

Lecture 3: Human-Centered Design Principles

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Readings: *Pea [1987], Friedman et al. [2017], Birhane et al. [2022]*

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1 Guiding Questions

- Why is design important in the context of NLP models?
- How do we go from cool to useful?
- How much do technical increases translate to user benefit in terms of value?
- How do you work with the unique, complex, and different challenges between HCI and NLP?

1.1 Motivating Example: Copyrighting Tool

Imagine you are tasked with the problem of building a tool that uses LLM to support copywriting. The NLG task is for users to input the goal (e.g. advertising header) & provide context (e.g. product description) and have the model output suggestions accordingly. There are many methods, interfaces, and design choices that should be taken into account, such as:

- How should a user provide the input context?
- How many suggestions should be shown to the user?
- How do you rank suggestions to help users know which one they should pick?
- How do you allow users to balance their personal preferences with what the model thinks is optimal?

These challenges are not just NLP questions, but HCI questions that exist beyond the systems accuracy (within some bounds). Regardless of if the LLM accuracy is 80% or 95%, users will still need to reason through failure modes and understand what to expect when interacting with the system.

2 Design Thinking: User-centered Design

Design through matchmaking is an antiquated approach to design, mapping technology to application domains. This relies on finding a use-case for technological innovations passively *after* a system is built. Nowadays, modern design processes often focus on user-centered design. **User-centered design (UCD)** is an iterative design process in which designers focus on the users and their needs in each phase of the design process.

2.1 Double-Diamond Design Process

Double Diamond is a typical design process, where the first diamond finds a specific problem, and the second diamond finds a specific solution. Each diamond relies on the principles of divergent and convergent thinking. *Divergent thinking* is aligned with ideation, and involves thinking broadly, keeping an open mind, and considering anything and everything. *Convergent thinking* involves thinking narrowly, bringing back focus, and identify 1-2 key problems / solutions.

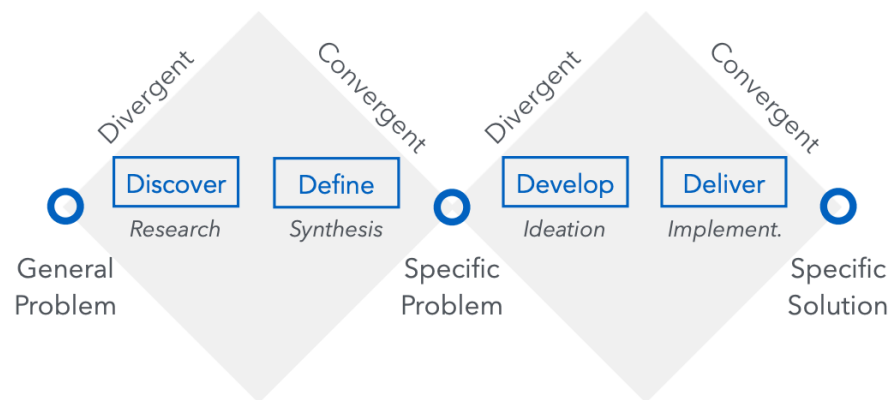


Figure 1: Double-Diamond Design Process

2.2 Diamond 1: Discover and Define

The first diamond in the double-diamond process involves discovering and defining the problem.

Discover: Understand the issue rather than merely assuming it. It involves speaking to and spending time with people who are affected by the issues. Methods to do this include interviews, field studies, and perspective reframing.

Define: Use the insight gathered from the discovery phase can help to define the challenge in a different way. This involves tasks and interview analysis, as well as affinity diagrams.

2.2.1 Interview

Interviewing is a method of asking questions and listening, asking about things that can't be observed. While there are a variety of different interview methods and types, semi-structured is most common, because it allows for exploratory studies and provides comparable, reliable data, and the flexibility to ask follow-up questions. The number of interviews depends on goals, context, resources, and timing. While 12 is a "magic number" for interviews (with a minimum of 5), a good rule of thumb is to stop when findings converge. Perspective reframing can even be used in interviews

Interview Analysis: Although analyzing interviews is often qualitative, the process can still be rigorous and principled. Computational tools such as LLMs or annotation can be helpful for analyzing interview. Thematic analyses helps identify common themes from transcriptions, such as topics, ideas and patterns of meaning that come up repeatedly.

Could we leverage LLMs to simulate users/interviews? Interviews are computationally expensive, so what if we try and simulate either users or interviews? While this could be a productive method to gain more interview information, there are many potential pitfalls with this approach. If we're simulating users, its easy for stereotypes perpetuated by data. If we're simulating interviewers, the participants have no real incentive to provide accurate answers. And on top of that, there is no true way to evaluate the accuracy and trustworthiness to the data.

2.2.2 Perspective Reframing

Perspective reframing involves getting to the problem behind a problem and creating a fresh perspective. For example, the concept of an "intelligent word editor" could be framed in many ways: a writing assistant, a conversational AI, a grammar checker, a paraphraser/trasnaltor, etc.

2.3 Diamond 2: Develop & Deliver

Once a clear problem has been defined, the next step in the "double-diamond" is to develop and Deliver a solution.

Develop: Give different answers to the clearly defined problem, seeking inspiration from elsewhere and co-designing with a range of different people. This involved Storytelling, creating a MVP (minimum viable product, and rapid prototyping). During this phase, its important not only to evaluate a product or prototype, but to provide recommendations to improve it. This can be done with **formative usability testing:** testing with representative users and representative tasks on a representative product.

2.4 Prototype

A prototype is a physical realization of the research and design process in a tangible form. It is used to get a sense of how a product/service is experienced, and appears at varying levels of fidelity. Common prototyping methods include:

- *Wizard-of-Oz*: Fake features so that the user thinks that the responses are computer-driven when they are actually human-controlled. This is challenging for NLP systems because AI errors are hard to simulate.
- *Mimic simple functionality*: Start with most simple example and build in complexity. This is challenging for NLP systems because it doesn't afford simulating SOTA model capabilities.

2.4.1 Case Study: Personas in Prototyping with NLP [Wu et al., 2019]

An *algorithmic persona* is a human role that users assign to the algorithm to explain the algorithm's goals, behaviors, and characteristics. These can be used to develop various prototypes with different values and features.

For example, 65 years of video are uploaded every day to Youtube. By framing the goals and expectations of algorithms in different ways, we can see different responses and interactions.

- **Agent**
 - *Goal*: Manage and help creators in their work by finding an audience for them and promoting them
 - *Expectation*: Creators might want to be friends with the algorithm because it helps decide what is pushed
- **Gatekeeper**
 - *Goal*: Stands between content creator/viewer, determines whether content gets viewed
 - *Expectation*: Creators might want to befriend or trick the persona into allowing their videos to bypass the filter
- **Drug Dealer**
 - *Goal*: Keep viewers addicted to the platform
 - *Expectation*: Creators might want to counteract the model to prefer slower growth rather than addiction, and users could interact with the platform more warily.
- **Others**: Researcher (try and help the user explore content that they might want to see), Bad Actor (push out negative, addicting, or harmful content to everyone)

2.4.2 Principles for Mixed-Initiative Interactions

Mixed-initiative systems allow users to interact with system in collaborative ways where the user and the system both take an active role in carrying out tasks or making decisions. The following principles are helpful in developing mixed-initiative interactions [Horvitz, 1999]:

1. Developing significant value-added automation
2. Considering uncertainty about a users goals
3. Considering the status of users attention (minimize distraction, cost vs. benefit of deferring action)
4. Inferring ideal action in light of costs, benefits and uncertainties (expected values of actions)
5. Employ dialog to resolve key uncertainties (interactions)
6. Allowing efficient direct invocation and termination
7. Minimizing the cost of poor guesses about action and timing
8. Scoping precision of service to match uncertainty, variation in goals: do less if uncertain!
9. Providing mechanisms for efficient agent-user collaboration to refine results
10. Employing socially appropriate behaviors for agent-user interaction
11. Maintaining working memory of recent interactions
12. Continuing to learn by observing (e.g., about users goals, etc.)

2.4.3 Case Study: Interactive Machine Translation Green et al. [2014]

This case explores a Predictive Translation Memory interface and the various design choices involved.

Seemingly Simple Decisions: 1-3 highlight rationales for seemingly simple decisions that the designers made, grounded in the Horvitz Principle # 6: Employing socially appropriate behaviors for agentuser interaction.

- *Design Choice 1:* Re-use familiar hotkeys (ie. CTRL+Enter Typing activates interactions)
Rationale: Translators are fast typists and often want to avoid the mouse
- *Design Choice 2:* One column, interleaved layout
Rationale: Translators read 20-25% of translation session, a 2-column design is cumbersome for the user



Figure 2: 1, 2, 3: Seemingly Simple Decisions

- *Design Choice 3*: Text color encoding
Rationale: Employ socially appropriate behaviors for agent-user interaction

Source comprehension:

- *Design Choice 4*: Highlight translated words
Rationale: Maintain working memory of recent interactions (Horvitz #11)
- *Design Choice 5*: allow for word-to-word query
Rationale: allowing efficient direct invocation and termination (Horvitz #6)

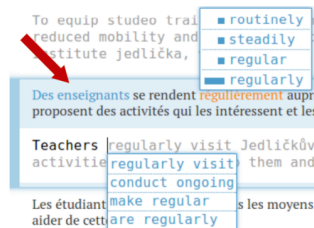


Figure 3: 4, 5: relating to source comprehension

Target Gisting

- *Design Choice 6*: Full best translation
Rationale: Employ socially appropriate behaviors for agent-user interaction (Horvitz #10)
- *Design Choice 7*: Real-time updating
Rationale: Provide mechanisms for efficient agent-user collaboration to refine results termination (Horvitz #9)

Target Generation

- *Design Choice 8*: Insert complete translation
Rationale: Allow efficient direct invocation and termination (Horvitz #6)
- *Design Choice 9*: Real-time autocomplete dropdown
Rationale: Employing dialog to resolve key uncertainties (Horvitz #5)

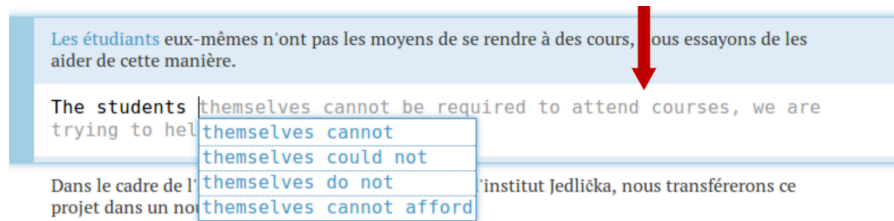


Figure 4: 6, 7: relating to target gisting

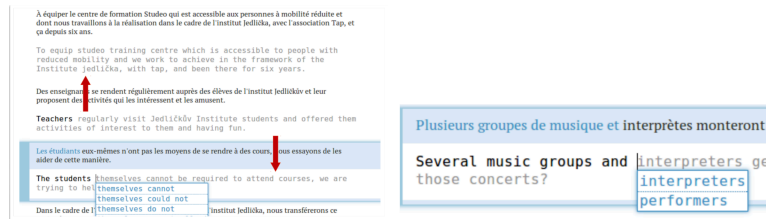


Figure 5: 8, 9: related to Target Generation

2.5 Evaluating usability results

2.5.1 Think Aloud

Think aloud is a research method used to gain insight into a person's thought processes as they perform a task or solve a problem. The participant is asked to verbalize their thoughts as they perform the task, which allows the researcher to understand how the participant approaches the task. This is typically used to test the usability of a website, app or object, and often involves a mix of qualitative and quantitative methods.

Protocol

- Give participants specific tasks to accomplish (but not HOW to do it)
- Have them speak aloud as they complete the tasks
- Keep interruptions to a minimum
- Ask for open-ended questions & clarification after the task is complete
- Watch for biasing test due to order (learning effect)

Advantages: Think-aloud studies provide rapid, high-quality, qualitative user feedback. Data is available from range of sources, including direct observation of what the subject is doing as well as verbalization of what the subject wants/is trying to do. If participant runs into difficulties, the observer has the chance to clarify situation. Additionally, this method allows for a high degree of flexibility and meaningful, direct dialogue.

3 Design Frameworks

Beyond just human-centered design, there are different approaches to design that encompass greater spheres, including user-centered Design, value-centered design, and humanity-centered design. These various perspectives bring to light the questions: What perspectives do we take on design? What do we value in design?

3.0.1 Humanity-Centered Design

Humanity-centered design is a practice where designers focus on peoples needs not as individuals but as societies with complex, deep-rooted problems. Designers can co-create proper solutions when they work with populations, address the right problems, perform systems analyses and co-design small, simple interventions Hum. The five fundamental principles of Humanity-centered design are:

1. Focus on the entire ecosystem of people, all living things, and the physical environment.
2. Solve the root issues, not just the problem as presented (which is often the symptom, not the cause).
3. Take a long-term, systems point of view. We must realize that the impact of our actions on society and the ecosystem can take years to appear or manifest even decades later.
4. Continually test and refine the proposed designs to ensure they truly meet the concerns of the people and ecosystem for whom they are intended.
5. Design with the community, not for them.

4 Takeaways

- *User-centered* design is important.
- *Double Diamond* is a typical process.
- *Reframing* the problem and the persona can change human behavior.
- *Interviews & think-aloud* are important HCI methods for building NLP-infused applications.
- *Quantitative & qualitative* studies are both important.

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