

#2 Human-Computer Interaction



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- Last week
 - What is HCI & HCI framework
- This week
 - Multi-tasking
 - Design
 - What is design?
 - Design thinking
 - HCI artifacts
 - Design methodologies
 - Your projects

Multi-Tasking

First: The problem with multitasking



https://www.youtube.com/watch?v=kpBi0_nILME

<https://www.youtube.com/watch?v=tMiyzuO1qMs>

<https://www.youtube.com/watch?v=0YNeyBANrTI>

https://www.youtube.com/watch?v=JVt9_U9adRE

<https://www.youtube.com/watch?v=iM4u-7Z5URk>

Clifford Nass: Multi-tasking, the brain, and HCI



<https://www.youtube.com/watch?v=BEbmUQpwR2E>

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

Summary

- Humans are very bad at multi-tasking
- Multi-tasking is bad for performance
- Multi-tasking is bad for your brains
 - Short term and long term
- Remember not to build a system that incentivizes users to do multitasking

Design and Design Thinking

What is design?

- “What is design? It’s where you stand with a foot in two worlds—the world of technology and the world of people and human purposes—and you try to bring the two together.”
 - Mitch Kapor in *Bringing Design to Software*
- “The word ‘design’ is everything and nothing. The design and the product itself are inseparable.”
 - Jony Ive
- “Design is not just what it looks like and feels like. Design is how it works.”
 - Steve Job

What is design?

- “Design isn’t crafting a beautiful, textured button with breathtaking animation. It’s figuring out if there’s a way to get rid of the button altogether.”
 - Edward Tufte
- “Creating an interface is much like building a house: If you don’t get the foundations right, no amount of decorating can fix the resulting structure.”
 - Jef Raskin
- “It is absolutely crucial to identify what core activities you want to support so that you have a clear picture of what lies outside of that core.”
 - Paul Boag

What is being designed?

- Products, tools, games, user interfaces, ...
 - Directly creating the desired object
 - This is called “first-order design”
- Behaviour, thought, experiences, gameplay,
 - ...
 - Indirectly creating the desired non-physical aspects
 - This is called “second-order design”
 - Is created regardless of whether we are conscious of it or not

The Super Mario Brothers 2

- What is happening in the screenshot below?



http://www.nintendo.com/games/detail/ehSBsDqZYxWzmHC9ODf7wDDu5_TdrXhw

- How would you describe it to someone who has never played this game before?

Design Thinking – Conceptual Structures

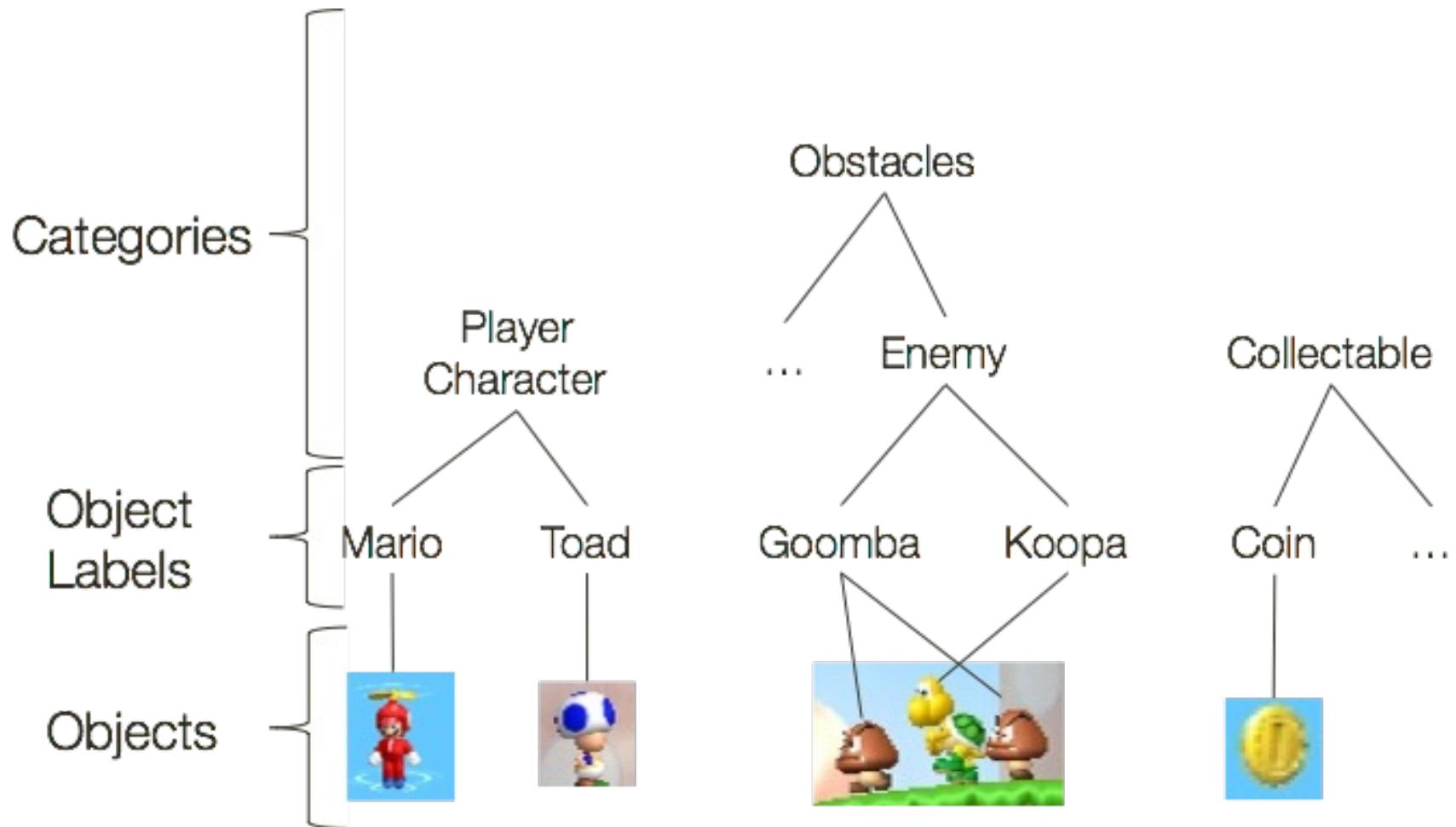
- We need to generalize and label things
 - To think clearly
 - To communicate
 - To make sense of the world
- But there are so many things! To have a common language, we need to **identify fundamental objects, ideas, processes, and structures as the main categories**
 - This is why we classify, categorize, and generalize—to reduce the space of possible phenomena

This is critical for design thinking, to reduce the possible problem components and design solutions

Design Thinking – Conceptual Structures

- What was needed to describe the screenshot?
- **Identify** important objects
- **Compare** objects to determine similarity & differences
 - What is the difference between a “friendly” object and an “unfriendly” one?
- **Label** objects to clearly think and talk about them
 - Labels such as “Mario” and “Yoshi” designate specific objects
 - Labels such as enemies, collectables, and obstacles are used for categories of objects

Conceptual Structures of Screenshot



Design Thinking – Abstraction

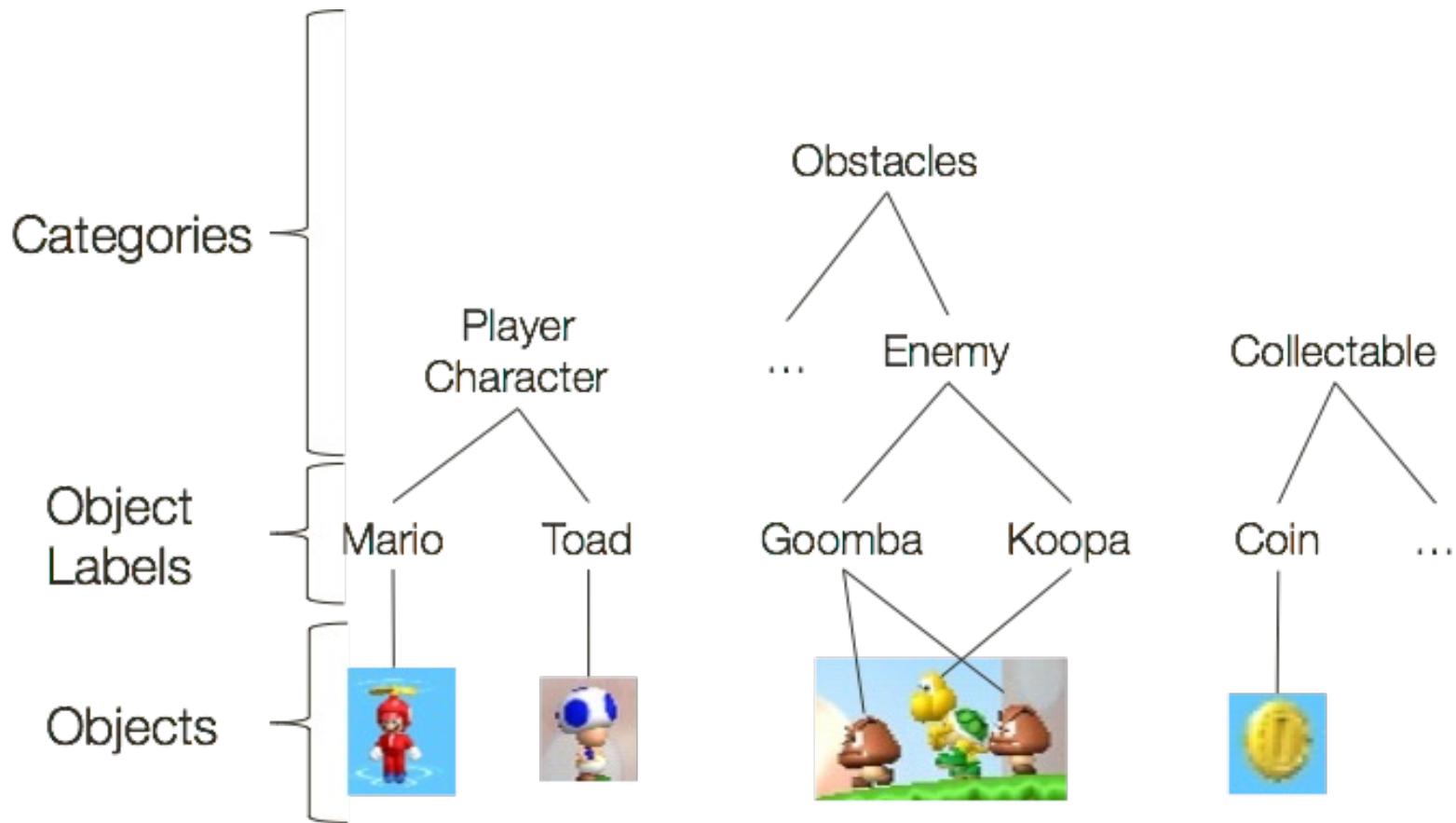
- One crucial aspect of design thinking:
abstract vs concrete
 - What is abstraction?
- What is the difference between the following:
 - Dog
 - German Shepherd
 - Rocky, our neighbour's dog

Levels of Abstraction

Design Thinking – Levels of Abstraction

What are the levels of abstraction?

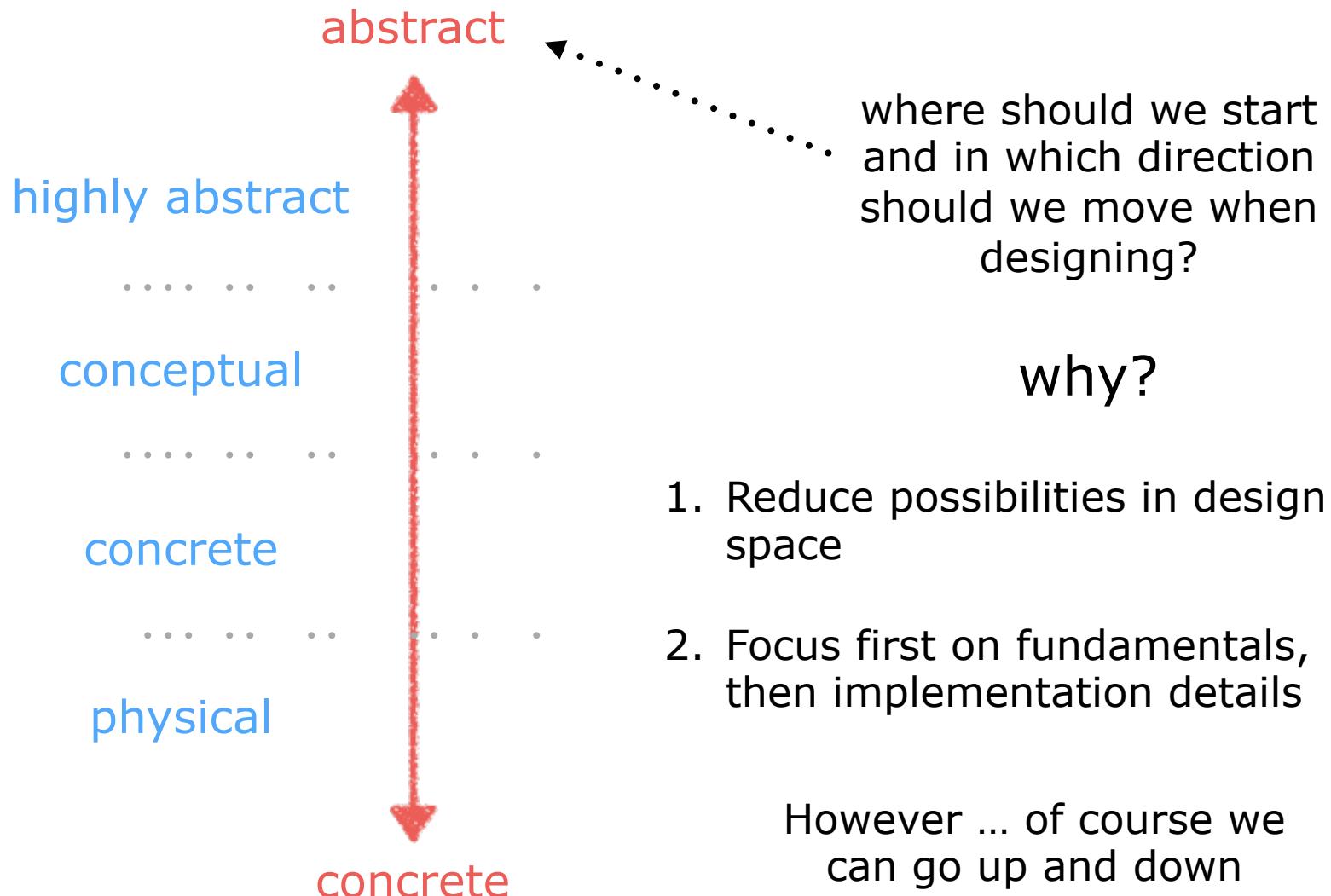
Which are abstract and concrete?



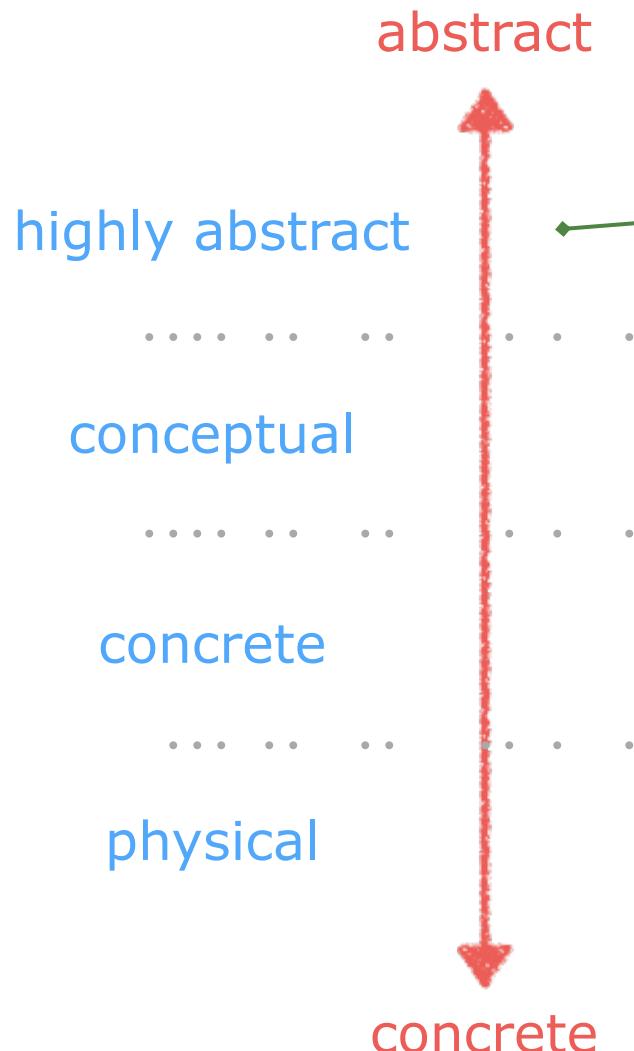
Design Thinking – Levels of Abstraction

- Abstract and concrete are **hierarchical** and **relative** terms in design
 - Abstraction at higher level of hierarchy
 - Concrete at lower level of hierarchy, closer to what can be perceived by senses
- Concrete designs must have some degree of abstraction. Why?
 - If too concrete, number of details becomes unmanageable
- Abstract designs are also not at the highest level of abstraction
 - Why?
 - Would become so general that it would not benefit the design activity

Levels of Design



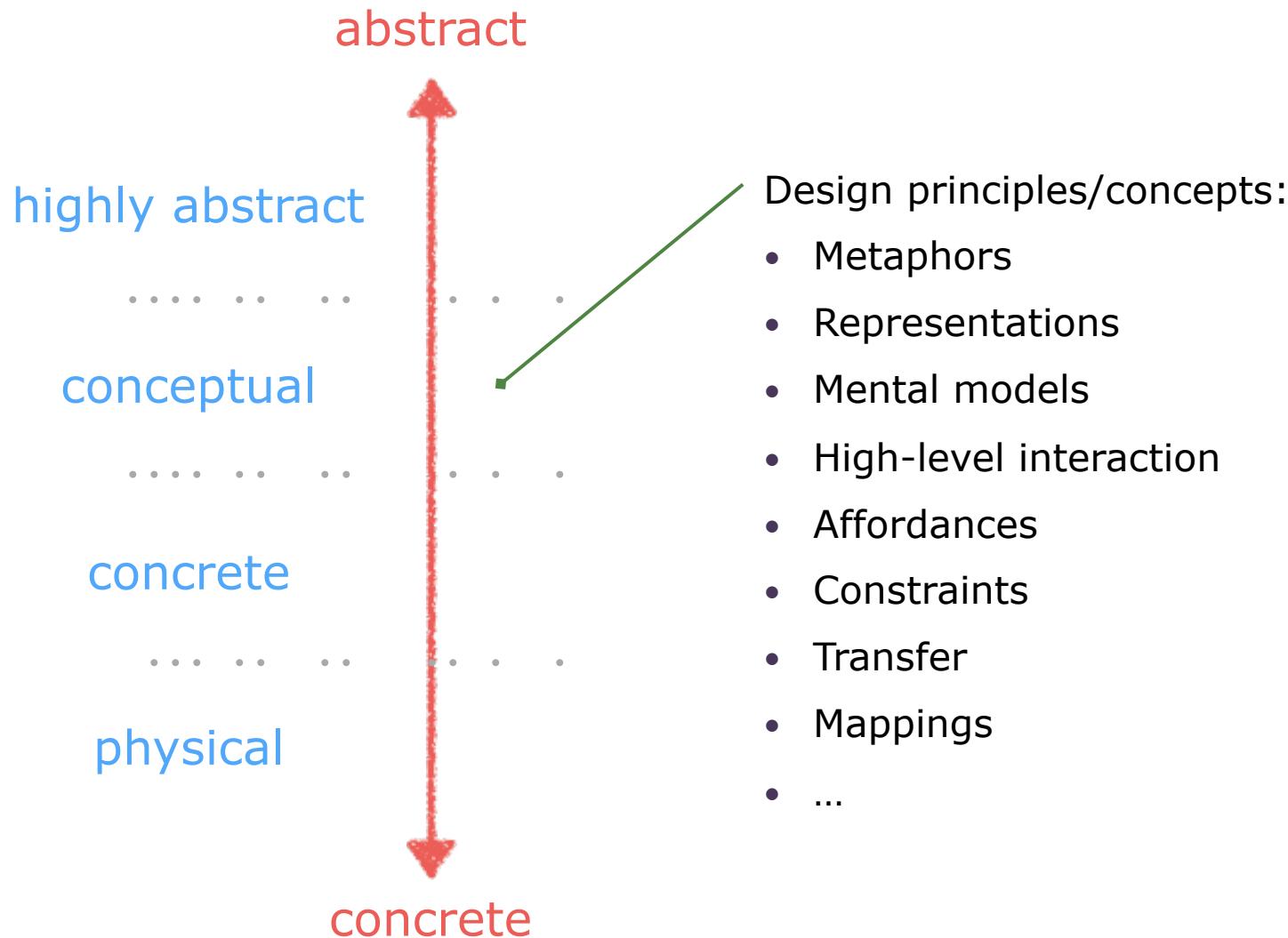
Levels of Design



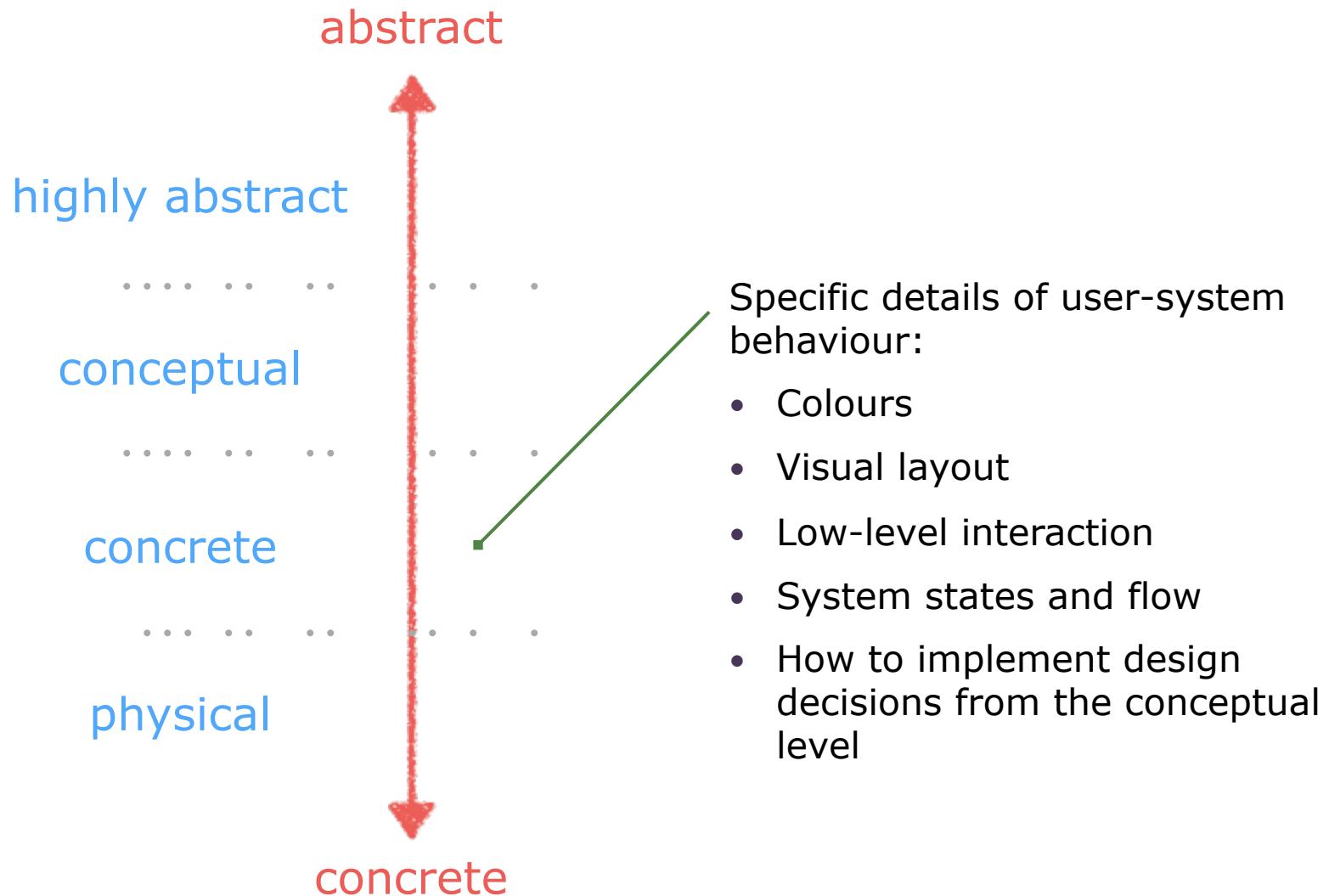
Fundamentals of the design:

- What entities are involved?
- To what categories do they belong?
- What labels should be used?
- What is the overall function of the system?
- What processes are involved?
- Structure of the design—how is everything above related?

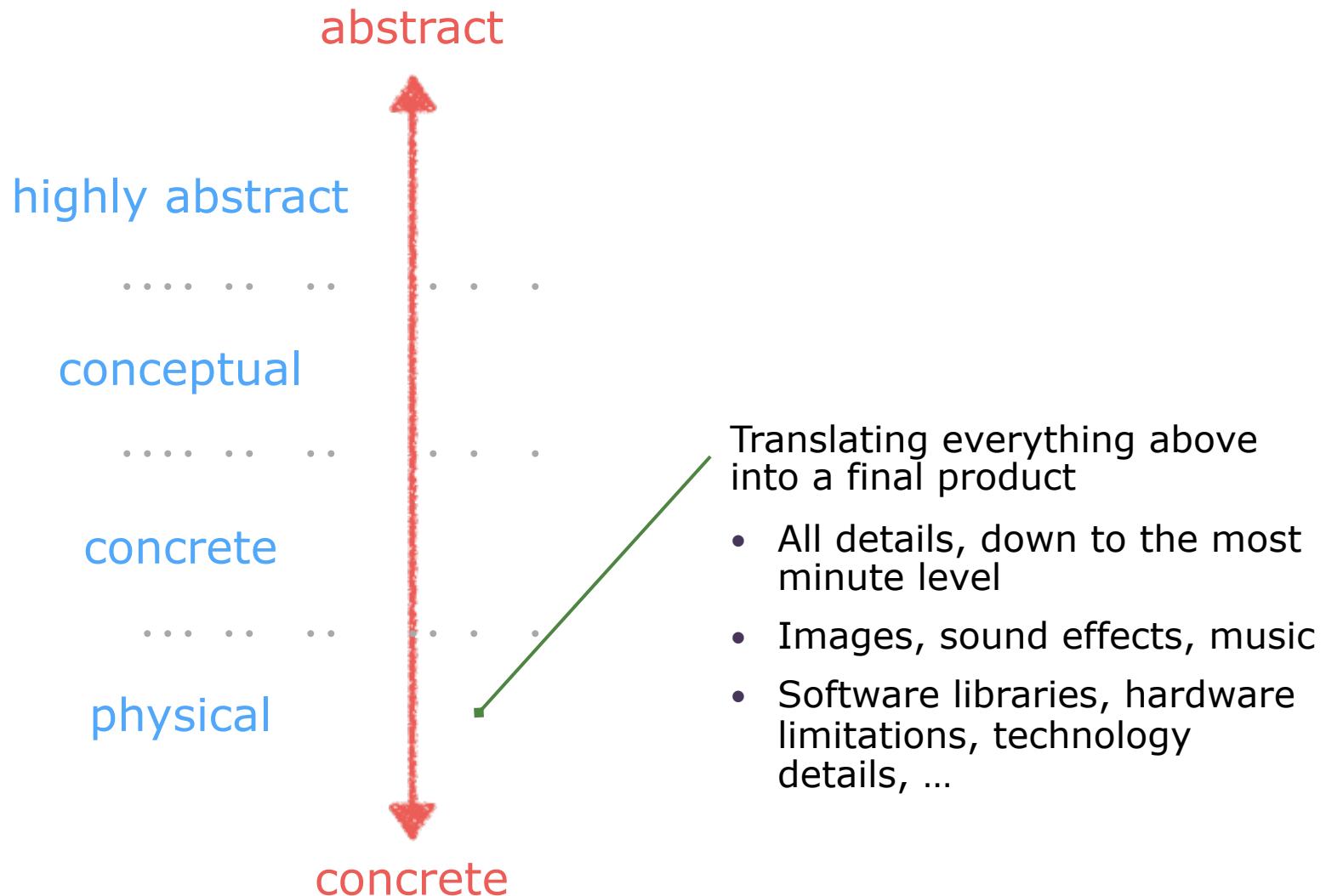
Levels of Design



Levels of Design



Levels of Design

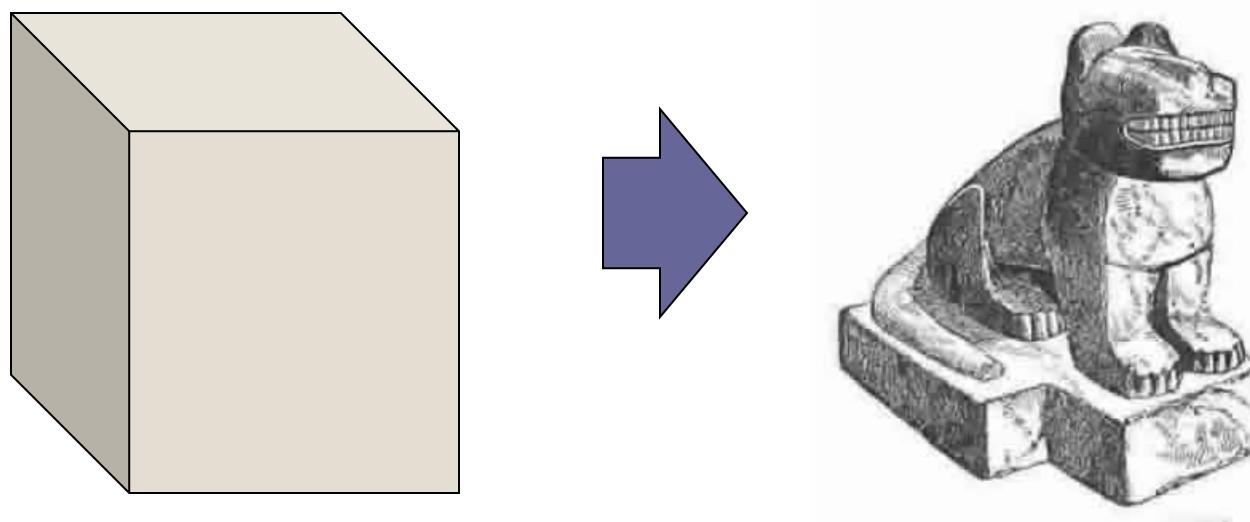


Design of HCI Artifacts

Artifacts

- What is an artifact?
 - Any object produced by human beings
 - Not naturally present in the world
 - Especially designed for subsequent use
 - We use probably 20,000 daily!
- Some artifacts are complex, some simple; some are physical, some non-physical
 - Computers
 - Hardware
 - Software
 - Primitive tools
 - Books

A bit like crafting a sculpture



Sculpting Tools/Artifacts

**Natural
form**

Artifact

There are a set of principles involved in the process of creating an artifact

Questions

- Do you design artifacts?
- What kinds of artifacts?
- ANSWER: Computational artifacts, and if people use them, then HCI artifacts
- What are some features of these artifacts?

Cognitive Artifact

“A cognitive artifact is an artificial device designed to maintain, display, or operate upon information in order to serve a representational function...”

Donald Norman

A certain class of *physical models* that help us perform activities/tasks

Question

- What are the fundamental characteristics of cognitive artifacts?
 - Are devices
 - Artificial ones
 - Deal with information
 - Maintain it, display it, OR operate on it
 - Serve a purpose
 - A representational purpose

HCI Artifacts

- Are cognitive artifacts
- Why?
 - They are artificial devices
 - They maintain, display, or operate upon information
 - They serve a representational purpose and allow users to think through and act upon the representations
- But more specific
 - They are computational/digital
 - They embody cognitive assumptions about people

HCI Artifacts

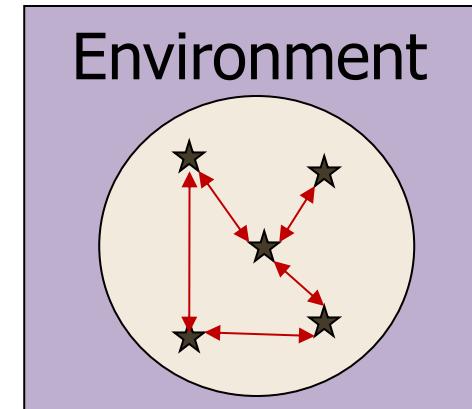
- They allow us to think through and act upon representations
- As designers do we:
 - Know much about representations?
 - Know anything about human cognition?
 - Know how people think through representations?
 - Know how people act upon representations?
- If we don't, how do we know if we are designing properly?
 - Our designs may not achieve what we intend

So far and beyond

- So far, we have talked about a set of general methodologies that guide the process of design of HCI artifacts
- Now, we need to develop a theoretical model that helps us think about the principles that are involved in design of artifacts

Systems

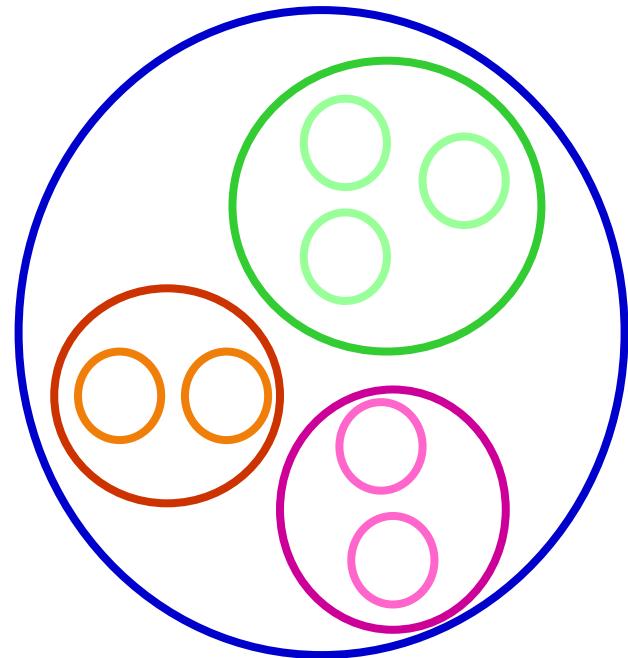
- 3 things constitute a system
 - Entities (physical or abstract)
 - Also called: Objects, parts, elements, components
 - Properties
 - Qualities, attributes, characteristics, features
 - Relationships among its entities
 - Internal relations
- + Environment or context in which a system exists and functions
 - External relations



A system is made of a group of interrelated, interacting, or interdependent entities that together form a whole.

Embeddedness of systems

- A system can be contained in another system
- A system can contain a set of subsystems
- Each subsystem can have other subsystems
- Systems are hierarchical
- Position of systems in a hierarchical structure is relative
 - A system can both be a supersystem and a subsystem at the same time



Systems

- Simple/atomic system
 - Does not have any subsystems
- Composite system
 - Does have subsystems (which themselves can have subsystems)
- Closed system
 - Does not exchange information with its environment
- Open system
 - Has an interface and exchanges information with its environment
- Complex system
 - A system that has many subsystem, that have many properties, and whose subsystems have many relationships
- Simple system
 - A system that does not have many subsystems or internal relationships

HCI artifacts & systems

- How are the concepts of HCI artifacts and systems related?
- HCI artifacts are systems
- Humans are systems
- Humans have a cognitive subsystem
- A computational artifact along with its users forms a **joint cognitive system**

A joint cognitive system

Cognitive system 1



Cognitive system 2

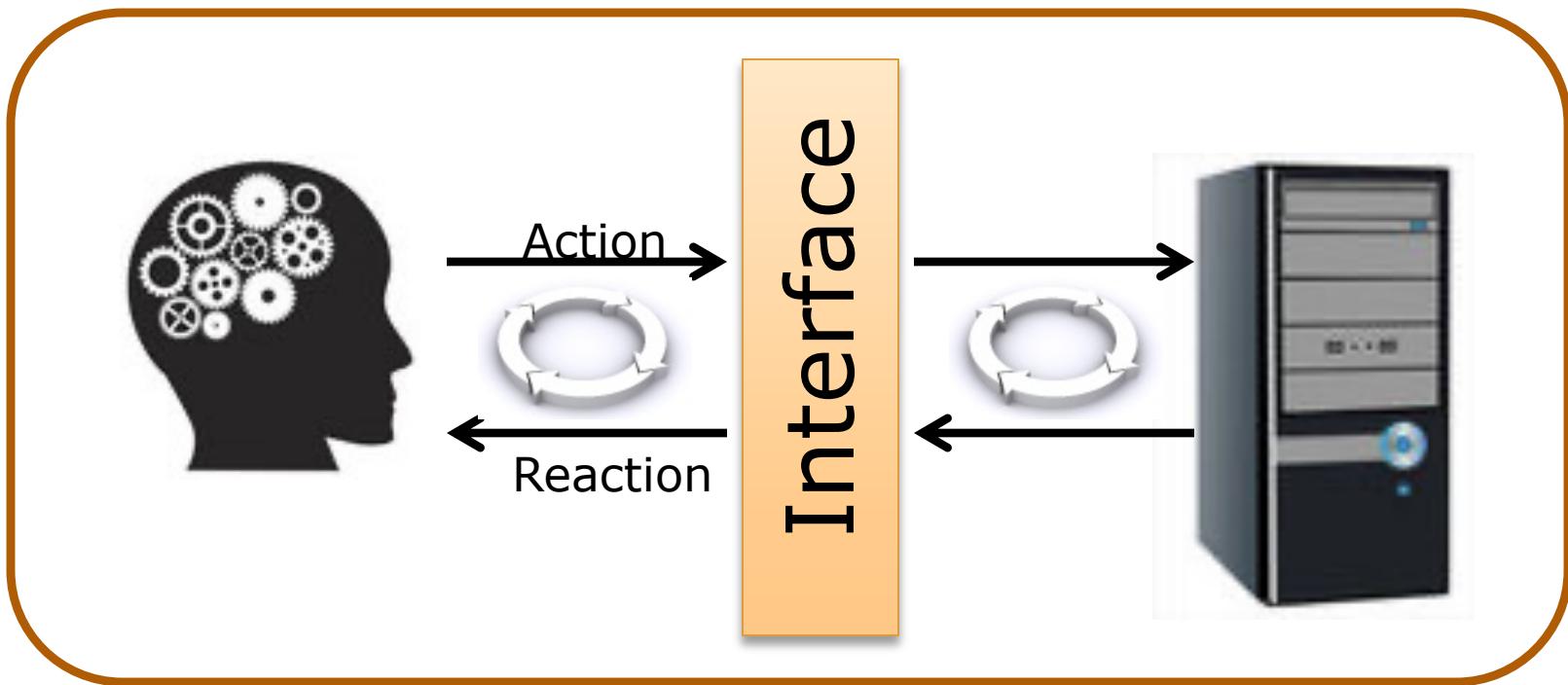


Joint Cognitive System



depositphotos.com

A joint cognitive system



Human S Interface S

Perception SS
Attention SS
Other subsystems

Representation SS
Interaction SS

Computer S

Vision SS
Machine learning SS
Data analytics SS
Data modeling SS
Etc.

Summary

- We are interested in the design of HCI artifacts
 - Are artificial tools
 - Maintain, display, and allow operation on information
 - i.e., representations, interactions, tasks
 - Are systems
- Our HCI artifacts are cognitive artifacts that interact with the human cognitive system
 - The two form a joint cognitive system
 - Each having many embedded subsystems

Design Methodologies

What is problem solving?

- Bridging a gap
 - from what *is* to what *should be*
 - Given some information, resources, and state of something, we want to use the information and resources to create a different state of that thing

Design as problem solving

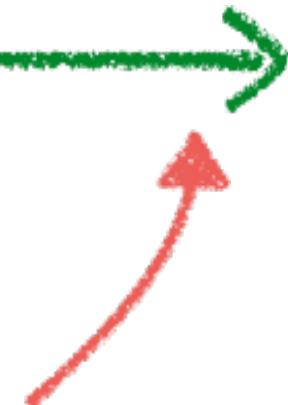
- There are roughly three types of problems:

well-structured



semi-structured

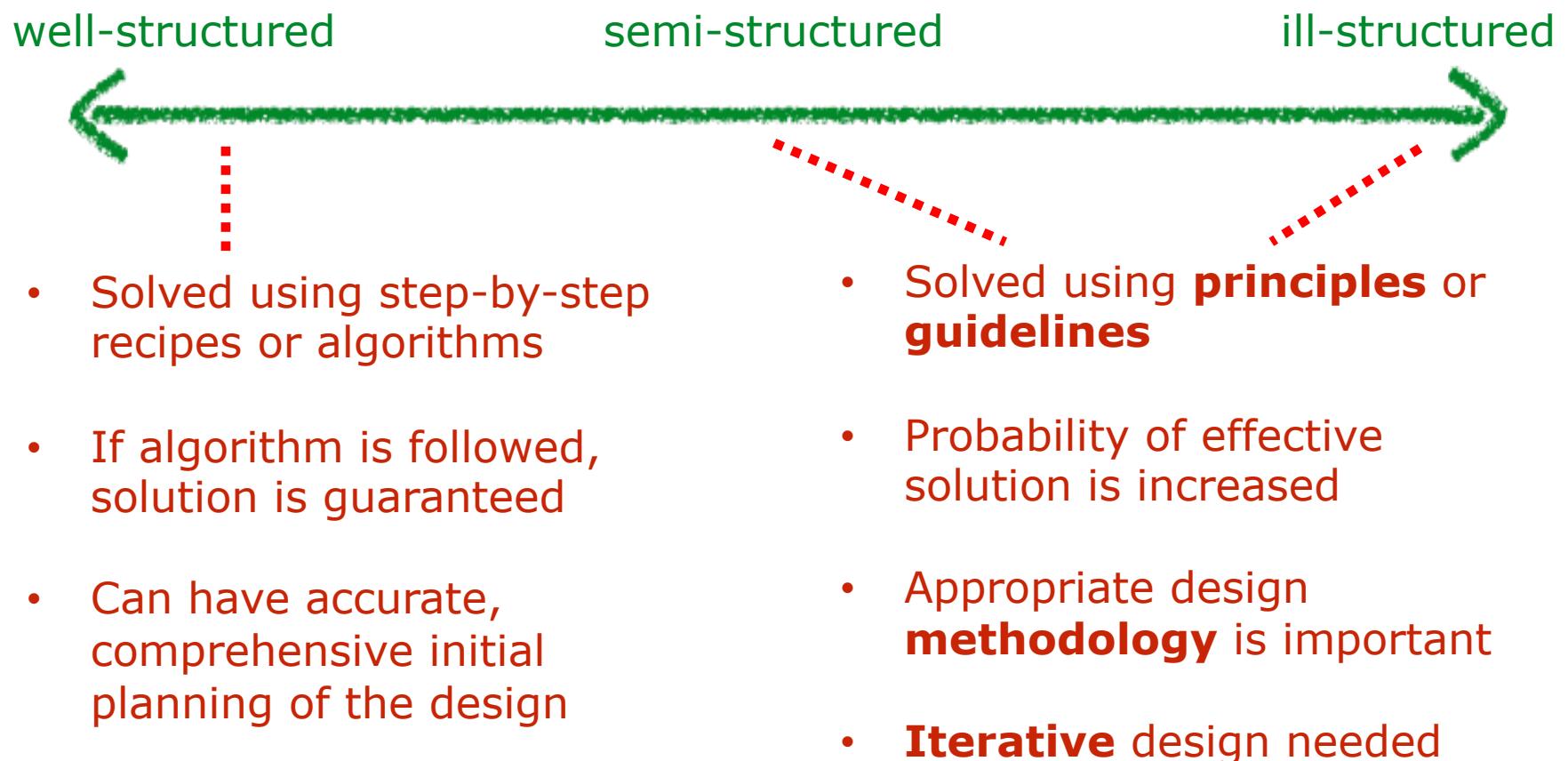
ill-structured



- Well-defined
- Most problems you experience in school

- Not well-defined
- Most real-world design problems

Design as problem solving



Common misconceptions about design

Most important aspect of design is to have a good idea

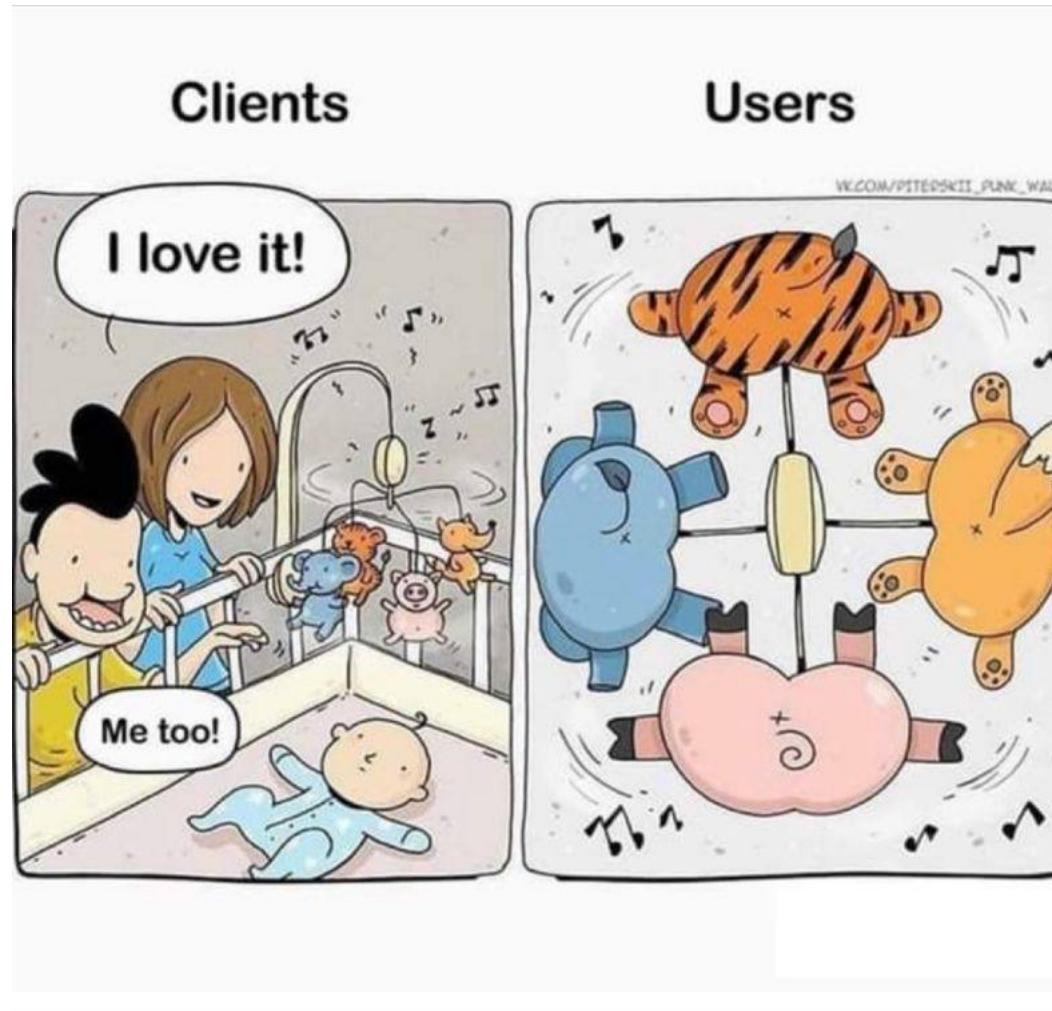
- No! Good ideas are only the **basis** of design!
 - Most creative people can come up with good ideas
- Good designers **develop** ideas into effective products
 - For HCI: need to **integrate** good ideas into the HCI framework
 - Need an appropriate design **methodology**

Activity

- Let's say we want to design a kitchen
 - Where would you start?
 - What would be the first thing to think about?

With the people (the users) and their needs!

System-Centered Design



System-Centred Design



<http://dilbert.com/strips/comic/1994-09-30/>

- Design questions are **centred around the technology and designer**
 - What can be built easily on this platform?
 - What can I create from the available tools?
 - What do I as a programmer find interesting to work on?

Most users don't care about these design decisions *unless* they impact usability and user experience

Programming in school vs. industry

School:

- How to write code
- Algorithms
- Control the machine
- Work along or in small groups
- Little interaction with non-programmers
- Small projects

Industry:

- How to create products for users
- Working in small to large teams
- Constant interaction with non-programmers
- Huge projects

Programming in school tends to be system-centered...transition may not be easy

Three Things

- Design Principle:
 - **Rule**, law, standard, or generalization that is used in design
- Design Method:
 - Systematic and orderly procedure or **process** for design
- Design Methodology:
 - **Philosophical approach** to design
 - The methods, rationale, and assumptions underlying a particular design process
 - Also includes principles, techniques, models

First HCI Design Principle

- Know Thy User
- Why is knowing your users the first principle of HCI design?
- We want our systems to meet user experience and usability goals
 - This cannot be done unless we know our users well

“Know thy user, know thy user, know thy user—
YOU ARE NOT YOUR USER”

“The key to making things understandable is to understand
what it’s like not to understand.”

--Richard Saul Wurman



@francisrowland

@technorasis

Our Methodology: User-Centred Design



<https://www.youtube.com/watch?v=O94kYyzqvTc>

User-Centred Design (UCD)

- Loose methodology, not a rigid process
 - Don't become dogmatic about it
- Things to keep in mind
 - Know users
 - Focus on users
 - Test with users
 - Involve users in design

User-Centred Design (UCD)

- Design based on the users'
 - characteristics
 - actual needs
 - abilities (accessibility!)
 - context
 - work/tasks
 - knowledge
 - expertise
 - ...

Task-Centred Design (TCD)

- Aspect of UCD
 - Exactly who would use the system and what exactly would they do?
 - Enables design and evaluation of systems based on the users' real-world tasks
- Can be viewed in two ways:
 - As design
 - Analysis of requirements of the task that needs to be satisfied
 - As evaluation
 - Walking through the system to test it

Watch this: Task Analysis in TCD



Susan Weinschenk, Ph.D.
Weinschenk Institute, LLC

5 Ways A Task Analysis Results In Great Design

<https://www.youtube.com/watch?v=1IwT2VD5CJo>

Two main aspects of any design

- What are the two main things you would expect from any designed artifact?
 - Must be usable and useful (efficacy & utility)
 - ◆ Usability design
 - Must be experientially pleasing and meaningful to use
 - ◆ Experience design

Problem with TCD

- The main problem with TCD is too much emphasis on task performance
 - Historically, TCD has emphasized usability goals over user experience goals
 - Assumes it is more important for the user to efficiently and correctly perform a task than to enjoy their work
- Assumption not valid in today's society
 - People may choose a product that is less efficient but provides a better overall experience
- Need to use TCD but remember to also ask "how will this design affect the user experience?"

Problem with UCD

- Even when trying to design for the user, the designer may think “the user is like me”
- Designer intuition is often wrong
- Interviews are often imprecise
 - Interviewing is also a difficult art
- Designers don’t get to know the users sufficiently well to answer all the issues that come up after interviews, such as during the design



Participatory Design



<https://www.webdesignfanatic.com/participatory-design-valuable-designers/>

- Design **with** the user, rather than **for** the user
- Attempt to **actively** engage all stakeholders in the design process
- Designers should have access to a pool of representative users
 - Not their managers, middlemen, etc.

Participatory Design Case Studies



<https://www.youtube.com/watch?v=MhkMre5Ls50>

Problem with Participatory Design

"All I want for Christmas is some faster horses"

"If I had asked people what they wanted,
they would have said faster horses."

-- Henry Ford



<http://dilbert.com/strips/comic/2000-02-24/>

Too much user involvement - Homer builds a car



<https://www.youtube.com/watch?v=WPc-VEqBPHI>

User- vs Client-Centred Design

- You have a client – a company that wants a system to sell its products online
 - Who do you design for?
 - The client who is paying you to develop this system, and who will use it to add products?
 - The customer who will use this system to buy products?

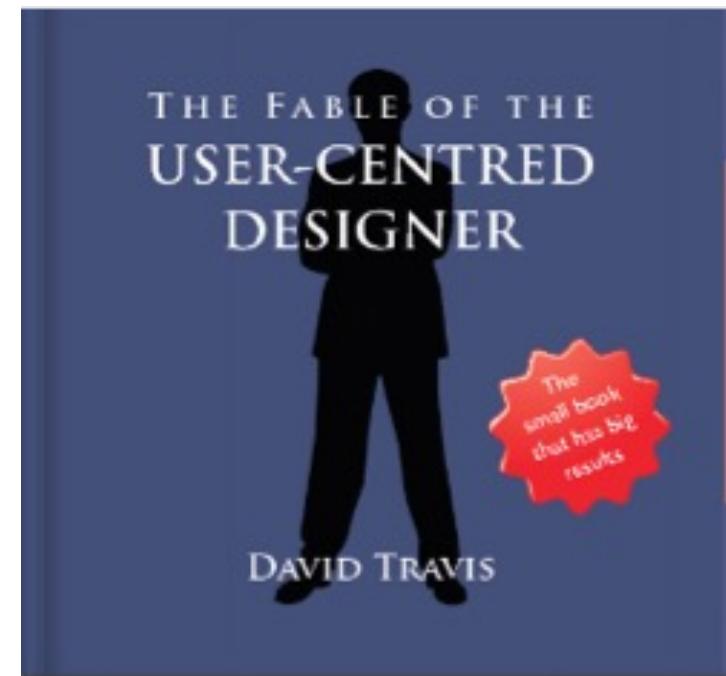
Watch the following:

<https://www.youtube.com/watch?v=dIn9xDsmCoY>

User- vs Client-Centred Design

- Satisfy the user first, then the client
- You are not the user
- Find ways to play on the user's motivations

“Most companies think they are customer-centred,” explained the designer, “but when you ask their customers, very few of them agree. The first secret of user-centred design has four ingredients. You need to focus on users. You need to understand the users’ tasks. You need to do this early. And you need to do the research continuously. Few companies invest the effort in each of these components.”

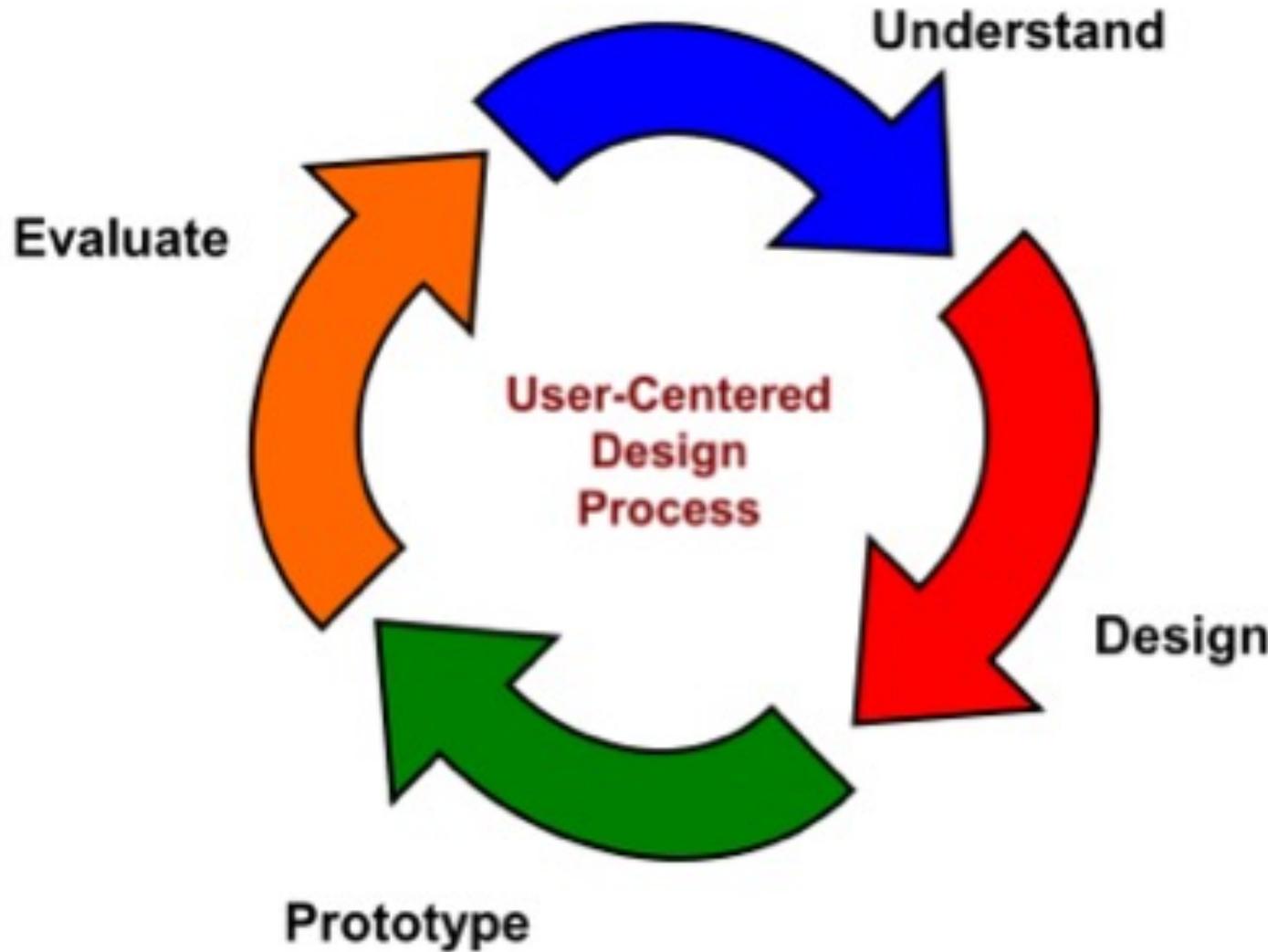


UCD as Design Thinking

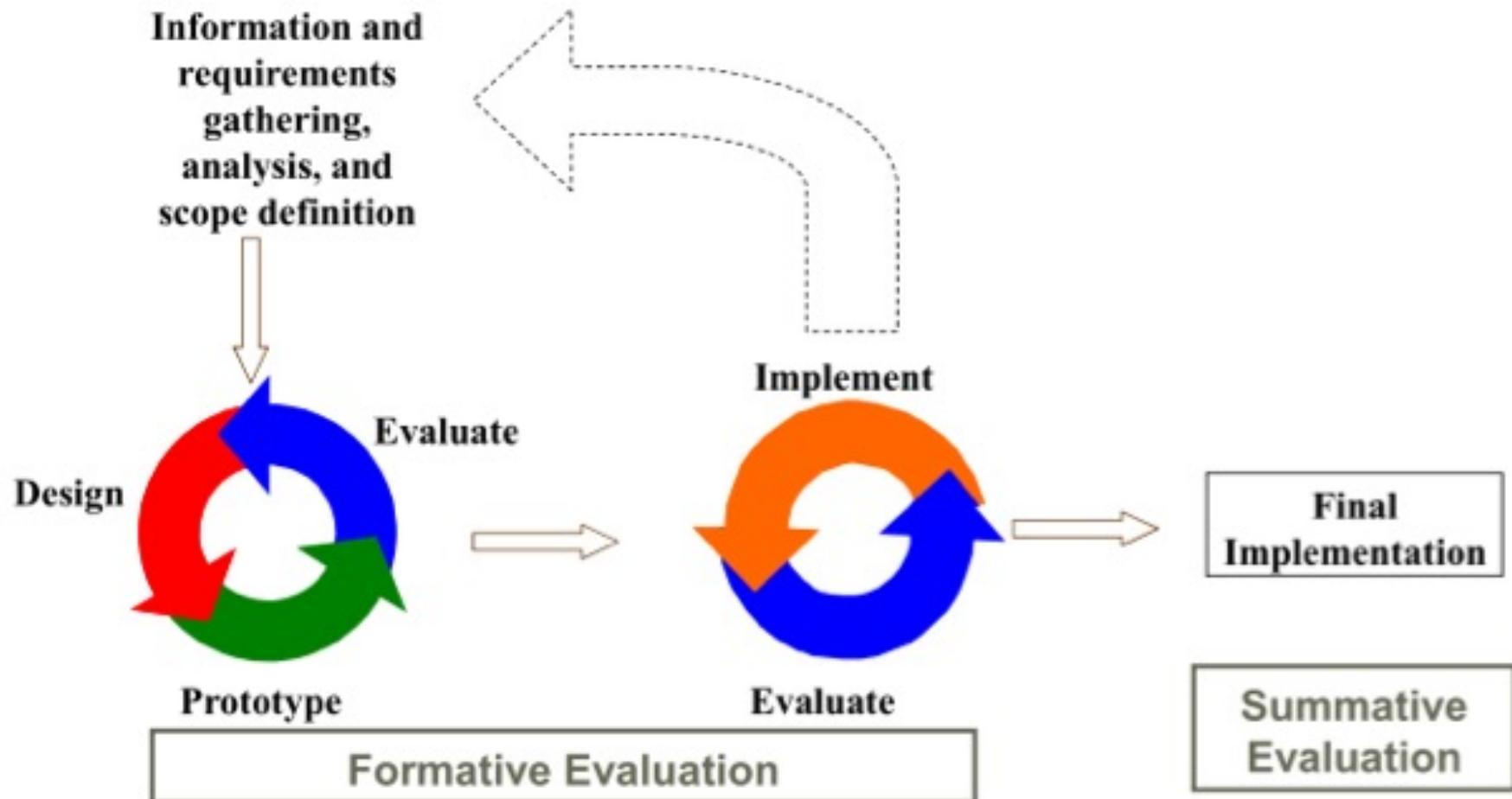
Complex systems design
Design Thinkin

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

General UCD Process



UCD: Iterative process



UCD: Evaluation

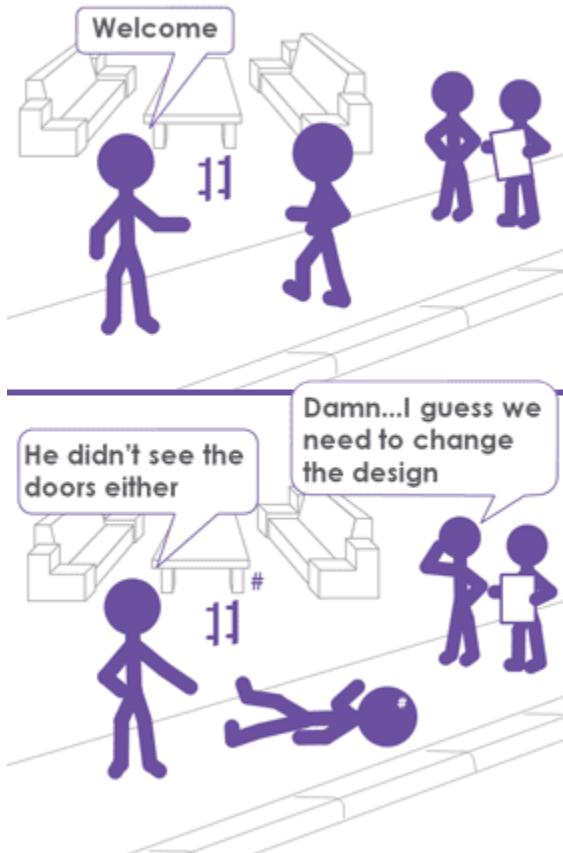
- For now: 2 types of evaluation
 1. Formative: takes place **during** design and implementation
 2. Summative: takes place **after** design and implementation

Design and evaluation are two sides of the same coin

- This can be a big shift for some people; do not think of evaluation as an after-the-fact thing!

UCD: Focus

Usability testing



- Early and continual users testing
 - Test with users, starting from the beginning of the design process
- Testing methods
 - Mock-ups
 - Storyboards
 - Early prototyping
 - Early demonstrations
 - Video recordings
 - ...

Summary

- Design thinking
 - Levels of abstraction, categorization, generalization
- Design principles and methodology
- First principle of design
- User-centred design
 - Task-centred design
 - Participatory design
 - Client vs. User-centred design
 - Iterative design
 - Design and evaluation
 - Design thinking and UCD

The Project

Project Reminder

- Small and manageable
- Based on existing design
- Your project is a **re-design** of an existing tool
- Could be
 - An online game
 - Productivity tool or app
 - Interface of an hardware-focused system

Use of Languages / Frameworks

- Use any language / framework / library that you are most familiar or comfortable with
- Technical CS matters are outside the scope of this course and SHOULD NOT pose a significant challenge to you
- If need be, take advantage of resources like “The Missing Semester of Your CS Education” to update yourself on technical skills:
 - <https://missing.csail.mit.edu/>

Example Project #1 – Original game

Vector Island Game

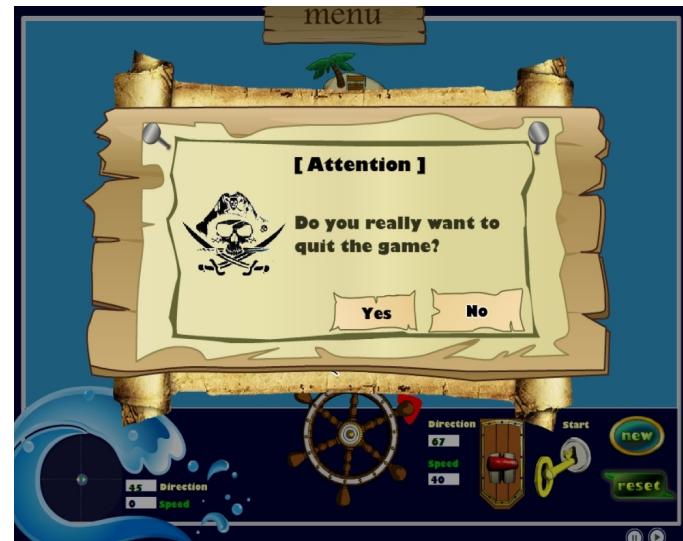
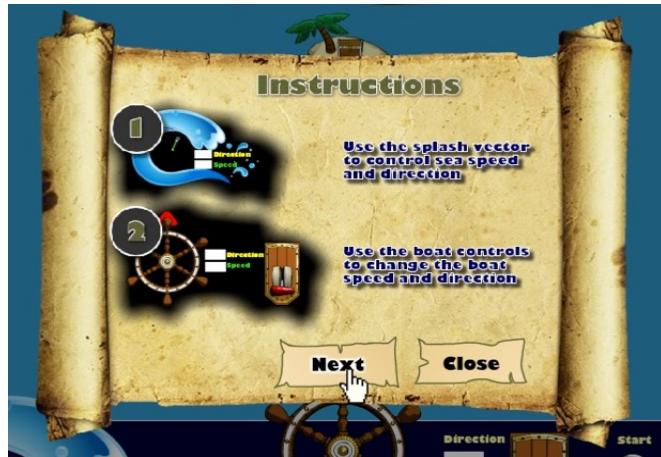
<http://illuminations.nctm.org/Activity.aspx?id=3536>

Move the boat around the water by changing the magnitude and direction of the boat's speed (blue vector) or the magnitude and direction of the water current (red vector).

Try to land the boat on the island — but be careful not to hit the walls!

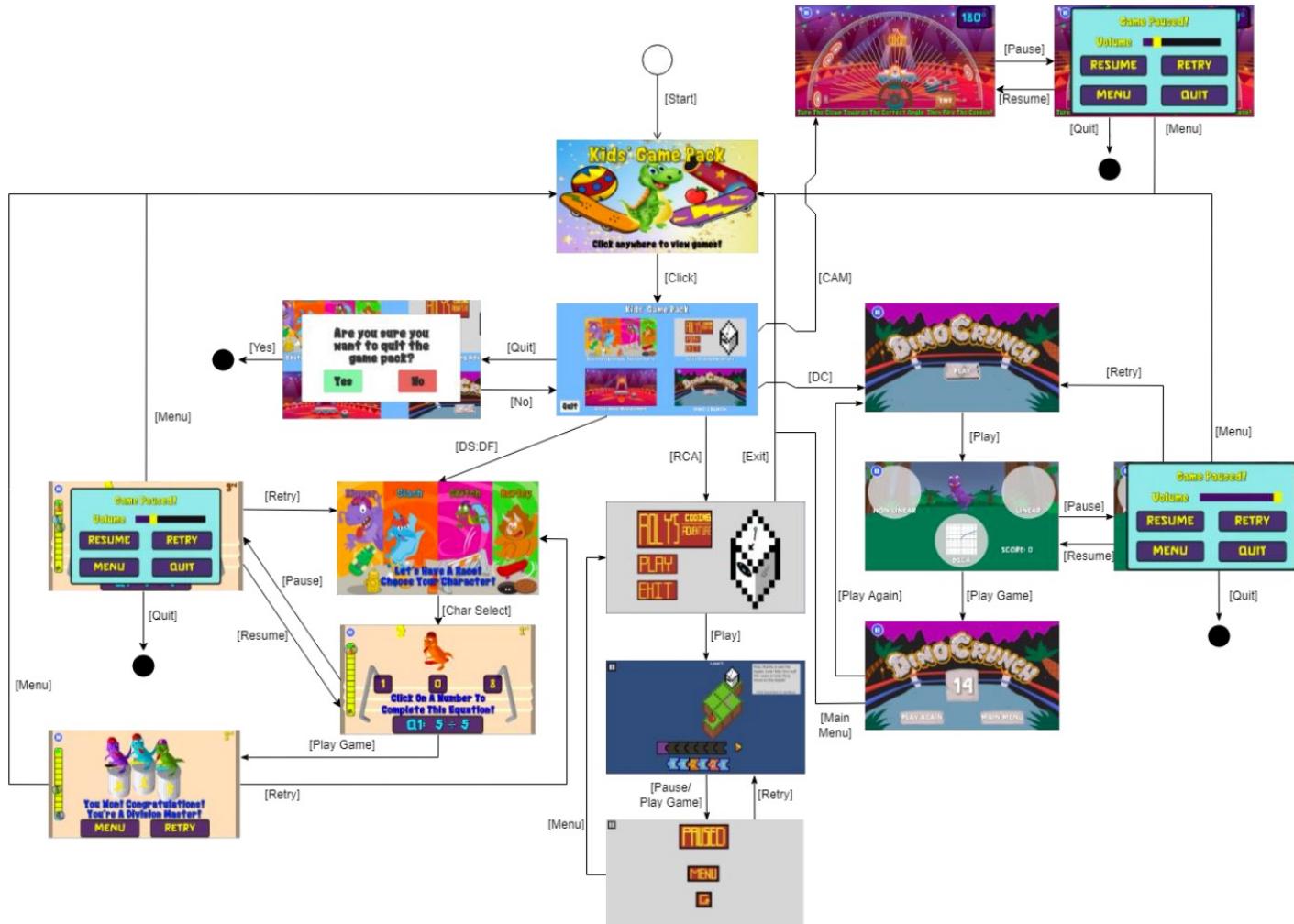


Example Project #1 – Redesigned game



Example Project #2 – User Scenarios

- 4 disjoint games bundled into a coherent system



Example Project #3 – User Scenarios

- A weather app



Example Project #3 – User scenarios



Project

- Remember: you are **not just** re-designing the 'look and feel' of the visual interface
 - You are re-designing the whole system and user experience—the user's behaviour, cognition, interaction, ...
- A fancy looking re-design is a must-have feature, but only if the underlying principles are adhered to
- Most of the grade will come from how well you apply material from the course to the design
- We want to see that you have carefully considered all aspects of the system using what you have learned in the course

Project Components

- Team profile
 - Explain who is on your team and their backgrounds
- Project proposal
 - Identify the system / tool / app / game you will be redesigning
 - Identify who the typical user would be
 - Describe the scope (explain what you plan to re-design)
- You do NOT need to have very detailed design ideas at this point
 - Save that for later