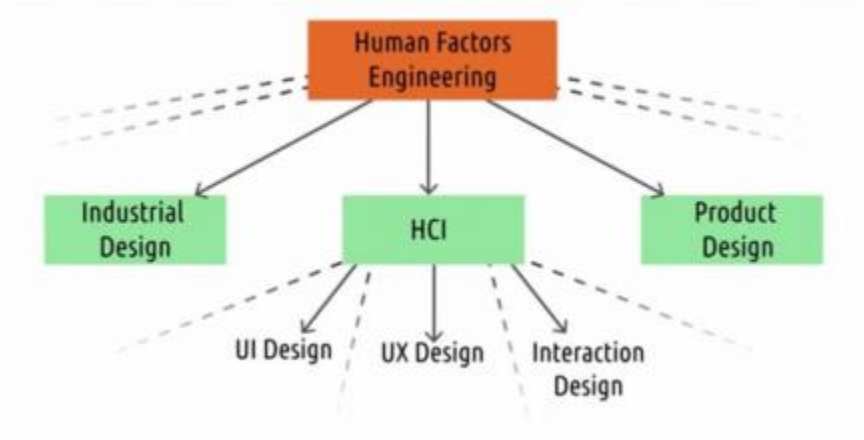
This is a document that we've split for the people who joined the study session. That guarantees that the study guide will be filled out for all sections but anyone can join and add what they feel is missing or important to any section. Definitely post in discord if you would like to join the next study session, which we plan to have at 8PM PST / 11PM EST on Friday (3.5.21). Countdown: https://itsalmo.st/hci-prep-vk5q

There is a question section on the last page.

Week 1

1.1 Intro to HCI

- Human interaction is related to tasks, Interfaces mediate interactions.
- Our goal in HCI is to make interfaces invisible, which means humans can then focus on the task and not the interface.
- 

1.2 Intro to CS6750

- Learning Goals - What you will know at the end of the course
    - Understand the common principles of HCI
    - Understand the design life cycle
    - Understand current applications of HCI
- Learning Outcomes - What you will be able to do at the end of the course
    - Be able to design effective interactions between humans and computers
        - Design
            - Applying known principles to a new problem

            - An iterative process of needfinding, prototyping, evaluating, and revising
        - Effective Interactions - Depends on the goals
            - Usability
                - Letting the users create the outcome they want easily
            - Research
                - Investigating what people like and dislike about interfaces
            - Change
                - Changing the activity for a specific reason
- Learning Strategies - How they plan to actually impart that knowledge to you
    - Learning by Example
        - Every lesson and, in fact, this course, as a whole. Is organized around a collection of running examples that will come up over and over again.
    - Learning by Doing
        - Throughout the course we'll ask you to engage in designing interactions to solve different problems in different contexts.
    - Learning by reflection
        - Reflect on times when you've encountered these things in your own everyday life
    - Peer Learning
        - Learning from others
    - Collaborative Learning
        - Learning with others
    - Learning by Teaching
        - Teaching others
    - Communities of practice
        - Group of people who share a common concern, a set of problems, or an interest in a topic and who come together to fulfill both individual and group goals.
    - Project based Learning
- Learning Assessments - How they will evaluate whether you can do what we want you to be able to do and understand what we want you to understand
    - Design effective interactions between humans and computers.

    - Small scale tasks, recommending improvements to existing interfaces or undertaking some small design challenges.
    - Individually working on bigger design challenges
    - Merge into teams to prototype and evaluate a full solution to the challenge you chose
    - Evaluated not just on the final design you generate but on the process by which it was generated

1.3 Exploring HCI

- Application Areas
    - Technologies
        - Virtual Reality
        - Augmented Reality
        - Ubiquitous Computing and Wearables
        - Robotics
        - Mobile
    - Domains
        - Special Needs
        - Education
        - Healthcare
        - Security
        - Games
    - Ideas
        - Context-sensitive Computing - Equipping user interfaces with historical, geographical, or other forms of contextual knowledge
        - Gesture-Based Interaction
        - Pen and Touch based Interaction
        - Information Visualization
        - Computer-Supported Cooperative Work - Using computers to support people working together
        - Social Computing - How computers affect the way we interact and socialize

MacKenzie, I.S. (2013). Chapter 1: Historical Context. *Human-Computer Interaction: An Empirical Research Perspective*. (pp. 1-26). Waltham, MA: Elsevier.

Norman, D. (2013). Chapter 1: The Psychopathology of Everyday Things. In *The Design of Everyday Things: Revised and Expanded Edition*. (pp. 1-36). Arizona: Basic Books.

https://edstem.org/us/courses/3826/discussion/208668

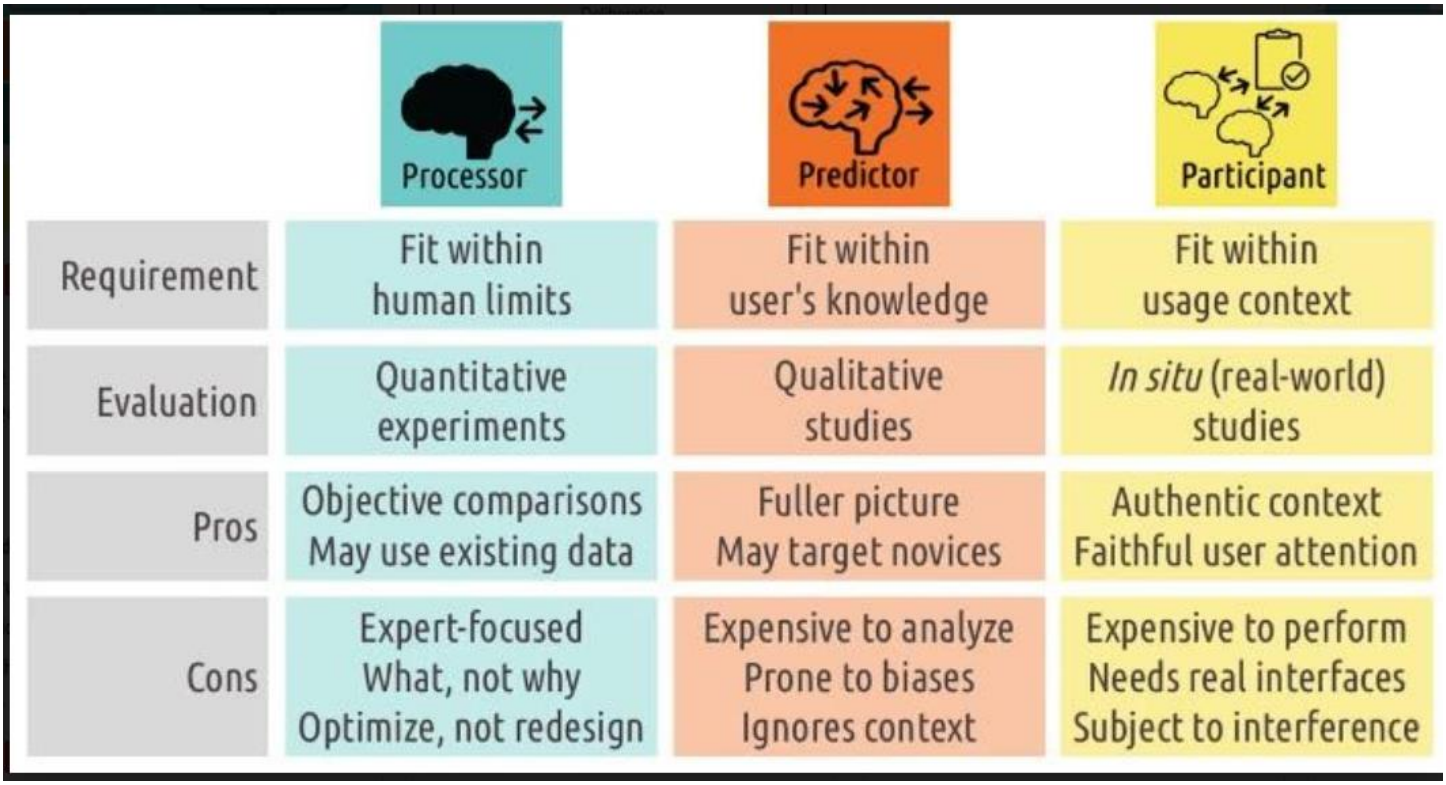
Week 2

2.1 Introduction to Principles

- You are not your user
- Keep in mind the difference between useful(low bar, can be used to help complete some task) and usability (ease of use)
- Different roles of user
    - Processor - a user just takes in input and produces output
        - main thing to remember the interface must fit within human limits(see, hear, etc.)
        - Evaluated by quantitative experiments
        - People:
            - John B. Watson - main
            - Pavlov, Skinner
            - Founded on beliefs of **testing observable behavior**
    - Predictor - want user to be able to predict what will happen as result of actions
        - Main thing - fit within user's knowledge
        - Evaluated by qualitative studies out of context
        - Gulf of evaluation/execution are main components of this
        - People:
            - Kant
            - Descartes
            - Chomsky, Carey, McCarthy, Minsky, Newell, Simon
            - Founded on beliefs of trying to figure out **what does the user predict**

- Participant: takes into account the user and the environment the task is preformed in (though this is not as defined)
    - Must fit within context
    - Evaluated by studies in context
    - People:
        - Hutchins
        - Suchman
        - Salomon
        - Nardi

Comparison

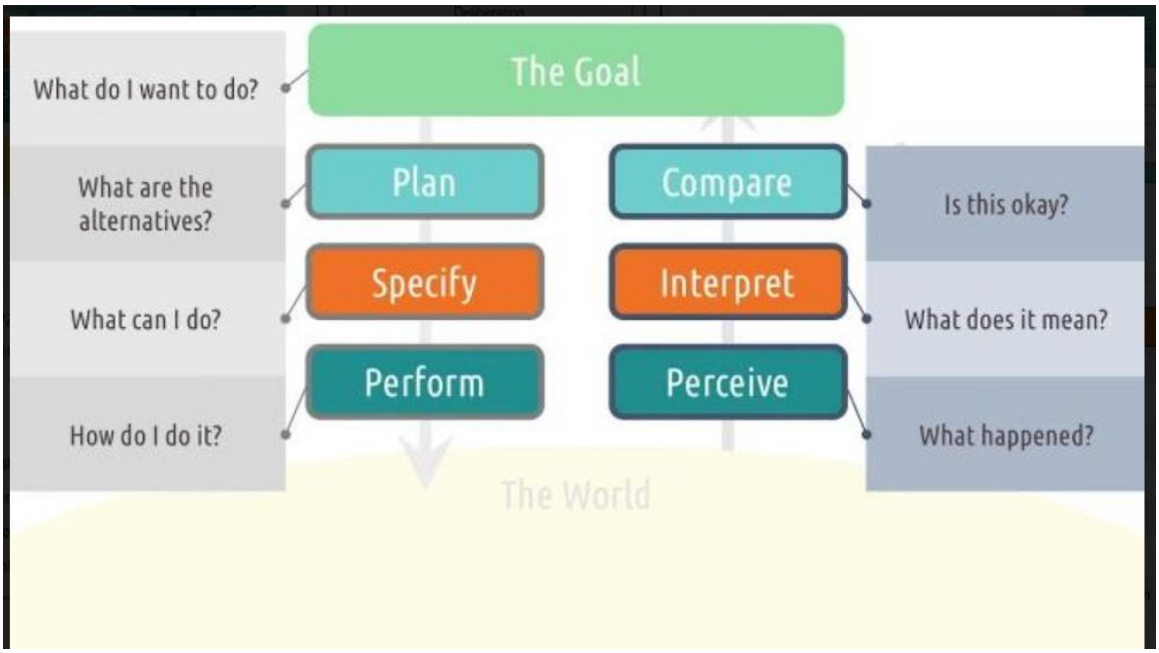


	Processor	Predictor	Participant
Requirement	Fit within human limits	Fit within user's knowledge	Fit within usage context
Evaluation	Quantitative experiments	Qualitative studies	*In situ* (real-world) studies
Pros	Objective comparisons May use existing data	Fuller picture May target novices	Authentic context Faithful user attention
Cons	Expert-focused What, not why Optimize, not redesign	Expensive to analyze Prone to biases Ignores context	Expensive to perform Needs real interfaces Subject to interference

These models aren't mutually exclusive, different phases of the design require different model requirements

2.2 Feedback Cycles

I would say this below diagram is probably one of the most representative slides for this series of lectures; a lot of it is just examples.



Norman, D. A. (1986). Cognitive engineering. In D. A. Norman & S. W. Draper (Eds.) *User-Centered System Design: New Perspectives on Human-Computer Interaction*. (pp. 32-61). Hillsdale, NJ: Lawrence Erlbaum Associates.

- Theory of action
    - How do people actually do things?
    - Gulf of execution : intention formation, specifying the action sequence, executing the action, and, finally, making contact with the input mechanisms of the interface.
    - Gulf of evaluation: starting with the output displays of the interface, moving to the perceptual processing of those displays, to its interpretation, and finally, to the evaluation-the comparison of the interpretation of system state with the original goals and intention.
    - The seven steps : Establishing the Goal, Forming the Intention, Specifying the Action Sequence, Executing the Action, Perceiving the System State, Interpreting the State, Evaluating the System State with respect to the Goals and Intentions
    - However “Real activity does not progress as a simple sequence of stages. Stages appear out of order, some may be skipped, some repeated.”
- “Think of a conceptual model of the system as providing a scaffolding upon which to build the bridges across the gulfs. “
- “First, there is the conceptualization of the system held by designer[Design Model]; second, there is the conceptual model constructed by the user[User’s Model]; and third, there is the

physical image of the system from which the users develop their conceptual models. [System Image]“

- Directness is of big importance in bridging the gulfs
- A point he discusses is the user having “the feeling of control” because good design systems are viewed as “tools”
- “Start with the needs of the user”

Norman, D. (2013). Chapter 2: The Psychology of Everyday Actions. In *The Design of Everyday Things: Revised and Expanded Edition*. (pp. 37-73). Arizona: Basic Books.

https://edstem.org/us/courses/3826/discussion/214303

- “The Gulf of Evaluation reflects the amount of effort that the person must make to interpret the physical state of the device and to determine how well the expectations and intentions have been met”
- “We bridge the Gulf of Execution through the use of signifiers, constraints, mappings, and a conceptual model. We bridge the Gulf of Evaluation through the use of feedback and a conceptual model. ”
- “This is called a root cause analysis: asking “Why?” until the ultimate, fundamental cause of the activity is reached.”
- Different types of behavior: goal-driven(starts with goal and then goes through execution) or event-driven(cycle starts with environment then goes through evaluation)
- “Most of human behavior is a result of subconscious processes. We are unaware of them. As a result, many of our beliefs about how people behave—including beliefs about ourselves—are wrong”
- “Cognition and emotion can’t be separated”, “Cognition attempts to make sense of the world: emotion assigns value”
- Conscious(careful comparing, rationalizing, finding explanations) vs Subconscious thought(biased towards regularity and structure)

- Discusses a lot about the different types of processing/thought

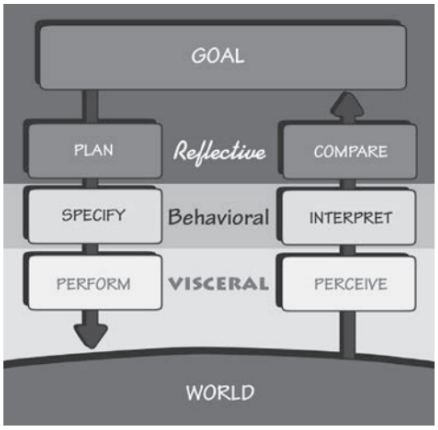


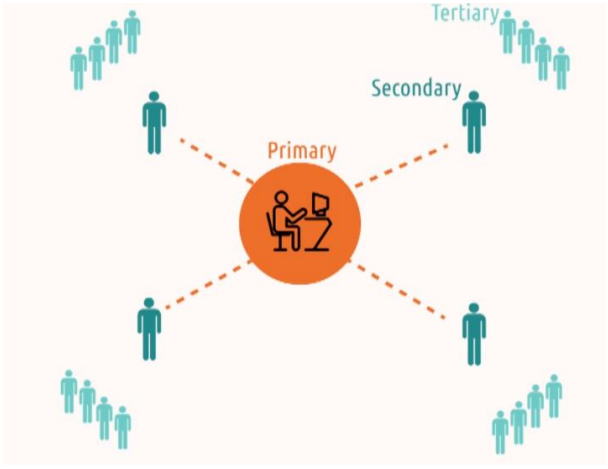
FIGURE 2.4. Levels of Processing and the Stages of the Action Cycle. Visceral response is at the lowest level: the control of simple muscles and sensing the state of the world and body. The behavioral level is about expectations, so it is sensitive to the expectations of the action sequence and then the interpretations of the feedback. The reflective level is a part of the goal- and plan-setting activity as well as affected by the comparison of expectations with what has actually happened.

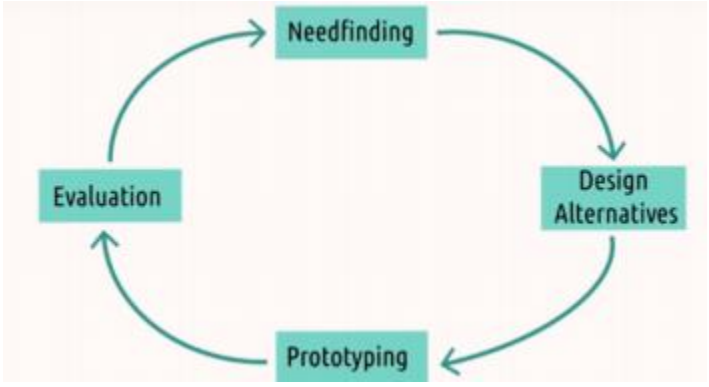
- Csikszentmihalyi - the “flow” state
- People commonly have incorrect conceptual models
- Human error should be system error

Week 3

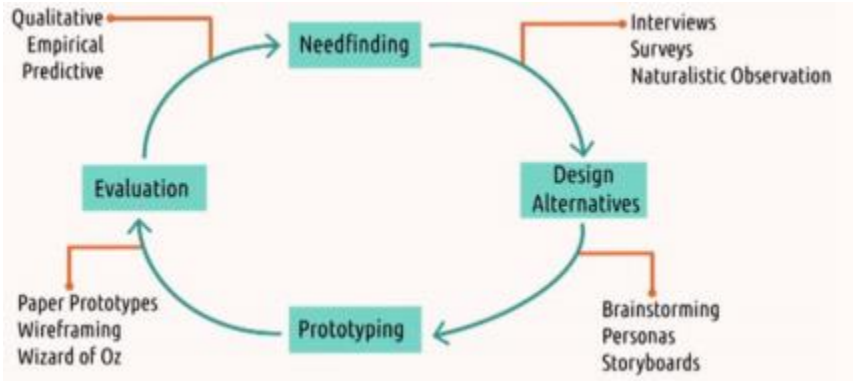
3.1 Intro to Methods

- User-centered design - Design that considers the needs of the user throughout the entire design process. **“You are not your user”**
    - 6 Principles created by International Standards Organization
        - The design is based upon an explicit understanding of users, tasks and environments. We must gather information about the users, the tasks they perform, and where they perform those tasks, and we need to leverage that knowledge throughout the design process.
        - Users are involved throughout design and development
        - The design is driven and refined by user-centered evaluation
        - The process is iterative. Designs undergo constant iteration and improvement, even after being released

        - The design addresses the whole user experience
        - The design team includes multidisciplinary skills and perspectives. Good teams for pursuing user-centered design include people with a number of different backgrounds, like psychologists, designers, computer scientists, domain experts, and more.
- Stakeholders - Users affected by your interface
    - Primary - Those who use the tool directly
    - Secondary - Might interact with output
    - Tertiary - Affected by existence of the tool
    - 

- Design Life Cycle
    - 

    - Needfinding
        - Gather a comprehensive understanding of the task the users are trying to perform. That includes who the user is, what the context of the task is, why they're doing the task, and any other information related to what we're designing.
    - Design Alternatives

        - Develop multiple design alternatives. These are very early ideas on the different ways to approach the task
    - Prototyping
        - Take the ideas with the most potential and build them into prototypes that can ne put in front of a user
    - Evaluation
        - Take our ideas that we prototyped and put them in front of actual users. We get their feedback, what they like and what they don't like, whatworks, what doesn't
    - Repeat the cycle
    - 

    - Qualitative Data - 'What'
        - Observations described or summarized numerically
        - Supports formal test, comparison, and conclusions
        - Str small class of things
    - Qualitative Data - 'How' or 'Why'
        - Observations described or summarized non-numerically
        - Supports and kind of response or observation
        - Descriptions, accounts, observations, often in natural language.
        - Prone to biases
        - Broad viewpoint

3.2 Ethics and Human Research

- Unethical experiments that lead to creation of Institutional Review Board
    - Milgam's obedience experiment

        - Participants were tricked into thinking that they had administered lethal shocks to other participants to see how obedient they would be.
    - Tuskegee syphilis study
        - Rural African American men were intentionally injected with syphilis to study its progression.
    - Stanford prison experiment
        - Participants were psychologically abused to test their limits or test how they would act under different circumstances.
- These experiments led to passing the National Research Act of 1974, which led to the creation of institutional review boards to oversee research at universities.
- The Belmont Report further summarizes basic ethical principles that research must follow in order to receive government support.
    - Respect for Persons
        - Treating people as autonomous and protecting those with diminished autonomy
    - Beneficence
        - Minimizing potential harms and maximizing benets of participation
    - Justice
        - Distributing benefits/risks fairly
- Steps for creating a protocol
    - A protocol is a description of a particular research project. It outlines the procedures that the IRB has approved regarding consent, recruitment, experimentation and more
    - Basics
        - Title
        - Certified Personnel
        - Description
    - Research Design and Methodology
        - What will the subjects experience or their conditions
        - Data collection methods
        - Risks associated
        - Statistical analysis plan
    - Human Subject Interaction

        - Describe subjects
        - Data we plan to collect
        - Justification for amount
        - inclusion and exclusion criterion. The inclusion criterion are, who we specifically including, who's our targeting audience? The exclusion criterion are those that we're specifically excluding
        - Compensation
    - Consent Procedures
        - What kind
        - Waiver details
        - Waiver of documentation of consent details
        - Whether they continue to consent

3.3 Needfinding and Requirements Gathering

- Identify the problem space
    - Where is the task occurring, what else is going on, what are the user's explicit and implicit needs?
- Needfinding - stage where you go and try to find out what the user really needs
    - Defining questions about the e.g. who the user is, what they're doing, and what they need.
    - Generating answers to those questions to gain a better understanding of the user
    - Formalize the data we gather into a shareable model of the task and a list of requirements for our ultimate interface.
- Data Inventory
    - Who are the users?
    - Where are the users?
    - What is the context of the tasks?
    - What are the goals?
    - What do they need?
    - What are their tasks?
    - What are their subtasks?
- User Types
    - Who are we designing for
    - Different people have different needs
    -

MacKenzie, I.S. (2013). Chapter 4: Scientific Foundations. *Human-Computer Interaction: An Empirical Research Perspective*. (pp. 121-152). Waltham, MA: Elsevier.

Müller, H., Sedley, A., & Ferrall-Nunge, E. (2014). Survey research in HCI. In J. Olson & W. Kellogg (Eds.) *Ways of Knowing in HCI* (pp. 229-266). New York: Springer.

https://edstem.org/us/courses/3826/discussion/224379

Week 4

2.3 Direct Manipulation

- User feels like they are controlling objects of the task through the interface
- Distance between user goal and representation, I think better definitions for these were found in the text
    - Semantic - difference between user's goals and system in expression(how hard it is to know what to do)
    - Articulatory - how hard it is to do what you know to do (in the real world)
- Invisible Interfaces
    - The user feels like they are interacting directly with the interface. (ease of use, lower cognitive load)
    - Does not necessarily translate to good design

2.4 Human Abilities

- Mostly thinks about the user in the processor view
- Each sense makes you think about the general abilities of the population and different ways to segment users based on that.
- Senses(Mackenzie Chapter 2 goes a lot more into depth)
    - Eye -> center - color, movement , peripheral -> movement maybe
    - Ear -> pitch and loudness, not easy to filter audio information
    - Haptic
- Memory
    - Perceptual(Working)
        - Lasts less than a second
        - Visuospatial sketchpad - where you visual things
        - Phonological loop - most recent sounds you've heard
        - Episodic buffer - what keeps track of recent events

        - “Central executive” relates the above three
    - Short-term
        - “Chunking” 4-5 at a time
        - Recognition over recall
    - Long-term
        - Harder to put things into long term memory, by constant repetition
- Cognition
    - Learning
        - The user should learn but the interface should also teach
        - Procedural - something you do, mainly in HCI
            - Unconsciously competent
        - Declarative - knowledge about something(facts)
            - How we communicate
        - Have to be able to translate subconscious procedural knowledge to declarative
    - Cognitive Load
        -

MacKenzie, I.S. (2013). Chapter 2: The Human Factor. *Human-Computer Interaction: An Empirical Research Perspective*. (pp. 27-66). Waltham, MA: Elsevier.

This chapter focuses pretty broadly on human ability and the different components of it(receptors vs responders) Human error also included in this chapter. MacKenzie agrees with Norman(though not as passionate) “human-error” is most likely design-error.

- Newell’s time scale of Human Action
    - Biological band, cognitive bacn, rational band, social band
    - Each corresponds to the amount of time a user is involved in the task
    - Research can be done within each band
- There is a lot here in these chapters about the different senses a human phase most notably vision, audio.
    - Eye-tracking movement is researched a lot especially when reading web pages described as scanpath
    - Fixations and saccades(when an eye moves rapidly to a new position) I thought were interesting

- “Another property of perception is ambiguity—the human ability to develop multiple interpretations of a sensory input.” “Related to ambiguity is illusion, the deception of common sense”
- “Beyond perception, sensory stimuli are integrated into a myriad of other experiences to yield ideas, decisions, strategies, actions, and so on.”
- “Cognition occurs within the human brain, so studying cognition presents special challenges. For example, it is not possible to directly measure the time it takes for a human to make a decision. When does the measurement begin and end? Where is it measured? On what input is the human deciding? Through what output is the decision conveyed?”
- “A declarative/explicit area stores information about events in time and objects in the external world. This is similar to a data space. An implicit/procedural area in the brain’s memory stores information about how to use objects or how to do things. This is similar to a code space.” In another Norman chapter he similarly describes the human’s memory (Chapter 2 I believe)
- “Humans intuitively build up chunked structures recursively and hierarchically, leading to complex organizations of memory in the brain”
- “Native speakers of a language innately possess an immense understanding of the statistics of the language. “
- “If redundancy in language is what we inherently know, entropy is what we don’t know—the uncertainty about forthcoming letters, words, phrases, ideas, concepts, and so on.”
- “Humans bring diversity and variability, and these characteristics bring imprecision and uncertainty”
- “Attention is often studied along two themes: divided attention and selected attention”

Hutchins, E. L., Hollan, J. D., & Norman, D. A. (1985). Direct manipulation interfaces. *Human–Computer Interaction*, *1*(4), 311-338.

This seems to be the introductory paper in direct manipulation, mention of gulf of evaluation and execution

- Important properties of direct mapping
- 1. Continuous representation of the object of interest. 2. Physical actions or labeled button presses instead of complex syntax. 3. Rapid incremental reversible operations whose impact on the object of interest is immediately visible.

- " the need to commit additional cognitive resources in the use of an interface leads to the feeling of indirectness"
- The two main aspects are "directness"/"distance" and "engagement"
- " The gulf of execution is bridged by making the commands and mechanisms of the system match the thoughts and goals of the user. The gulf of evaluation is bridged by making the output displays present a good conceptual model of the system that is readily perceived, interpreted, and evaluated. The goal in both cases is to minimize cognitive effort. "
- "the nature of the relationship between input and output language must be such that an output expression can serve as a component of an input expression. Draper (1986) has coined the term inter-referential"
- "Semantic distance concerns the relation of the meaning of an expression in the interface language to what the user wants to say."
    - "Semantic distance in the gulf of execution reflects how much of the required structure is provided by the system and how much by the user. The more that the user must provide, the greater the distance to be bridged. "
    - "On the evaluation side, semantic distance refers to the amount of processing structure that is required for the user to determine whether the goal has been achieved."
- "Tasks that do not easily decompose into the terms of the language may be difficult or impossible to represent. In the extreme case, what can be done is easy to do, but outside that specialized domain, nothing can be done."
    - "The point is that as the interface approaches the user's intention end of the gulf, functions become more complicated and more specialized in purpose."
- "Although practice and the resulting expertise can make the crossing less difficult, it does not reduce the magnitude of the gulfs"
- "articulatory distance has to do with the relationship between the meanings of expressions and their physical form"
- "Direct manipulation interfaces do not pretend to assist in overcoming problems that result from poor understanding of the task domain."

https://edstem.org/us/courses/3826/discussion/234512

Week 5

2.5 Design Principles and Heuristics

Principles of Design

- Discoverability: when the user doesn't know what to do, they should be able to easily figure out what to do
- Simplicity: common tasks easy. Communicating clearly and simply in the user's own language and providing good shortcuts
- Affordance: design of a thing affords or hints at the way it's supposed to be used
- Mapping: creating interfaces where their design makes it clear what the effect will be of using them
- Perceptibility: refers to the user’s ability to actually perceive the state of the system
- Consistency: should be consistent both within and across interfaces to minimize the amount of learning the user needs to do to learn our interface
- Flexibility: principles that advocate user customizability and supporting multiple designs for the same task, accommodating users of various abilities and preferences
- Equity: making the user experience the same for all users, treating every user like they’re within the target audience and extending the same benefits to all users, including things related to privacy and security
- Ease: design can be used efficiently with minimum fatigue
- Comfort: appropriate size and space is provided for each approach, reach, manipulation, and use regardless of user’s body size, posture of mobility
- Structure: concerned with the overall architecture of a user interface
- Constraints: constraining the user from only performing the correct actions in the first place
- Tolerance: users shouldn’t be at risk of causing too much trouble accidentally
- Feedback: the system should give plenty of feedback so that the user can understand why the error happened and how to avoid it in the future
- Documentation: one goal of usable design is to avoid the need for documentation altogether, but if need be, it should be easy to search, focused on user’s task, list concrete steps, and not be too large

	Don Norman	Jakob Nielsen	Constantine & Lockwood	Universal Design
Discoverability	✓	✓	✓	
Simplicity		✓	✓	✓
Affordances	✓			
Mapping	✓	✓		
Perceptibility	✓*	✓		✓
Consistency	✓	✓	✓	
Flexibility		✓		✓
Equity				✓
Ease				✓
Comfort				✓
Structure			✓	
Constraints	✓	✓		
Tolerance		✓	✓	✓
Feedback	✓	✓	✓	
Documentation		✓		

There are some subtle differences between

2.6 Mental Models and Representations

5 Tips: Mental Models for Learnable Interfaces

Good Representation Criteria

1. Makes relationships explicit
2. Brings objects and relationships (closer) together
3. Excludes extraneous details
4. Expose natural constraints

Readings

Brainstorm, Chainstorm, Cheatstorm, Tweetstorm

- Design-driven study of collaborative ideation
- chainstorming = online communication brainstorming
- cheatstorming = previous ideas are voted on (bypassing concept generation -> direct to vote)
- tweetstorm = prototype system that combines chainstorming with cheatstorming

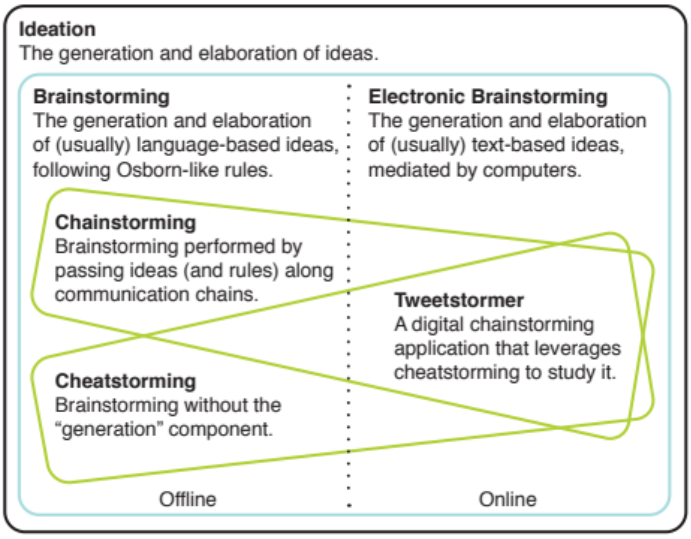


Figure 1. A taxonomy of interrelated ideation techniques.

Observations on concept generation and sketching in engineering design

- Basically more ideas lead to better ideas / improving quality of ideas through increasing quantity of ideas
- Study looked at brainstorming, morphology charts, sketching
    - statistical significant correlation between quantity of brainstormed ideas and design outcome
- concrete sketching, timing, milestone important in design process

The process of interaction design

- 4 basic activities of interaction design
    1. identifying needs and establish requirements
    2. develop alternative designs
    3. building interactive versions of the design
    4. evaluate design
- 3 key characteristic of interaction design process
    1. focus on users
    2. specific usability and user experience goals should be identified
    3. iterate (refine) based on feedback
- before establishing requirements, need to understand who and goal of user
- looking at other design is good start/alternative design solution

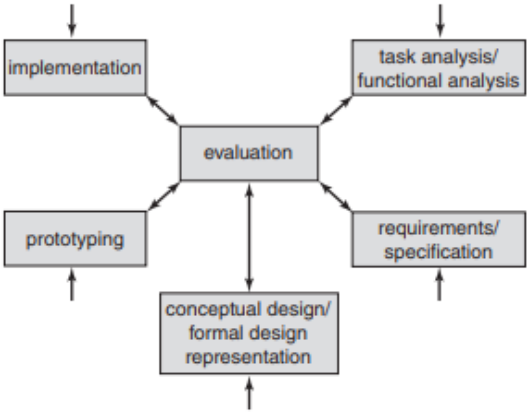


Figure 6.13 The Star lifecycle model.

2.5 Design Principles and Heuristics

2.6 Mental Models and Representations

Faste, H., Rachmel, N., Essary, R., & Sheehan, E. (2013, April). Brainstorm, Chainstorm, Cheatstorm, Tweetstorm: new ideation strategies for distributed HCI design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1343-1352). ACM.

Yang, M. C. (2009). Observations on concept generation and sketching in engineering design. *Research in Engineering Design*, *20*(1), 1-11.

Rogers, Y., Sharp, H., & Preece, J. (2011). Chapter 6: The Process of Interaction Design. In *Interaction Design: Beyond Human-Computer Interaction*. John Wiley & Sons.

https://edstem.org/us/courses/3826/discussion/249159

Week 6

3.4 Design Alternatives

MacKenzie, I.S. (2013). Section 3.4: Mental Models & Metaphor. *Human-Computer Interaction: An Empirical Research Perspective*. (pp. 88-92). Waltham, MA: Elsevier.

MacKenzie, I.S. (2013). Section 3.8: Interaction errors. *Human-Computer Interaction: An -Empirical Research Perspective*. (pp. 111-116). Waltham, MA: Elsevier.

Norman, D. (2013). Chapter 5: Human Error? No, Bad Design. In *The Design of Everyday Things: Revised and Expanded Edition*. (pp. 162-216). Arizona: Basic Books.

Mander, R., Salomon, G., & Wong, Y. Y. (1992, June). A “pile” metaphor for supporting casual organization of information. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 627-634). ACM.

https://edstem.org/us/courses/3826/discussion/262269

Questions

Difference on internal and external validity? (Chapter 4 of Mackenzie)

"Huy

- internal validity = result from test condition
- external validity = result extended to outside situations

> **Internal validity** refers to the degree of confidence that the causal relationship being tested is trustworthy and not influenced by other factors or variables.
>
> **External validity** refers to the extent to which results from a study can be applied (generalized) to other situations, groups or events.

- improving one of them makes the other worse
    - an experiment can either be done in a lab setting or in the real world
    - doing in the lab setting = better internal validity since external (outside) influences are minimized, but external validity is worse since it's not as applicable to real world
    - solution: do lab experiment in lab setting first to establish a causal relationship, then do same experiment in real world to see if the results are verified"