4M21 Software Engineering and Design
Human-Computer Interaction

Lecture 6/8

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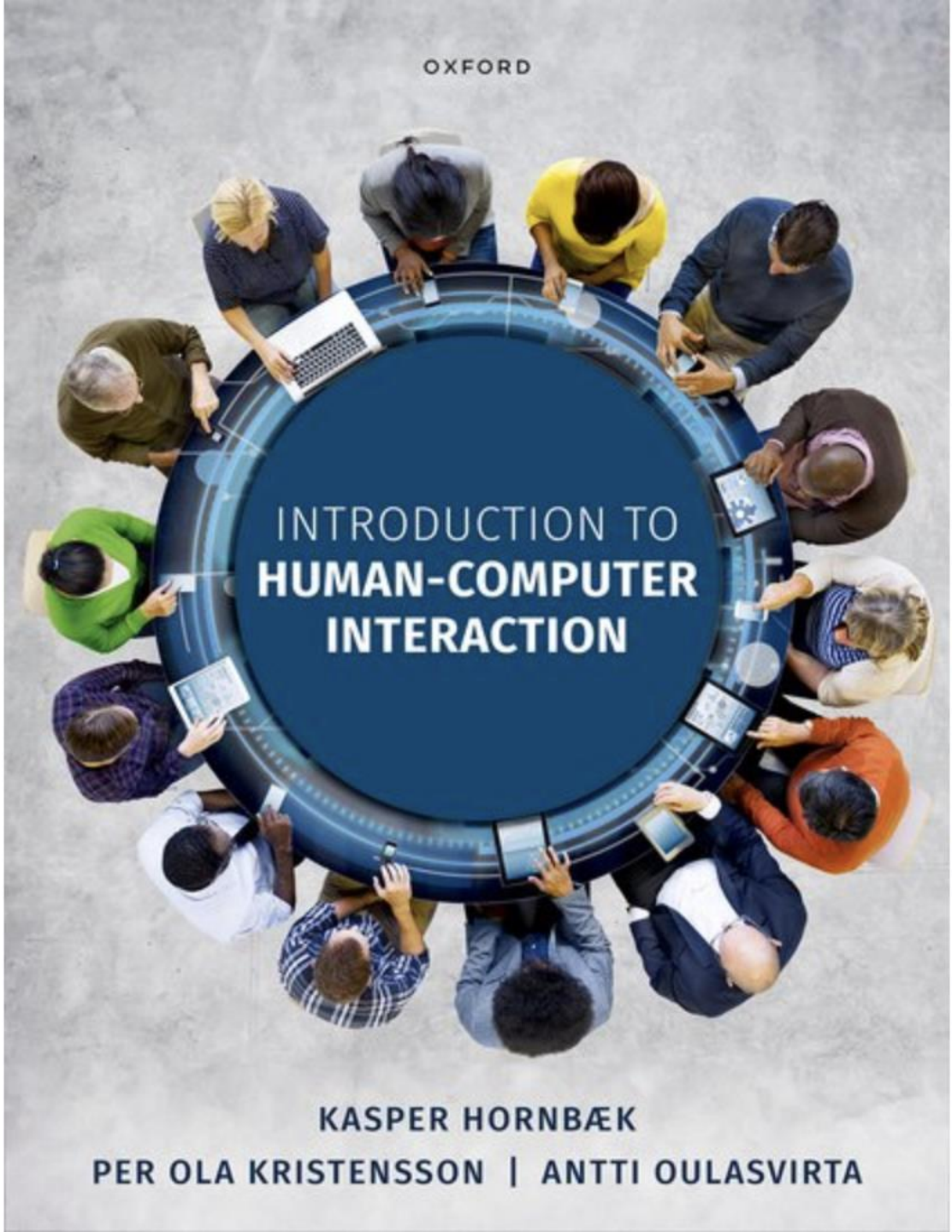


Design

Design

- Look around you and choose an artifact
- For example, grab your smartphone, unlock it, and look at it
- Everything that you see, from graphics to functionality, all applications, icons, contents, and widgets, has been designed
  - Someone has made an active decision about what functions to include and how they look and feel
- When ‘just’ using something, we easily miss the fact that a considerable number of decisions have been taken to define look and feel
- Every aspect from high-level concepts to the smallest details has been designed

- *The design of computer games for elderly users*
- *The design of an ambient lighting for bedrooms that changes the hue of the light in synch with the storyline of a fairytale told to a child*
- *The design of digital support tools for impoverished communities*
- *The design of a device that suggests topics for prayers for cloistered nuns*
- *The design of media facades for buildings for people on-site to interact with*
- *The design of ‘ridiculous software’; software that makes users reflect on their relationship with software*
  - *For example, ATTN is a mobile app that shows an empty screen that dims away slowly, to remind users about the scarcity of their attention*

Design impact

- Design matters to people
  - The daily experience of computer use is—unacceptably often—cumbersome, unpleasant, or simply impossible for some of us
  - Design affects the way we perceive, experience, remember, decide, and form habits
  - Design can be decisive for someone's ability to use something
  - At the same time, even the tiniest improvements in design can have massive effects when their total impact is considered
- Design is also a catalyst of innovation
  - The top innovating companies produce a major part of revenue from services and products that did not exist five years ago
  - Design is also a central driver of the renewal of societies and economies
  - The design of services that are more lucrative, accessible, efficient, and fair is a central concern

Ultimate particular

- At the end of a design project, designers arrive at some **ultimate particular**: a concept, plan, artifact, or something that realizes the idea in some form that can be trialed
- Ultimate particulars are about **possible worlds**
- While we live in the present world, design can create an alternative reality
- This sets HCI apart from some of its neighboring disciplines: HCI aims to change the world through design
- Since, in principle, anyone can come up with such ideas, design is not the privilege of a professional designer
- Designers follow a multiplicity of processes, techniques, and practices that help them create novel ideas

Design as an activity

- **Solving problems** is a central challenge in design
- Design requires decisions and plans
- Designing an interactive system requires figuring out how the user interface should look like, how the user journey is structured, and so on
- Each of these areas involves hundreds, if not thousands, of interconnected decisions
- Designers need to “get the design right”
- Designers’ problem-solving is often characterized as intensive iteration, trial and error, and search among possible solutions to problems

Research through design

- Design can produce new, valuable knowledge
- This knowledge can be a novel perspective to a problematic situation, or alternative futures, or insights, or implications, or just new insights about empirical phenomena
- Such insights can not only trigger new empirical or theoretical research, it can challenge and falsify assumptions that have been held in the community
- However, knowledge produced in research-through-design may not always take the shape we recognize and expect when approaching it from a traditional scientific angle
- The mere *existence* of a prototype can be considered knowledge
- After all, a prototype can embody knowledge about feasible solutions and options

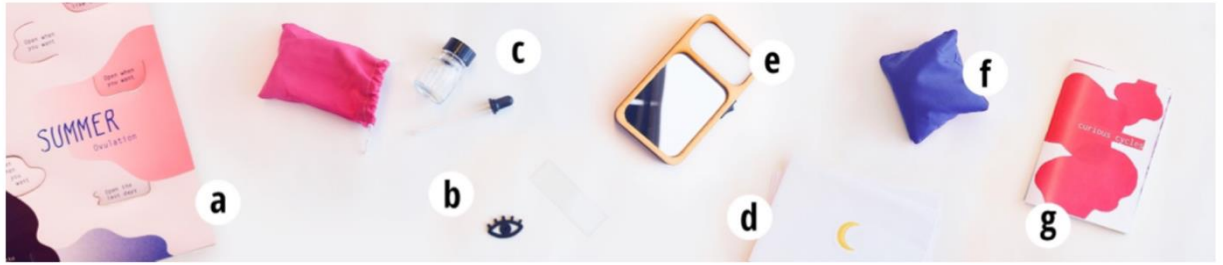
Design has transformative potential

- Design is not only about producing tangible objects you can touch and hold in your hand
  - Design can shake the world, get people to think and do things in new, better ways
  - Design can be considered as a means to change culture and human experience
  - Design is not simply an application of existing principles, but a constant search of new meaning and value in human life
  - Designers are not just translators who translate wishes into artefacts, they are facilitators that catalyze changes in the world with technology
- Instead of fixing problems, or *solutionism*, design should aim at creating new, *transformative possibilities*
  - Design can help challenge and rethink structures that limit us as humans
  - To achieve this, designers create narratives and interpretations of what something is, or could be

Example: design probes

- *Curious Cycles* is a research-through-design project that aims to encourage people to experience their menstruating bodies in new ways
- Curious Cycles is an example of **design probe**: a design method that involves sending a kit out in the wild to users and allow them to engage with it without the presence of a researcher
- Design probes seem particularly suitable for this research, because they allow the participants full control over what to try and what to share
- The kit was sent to five women and the purpose was to prompt participants to touch and explore their changing body during the cycle

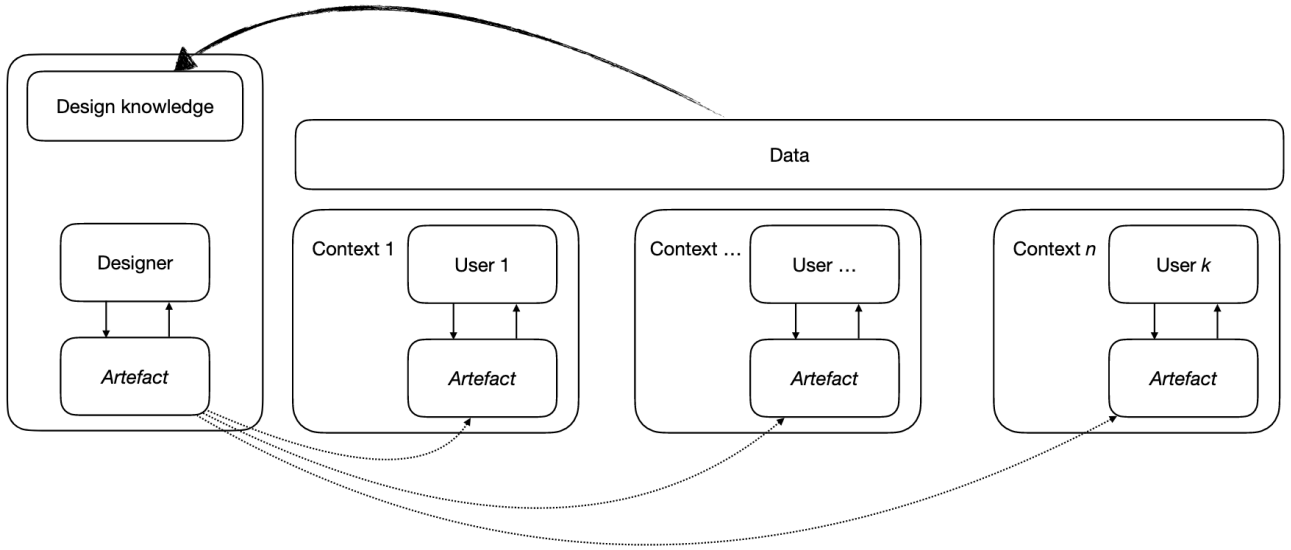
- The participants reported they learned to explore more about menstruation via touch
- An unexpected finding was that some of the participants shared their materials with other participants, which triggered understanding and improved their self-knowledge



Hannah's picture depicting a bloodstain on her underwear helped Emma feel more comfortable with her own experiences: 'The first time I posted a picture of my blood I felt weird, but then I thought, oh why am I feeling this, it's just blood. […] One girl posted bloody underwear and I was like what! that's so cool!'

Design in HCI

- Interactive technology focus
  - In HCI, design focuses on *interactive* technology
  - The engineering of a network protocol for secure payment transactions is not an HCI topic, while the design of a user interface for those transactions is
- Human-centeredness
  - The primary success criteria in design must refer to people who will be using the artefact and the choices that are made must be ethically sound and defendable
  - Design decisions should be based on an understanding of users



What is design? A simplified view of design is that the designer arrives at an artefact using design knowledge and direct experiences with their own artefact. Design knowledge, in turn, is captured as data informing the designer about possible contexts of use for particular users. The artefact, in turn, can be used in many contexts and by many users—some of these contexts, users, and use are anticipated by the designer, some are not. Regardless, the potential of the design is realized in these contexts and by these users. There is fundamental uncertainty of such potential as it is impossible for the designer to anticipate all contexts, users, and forms of use with the artefact.

What does it mean to be *user-centered?*

- **User focus:** understanding and serving the user's goals, tasks, and needs is the primary goal of design
  - When solutions are presented to users, these presentations must be clearly understandable to them, avoiding technical jargon when possible
  - This distinguishes user-centered design from many other processes developed for engineering and business
- **User involvement:** representative users are actively engaged throughout
  - Iterative and incremental development Iteration is necessary because it is practically impossible to know the specifics of what needs to be designed from the outset
- **Prototyping:** early and continuous prototyping, which helps evaluate ideas before converging to a particular solution prematurely
- **Evaluation in context:** prototypes should be evaluated with real users in real contexts whenever possible
- **Holistic design:** understanding that all designed aspects of a product, from its advertisements to social media presence and manuals, affect its use

Rationales for design

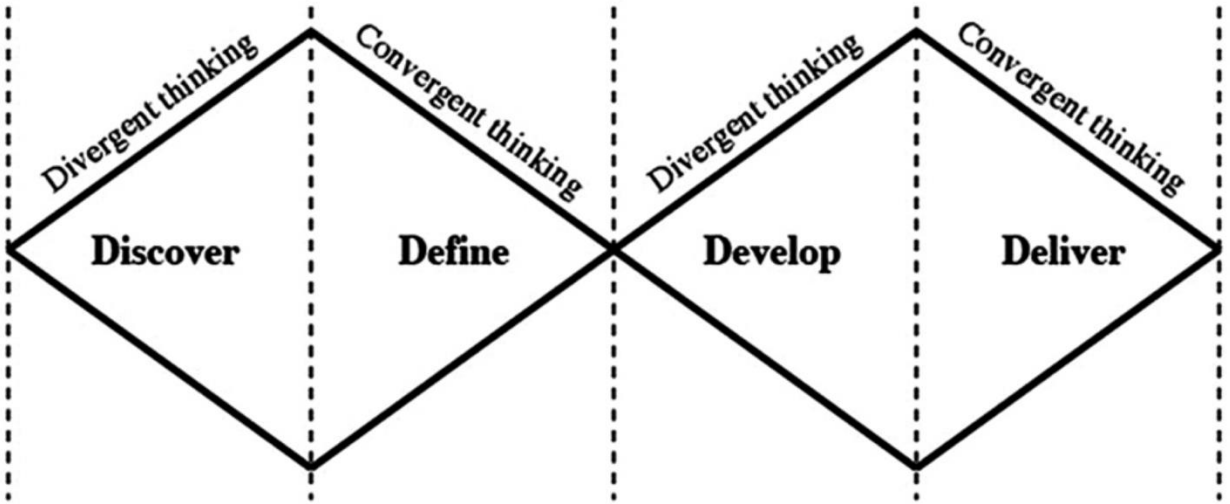
- Improve
  - Design can improve the usability, accessibility, and experience of computing systems
- Create
  - Design can create entirely new opportunities for people to use computing systems in contexts of ways not possible before
- Inform
  - Design is the study of what is possible
  - By showing alternatives to status quo, design informs decisions and create needs for change
- Produce knowledge
  - Design not only applies HCI knowledge, but is necessary to evolve such knowledge
  - Knowledge about interaction can be advanced by testing ideas in interactive prototypes and designs

Problem solving

- **Problem solving** is about identifying alternative solutions to a problem and translating these solutions into reality
- Designers need to be able to decompose the problem, for example, by enumerating available options or by imposing some form of structure on them
- So how do you explore these options?
  - In order to explore options, designers need different forms of judgment
  - Judgment is required to evaluate options and decide which options to explore next
  - Designers use their memory and experience, for example, they may use failed or successful past designs to inform their judgment.
  - Representing problems and solutions is an essential part of design as an efficient representation allows efficient problem solving
- In practice, designers tend to develop solutions and problems in tandem
- For example, under-defined problems can motivate an inquiry that subsequently leads to a new design and a new design situation with a better understood problem

Design thinking

- **Design thinking** has become a popular term that is used worldwide in educational programs and firms to define their view of what constitutes design
- Instead of relying on a creative individual, a "design hero", the key message in design thinking is emancipatory: creativity is something that anyone can develop and foster
- Design thinking offers methods for convergent and divergent thinking
- **Divergent thinking:** chart the options that are available
- **Convergent thinking:** narrow down the number of options to the most promising one
- Design thinking emphasizes two types of knowledge-creation activities: creative activities—knowing what to design; and problem solving activities—knowing how to design it



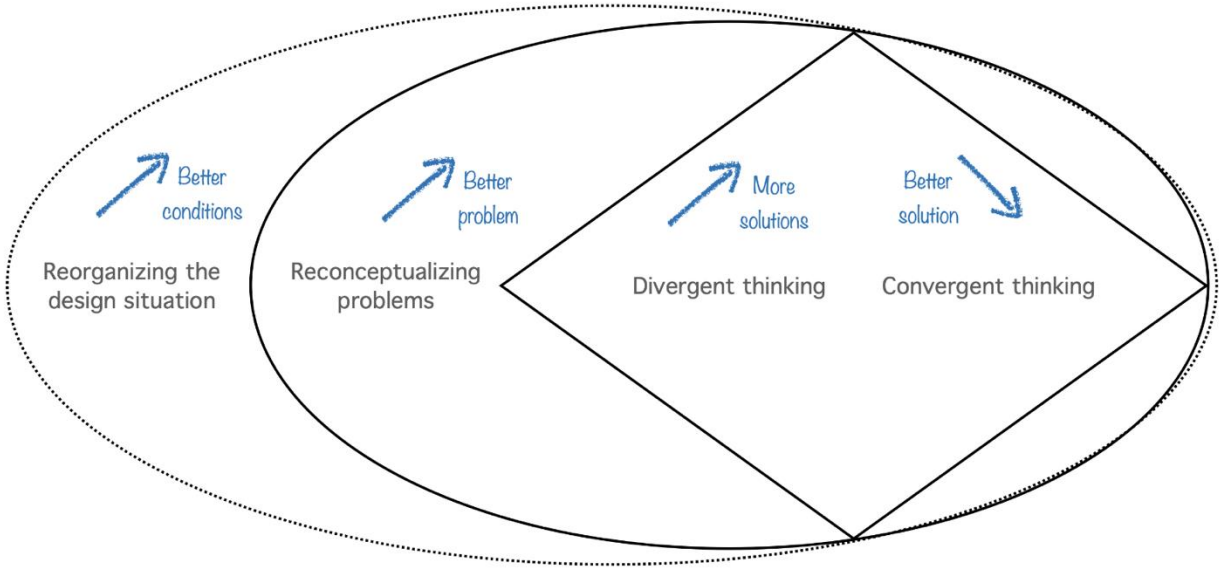
What should be designed?

- A key question in human-centered design is not what can be designed but ***what should be designed***
- **Value-sensitive design** is one among many design methods that aims to build designs rooted on principles that users find important
  - A *value* is any principle that users themselves consider important in their life
  - By making this the explicit goal of design is important, because it can help fight false human-centricity driven by economic or political needs
  - This means that, for accountability, value-based designs should be based on empirical data
  - In this sense, it is a design method firmly rooted on empirical user research
  - A central aspect of this approach is to involve users from early stage research via user research to late stage research through evaluation
- **Human-centricity** has a startling implication: the designer should be ready to not design when data suggests negative outcomes to users
- **Critical design** is the idea of recognizing ethical issues in design related to society, and using these as the basis for emancipatory activities

Design Cognition

Cognitive processes in design

- **Convergent thinking** attempts to improve existing solutions iteratively by making local adjustments rather than by considering more radical novel solutions
- **Divergent thinking** attempts to identify distant—novel—solutions, thus diverging from the solution at hand
- **Reconceptualizing problems** means rethinking defining elements of a design problem: what are the relevant objectives, constraints, viewpoints, and so on?
- **Reorganizing design situations** means designers facilitate cognition by organizing their external circumstances
  - This can involve externalizing thoughts, for example by the means of sketching, collaborative tools, or a design portfolio



General characteristics of design cognition

- Iteration
  - Design problems rarely have an apparent immediate solutions as many aspects of the design are likely to be vague in the beginning
  - Designers carry out cycles of combining known solutions and ideas into protosolutions, such as sketches, that can be evaluated and lead to further insight that can lead to new protosolutions, and so on
- Tight coupling between problems and solutions
  - Designers alternate between defining problems and generating solutions
- Awareness of the exploration–exploitation challenge
  - Designers deploy a variety of creative thinking methods to explore radically new ideas
  - Designers must decide whether to engage in divergent thinking (exploring) and convergent thinking (exploiting)
- Effect of experience
  - *Paradox of expertise*: even though producing multiple ideas is beneficial for creativity, experts often generate fewer ideas
  - However, their ideas tend to be better than those generated by novices
  - Experts generally focus more on redefining the problem
  - Experts are generally better at better strategizing when to explore and when to exploit

Heuristic thinking

- A **cognitive heuristic** is a rule of thumb used to identify a quick solution to a complex problem
- For example, if someone asks you to name a great design, you would be more likely to name something that comes to mind quickly, and recent designs you have experienced may be one of these designs you would suggest
- This particular heuristic is called the *availability heuristic*
- The catch with heuristics is that while they allow us to generate a solution quickly, they limit the visibility of other solutions
- This is known as **bias**
- While it allows quickly generating ideas, it can be a detrimental phenomenon in design where we want to produce new ideas

Biases

- Empirical research has exposed a number of biases caused by cognitive heuristics
- In general, a **bias** is the assignment of an undue weight to a particular idea or object
  - In the context of design, bias is a tendency to give a skewed subsample in a design space undue attention and significance
- Examples of biases
  - Availability: ideas that are readily available are given undue weight
  - Anchoring: the centering of a design solution around a known reference solution
  - Decoying: a reference point prevents us from seeing another solution behind it
  - Status quo: a tendency to give undue weight to a prevailing or well-known solution
  - Bandwagon: we observe our peers choosing a particular solution and we feel an urge to follow a similar solution path

Design fixation

- **Fixation** is a concept in psychology that means obsession with an idea or person
- **Design fixation** means being mentally locked to a particular solution and being unable to generate alternatives
- While bias is an undue tendency towards a particular subspace in the design space, fixation is stronger and more constraining: it is an inability to release the idea of a particular solution

- Fixation limits our ability to explore the design space more broadly

Breaking design fixation

- Design fixations are difficult to break
  - After investing effort into producing a particular solution, the alternatives can be perceived as riskier, less desirable, or involving too much effort
  - We tend to stick to conveniently available solutions that we are familiar with
  - Designers may not even be aware or notice their own design fixation
  - Even expert designers exhibit design fixation
- Breaking design fixation
  - Successful designers actively create new reference points, and collect and curate example designs for this purpose
  - Creative methods are systematic ways to explore directions in a design space
  - Designers also seek ideas from metaphors and analogues
  - Sometimes taking a creative break help: breaks can help incubate ideas
  - Designers also seek inspiration from art and nature
  - Computational methods can help explore design spaces prompted by a given design example

Generating solutions

- **Problem solving** is a general concept that was popular in early years of design research for understanding how designers generate and refine solutions
- Problem solving refers to the process of generating candidate solutions to meet objectives and constraints stated in a brief
- To generate some form of solution, one first needs to define what it is a solution for
- This requires a well-defined **design task**

Well-defined design task

- **Design decisions:** the open decisions that must be decided toward a design
- **Design space:** the set of all designs to be considered, as implied by any currently open design decisions
- **Objectives:** properties that an acceptable design must possess, such as those related to ease of use, cognitive workload, or manufacturing costs
- **Constraints:** hard limitations and requirements on the design
  - For example, in a menu design task we can insist that all commands must be placed within the menu
  - Budgets and software pose typical constraints in interaction design

Problem solving approaches

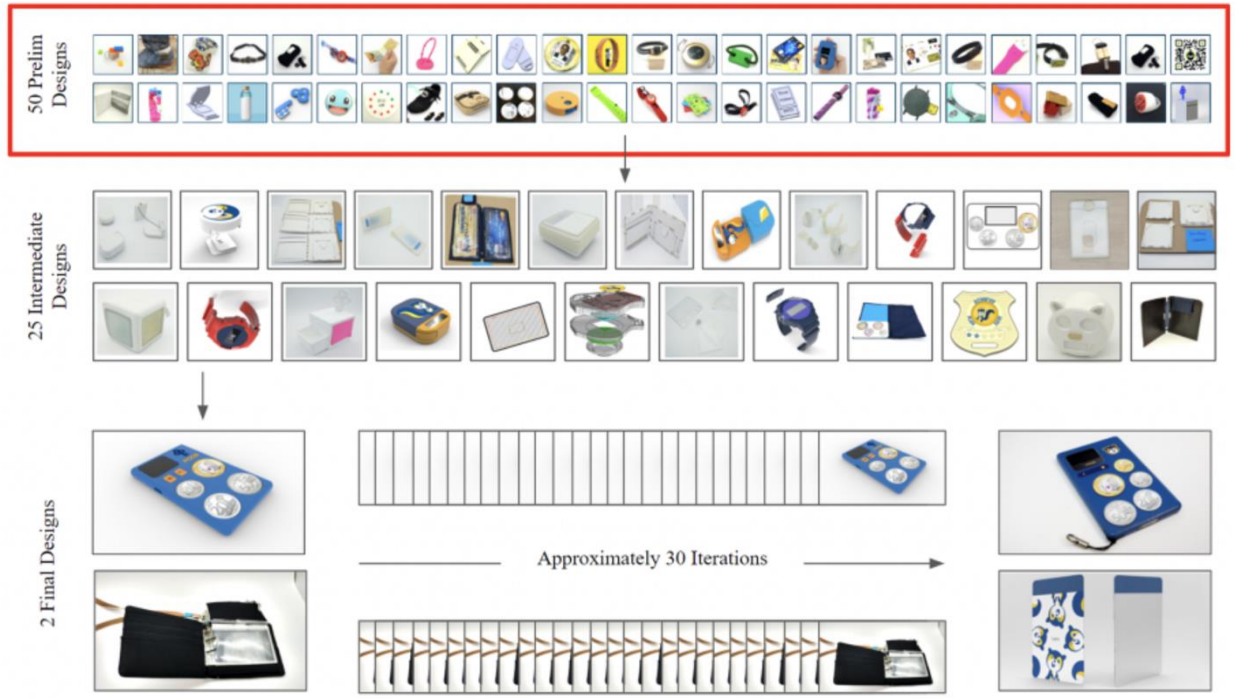
- Ideally, problem solving can be carried out through *optimization*
  - When all constituents of a design task can be precisely defined, the solution generation process reduces to a search process that systematically searches the design space using some form of rule or method
- However, an optimization process rarely works in practice
  - When searching for solutions, the designer must overcome bias and fixation to explore the design space broadly
  - The designer must decide how to divide time between (1) refining a known and promising solution (convergent thinking) versus (2) exploring novel options (divergent thinking)
  - Most problems are also vaguely defined to begin with

Generating creative ideas

- A key challenge in design is the creation of a creative idea
- **Creativity** refers to the ability to produce ideas or artefacts that are both novel and valuable
- A creative idea should contain an element of surprisal
  - Creative ideas can be unconventional and challenge existing solutions
  - They can involve a novel, insightful formulation of the problem itself
- Unfortunately, generating creative ideas is hard
  - Fixation and bias means it is difficult to arrive at novel ideas
  - In addition, ideas must be **valuable**
- The need for both **novelty** *and* **value** make idea generation challenging
  - On the one hand, the designer must create surprises
  - At the same time the designer must take into consideration what is considered valuable by relevant stakeholders, as informed for example by results from user research

Creative thinking

- A quality of creative thinking is that *quantity drives quality*
- In practice, designers alternate between generation, evaluation, and reflection:
    1. Generate as many low-fidelity candidates as possible, even up to 100 sketches per hour; suspend criticism to a later stage
    2. Select candidates by evaluating them against defined objectives
    3. Reflect on progress and try to find alternative approaches
    4. If needed, refine the problem description
    5. Iterate until satisfied



Designs produced in a project exploring the concept of the "cashless society" as part of Singapore's Smart Nation project.

E. Tiong, O. Seow, B. Camburn, K. Teo, A. Silva, K. L. Wood, D. D. Jensen, and M. C. Yang. The economies and dimensionality of design prototyping: value, time, cost, and fidelity. *Journal of Mechanical Design* **141**(3):031105, 2019.

Ideation methods

- Creative ideation requires producing alternative ideas that are of high quality
- A survey of idea generation practices found that brainstorming, function (or morphological) analysis, scenarios, conceptual maps, checklists, analogues, metaphors, and storyboards are the eight most commonly used ideation methods among professional designers
- Across these methods, idea-generation follows the quantity-drives quality principle of expansion followed by selection
  - *Expansion*: designers seek to generate several alternatives using generative ideation techniques, such as sketching and brainstorming
  - *Selection*: designers critique, evaluate, elaborate, and discuss ideas for further selection
- Idea generation methods have three dimensions:
  - How far associations are sought: the further the associations, the more novel ideas can be generated; though the proportion of valuable ideas tend to decrease the more distant the ideas are from known solutions
  - How other people are involved: the number of people and use of a moderator
  - Use of different representations: sketching is visuo-spatial while brainstorming uses verbal representations

Example: brainstorming

- **Brainstorming** is one of the most widely used idea-generation methods among creative professionals
- Principles:
    1. Postpone criticism: withholding criticism means the team can avoid throttling the generative process
    2. Divergence: encourage wild, diverse ideas
    3. Quantity: try to produce as many ideas as possible
    4. Accumulation of knowledge: it is acceptable and encouraged to build on proposed ideas and known solutions
    5. Equal significance: every participant and every idea is equally valuable
- To avoid becoming *biased* by others' ideas when brainstorming in a team, individuals are often provided time alone to think about solutions
- Another practice is naming a facilitator that is tasked with keeping time and assisting the team in sticking to agreed upon principles

Ill-defined and wicked problems

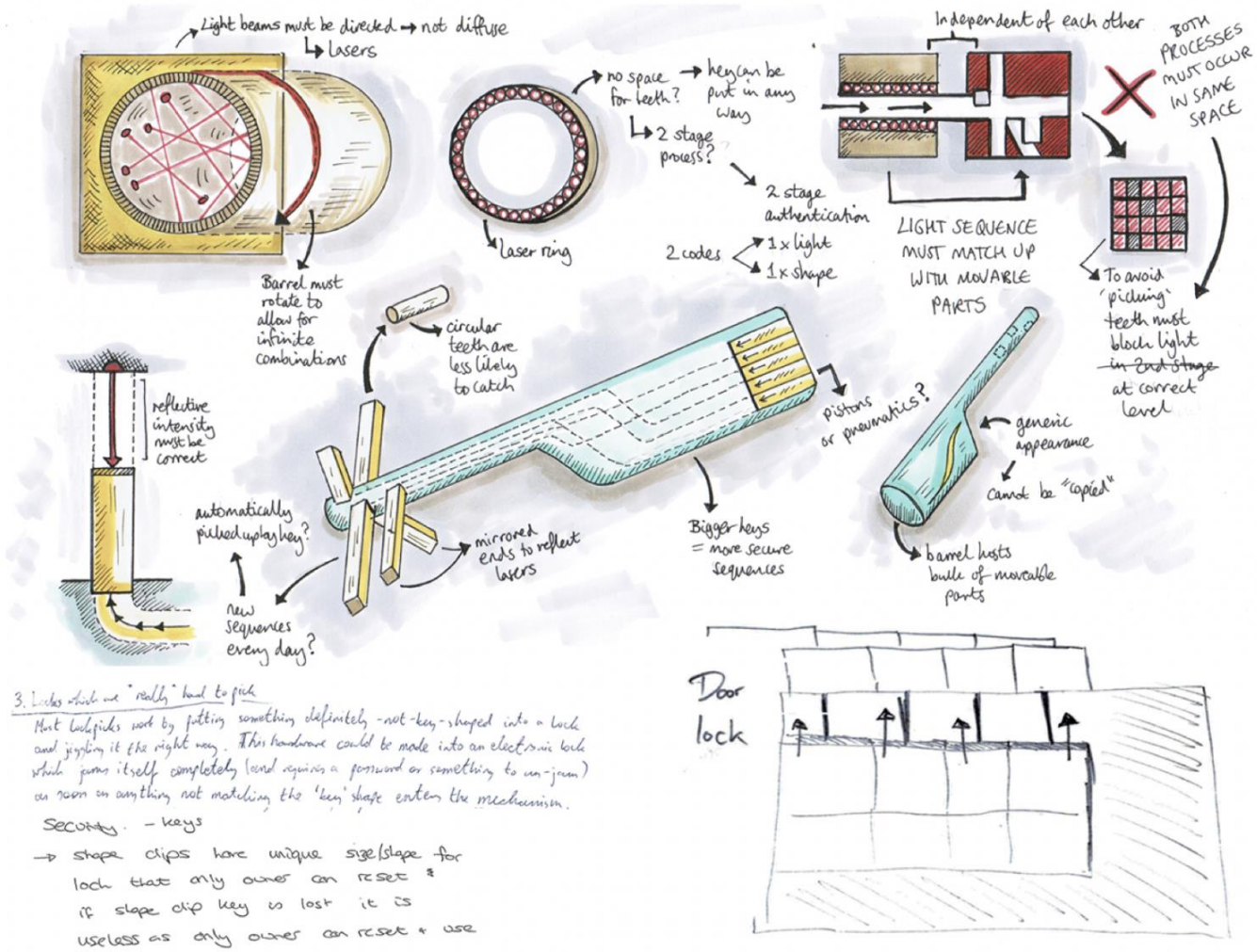
- A common challenge designers face is that design briefs given to them are *ambiguous*: they do not specify the elements of a task
- For example, imagine you were asked to “innovate a new style to interact” with a particular webpage
  - What exactly is the meaning of *new* or *style*?
  - It is not meaningful to talk about problem solving if the design task is not properly defined
- An **ill-defined problem** has no clear objectives, or has too many constraints that may be mutually dependent in some complex or unknown manner
  - Ill-defined problems may also fail to capture example solutions, resulting in the unavailability of a default design at the outset
- An extreme version of ill-defined problems is a **wicked problem**, where such unfavorable properties are extreme to such an extent that the problem-solution alignment is not a meaningful question to ask
  - An example of a wicked problem is ”Devise a means to eliminate homelessness in society”

Goal refinement

- To avoid ill-defined problems it is necessary for designers to focus on properly defined objectives and constraints
- This can be achieved by iterative refinement in a process called **goal refinement**
- Designers take perspectives to redefine the problem and reinterpret it in the light of a potential solution under consideration
  - This may involve relaxing assumptions, or refining them in light of knowledge and insight gained by considering a potential solution
  - Designers study technical and organizational materials to understand the constraints, and discuss them with relevant stakeholders
- Ensuring objectives and constraints are defined to an appropriate degree is an important challenge of design
- Poor work in this regard will not only affect the quality of the outcome, but also the designer's ability to communicate the purpose of the design, convince stakeholders, and present rationale and evidence
- The lack of clear, agreed-on objectives also implies that there is no stopping rule

Sketching

- **Sketching** is an idea generation method that uses visual representations, which is natural across many areas of interaction design
- Like brainstorming, ideation in sketching should be done quickly, focusing on quantity over quality
- Sketching should also use clear vocabulary, including visual conventions, for example, techniques for drawing user interface elements
- A sketch should not be of higher resolution than required for the intended purpose
- Sketching has a role in *both* convergent and divergent thinking: generating ideas and refining them



Sketches of shape-changing keys produced by a researcher and a study participant. The sketches explore different ways of constructing a key with desired properties, avoiding it to become too bulky or requiring charging.

M. Sturdee and J. Lindley. Sketching & drawing as future inquiry in HCI. In Proceedings of the Halfway to the Future Symposium 2019, pages 1–10, 2019.

Design Practice

Design is complex

- Designers have difference practices when designing
- Such design practices have evolved as designers need to manage **complexity**
- There are at least six reasons for a variety of design practices:
  1. Designers need to renew themselves to be **creative**
  2. Design has multiple **objectives** and **constraints**
  3. Design choices are made under **uncertainty**
  4. Design is affected by many **contextual factors**
  5. Design projects consist of many **stakeholders**, **materials**, and **documents**
  6. Design is a **multi-disciplinary**, **collaborative** effort

Example: practices of user involvement

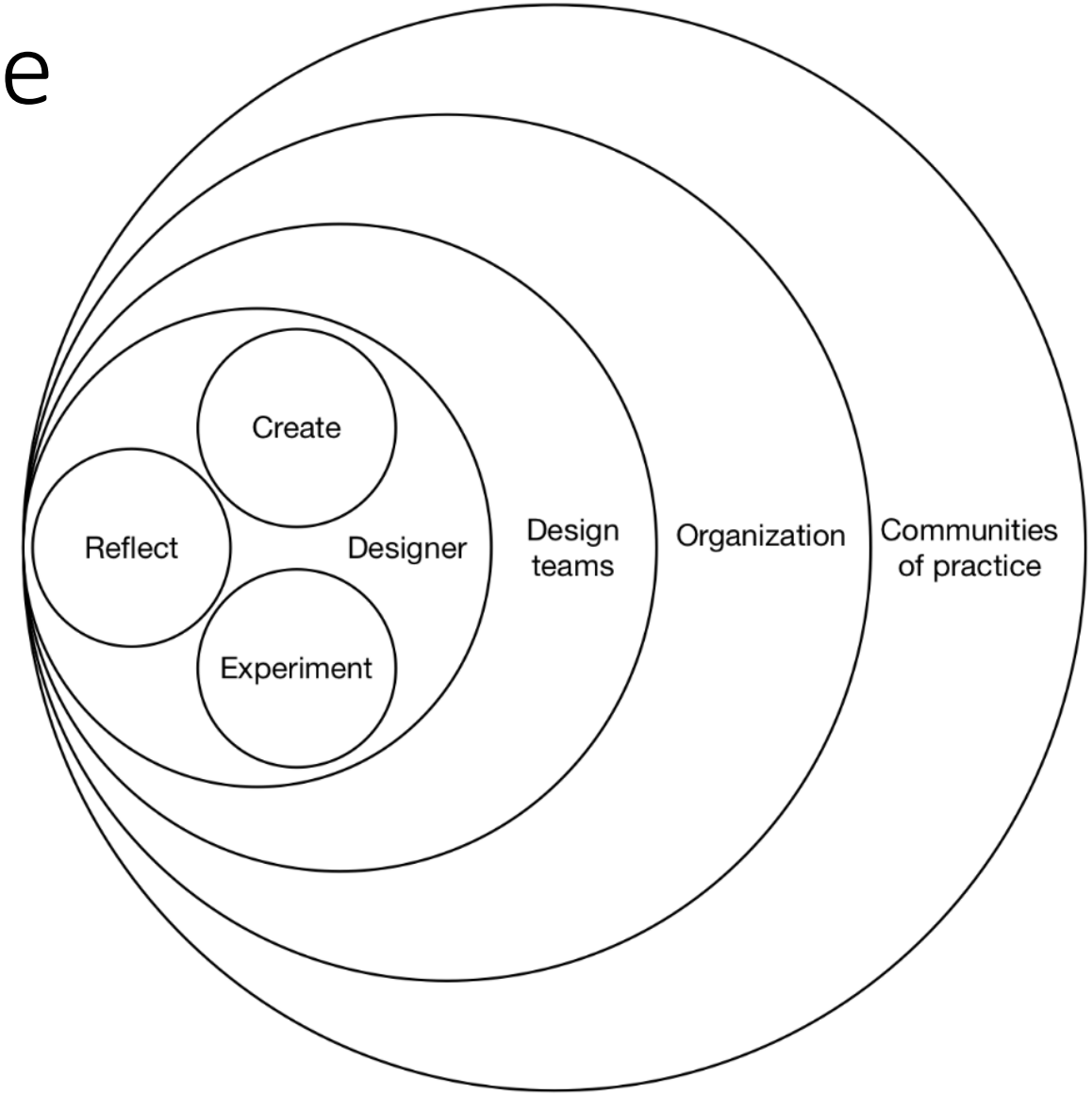
- To learn about the practices of user involvement, a mixed-methods study was carried out in a small department of a larger organization
- The department consisted of a number of internal sections, each with its own responsibilities, practices, and tool
- The findings, through eight weeks of interviewing and observation, was that in order to ensure user involvement, the design team had to tackle the five challenges to the right
- *Conclusion*: being user-centered is much harder than it sounds

1. *Motivate not only managers but all stakeholders that user involvement is beneficial*
2. *Decide what a "representative" user means:*
   - *Convincing others that the most representative users are not the ones who know most about the existing system*
   - *The designers themselves had not fully understood the organizational context of the project*
3. *Nominate a champion of user involvement to influence the design process, motivate people, and organize the design activities*
4. *Contact and keep selected users engaged, informed, and educated about the process*
5. *Manage expectations by ensuring that the people involved understand that users are not treated as designers*

S. Wilson, M. Bekker, P. Johnson, and H. Johnson. Helping and hindering user involvement—a tale of everyday design. In Proceedings of the Conference on Human factors in Computing Systems, pages 178–185, 1997.

Spheres of design practice

- The individual designer's practices in creating novel ideas, experimenting, and growing as a designer via reflection and critique
- The participatory practices in teams and within an organization
- Collaboration with peers and communities of practice



Prototyping

- Prototypes are used in HCI for two main purposes:
  1. Studying the feasibility of an idea by creating it
  2. Presenting an idea in a concrete form for others, such as users and colleagues, to experience and test
- Design research distinguishes a continuum of prototyping fidelity:
  - Low-fidelity prototypes, such as paper prototypes or prototype made with rapid prototyping tools
  - Medium-fidelity prototypes include more details about each element, such are their type, color, and position
  - High-fidelity prototypes are best-effort simulacra of the final product and cover key details that affect interaction in selected prime scenarios

Prototypes developed to explore how children could carry out electronic payments.

E. Tiong, O. Seow, B. Camburn, K. Teo, A. Silva, K. L. Wood, D. D. Jensen, and M. C. Yang. The economies and dimensionality of design prototyping: value, time, cost, and fidelity. *Journal of Mechanical Design* **141**(3):031105, 2019.

Example: getting more out of prototyping

- Prototyping is a practice that helps understand problems more deeply
  - However, it is often difficult to justify the value of prototyping to others
  - From an organizational point-of-view, prototyping is time- and resource-intensive
- Here are five practices for scaling up prototyping to larger projects

1. *Test core concepts quickly with low fidelity prototypes, but try to increase the fidelity of prototypes*
2. *Use maker tools and DYI design to produce prototypes within the team, as opposed to outsourcing prototyping*
3. *Augment non-prototypable functions with videos and other types of multimedia to help communicate the point*
4. *Use higher-fidelity prototypes to do systems testing by conducting simple tests*
5. *Use real data if possible when simulating how the system works with the prototype*

E. Tiong, O. Seow, B. Camburn, K. Teo, A. Silva, K. L. Wood, D. D. Jensen, and M. C. Yang. The economies and dimensionality of design prototyping: value, time, cost, and fidelity. *Journal of Mechanical Design* **141**(3):031105, 2019.

Reflection and critique

- **Reflective practice** is about developing and transforming one's ways of thinking and doing, divided into two dimensions:
  - **In-action vs. out-action:** reflections that occur while designing (*in*) versus reflections outside of design (*out*)
  - **Remembering vs. gathering:** Reflection that focuses on the past versus the collection of new materials
- A **design rationale** is a statement about the reasons why a particular decision was made in design
  - Among other things, it can explicate reasons for rejecting other choices
- **Design critique** is a practice of reflection, evaluation, knowledge sharing, and accountability
  - Designs are critiqued by peers in so-called *crits*
  - Crit sessions are important for the growth of competence and for forming a design identity

Collaboration in design

- Design is almost always teamwork
  - A designer needs to work not only with other designers but with a number of other professionals from other fields
  - A regular project team in information technology consists of 10–20 members, of which two to three are tasked with user-centered design
- To enable multidisciplinary collaboration, team members need to **emphasize** with different viewpoints, develop a joint **language** for communicating ideas, and take different **roles** flexibly
- Organizational setting drives designers to work with at times debilitating constraints
  - At times this can be contradictory to their own aims at producing high quality outcomes
  - The pressure to deliver results may drive designers to forgo healthy criticism

Example: design thinking can reduce bias in management and improve quality of outcomes

- **Design thinking** is the idea of bringing designers' approaches to bear on problem solving also outside of design, including approaches such as observation, collaboration, rapid prototyping, and visualization of ideas
- The key assumptions are:
    1. Defining a problem is often more valuable for innovation than seeking a solution
    2. A focus on users early on decreases risk related to innovation failure
    3. Such understanding must be translated into criteria to guide design and evaluation
    4. Iteration is necessary for success

- Design thinking can:
- Mitigate **egocentric bias**: the tendency of managers to focus on values and experiences familiar to themselves, by collecting data on users that help them take perspectives
- Mitigate **confirmatory bias**, or the tendency of managers to look at opportunities they already know are valuable, by revealing results of real experiments and user studies
- Mitigate **availability bias**, or the tendency to prefer those ideas that quickly comes to mind, by showing the diversity of options concretely via user data

J. Liedtka. Perspective: Linking design thinking with innovation outcomes through cognitive bias reduction. *Journal of Product Innovation Management* **32**(6):925–938, 2015.

Communities of practice

- **Communities of practice** are groups of people who share an interest and interact regularly to become better at it
- **Design communities** are local organizations or internet-mediated collectives focused on different topics in design
  - They share experiences, samples, patterns, code, and so on
  - For practitioners, design communities offer a channel to find guidance on design problems, share experiences, and develop professionally
- **Design forums** are online discussion forums that allow asking questions, learning from others, and contributing to the community
- **Design systems** are organizationally developed coherent systems for producing high quality designs in an area
  - They contain values (“philosophies”), rules, and samples
  - Many larger design teams develop their own systems collectively

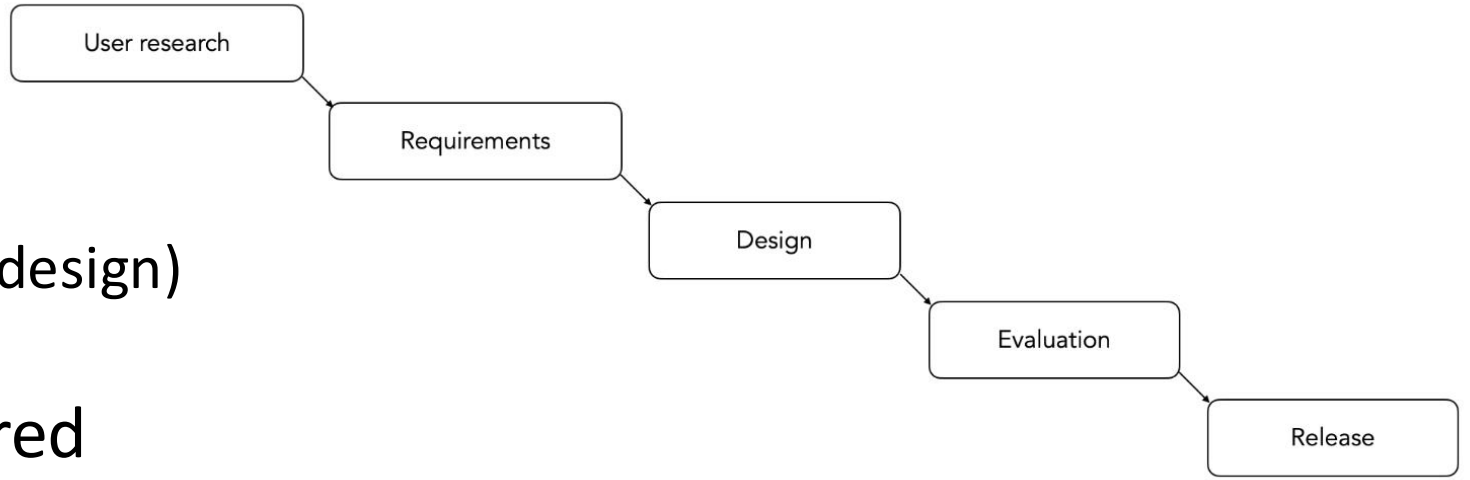
Design Processes

Design process

- A **design process** defines a structure and practices for carrying out design projects in an organization
- **Process models** also often define practices—"the ways of the house"
- The main purpose of a process is to ensure a certain level of quality in the way a project is carried out and in the outcomes it produces
  - To this end, processes can set **criteria** that define acceptable levels of quality in execution, outcomes, or both
- **User focus:** setting user-related end goals by ensuring success criteria for a project are defined in terms relating to the user
- **Iteration:** recognizing that perfect solutions are practically impossible to create in a single shot, HCI's process models integrate iterative design at their heart
- **Evaluation with users:** the suitability of a design is demonstrated by reference to empirical or other evaluation that involves users

User-centered design processes

- **User-centered design processes** share four core phases:
  - User research
  - Formation of design goals (requirements)
  - Generation of design ideas (design)
  - Evaluation
- There are many user-centered design processes, the simplest being the waterfall model shown to the right



The waterfall model assumes a logical flow of information from user research to eventual release of software. Before the onset of the project, minimum criteria are defined to the different stages. However, the model has been criticized for neglecting the important role of iteration in design.

Usability engineering

- The **usability engineering** lifecycle is perhaps the most successful user-centric process model with an impact on software engineering processes
- It is a *lifecycle model* to help developers not only launch products but to keep them updated
- It is one of the most widely used process models in industry
- However, it has attracted serious criticism:
  1. Limited support for design as a creative activity: little help is provided on *how* to produce design ideas
  2. Glorified trial and error: usability engineering is theoryless and does not embrace theoretical knowledge in any significant form

The ten phases of usability engineering

1. **Know thy user:** perform user research
2. **Competitive analysis:** analyze existing products to understand their design
3. **Setting usability goals:** learnability, efficiency, re-learnability (ability of infrequent users to return to use the system without having to learn it all over), user errors, and subjective user satisfaction
4. **Design stage:** produce a usable implementation that can be tested and, if successful in meeting the goals, deployed
5. **Coordinated design:** consistency of the interface with other products and versions is a key to achieve high learnability
6. **Guidelines and heuristics:** rules-of-thumb help designers ensure a minimum level of quality and assist them in pursuing consistency
7. **Prototyping:** develop prototypes for testing
8. **Empirical user testing:** use the prototypes to empirically test whether the usability goals have been achieved
9. **Iterative design:** iteratively improve the prototype until it meets the stated goals
10. **Collecting feedback from the field:** log data, customer reviews etc. should be collected to continuously track usability as the users and the market evolve

Agile development

- **Agile development** processes arose as a response to the felt shortcomings of traditional software engineering process model
- The central idea is that if you discover a new idea or problem during a project, it would be unwise not to consider changing direction
  - Consequently, agile methods put the emphasis on design sprints over requirements-based engineering
- Agile processes focus on rapid iteration: *design sprints*
- HCI methods play a central role in many agile projects
  - A survey of 92 developers using agile methods found that HCI methods are integrated into their processes
  - The most used methods are anything that can be done quickly during a sprint, such as low-fidelity prototyping, concept designs, rapid observational studies, and heuristic evaluations

Z. Hussain, W. Slany, and A. Holzinger. Current state of agile user-centered design: a survey. In Symposium of the Austrian HCI and Usability Engineering Group, pages 416–427. Springer, 2009.

Human factors engineering

- **Human factors engineering** refers to the design and construction of safe and reliable technological systems
- Unlike other user-centered design processes, it puts a greater emphasis on **safety**
- There is a greater emphasis of identification and mitigation of **human error** in design
- It frequently consists of five stages that are iterated until the requirements are met
- It differs from other process models in one defining aspect: design is about affecting psychological variables, such as a person's workload, or feeling of trust, or perception
- This enables designs to selectively reduce the possibility of error

1. **Ideation:** using methods such as use cases and personas to ideate cases for new features or devices
2. **Requirements:** using empirical methods such as field studies and analytical tools such as task analysis to analyze use environments and work
3. **Design:** in addition to sketching and prototyping, using theories from cognitive psychology as further justification for design decisions
4. **Testing:** making use of usability tests, heuristic analyses, cognitive walkthroughs, and other methods to directly measure whether original requirements are met
5. **Maintenance:** reviewing and reacting to adverse event reports, for example accident analyses

- Open access (PDF at link)
- Further reading:
  - Part VI: Design
  - Chapters 30–33