Human-Computer Interaction

2024/2025

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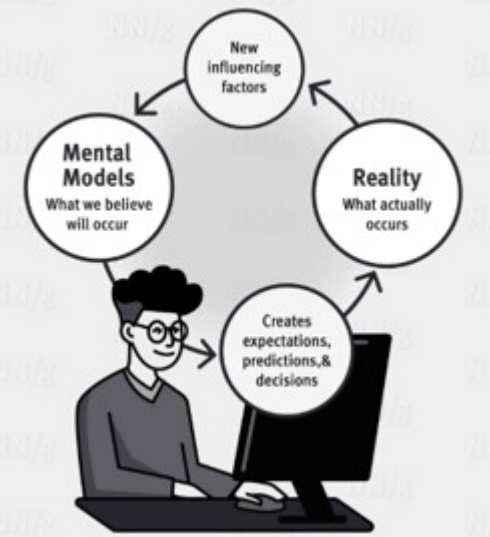
Lecture 3

User models and other models

universidade de aveiro
deti departamento de electrónica, telecomunicações e informática

From the User to the UI

Mental and conceptual models



https://www.nngroup.com/articles/mental-models/

Relevant issues:

- What are mental models?
- How do we construct them?
- What is known about them?
- What are they used for?
- What are conceptual models?
- Guidelines to obtain good conceptual models (promoting good mental models)

What are Mental Models? | IxDF (interaction-design.org)
Mental Models and User Experience Design

Mental models and Conceptual models

- A **mental model** (in a simple way) is the **user's internal representation** and understanding of the system; what the user believes about the system
- The **conceptual model is the UI highest level**
- The conceptual model is the conceptual framework in which the functionality is provided to the user
- **To understand how to design a good conceptual model it is necessary to understand mental models**
- **A conceptual model is the designer's attempt to foster good mental models through UI aspects**

Mental models

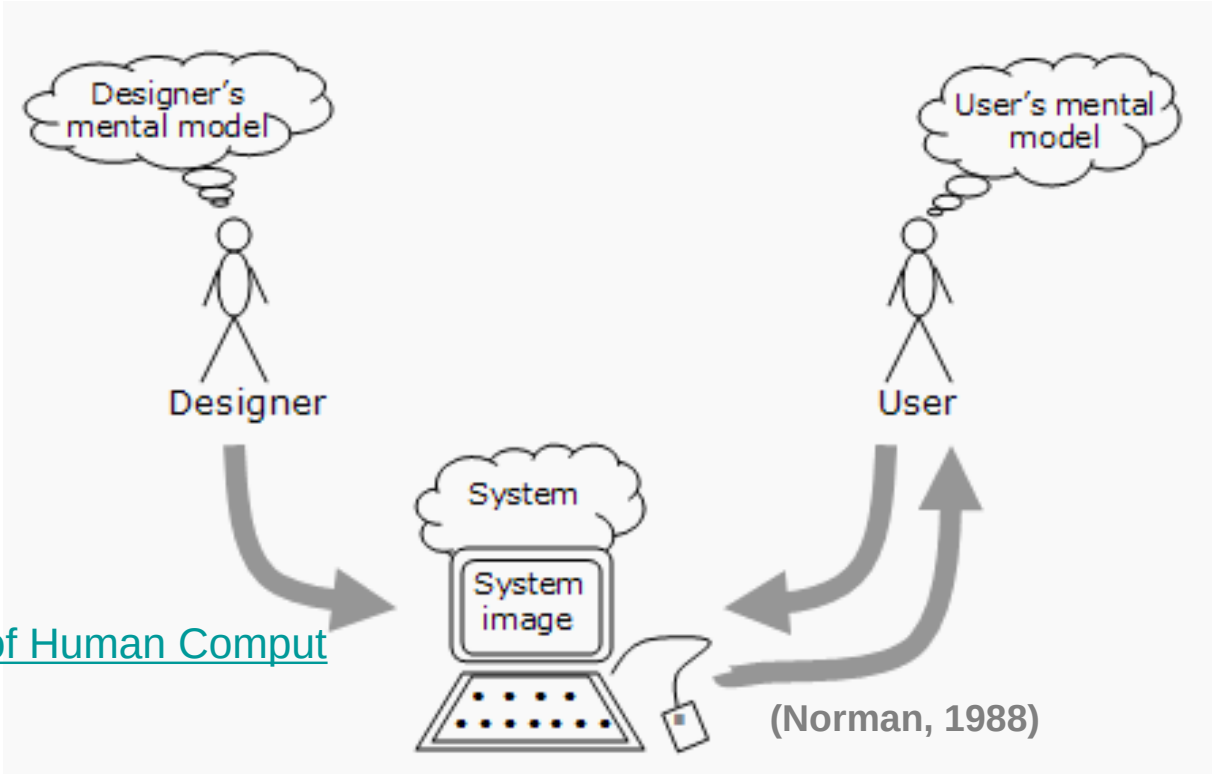
Mental models are representations of the world that help us understand complex concepts and make better decisions

- based on past experiences, beliefs, and assumptions to understand how the world works
- essential for decision-making, problem-solving, and learning, as well as effective communication and collaboration in group settings

https://www.interaction-design.org/literature/topics/mental-models

- The user develops a **mental model** of how he/she thinks the system works

- And uses it to:
  - reason about the system
  - anticipate system behavior
  - explain why the system reacts as it does



Mental models | The Glossary of Human Computer Interaction

Example: TV remote controller

- If I grab my TV remote controller and press the on button:
- What should happen?

But nothing happens …

- What will be the diagnosis?
- What can I do to solve the issue?
- What if I try to use a different one?

Which button shall I press?

Example: remote controller of some projectors
@ DETI

- This device has a different UI from the others I am used to
  (not complying with the consistency and standards heuristic)
- I will try to infer how to use it based on the mental models I have
- But it is ambiguous and it does not give prompt feedback
  (not complying with the visibility of the system status heuristic)
- Determining adequate actions to produce the wanted changes fails!
- … I press one button, nothing happens, I press the other ...

… low efficiency, low efficacy, low satisfaction

poor usability and UX

Mental models allow:

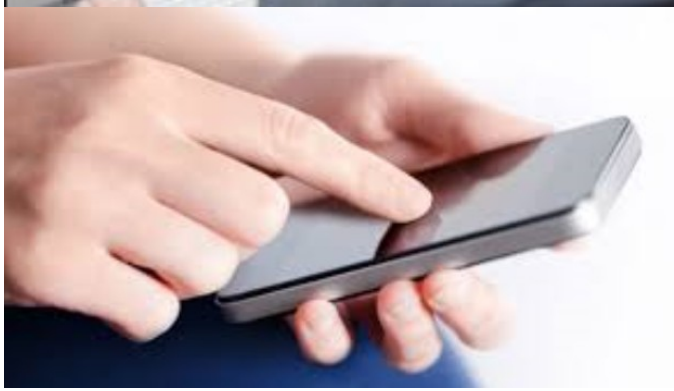
- Make **predictions**
- Determine **causes** of observed events
- Determine **adequate actions to produce** the wanted changes
- **Understand analogous devices**
- ...

"What users believe they know about a UI strongly impacts how they use it. Mismatched mental models are common, especially with designs that try something new."

https://www.nngroup.com/articles/mental-models/

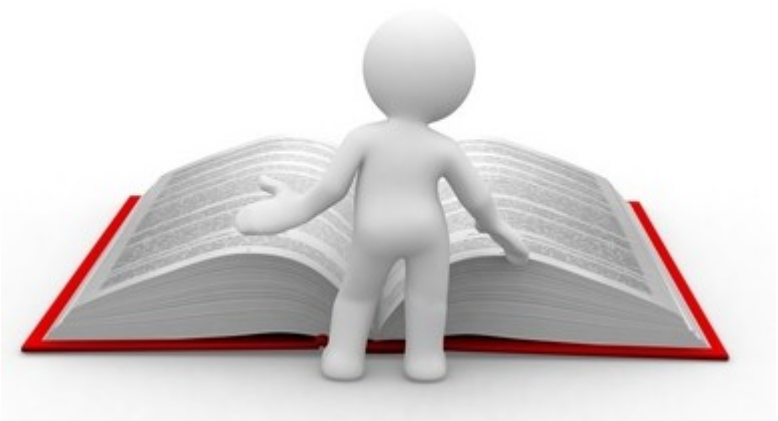
How do we create a mental model?

How do we create a mental model?



- Using the system
- Observing others using the system
- Reading documentation
- …

and thus **all these are important ways to train the user to use a system**



Mental models:

- Are **incomplete**
- Are **unstable** (people easily forget the details)
- Are **not scientific** (maintain "superstitious" behaviours)
- **Don´t have specific limits** (mistake similar devices and operations)
- …

Often people do a lot of extra actions instead of planning,
which would avoid those actions!

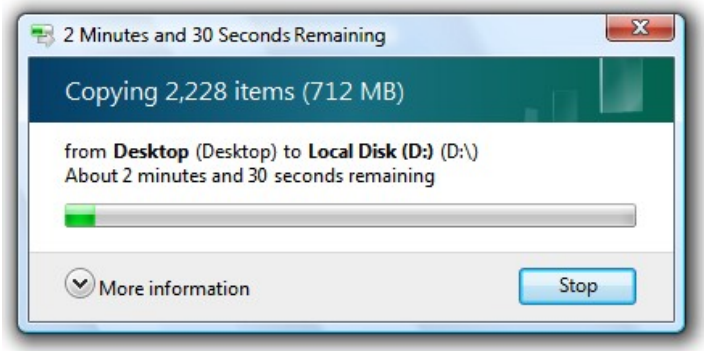
“We must give up finding elegant mental models, and instead learn how to understand the incomplete and confuse structures people have”

Donald Norman

And create conceptual models that take this into consideration ….

Main guidelines to obtain a good conceptual model
(that fosters a good mental model)

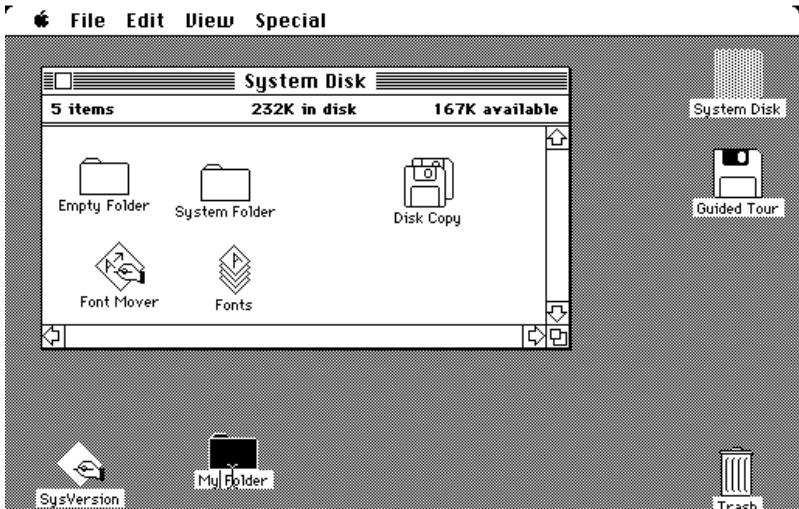
- **Make visible** invisible parts and processes



- Give **feedback**

- Use **coherence** (colors names, command syntax, dialog styles, information location on the screen, etc., etc.)

Desktop metaphor →



- Use a **metaphor** (optional)

All this may help the user to understand better how the system works

Metaphors

- Exploit existing mental models of the real world

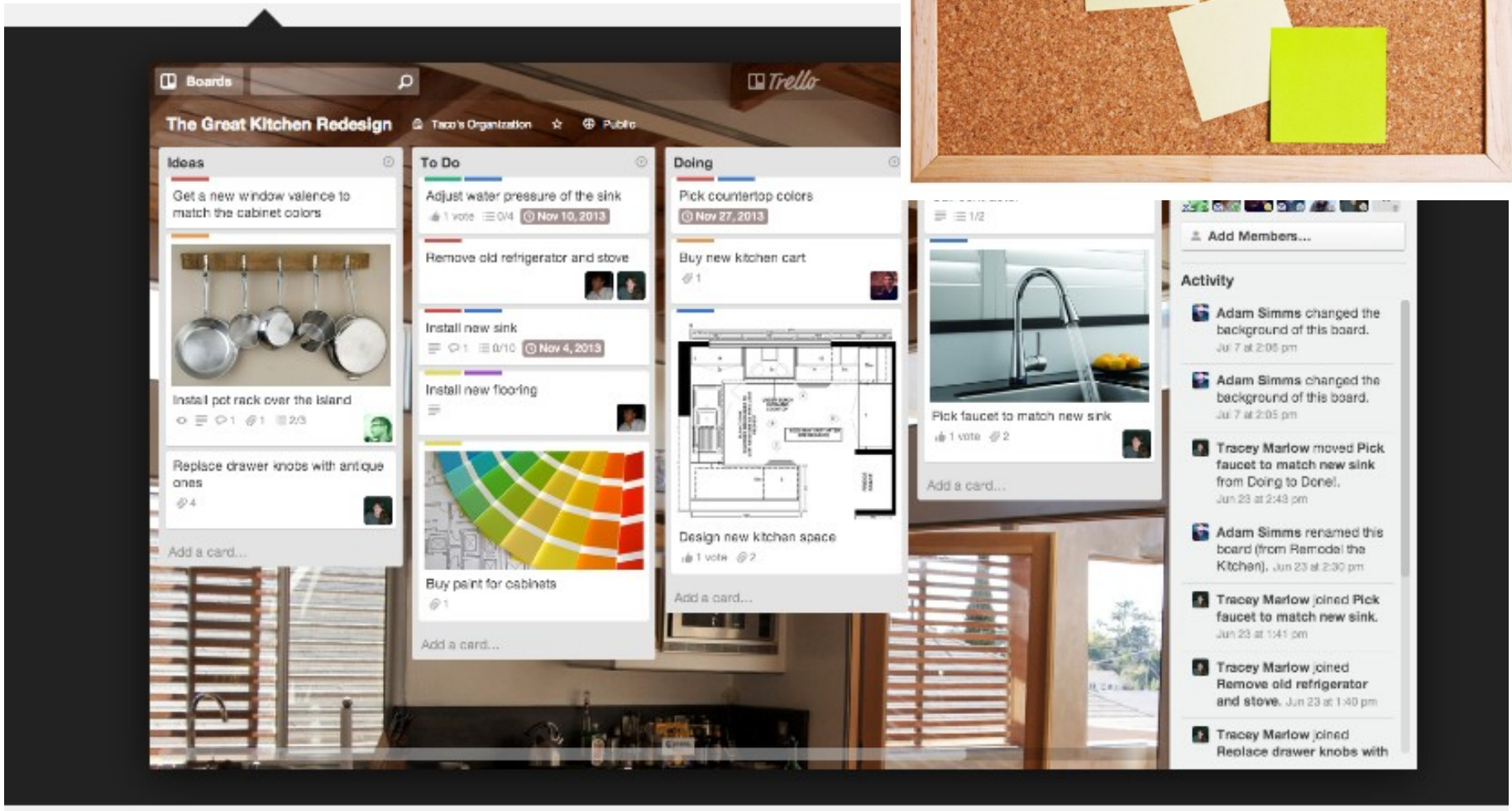
Metaphors **can be misleading** since the “the essence of metaphor is understanding and experiencing one kind of thing in terms of another” (Lakoff and Johnson, 1983)

- Which, by definition, makes a metaphor different from what it represents or points to

https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/human-computer-interaction-brief-intro

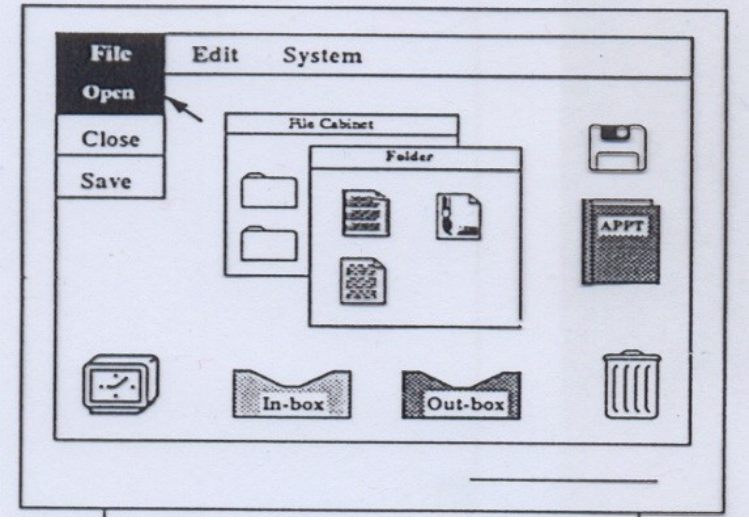
Example: The Desktop metaphor:

Another example:
the bulletin board (Trello)



https://trello.com/tour

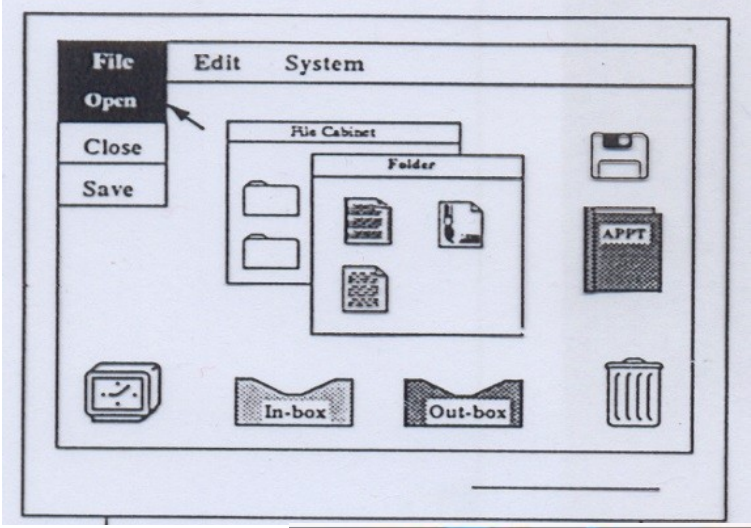
Potential problems in using metaphors



- Incomplete metaphors may **confound** the user
- Risk of **under-utilization** of the system's capacities
- Less experienced users (e.g. children) seem to expect more **"literal" metaphors**
- Sophisticated users seem to expect more **"magical" metaphors**

Thus, the use of a metaphor should be carefully pondered …

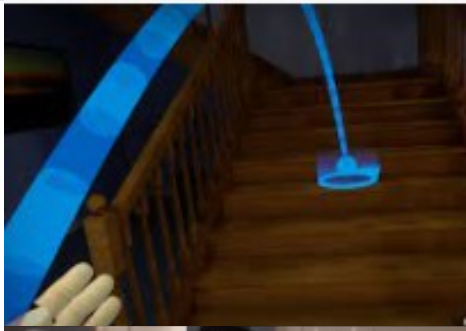
Examples of using metaphors



- In Apple's original desktop metaphor:

  remove the diskette from the system ->

  -> drag it to the recycling bin !! (unlike the real world…)



- Navigation/locomotion in VR systems:

  Magical metaphor -> "teleportation"

  Less magical (more literal) -> "physically" walking

Conceptual models – the take away

- A conceptual model is a **high-level description** of a product in terms of:
  - what users can do with it
  - the concepts they need to understand how to interact with it

- Developing a conceptual model involves:
  - Understanding the problem space
  - Specifying how the proposed design will support users

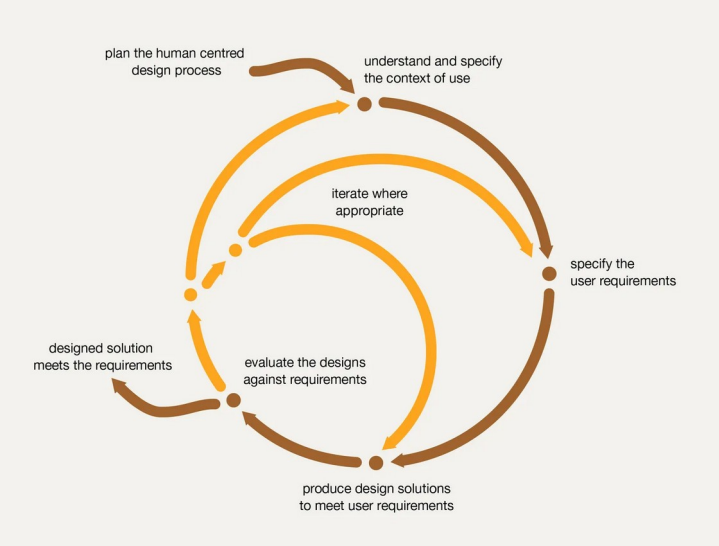
- Conceptual models **must foster good mental models**

- Paradigms, visions, theories, models, and frameworks
  - Provide ways of framing design and research

How can we create a UI with an adequate conceptual model?

Models

For the development of interactive systems



What is The Interactive Design Process? | IxDF

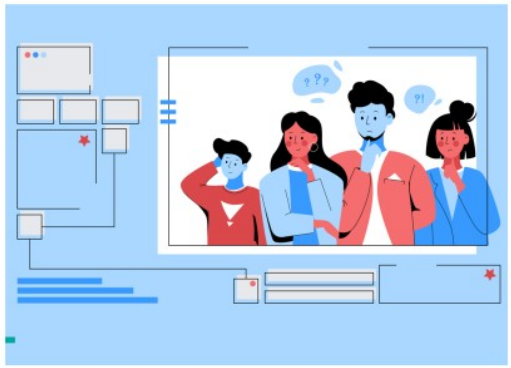
Requirement analysis for the Lab project

What **models** can we use?

Users

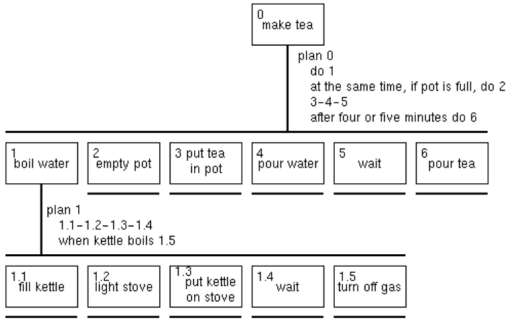
Personas

Contexts of use



Scenarios

Tasks



Task analysis

Functional and non-functional requirements

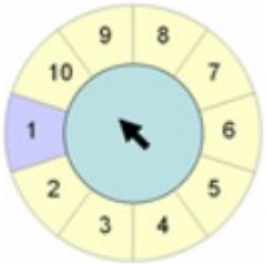
User Models

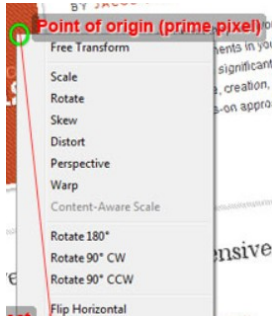
- There are several models of the users' mental, perceptual and motor processes (GOMS, KLM, **Fitts' Law**…)

- **Personas-** fictional characters based upon research in order to represent the different types of users

- ...

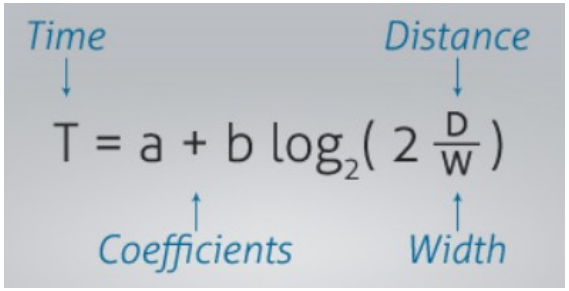
Fitts's law

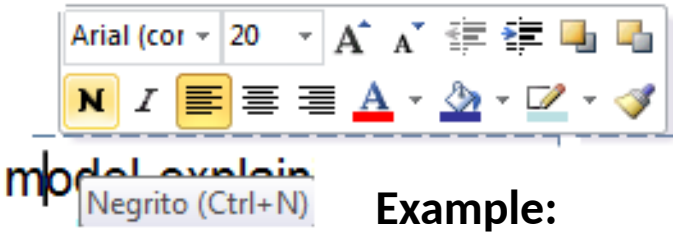




- Empirical model explaining speed-accuracy tradeoff characteristics of human muscle movement

- Estimates the **average time** a user takes **to select a target** considering the distance (D) from the cursor and the Width (W) of the target:



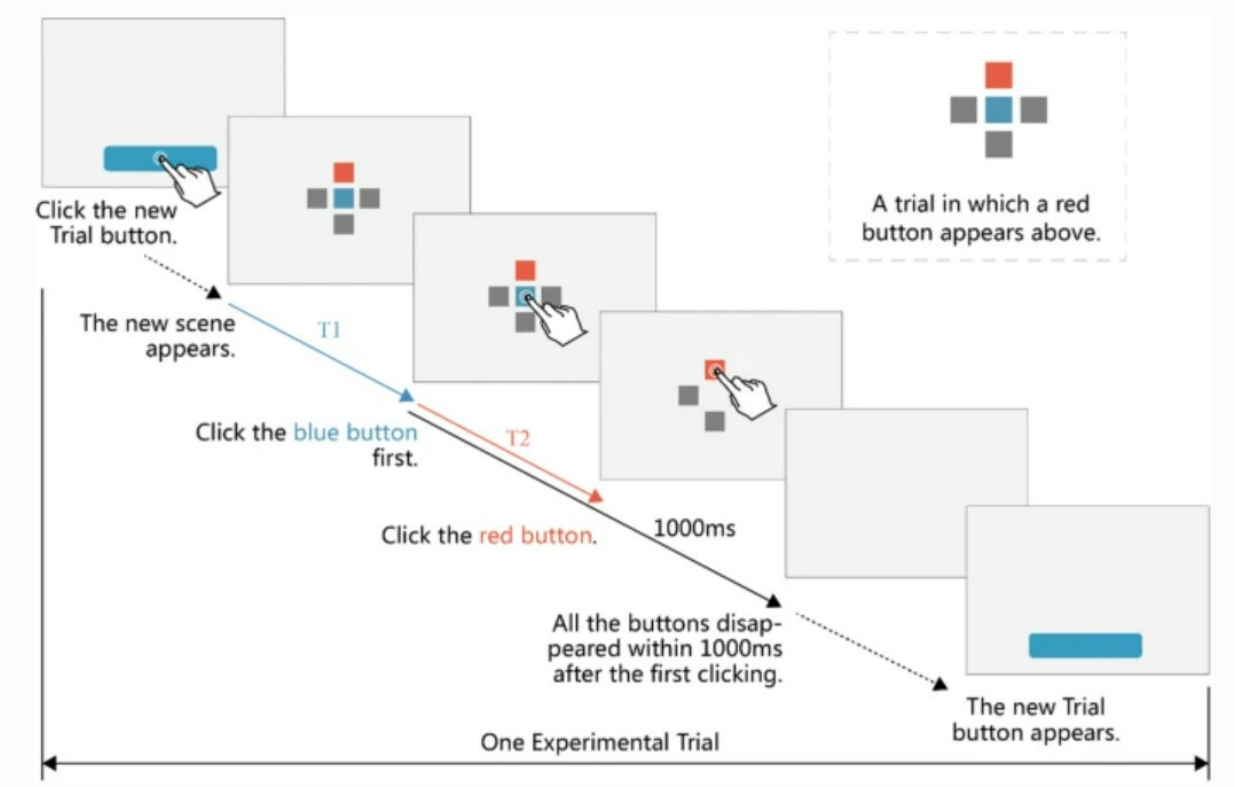


Example: Minimizing D

- The larger the target the easier to select (no fine control needed)
- The farther the target from the cursor the longer it will take

http://www.interaction-design.org/encyclopedia/fitts_law.html

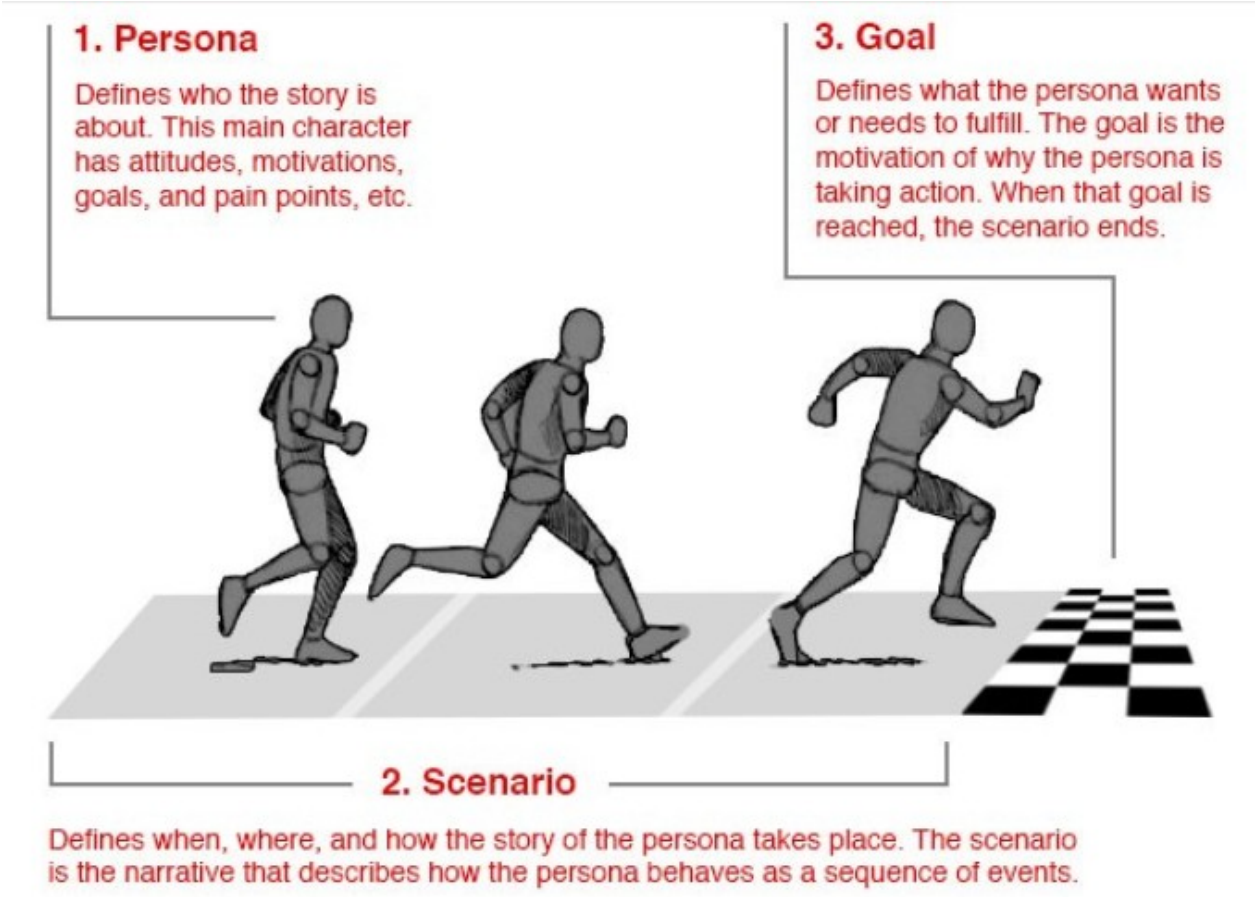
Example: using Fitts's law in Virtual Environment research



Zhou, X., Guo, Y., Jia, L. *et al.* A study of button size for virtual hand interaction in virtual environments based on clicking performance. *Multimed Tools Appl* 82, 15903–15918 (2023). https://doi.org/10.1007/s11042-022-14038-w

Personas and scenarios

modeling users and contexts of use



https://www.interaction-design.org/literature/article/personas-why-and-how-you-should-use-them

Personas

- **Fictional characters based upon user research** to represent the different user types that might use a service/product in a similar way

- make the design task less complex,
  and **guide the ideation process**

- help:
  - understand users' needs, experiences, behaviors and goals
  - step out of oneself and recognize that different people have different needs and expectations
  - uncovering universal features and functionality
  - create a good user experience for your target users

History of Personas

Stem from IT system development during the late 1990s

How to best communicate an understanding of the users?

Various concepts emerged:

user archetypes, user models, lifestyle snapshots, …

Alan Cooper (1999) proposed personas to describe fictitious users

There is **no single definition** of what a persona should contain

Nor a unified understanding of how to apply the method

Benefits of Personas

- Offer a quick and inexpensive way to test and prioritize features throughout the development process

- Help

  - Focus decisions by adding a layer of real-world consideration

  - Stakeholders evaluate new feature ideas

  - Information architects develop informed wireframes, and interface behaviors

  - Designers create the overall look and feel

  - System engineers/developers decide which approaches to take based on user behaviors

https://www.usability.gov/how-to-and-tools/methods/personas.html

Types of Personas

- Several types (most based on previous user research):

  - **Goal-directed** Personas (Cooper, 2007)

  - **Role-based** Personas (goals + behavior)

  - **Engaging** Personas (goals + behavior + backgrounds)

  - **Fictional** Personas (based on assumptions, not user research)

- **Fictional personas can only be used as an initial sketch of user needs**

https://www.interaction-design.org/literature/article/personas-why-and-how-you-should-use-them

Best Practices for Developing Personas

- Create 2-4 personas of the product/service main audiences

- Conduct user research:
  - Who are the users
  - Why are they using the system?
  - What behaviors, assumptions, and expectations?

- Develop the appropriate descriptions of each persona's: background, motivations, and expectations

- Do not include too personal information

- Be relevant and serious

Elements of a persona

- Persona Group (i.e. web manager)
- Fictional name
- Job titles and major responsibilities
- Demographics such as age, and education
- The goals and tasks they are trying to complete using the product
- Their physical, social, and technological environment

Personas have no value in themselves, until they become part of a scenario they do not have real value!

Example of a Persona

Persona:	USDA Senior Manager Gatekeeper
Photo:	
Fictional name:	Matthew Johnson
Job title/ major responsibilities:	Program Staff Director, USDA
Demographics:	• 51 years old • Has a Ph.D. in Agricultural Economics.

Goals and tasks:	Spends his work time: • Requesting and reviewing research reports, • preparing memos and briefs for agency heads, and • supervising staff efforts in food safety and inspection.
Environment:	He is comfortable using a computer and refers to himself as an intermediate Internet user. He is connected via a T1 connection at work and dial-up at home. He uses email extensively and uses the web about 1.5 hours during his work day.

https://www.usability.gov/how-to-and-tools/methods/personas.html

Example of using personas in VR

Model the people who will be using the VR application

Help to prevent the design from being driven by design/ engineering convenience

Personas should
- not be too detailed

- be validated in later stages

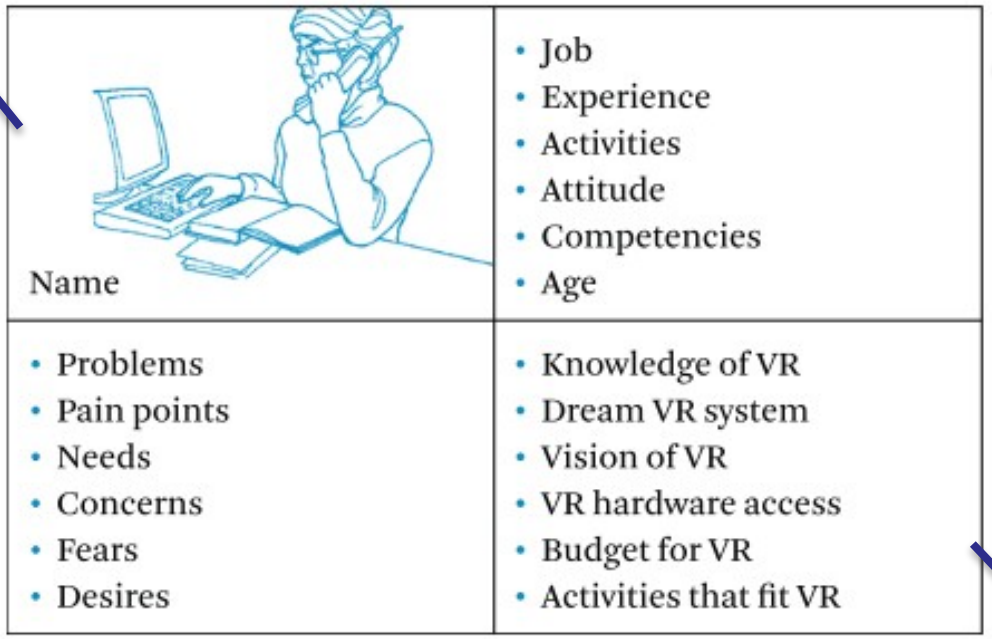
 Name	• Job • Experience • Activities • Attitude • Competencies • Age
• Problems • Pain points • Needs • Concerns • Fears • Desires	• Knowledge of VR • Dream VR system • Vision of VR • VR hardware access • Budget for VR • Activities that fit VR

(Jerald, 2016)

Describe ~2 characters representing the range of targeted users

Sketch/photo and name

Basic description of the user

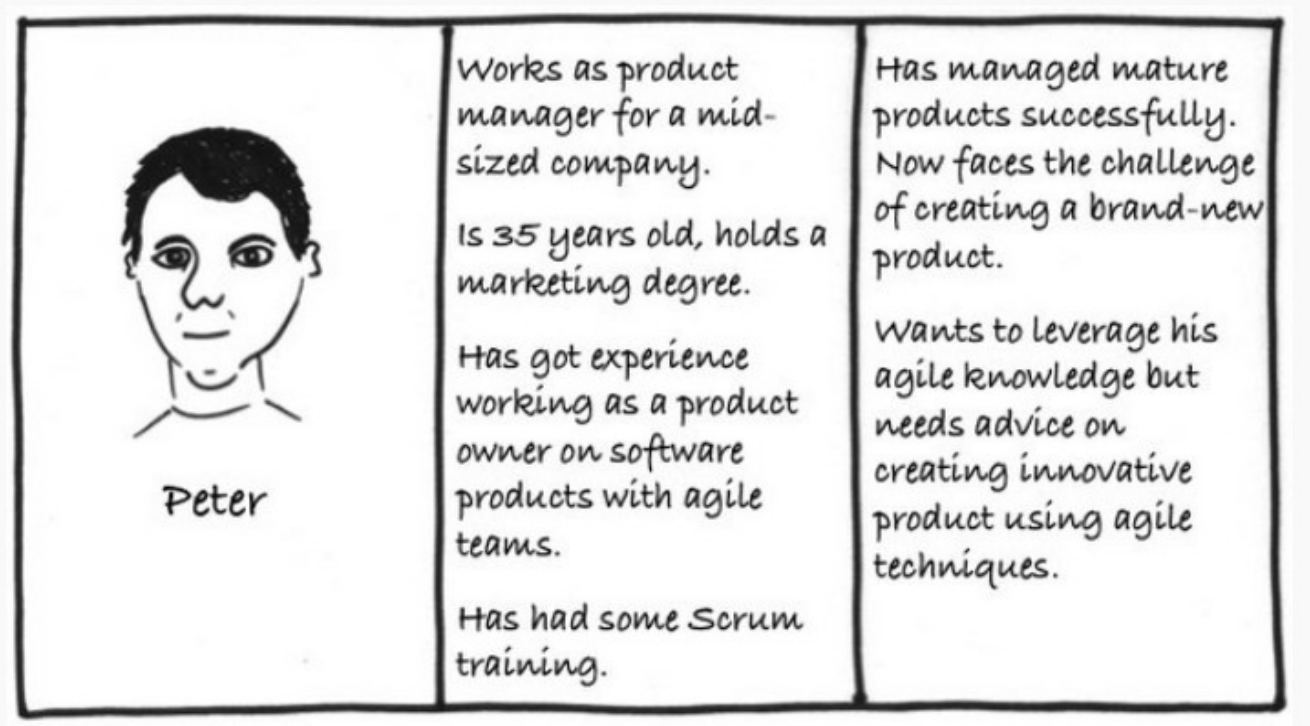


Challenges the person has

Relation to type of system (VR in this case)

If personas are especially important (e.g., for therapy applications), then data should be very carefully collected with interviews and/or questionnaires

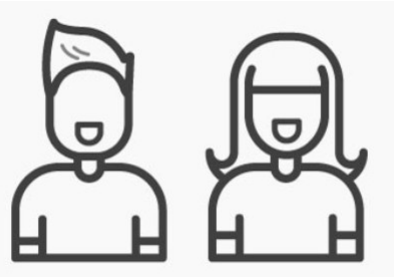
Another example of a Persona



- A main difficulty of the persona method is getting the team members to use it
- The 10-step process of creating a persona can help

https://www.interaction-design.org/literature/article/personas-why-and-how-you-should-use-them

10 steps to Creating Personas and Scenarios
(and getting them used by the team)



1- Collect data - and knowledge about the users

2- Form a hypothesis - general idea of the various users

3- Everyone accepts the hypothesis

4- Establish a number– the final number of personas

5- Describe the personas - to be able to develop solutions

6- Prepare scenarios for the personas to describe solutions

7- Obtain acceptance from the organization and participants

8- Disseminate knowledge for the participants to use them

9- Everyone prepares scenarios- Personas have no value in themselves

10- Make ongoing adjustments- revise the descriptions often

Personas: The Take Away

- Personas are user models, **fictional characters based on user research** to help understand:
  - users' needs, and experiences
  - behaviors and goals

- Make the design task at hand less complex

- Guide the ideation processes, and help to achieve the goal of creating a good user experience for the target user group

- The 10-step process covers the entire process from the preliminary data collection, through active use, to continued development of personas.

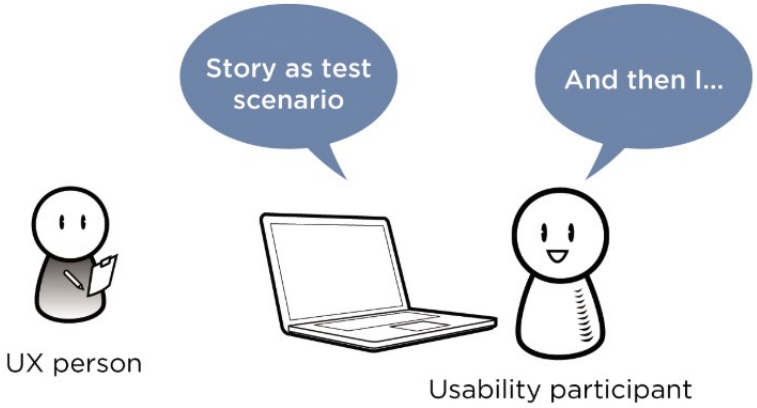
https://www.interaction-design.org/literature/article/personas-why-and-how-you-should-use-them

Scenarios

- **Stories and contexts about how the user groups use a future product/service**

- Note the goals and questions to be achieved and sometimes define the possibilities of how the user(s) can achieve them on the product/service

- Scenarios are critical for
  - **designing**
  - **usability testing**



https://www.usability.gov/how-to-and-tools/methods/scenarios.html

https://www.interaction-design.org/literature/topics/user-scenarios

- Scenarios should be used in the ideation phase of a project
- Need to be ***based on research*** with users
- Do ***not*** represent ***all*** possible users
- Typically account for the ***most common*** users or user motivations
- Are commonly ***based on personas***
- Can be used to determine the most important areas to test during usability testing, and to provide guidance to the test

https://www.interaction-design.org/literature/topics/user-scenarios

What to Consider When Writing Scenarios

- Good scenarios are concise but answer the following questions:

  - Who is the user? Use the **personas**

  - Why does the user uses the product? Note what motivates the user and their expectations, if any

  - What goals does s/he have? Use **task analysis**

  - How can the user achieve their goals with the product?

https://www.usability.gov/how-to-and-tools/methods/scenarios.html

Types of Scenarios

- **Goal/Task-based Scenarios** state only what the user wants to do

Example: You are traveling to Paris for your job next week and you want to check on the amount you can be reimbursed for meals and other expenses

- **Elaborated Scenarios** give more user story details

- **Full Scale Task Scenarios** include the steps to accomplish the task

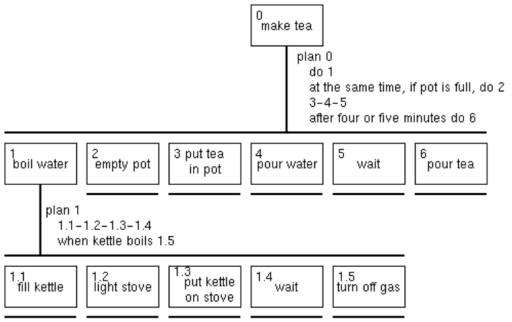
https://www.usability.gov/how-to-and-tools/methods/scenarios.html

Scenarios: The Take Away

- User scenarios are a **great way of communicating the key tasks a user will perform with a system**
- They can also **help define the usability testing** regime
- To create user scenarios is a simple process and **should be used for developing and iterating interactive products**

https://www.interaction-design.org/literature/topics/user-scenarios

Task Analysis

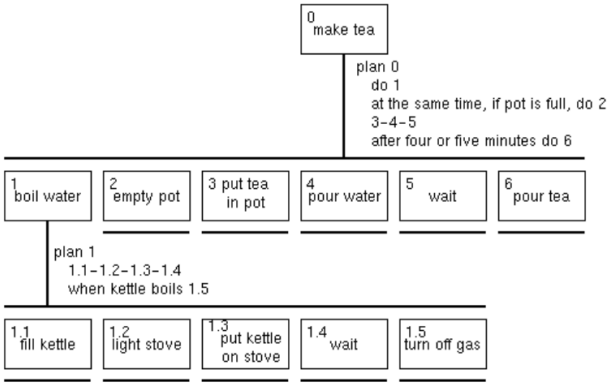


- The process of **learning about users** by observing them in action to **understand in detail how they perform their tasks** and achieve their intended goals.
- Helps identify the tasks that product/service must support
- Helps support other aspects of the user-centered design process
- It is important to perform a task **analysis early in your process**, in particular prior to design work

- **Task analysis is useful to** understand:

  - **Users' goals** and what they are trying to achieve
  - The **steps that users currently take** to achieve their goals
  - The personal, social and cultural experiences that **users bring to the tasks**
  - The **influence of the physical environment** on the users while attempting to meet a goal

https://www.interaction-design.org/literature/article/task-analysis-a-ux-designer-s-best-friend



- **Task analysis may be performed**:

  - in a **more formal way** (e.g. HTA - Hierarchical Task Analysis)

    (addressed in a following lecture)

    or

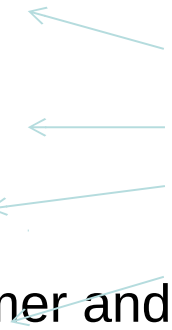
  - in a **more informal way**:

- First **use the 11 questions (at least 1, 2, 3 and 5)**

- Then **decompose the main tasks**

Standard/Informal Questions to be answered

1. **Who is going to use the system?**
2. **What tasks do they now perform?**
3. **What new tasks are desired?**
4. How are the tasks learned?
5. **Where are the tasks performed?**
6. What is the relationship between customer and data?
7. What other tools does the user have?
8. How do users communicate with each other?
9. How often are the tasks performed?
10. What are the time constraints on the task?
11. What happens when things go wrong?



Minimum set of questions to be answered

Note: These questions also contribute to the development of personas and scenarios!

1. Who is going to use the system?

- Use **all the information obtained previously about the users** (e.g. to develop the personas), concerning:

  age, needs, motivations, background, experience, technology literacy, physical characteristics…

2. What tasks do they now perform?

- **Identify the tasks that users perform currently, without using the system under development,** including:

  relative importance, frequency of performing the tasks, if they are performed by one or more users, …

3. What new tasks are desired?

- Identify new tasks that might empower the users **taking advantage of the new way of performing the tasks**
- Be careful and prioritize the new tasks to support …

5. Where are the tasks performed?

- **Observe the environment where users currently perform the tasks**

- **Identify other activities, the type of space** (office, shop floor, hospital, class room, shopping mall, …)**, noise, light and dust conditions, stress level, …**

How to analyze the tasks

- **Decompose a high-level task** into the following steps:
  - Identify the task to be analyzed
  - Break this high-level task down into 4 to 8 subtasks
  - Draw a layered task diagram of each subtasks
  - Produce a written account as well
  - **Present the analysis to someone else who knows the tasks**

- The decomposition level of detail should be coherent across subtasks

http://www.usabilitybok.org/task-analysis

Using Task Analysis:

- May be used in:

  - **Manuals and teaching materials**

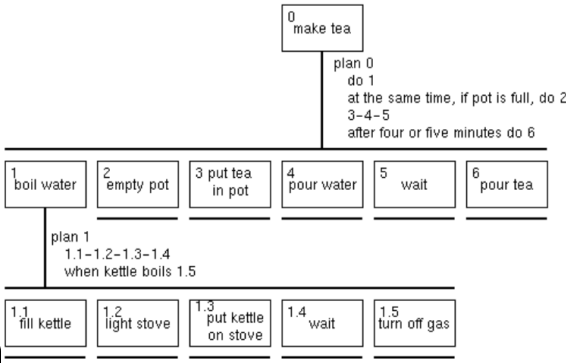
  - **High-level system design**

  - **Detailed design of the system user interface**

- In the first case users are observed while performing tasks using the system

- In the other cases task analysis contributes to the design of the new system

Task Analysis: The Take Away



- Is **one of the most powerful tools in UX design**
- It is not hard to get to know how to do it
- The difficult part is remembering to keep the user's perspective
- It is **useless when it is not backed by rigorous user research**
- is not a one-off process; **can be repeated** later in the process
- **It requires time, resources, people and budget. Be sure to have a sufficient amount of all**
- Like any other activity in UX design!

https://www.interaction-design.org/literature/article/task-analysis-a-ux-designer-s-best-friend

Other methods…

- The previous methods should be used in the Lab assignment (project)
- But there are **other methods** that can be used in a requirements analysis (and that you may already know…):
  - User stories
  - Use cases
  - Story boards
  - Etc.

User Stories

Emerged from agile development methods, are **short concepts or descriptions of features customers would like to see**

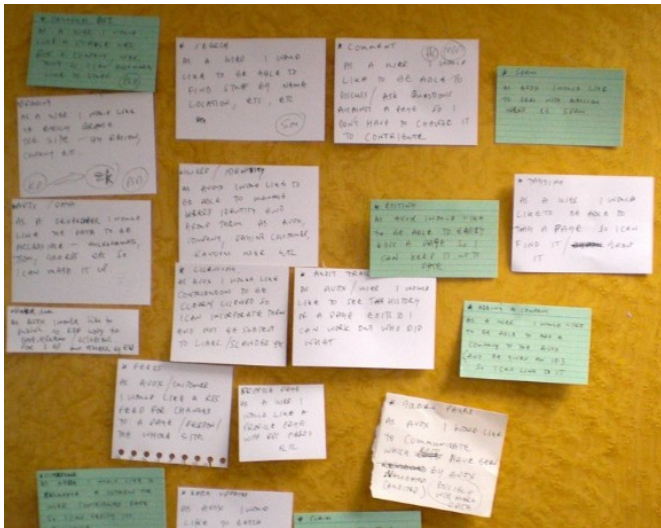
Should:

not go into too much detail

be written:

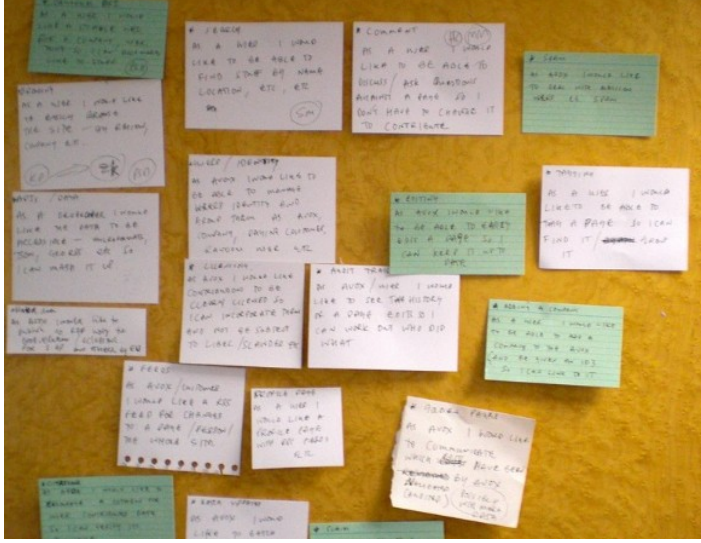
- **from the user's point of view**

- **with the client and team members**



What Are User Stories? | IxDF

User Stories



Short statements *about* a feature written from a user's perspective

"As a <type of user> I want <some goal> so that <some reason>."

Should be written with the minimum amount of detail necessary to fully encapsulate the value that the feature is meant to deliver

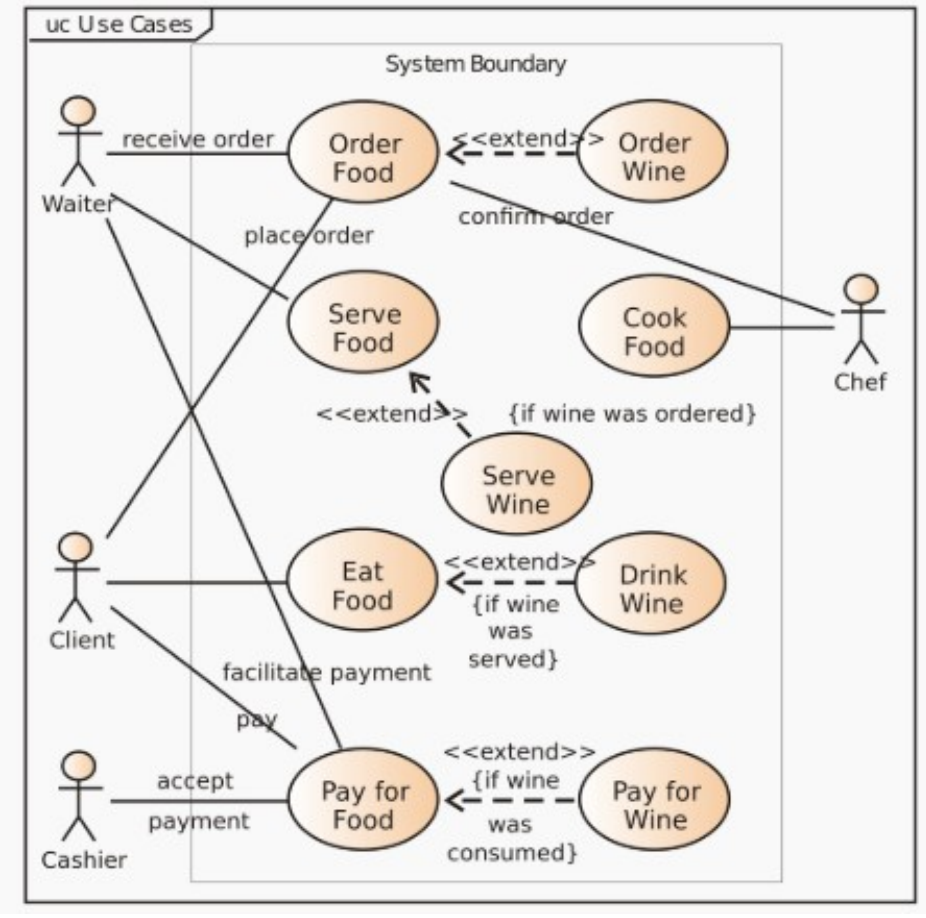
https://manifesto.co.uk/how-much-detail-should-a-user-story-have/
https://www.interaction-design.org/literature/topics/user-stories
https://www.interaction-design.org/literature/article/user-stories-capturing-the-user-s-perspective-quickly-and-simply

Use Cases

Written description of how users will perform tasks

Outlines a system's behavior responding to a request from a user's point of view

A common way for developers to explain user scenarios using UML



https://www.usability.gov/how-to-and-tools/methods/use-cases.html

Scenarios, User stories and Use cases

- Scenarios are **created by user researchers** to help communicate with the design team
- User stories are **created by project/product managers** to define the requirements prior to a sprint in agile development
- Use cases are **created for developers** to help with testing
- The difference in target audience means that the structure and information contained in the three approaches also varies.

Example

Scenario

“Jim, an internal medicine intern at Mount Pleasant Hospital, walks into the room of his patient, Andrew. Since Andrew stayed the night in the hospital, Jim needs to review Andrew’s medical records to see if the nurses on the night shift had checked in and recorded any changes in Andrew’s condition.”

User Story

As a doctor, I need to get up to medical date records so that I know how to proceed with my patients’ treatment

(it **does not reflect the context** of use)

Use case: *Review Records*
Actor: *Doctor*
Steps:

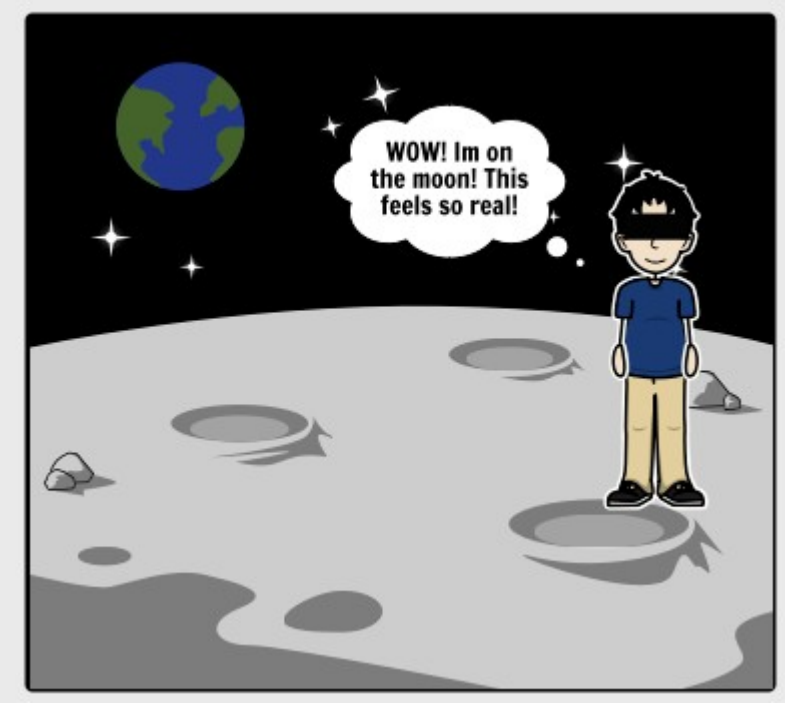
Doctor walks into room
Doctor sees patient in bed
Doctor identifies patient in bed
Doctor sees medical charts on foot of bed
Doctor gets medical charts from foot of bed
Doctor opens medical charts
Doctor reads medical charts
Doctor changes pages to continue reading
Doctor closes medical chart

https://www.akendi.com/blog/scenarios-user-stories-and-use-casesoh-my/

Storyboards

Are early visual forms of an experience

Derived from the film industry



Particularly useful for VR

The user can be shown directly interacting with objects

https://www.storyboardthat.com
http://usabilitybok.org/storyboard

Main bibliography

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