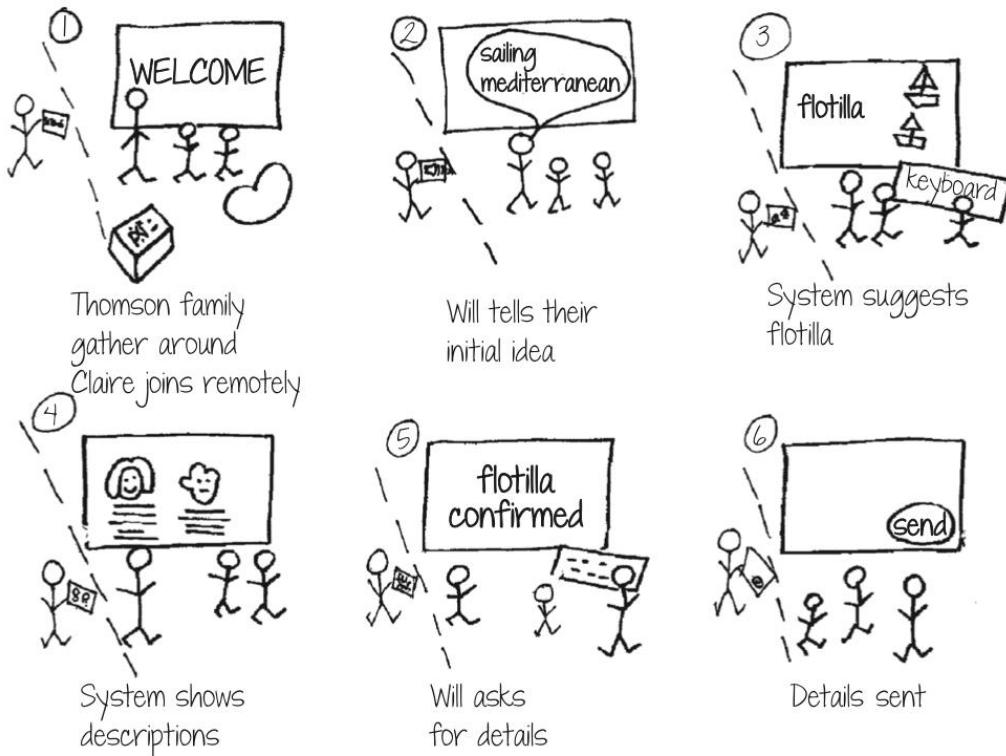


Figure 11.4 Some simple sketches for low-fidelity prototyping

# Generating Storyboard



# Generating Card-based Prototype

Where do you want to go?

My passport was issued in

Why are you going there?

- Tourism
- Business
- Passing through

Destination

Nationality

The purpose of my trip is

- Tourism
- Business
- Transit



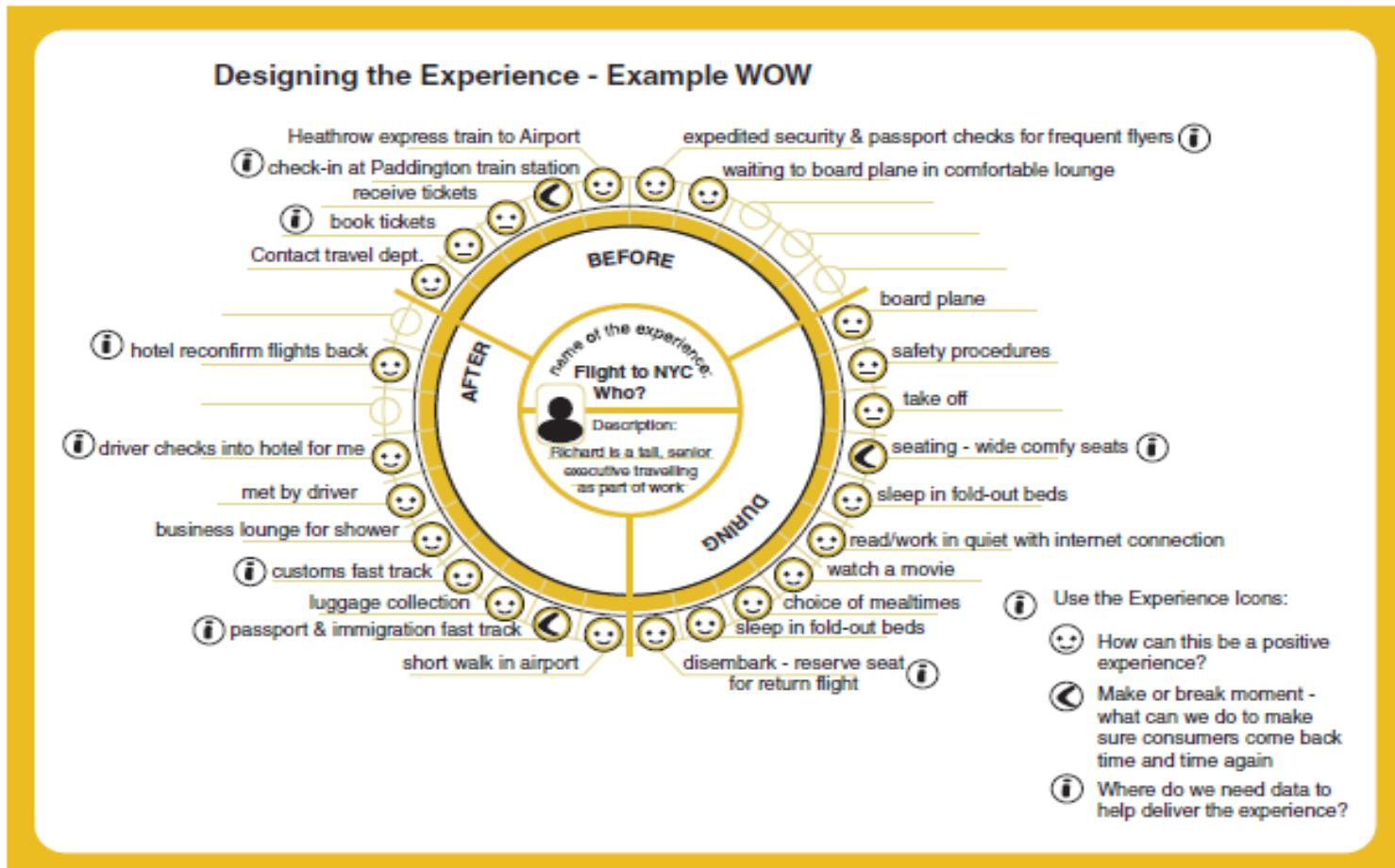
**EXPLORE THE  
USER'S  
EXPERIENCE**

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# Explore the user's experience

- Combination of **personas**, **prototypes**, or stickies to model the overall **experience**
- Visual representation called:
  - design map
  - customer/user journey map
  - experience map
- Two common representations
  - wheel
  - Timeline
- User flows focus on screen content and design, particularly used for mobile devices

# An experience map drawn as a wheel



(a)

**Figure 11.19** (a) An experience map using a wheel representation. (b) An example timeline design map illustrating how to capture different issues.

Source: (a) <http://www.ux-lady.com/experience-maps-user-journey-and-more-exp-map-layout/> (b) Adlin, T. and Pruitt, J. (2010) *The Essential Persona Lifecycle: Your guide to building and using personas*. Morgan Kaufmann p. 134.

# An experience map drawn as a timeline

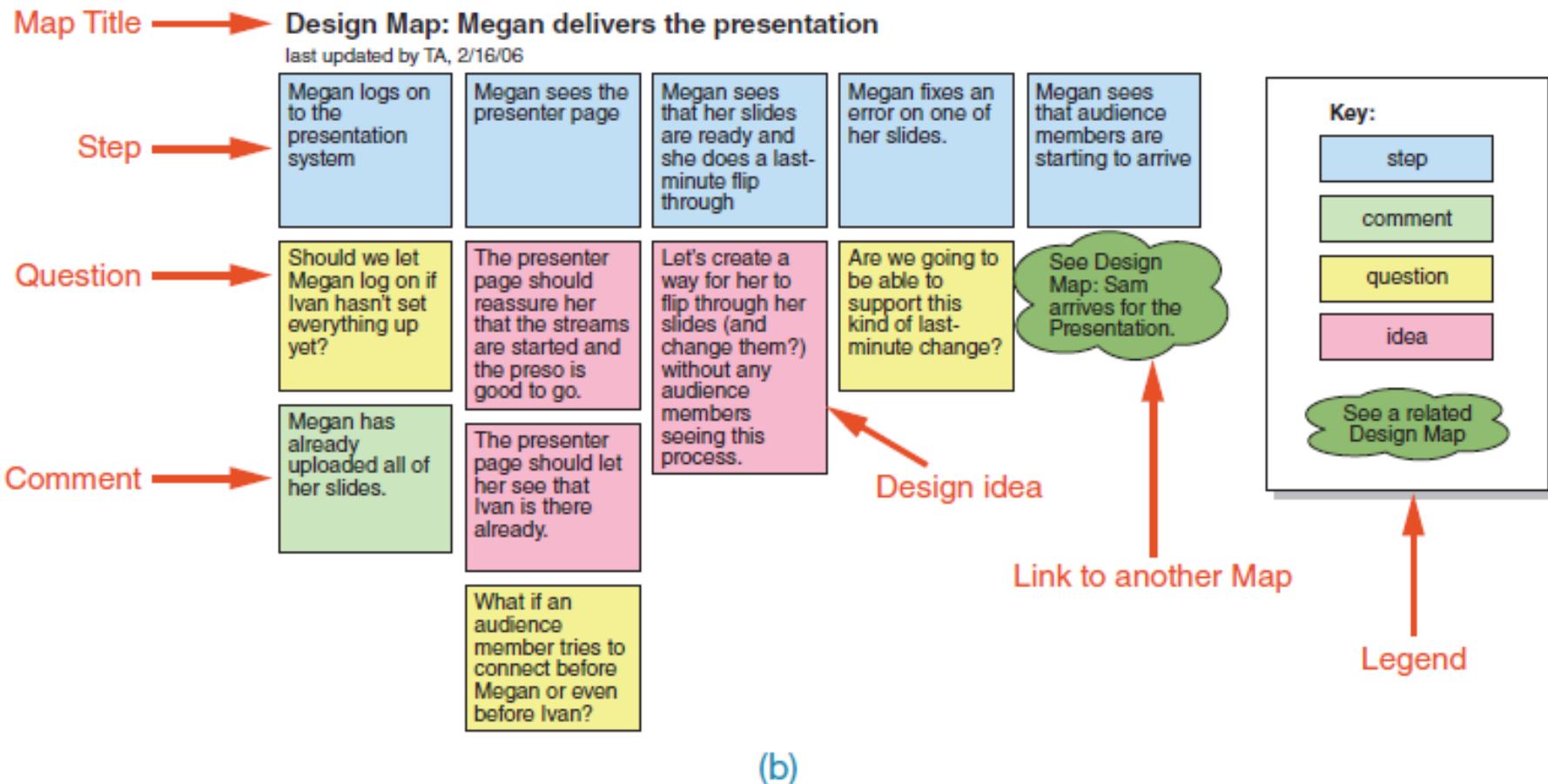
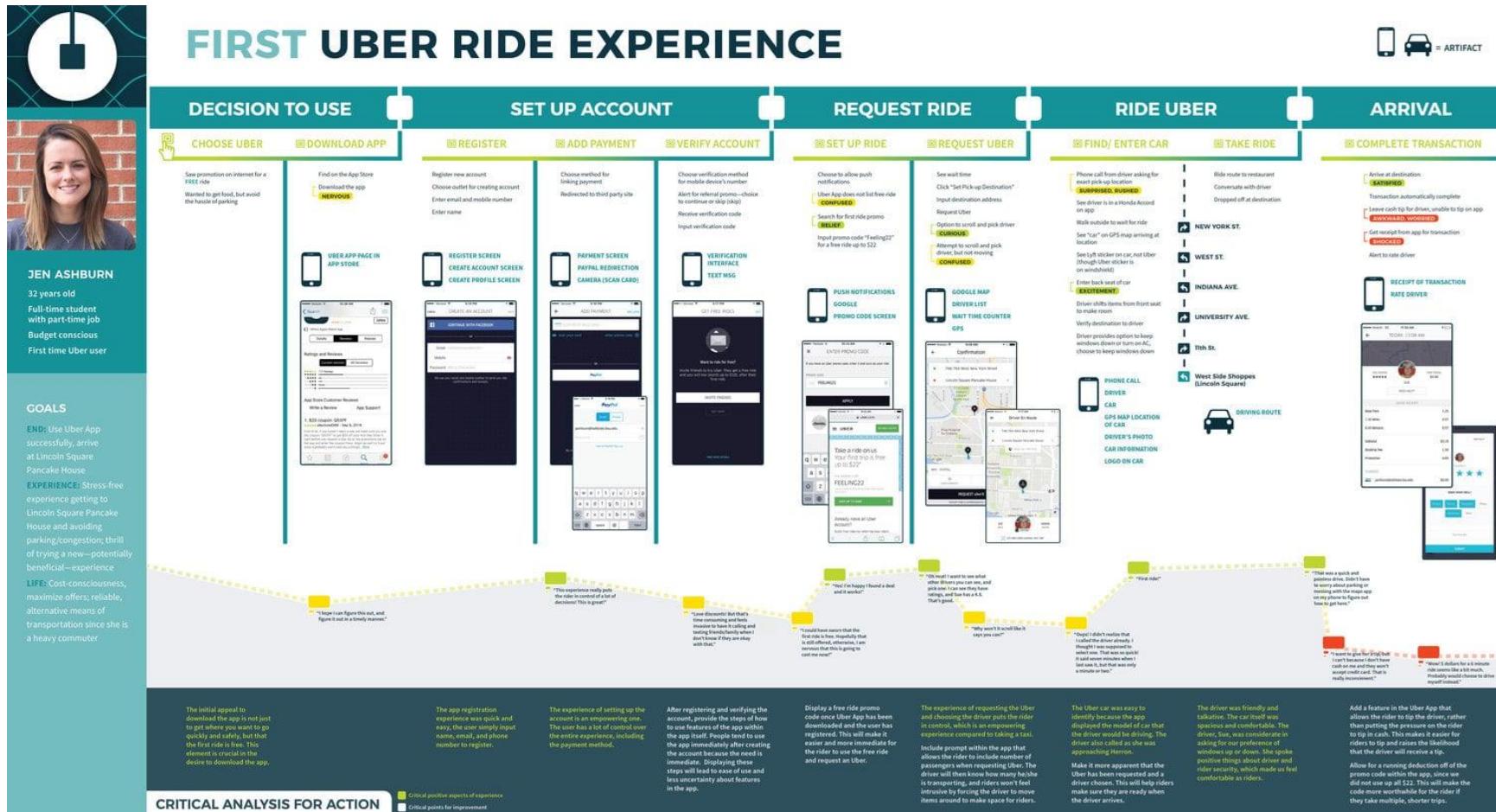


Figure 11.19 Continued

# User Journey Map



# Customer Journey Map

## Customer Journey Map Template



Persona

### Scenario

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Praesent ac lectus cursus, semper arcu eu, posuere nibh. Etiam sollicitudin, odio sed vulputate ultrices, elit lectus malesuada purus, eget rutrum turpis ipsum ut nunc.

Step 1

Step 2

...

Final Step

### Goals & Expectations

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Praesent ac lectus cursus, semper arcu eu, posuere nibh. Etiam sollicitudin, odio sed vulputate ultrices, elit lectus malesuada purus, eget rutrum turpis ipsum ut nunc.

#### Customer goals

- Goal 1
- Goal 2

#### Customer goals

- Goal 1
- Goal 2

#### Customer thoughts and emotions

Lorem ipsum dolor sit amet, consectetur adipiscing elit.

#### Customer thoughts and emotions

Lorem ipsum dolor sit amet, consectetur adipiscing elit.

#### Customer goals

- Goal 1
- Goal 2

#### Customer thoughts and emotions

Lorem ipsum dolor sit amet, consectetur adipiscing elit.



#### Opportunities & ideas to improve

- Opportunity 1
- Idea 1

#### Opportunities & ideas to improve

- Opportunity 1
- Idea 1

#### Internal ownership

- Team member 1
- Team member 2

#### Internal ownership

- Team member 1
- Team member 2

#### Opportunities & ideas to improve

- Opportunity 1
- Idea 1

#### Internal ownership

- Team member 1
- Team member 2



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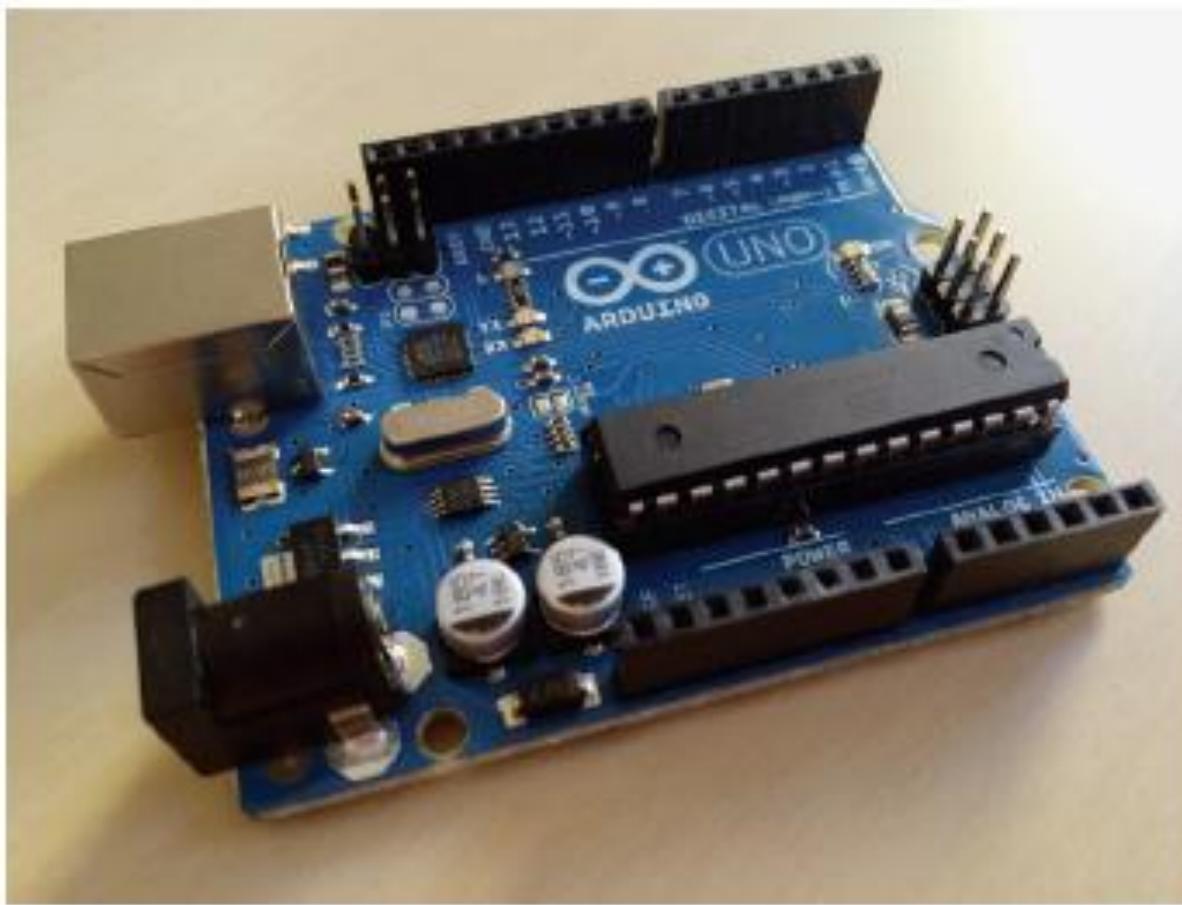
# CONSTRUCTION

• • •

# Construction: physical computing

- Build and code prototypes using **electronics**
- Toolkits available include
  - Arduino
  - LilyPad (for fabrics)
  - Senseboard
  - MaKey MaKey
- Designed for use by wide range of people

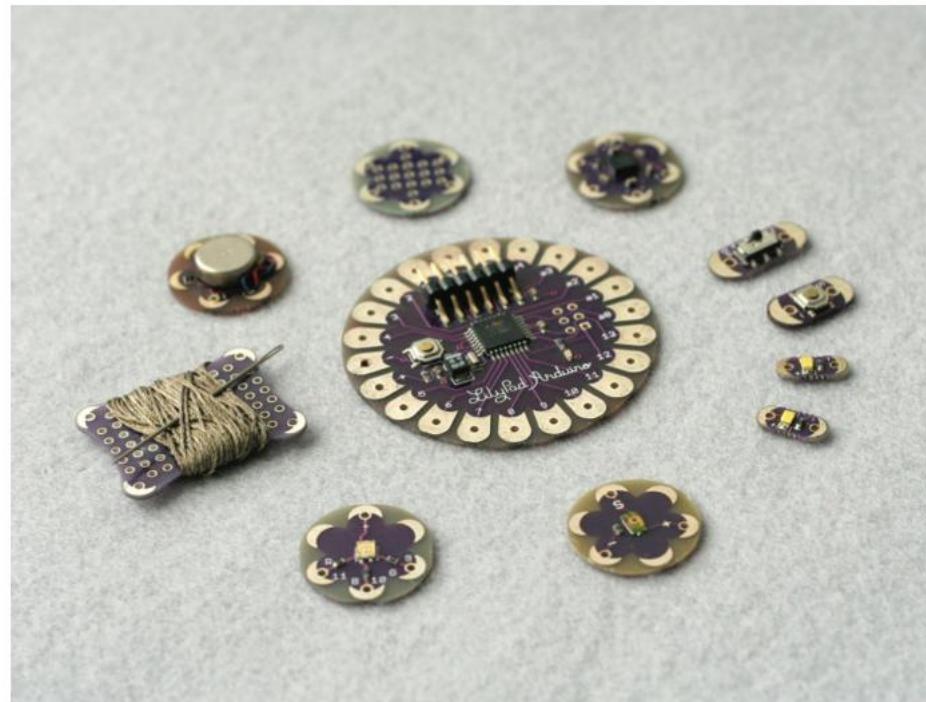
# Physical computing kits: Arduino Board



**Figure 11.22** The Arduino board

Source: Courtesy of Nicolai Marquardt

# Physical Computing Kits: Lilypad Arduino



Source: Courtesy of Leah Beuchley

# Physical Computing Kits: MaKey MaKey

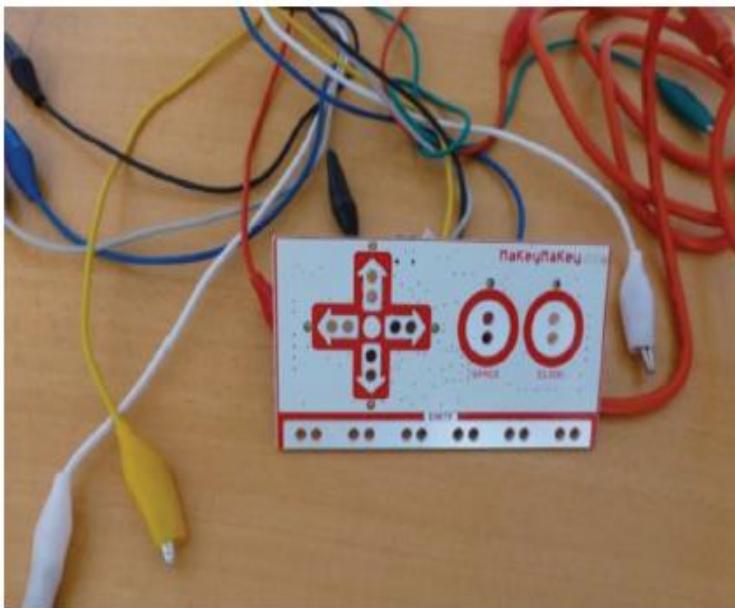
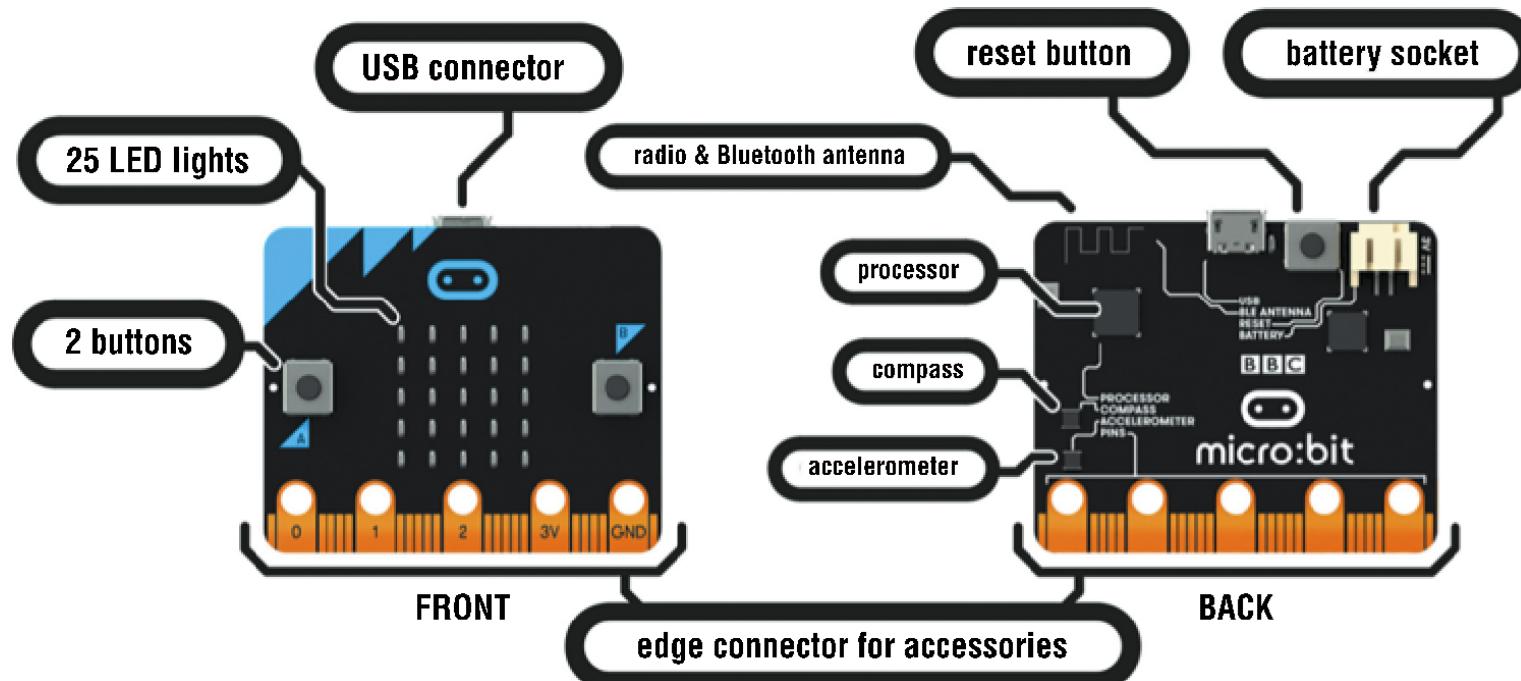


Figure 11.24 The MaKey MaKey toolkit



Figure 11.25 A group of retired friends playing with a MaKey MaKey toolkit

# Physical computing kits: Micro:bit



The BBC micro:bit

Source: [micro:bit](#). Used courtesy of Micro:bit Foundation

# Construction: SDKs

- Software Development Kits
  - programming tools and components to develop for a specific platform, e.g. iOS
- Includes: IDE, documentation, drivers, sample code, application programming interfaces (APIs)
- Makes development **much easier**
- Examples:
  - Amazon's Alexa Skills Kit for voice-based services
  - Apple's ARKit for augmented reality

# Summary

- Prototyping may be low fidelity (such as paper-based) or high fidelity (such as software-based)
- Ready-made software and hardware helps create prototypes
- Two aspects to design: conceptual and concrete
- Conceptual design develops an outline of what people can do and what concepts are needed to understand the product.
- Concrete design specifies design details, for example, layout or navigation
- Three approaches to develop an initial conceptual model: interface metaphors, interaction styles, and interface styles.
- Expand an initial conceptual model by considering whether product or user performs each function, how those functions are related, and what information is required to support them
- Scenarios and prototypes can be used to explore design ideas
- Physical computing kits and software development kits facilitate the transition from design to construction

A close-up of the white cat-like robot Doraemon, looking surprised or excited with his mouth wide open and eyes wide. He has a red collar with a bell.

ANY  
QUESTIONS  
?

- **The 10 best prototyping tools for UI/UX designers [2025 Update]**
  - [https://www.uxdesigninstitute.com/blog/best-prototyping-tools-for-ux-designers/?utm\\_source=chatgpt.com](https://www.uxdesigninstitute.com/blog/best-prototyping-tools-for-ux-designers/?utm_source=chatgpt.com)