

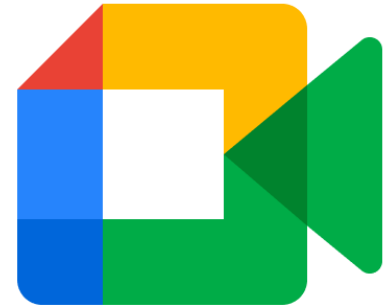
What is HCI?

Human Computer Interaction

Luigi De Russis

Academic Year 2024/2025

Hall of Fame or Shame?



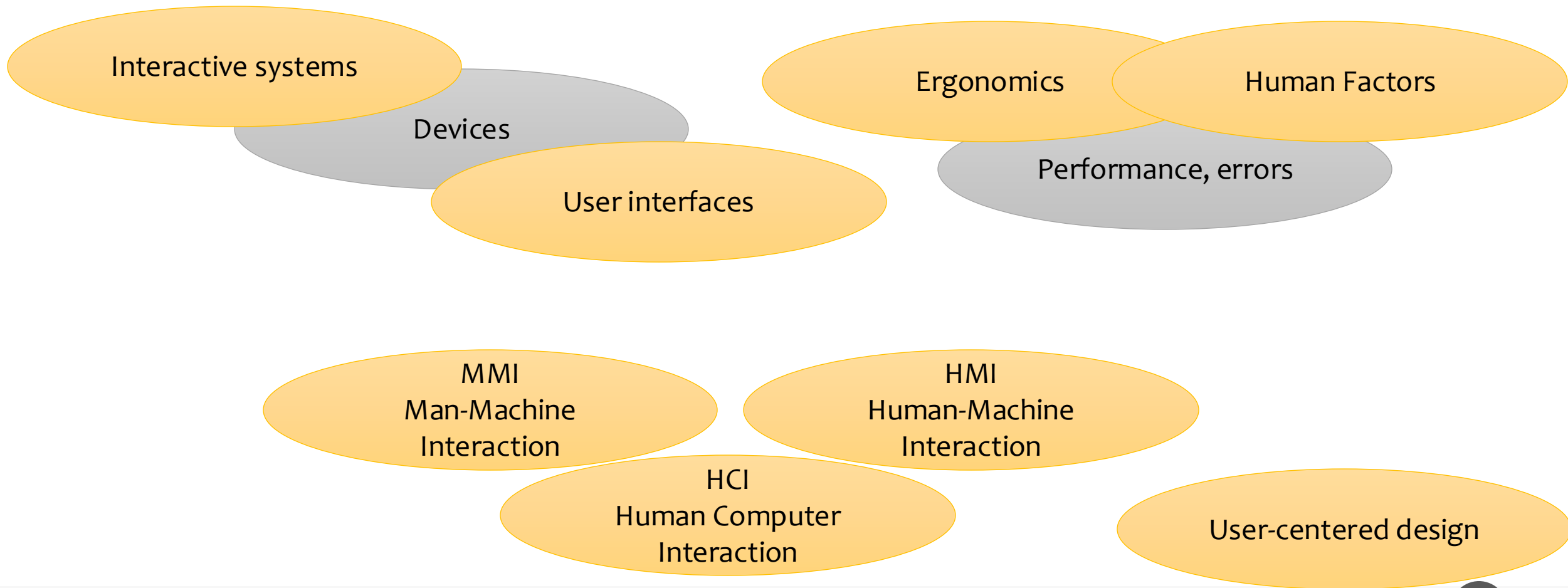
Hall of Fame or Shame?



Goals

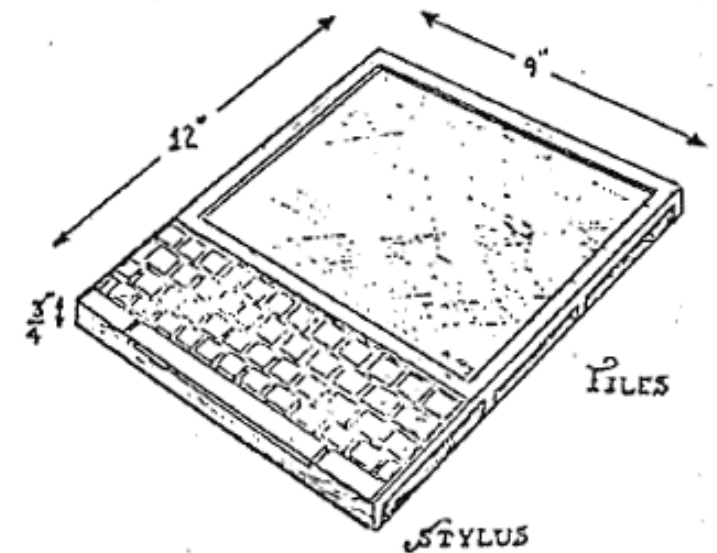
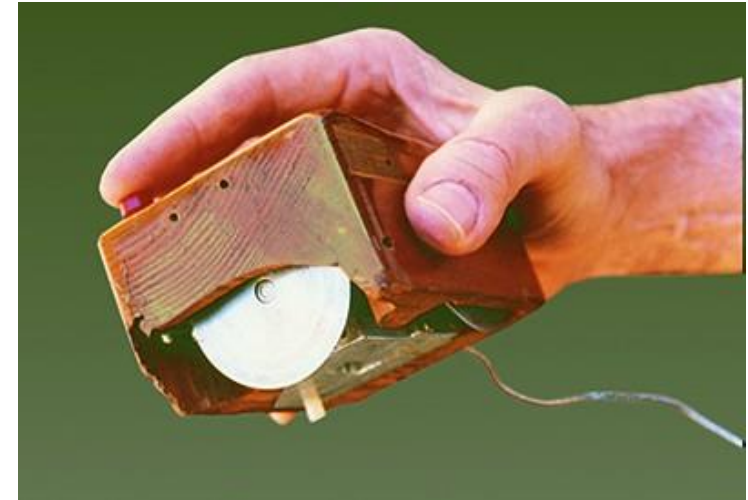
- What is HCI?
- What is usability?
- What are the Interaction Design processes, and how does they relate with Software Engineering processes?
- What is meant by User Centered Design?

Interconnected Concepts, and Evolution



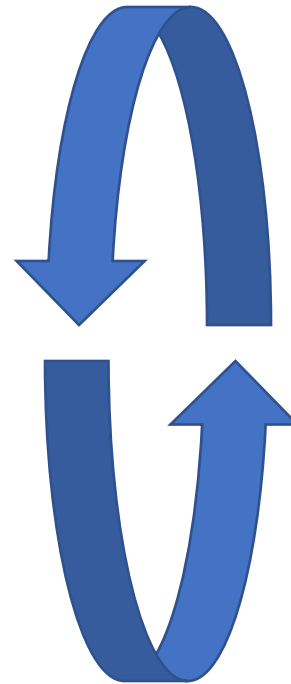
Human-Computer Interaction... In Brief

- A multi-disciplinary field
- Concerned with the **design, evaluation, and implementation** of interactive computing systems for human use
 - and with the study of **major phenomena** surrounding them
- Involves two *entities* (the human and the computer) that determine each other behavior over time
 - framed in terms of humans' **goals** and related **tasks/pursuits**



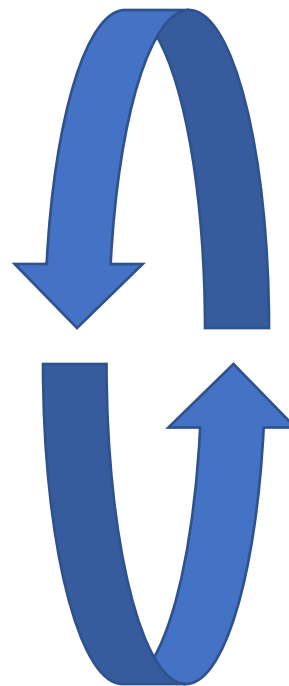
HCI Is Multidisciplinary

- Psychology and cognitive science
 - User perceptual, cognitive and problem-solving skills
- Ergonomics
 - User's physical capabilities
- Sociology
 - Understanding the wider context of the interaction
- **Computer Science and Computer Engineering**
 - **Building the necessary artifacts (HW, SW)**
- Business
 - Satisfying market needs
- Graphic design
 - Produce an effective interface presentation
- Technical writing
 - Documentation, manuals, on-screen content
- ...



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To help us in applying expertise from many different fields:

- Design methods and processes
- Models
- Heuristics
- Best practices
- Conventions
- Experiments and user studies

The Goal of HCI

Ingredients

- The **User(s)**
- The **Computer(s)**
- The **Task(s)** to be accomplished

Goal

- The system must support the user's **task**, with a focus on its **usability**
 - Useful
 - Usable
 - Used

The Ingredients

The human

- Sensory systems
 - Visual
 - Auditory
 - Haptic
 - Spatial
- Acting systems
 - Hands
 - Voice
 - Head, Body, ...
- Cognitive processes
 - Perception
 - Memory

The computer

- Input peripherals
 - Keyboard, mouse
 - Trackpad, trackball
 - Touch surfaces or screens
 - Microphone
 - Sensors
 - Card readers
 - ...
- Output peripherals
 - Screen
 - Audio (voice, sounds)
 - Haptics
 - VR/AR headsets
 - ...

Models of Interaction

A general framework to understand how User and System interact

What Is “Interaction” (in HCI)?

- Interaction is...

Concept	View of interaction	Key phenomena and constructs	Good interaction	Example support for evaluation and design
Dialogue	a cyclic process of communication acts and their interpretations	mappings between UI and intentions; feedback from the UI; turn taking	understandable; simple, natural; direct	methods/concepts for guessability, feedback, mapping; walkthroughs
Transmission	a sender sending a message over a noisy channel	messages (bits); sender and receiver; noisy channels	maximum throughput of information	metrics and models of user performance
Tool use	a human that uses tools to manipulate and act in the world	mediation by tools; directness of acting in the world; activity as a unit of analysis	useful and transparent tools; amplification of human capabilities	compatibility in instrumental interaction; break down analysis
Optimal behavior	adapting behavior to goals, task, UI, and capabilities	rationality; constraints; preferences; utility; strategies	improves or reaches maximum or satisfactory utility	models of choice, foraging, and adaptation
Embodiment	acting and being in situations of a material and social world	intentionality; context; coupling	provides resources for and supports fluent participation in the world	studies in the wild; thick description
Experience	an ongoing stream of expectations, feelings, memories	non-utilitarian quality; expectations; emotion	satisfies psychological needs; motivating	metrics of user experience; experience design methods
Control	interactive minimization of error against some reference	feedforward; feedback; reference; system; dynamics	rapid and stable convergence to target state	executable simulations of interactive control tasks

Taken from: Kasper Hornbæk & Antti Oulasvirta, What Is Interaction? In: *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*

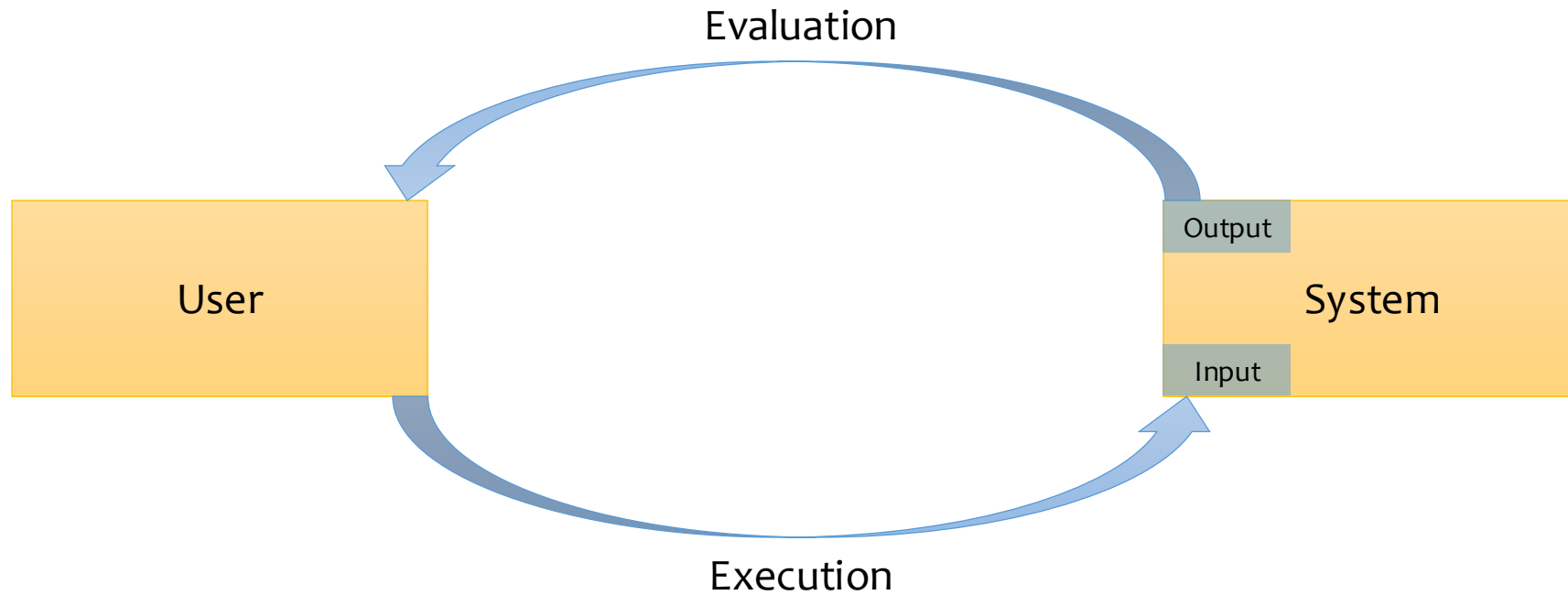
What Is Interaction (in HCI)?

- Interaction...
 - **is not** the idea promoted and repeated in folk notions that a computer and a human are engaged
 - it concerns two entities – humans and computers – that determine each other's behavior over time
 - Their mutual determination can be of many types, including statistical, mechanical, and structural
- **Users**, with their **goals** and **pursuits**, are the ultimate metric of interaction

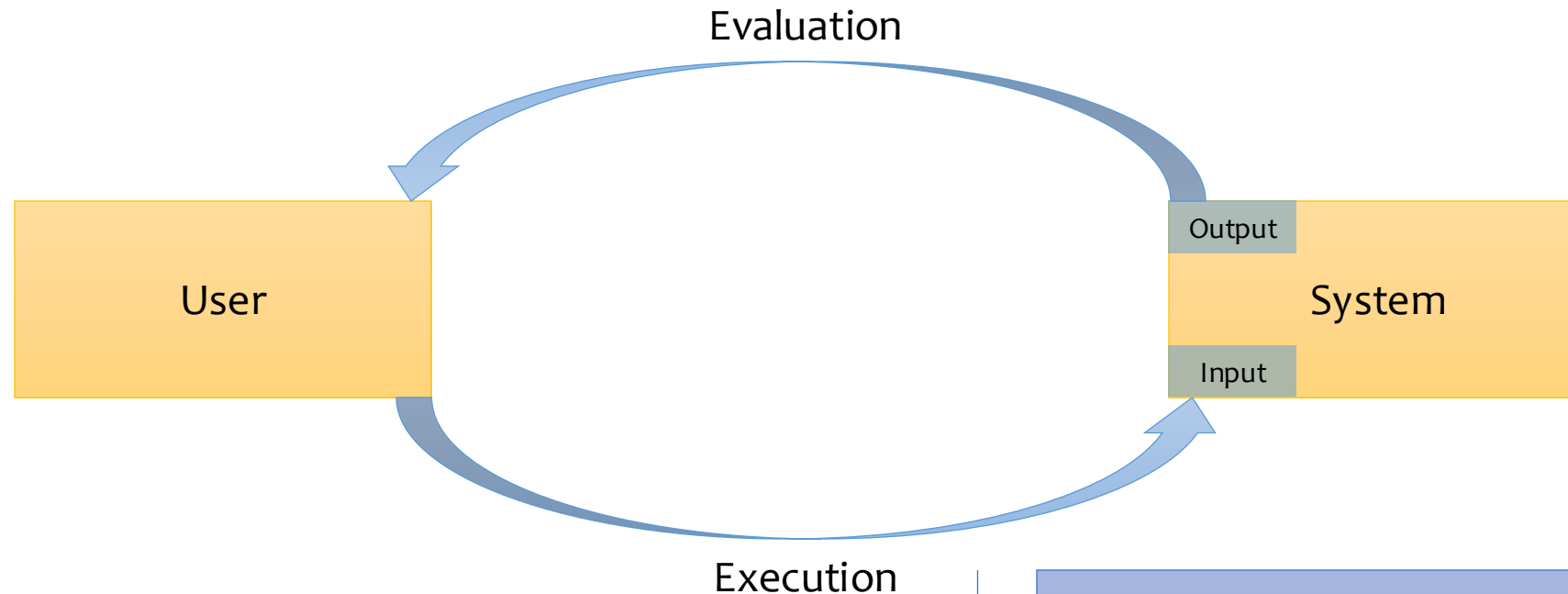
Assumptions

- The **user** wants to accomplish some **goals**, in a specific application **domain**
 - Each domain has a specific jargon, set of possible processes and goals, artifacts and building blocks, ...
- **Tasks** are operations to manipulate the concepts of a domain
 - The goal is attained by performing one or more tasks
- Interaction studies the relation between User and System
 - The system possesses a **state** and “speaks” a **core language**
 - The user possesses a **state**, that includes an **understanding** of the system’s state, some **intention** to perform a task, and “speaks” the **task language**

Norman's Model of Interaction

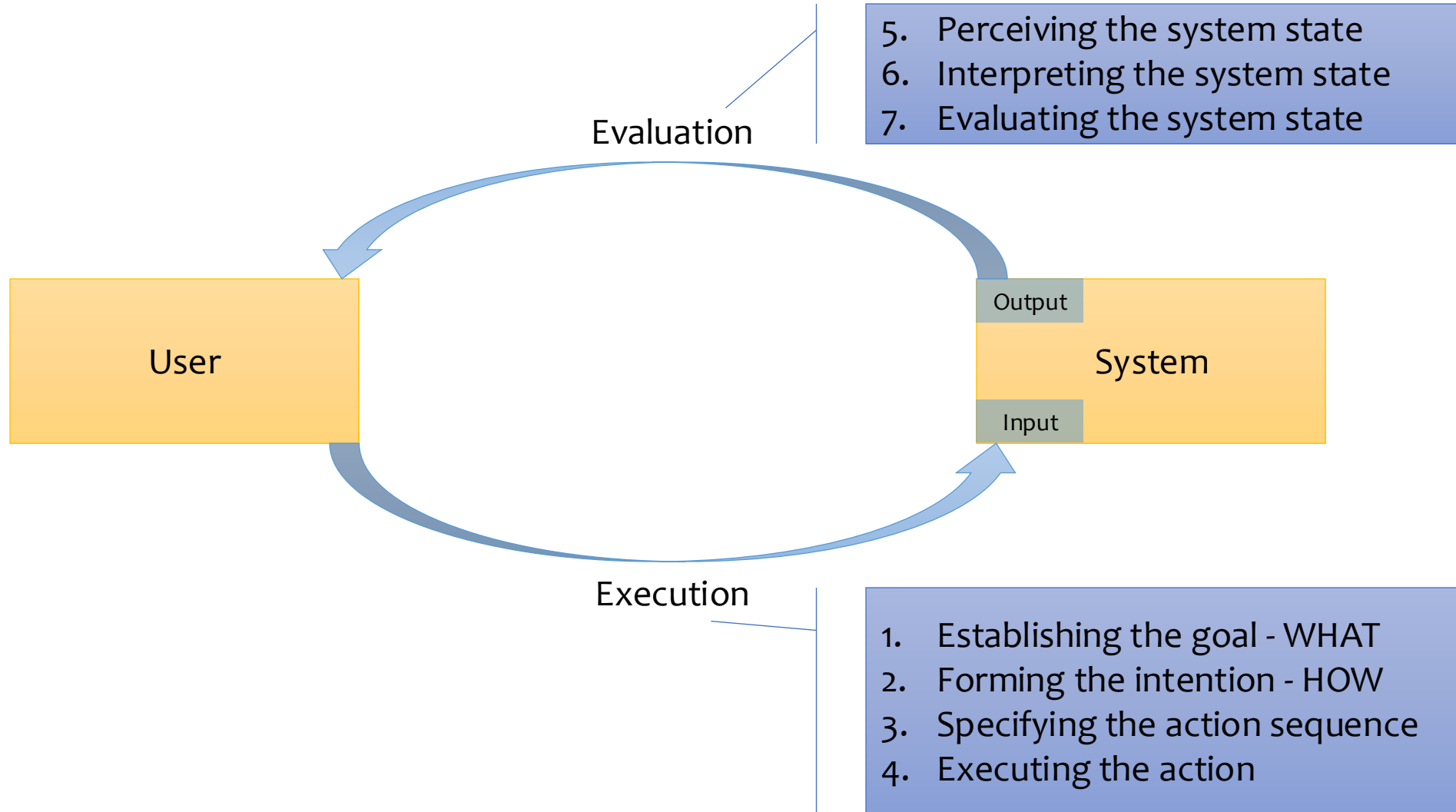


Norman's Model of Interaction

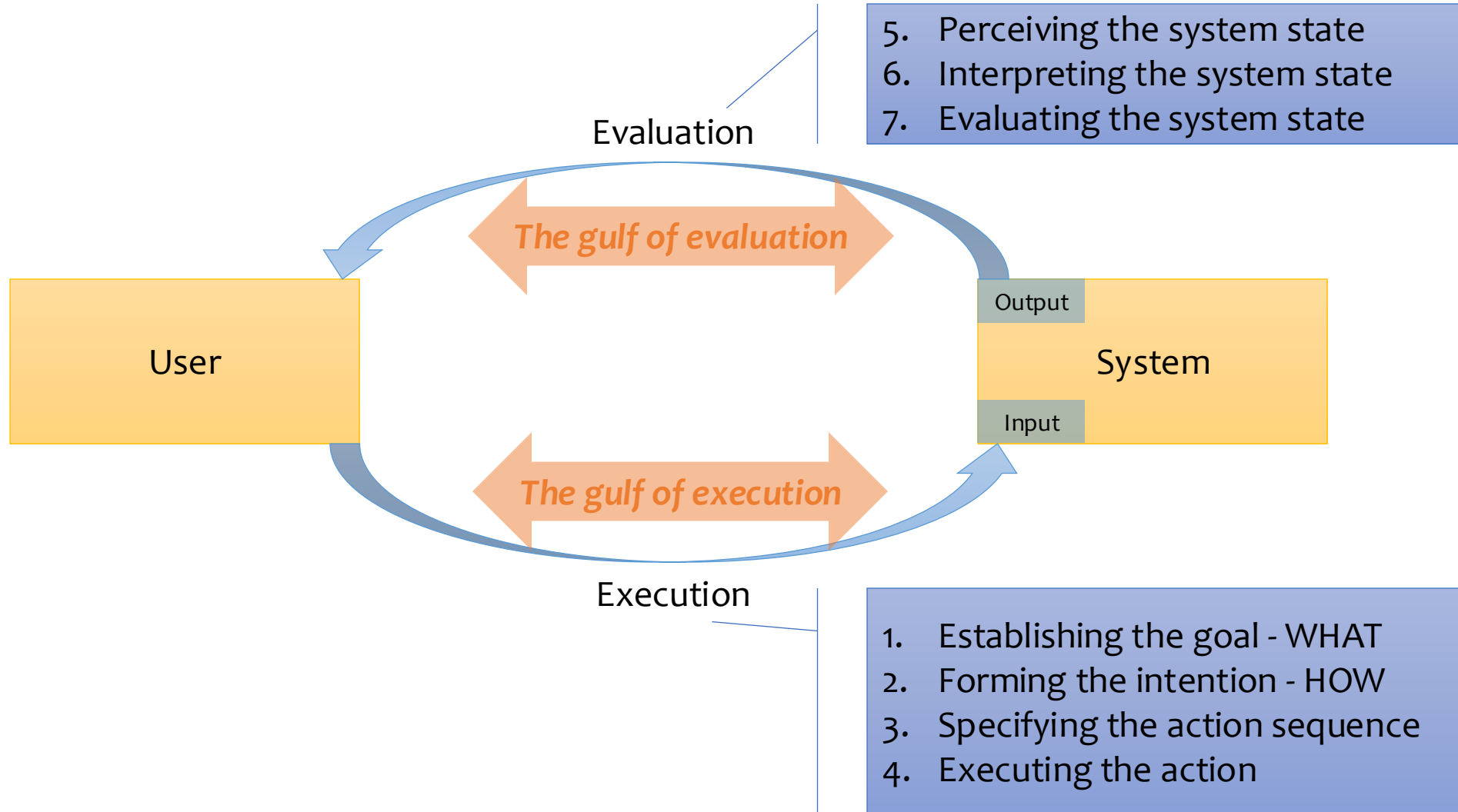


1. Establishing the goal - WHAT
2. Forming the intention - HOW
3. Specifying the action sequence
4. Executing the action

Norman's Model of Interaction

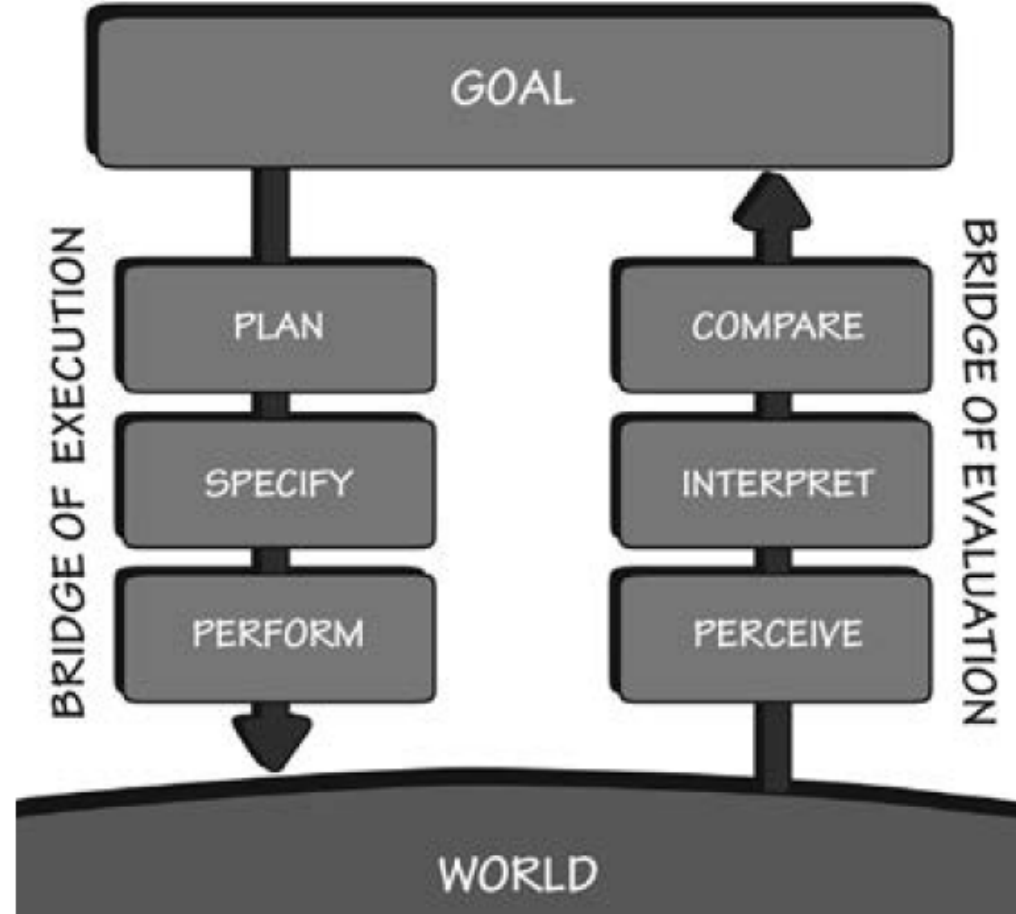
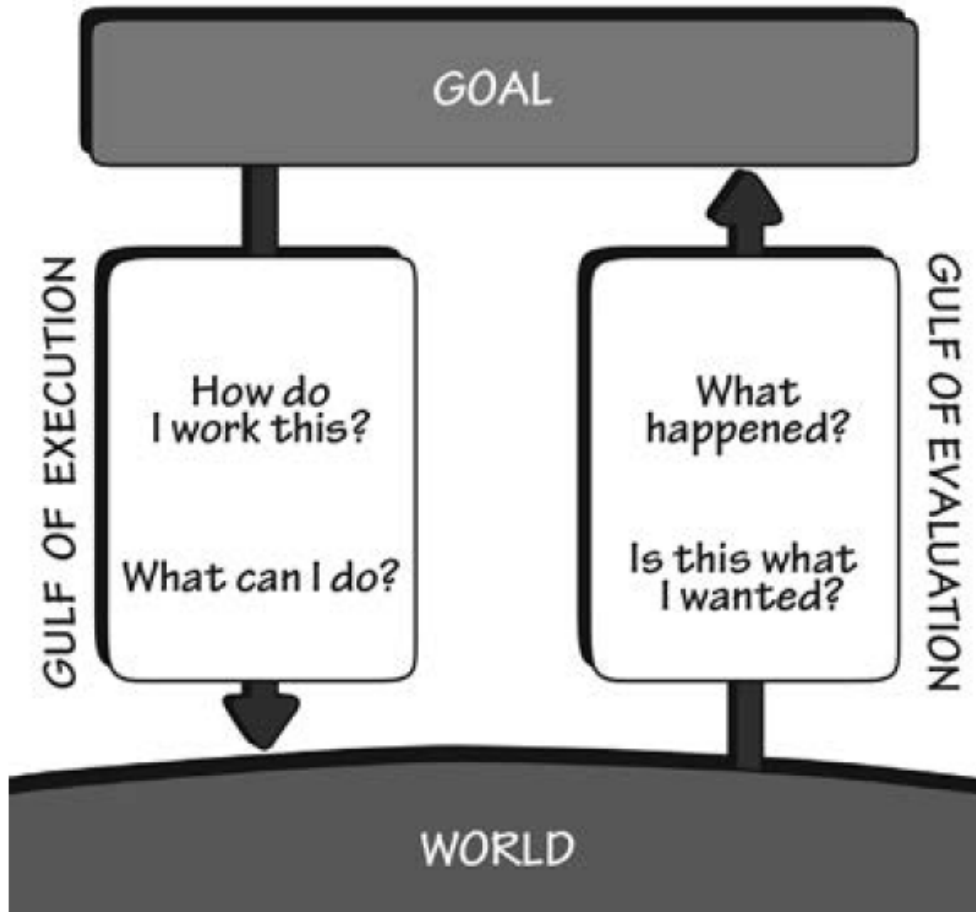


Norman's Model of Interaction

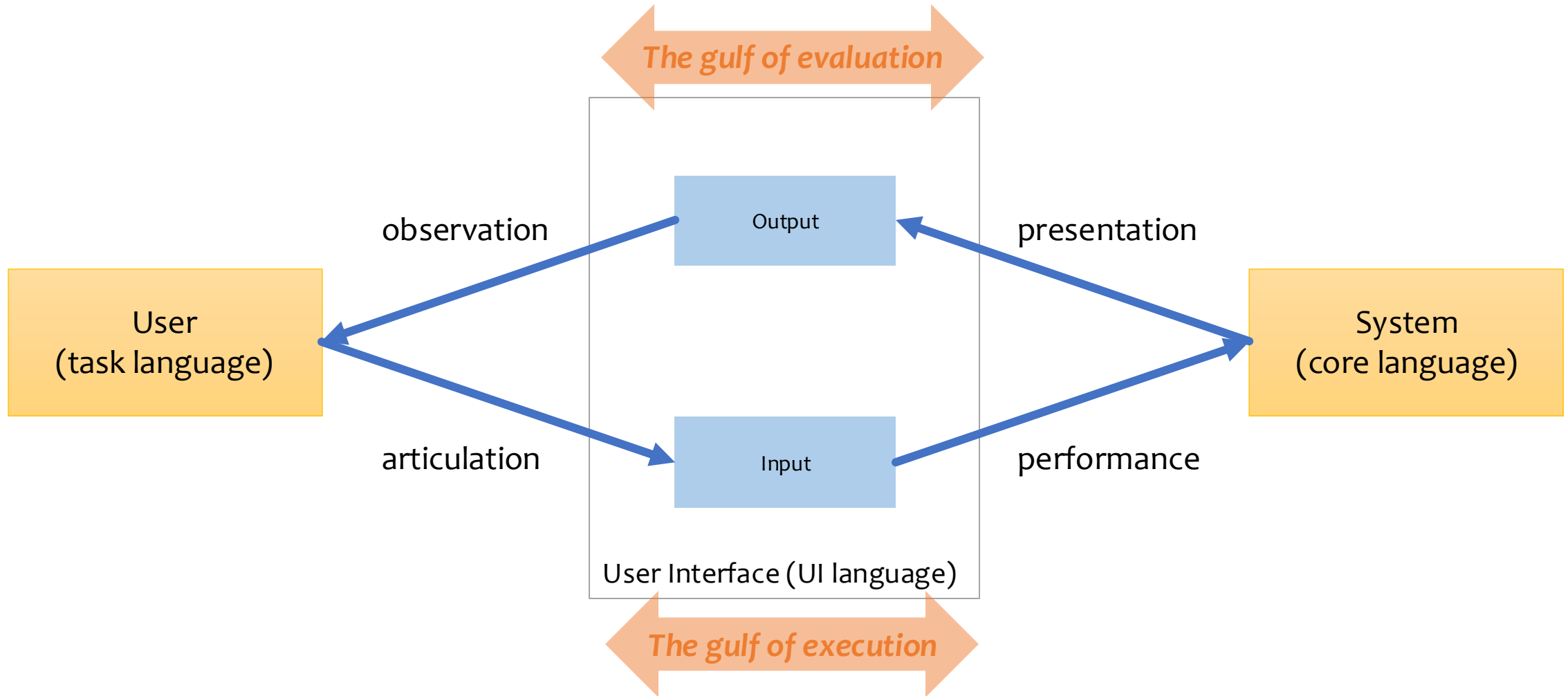


Norman's Diagrams

1. **Goal** (form the goal)
2. **Plan** (the action)
3. **Specify** (an action sequence)
4. **Perform** (the action sequence)
5. **Perceive** (the state of the world)
6. **Interpret** (the perception)
7. **Compare** (the outcome with the goal)



Abowd and Beale Model, with Explicit UI




Human Errors*

in the gulf of execution

Slip

- You have formulated the right action, but fail to execute that action correctly
 - E.g., click the wrong icon, or double-click too slow, ...
- May be corrected by a better interface (spacing, layout, highlights, ...)

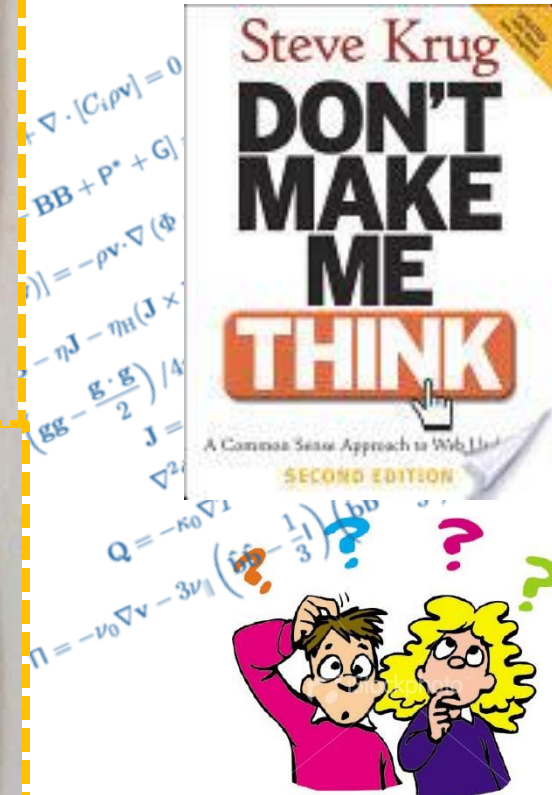
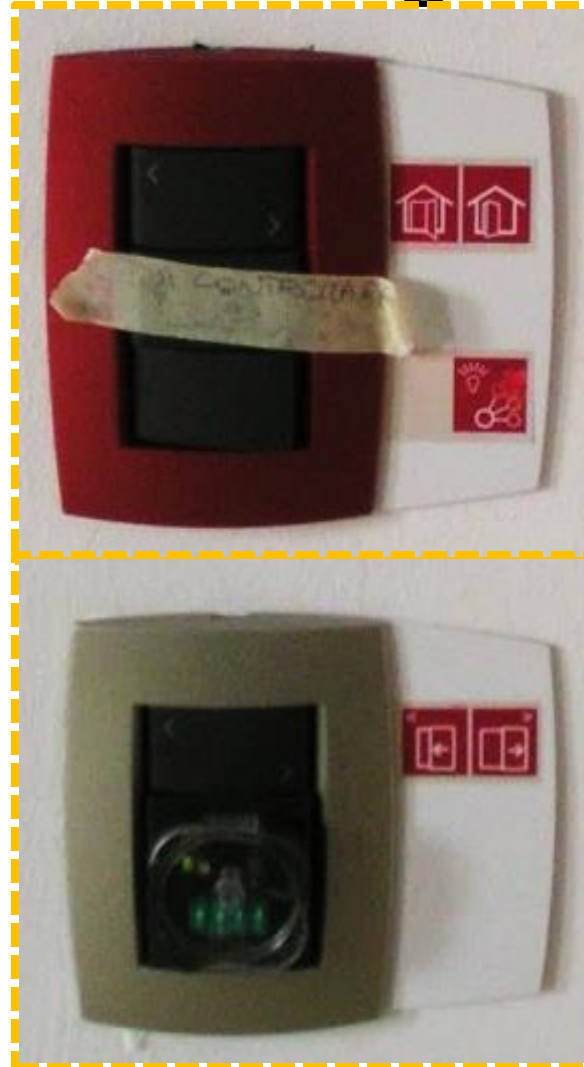
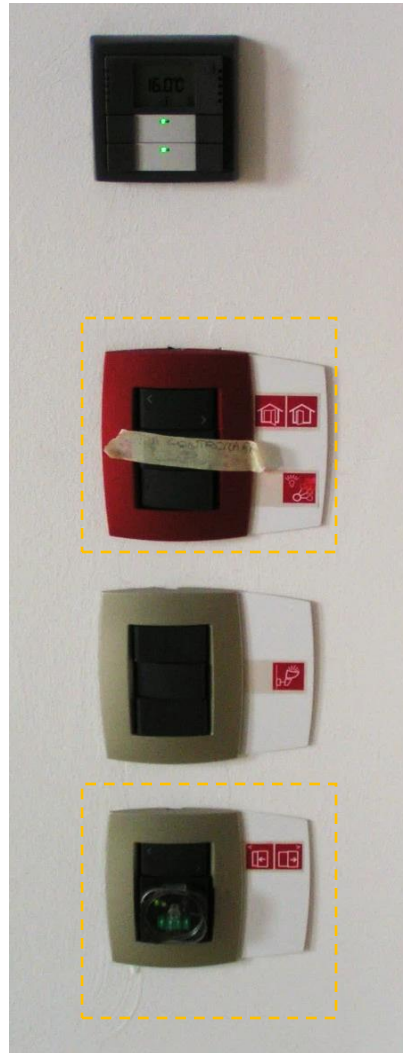
Mistake

- You don't know the system well and you may not formulate the right goal
 - E.g., click  for Zoom, but it means Search
- The user's mental model of the system's state is not correct
- Requires more radical redesign, or additional training

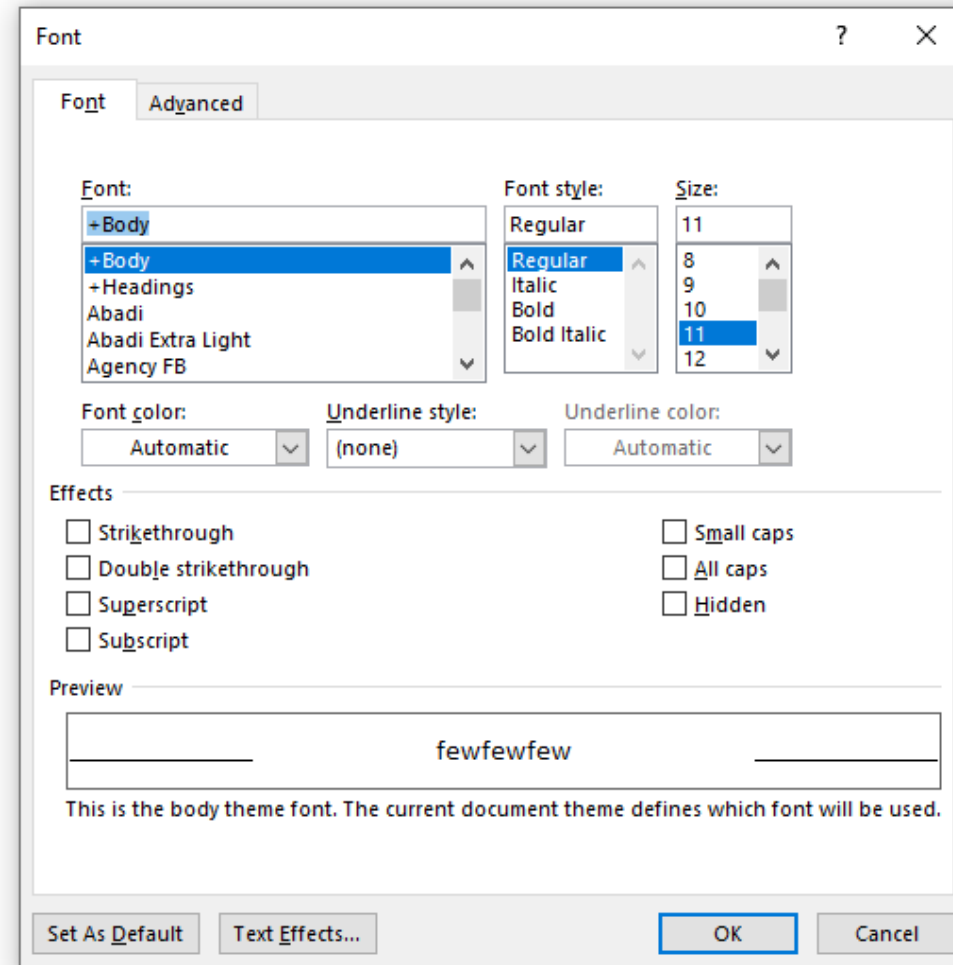
* About Human Errors

- Human errors should **never** be considered as faults of the user
- Rather, «they are usually a result of bad design» (Norman)
- Humans tend to be imprecise, distracted, not-omniscient
 - System design should anticipate this human behavior
 - Minimize the chance of inappropriate actions (evaluation)
 - Maximize the possibility of discovering and repairing an inappropriate action (execution)
 - Enable users to understand the state of the system and build an appropriate model

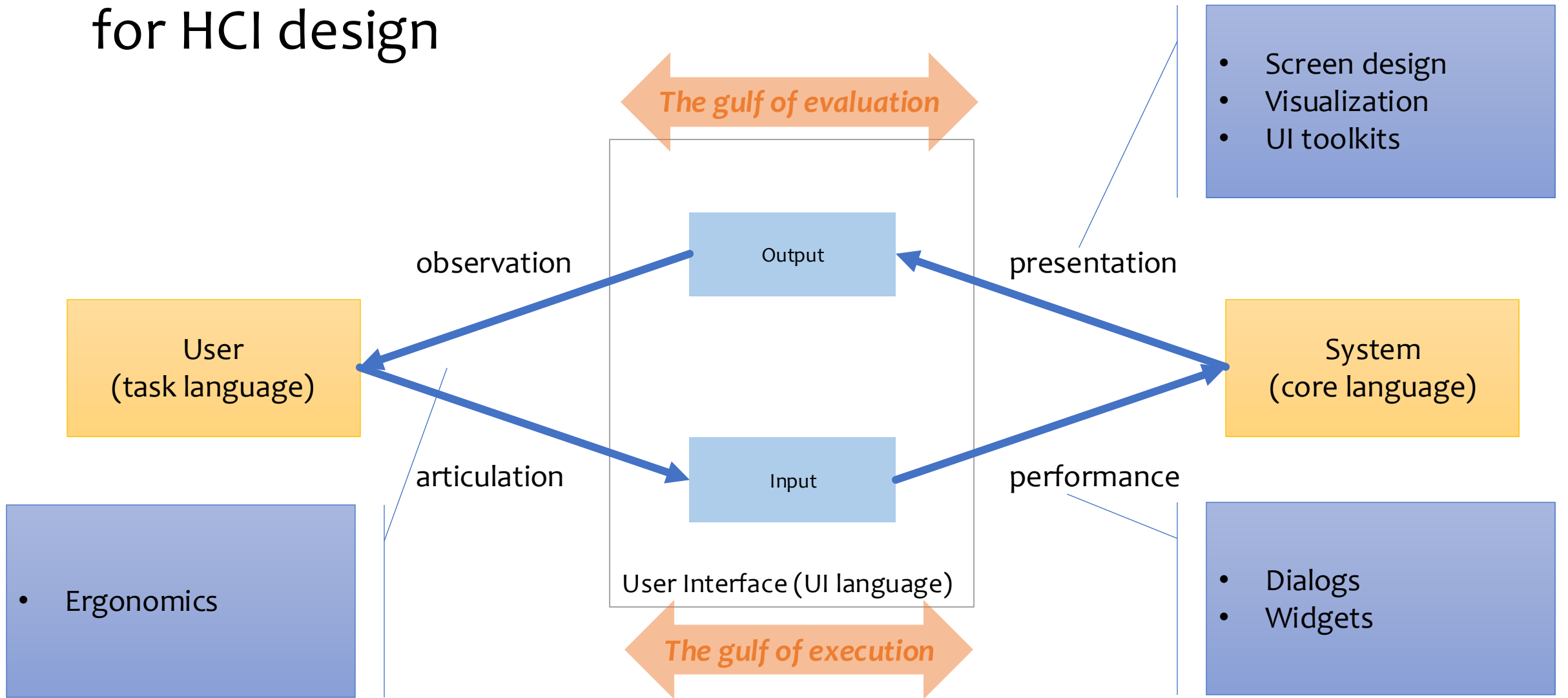
Example (articulation): find the right switch



Example (presentation): Which are the allowed combinations?



Tools, Techniques and Environments for HCI design



Frameworks: Major UI Styles

- Command line interface
- Menus
- Natural language
- Question/answer and query dialog
- Form-fills and spreadsheets
- Windows, Icons, Menus and Pointers (WIMP)
- Mobile
- Point and click
- Three-dimensional interfaces

Design Processes and Frameworks

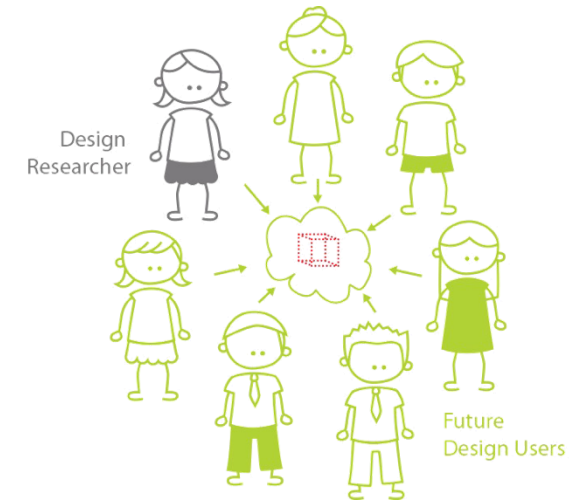
Approaches for shaping the design process

User-Centered Design (UCD)

- Avoid the risk of software project failure
 - Estimated 50% are affected by bad developer<->user/client communication
- UCD takes the needs, wants, and limitations of the **actual end users** into account **during each phase** of the design process
 - User-centered design issues are discovered during the early stages
- Benefits: systems easier to learn, with faster performance, with less human errors, encourage users to discover advanced features, and avoids “building the wrong system”
- Issues: how to find users? How many? How motivated? How to speak their language? How to extract user needs, business needs, organizational implications?

Participatory Design

- One step further than UCD, users are directly involved in the collaborative design of the things and applications they use
- Engage a group of users
 - Discussions
 - Creating scenarios, sketches, dramatizations
 - Creating and testing lo-fi prototypes
 - Continuous meetings, flexible management
 - Highly reliant on the skills of the group moderators/leaders (keep involved, filter ideas, reward participation, work around resistances, ...)
 - More effective with more mature and prepared user populations (less with kids, elderly, disabled, ...)



Agile Interaction Design

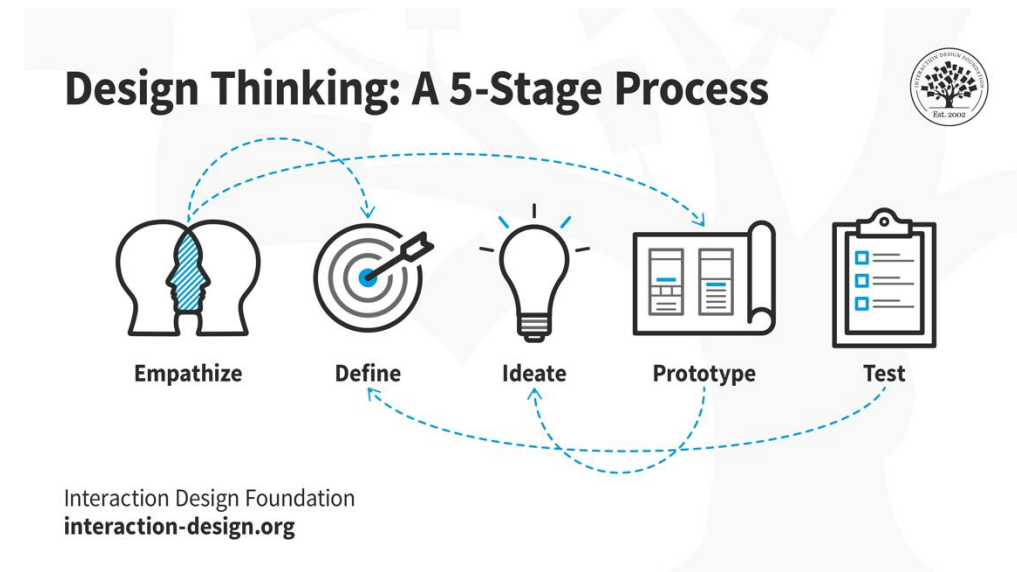
- Borrows ideas from Agile development in software engineering
- Key: evolutionary development
 - System is built incrementally in rapid release cycles
 - Rapid prototyping techniques (for hardware, software, and physical objects)
- Focus on low-cost many-iterations prototypes
- Requires fast usability inspection (extreme usability, XU)
- Makers' culture (only if it involves users!)

Design Thinking

- *“A human-centered approach to innovation that draws from the designer’s toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success.”*

— [Tim Brown, IDEO’s Executive Chair](#)

- A 5-stage, non-linear and iterative, process
 1. **Empathize** – research users’ needs
 2. **Define** – state the found needs
 3. **Ideate** – challenge assumptions and ideate
 4. **Prototype** – create solutions
 5. **Test** – try the solutions out



Service Design

- Describe the contemporary shift from *products* (e.g., a car of a specific brand) to *services*, e.g., the car as a tool for an elderly customer that wants to take an Uber ride to visit a friend
- Focus on the complete experience, including business resources and processes
- Build upon five *key principles*, according to “This is Service Design Thinking”:
 1. **User-centered** – focus on all users
 2. **Co-creative** – include all relevant stakeholders
 3. **Sequencing** – break a complex service into separate processes
 4. **Evidencing** – envision service, not product, experiences
 5. **Holistic** – design across networks of users and interactions

Human-centered Design Process

A process for designing interactive systems with a focus on usability

Usability (ISO standard definition)

- **Usability:** “extent to which a system, product or service can be used by specified users to achieve specified goals with *effectiveness, efficiency* and *satisfaction* in a specified context of use”
 - Note 1: The “specified” users, goals and context of use refer to the particular combination of users, goals and context of use for which usability is being considered
 - Note 2: The word “usability” is also used as a qualifier to refer to the design knowledge, competencies, activities and design attributes that contribute to usability, such as usability expertise, usability engineering, usability testing, etc.

Usability

- **Usability:** how well users can use the system's functionality
- Dimensions of usability:
 - **Usefulness:** does it do something people want?
 - **Learnability:** is it easy to learn?
 - **Memorability:** once learned, is it easy to remember?
 - **Effectiveness:** does it allow reaching the goal?
 - **Efficiency:** once learned, is it fast to use?
 - **Visibility:** is the state of the system visible?
 - **Errors:** are errors few and recoverable?
 - **Satisfaction:** is it enjoyable to use?

Usability: Don't Make Me Think

OK. This looks like the product categories...

Laptops, Memory... There it is: Monitors. *Click*

...and these are today's special deals.

The screenshot shows the TigerDirect.com website with a grid of product categories. Red arrows point from the text annotations to specific categories: 'Laptops, Memory... There it is: Monitors. Click' points to the 'Monitors' category; 'OK. This looks like the product categories...' points to the overall grid; and '...and these are today's special deals.' points to the 'Special Deals' banner at the bottom.

Hmm. Pretty busy. Where should I start?

Hmm. Why did they call it that?

Can I click on that?

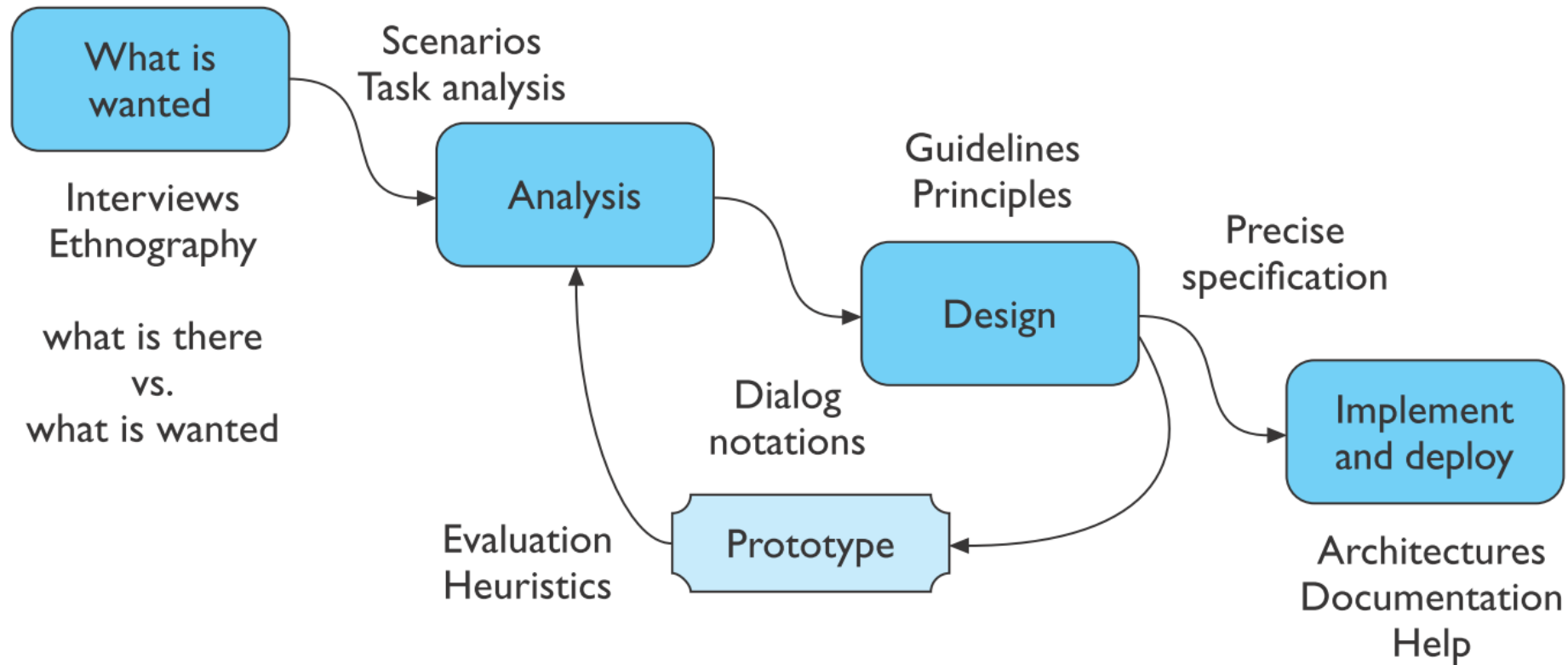
Is that the navigation? Or is that it over there?

Why did they put that there?

Those two links seem like they're the same thing. Are they really?

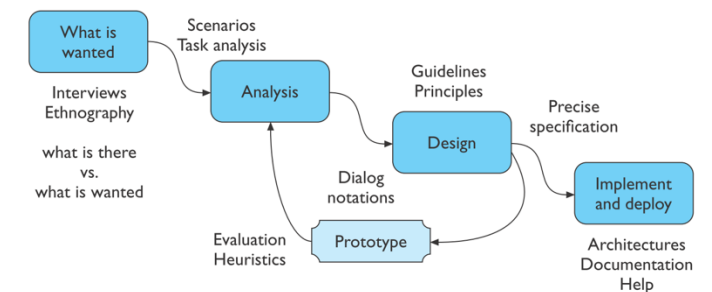
The screenshot shows the XYZnet.com website with a complex layout of news articles, a sidebar, and a navigation menu. Red arrows point from the text annotations to various elements: 'Hmm. Pretty busy. Where should I start?' points to the top navigation bar; 'Hmm. Why did they call it that?' points to a link in the main content area; 'Can I click on that?' points to a small icon in the sidebar; 'Is that the navigation? Or is that it over there?' points to the top navigation bar; 'Why did they put that there?' points to a link in the sidebar; and 'Those two links seem like they're the same thing. Are they really?' points to two links in the sidebar.

Human-Centered Design Process (simplified and generic)



Human-Centered Design Process – The Main Steps (1)

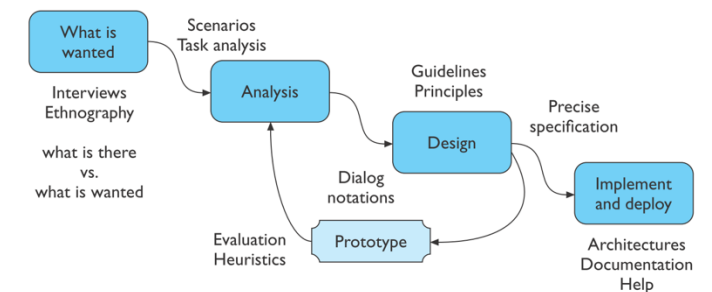
- **Needfinding – what is needed**
 - What exactly is needed? How are people currently accomplishing the goal?
 - User observation, interviews, ...
- **Analysis**
 - Formalize and structure the needs
 - Create interaction scenarios, stories, tasks
 - Compare current situation with expected new situation



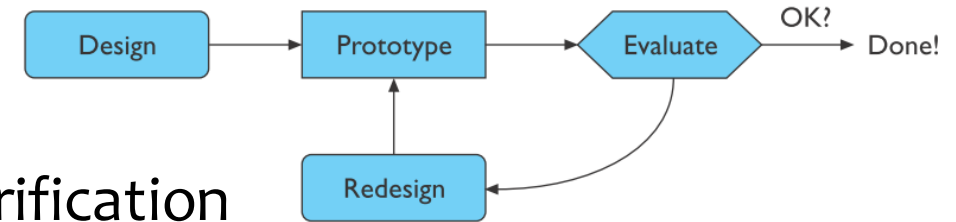
Human-Centered Design Process – The Main Steps (2)

▪ Design

- The main choices to shape the system
- Rules, guidelines, design principles
- Considering different types of users
- Modeling and describing interaction
- Visual layout
- Consider all inputs from cognitive models, communications theories, organization issues



Human-Centered Design Process – The Main Steps (3)

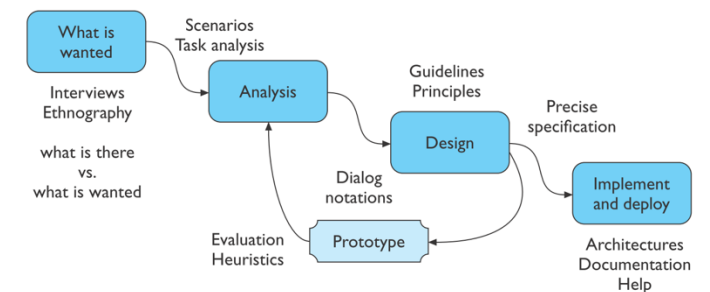


▪ Iteration and prototyping

- Design must be supported by intermediate verification
- Evaluate the design in its partial forms:
 - Prototypes
 - Evaluation metrics
- Involving users

▪ Implementation and deployment

- Hardware and software implementation
- Documentation

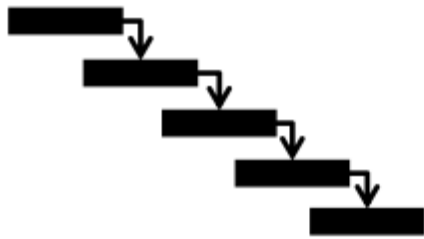


HCI in the Software Process

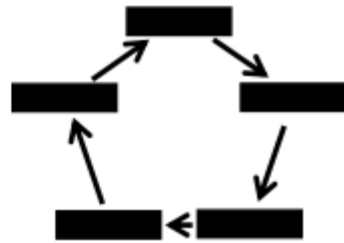
How to include Human-centered processes in Software Engineering

Software Engineering Processes

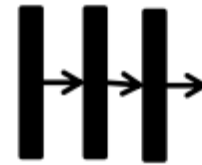
Where / how does HCI fit in?



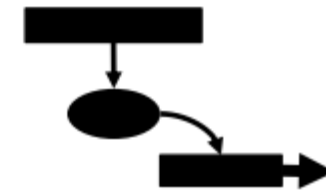
Waterfall



Iterative
waterfall



Agile
(scrum)

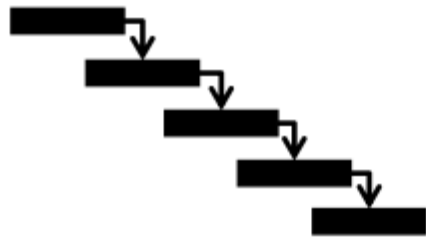


Lean

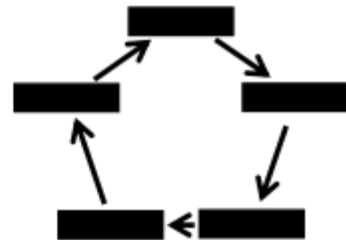
Software Engineering Processes

Where / how does HCI fit in?

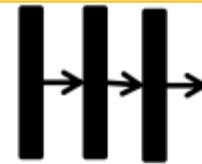
Always a step ahead!



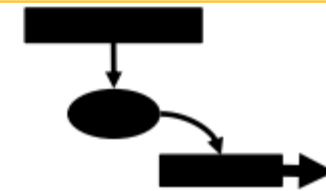
Waterfall



Iterative
waterfall



Agile
(scrum)



Lean

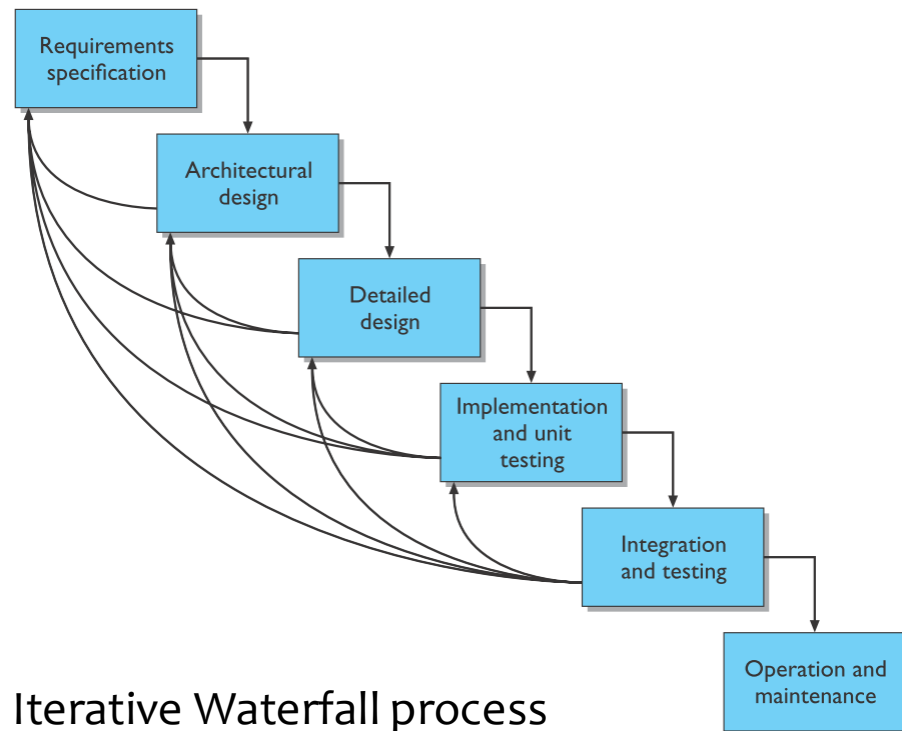
Always a Step Ahead (I)

- Before
 - Every design step
 - Every implementation step
 - Any product iteration (or sprint)
 - ...
- You need a user-centered step
 - Evaluate usability
 - Experiment with users
 - Evaluate alternative flows
 - Evaluate alternative layouts
 - ...

Always a Step Ahead (II)

- Usability, Safety, Performance, are part of Non-Functional Requirements
- User-centered steps are cheaper than development
 - User research about users' needs to decide what to design
 - Heuristic evaluations before testing with users
 - Evaluating prototypes instead of full-fledged products
- Anticipate critical decision points later in the project

Example



- Each step must be
 - Preceded with user evaluation of the design choices and formalized requirements
 - Followed with user evaluation of the result
- Must produce additional artifacts to allow this kind of iteration
 - Prototypes

References and Thanks

- Robert Miller, MIT Course “6.813/6.831: User Interface Design & Implementation”
 - Spring 2018 - <http://web.mit.edu/6.813/www/sp18/>
 - Spring 2011 - <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-831-user-interface-design-and-implementation-spring-2011/index.htm>
- Dix *et al*: Human Computer Interaction
 - Chapters 3, 5
- Norman: The Design of Everyday Things
 - Chapter 2
- Krug: Don't make me think
 - Introduction
- Shneiderman: Designing the User Interface
 - Chapter 4
- Thanks to Fulvio Corno, past teacher of the course, for his work on this slides



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