INFO 290T

Human-Centered Data Management

Primer on Usability and HCI

A Primer on Usability & HCI

- User interfaces are central to our everyday lives
  - In the real world: smart TVs, thermostats, cameras, …
  - In the virtual world: cell-phone apps, search engines, e-commerce websites, spreadsheets, IDEs, computational notebooks

- Designing and evaluating them is challenging!
  - At least partly because it is so centered on "humans"
  - And humans are complex creatures ☺

Slide Credits:
- NN Group
- "**Designing the User Interface: Strategies for Effective Human-Computer Interaction**" Book

Usability 101

	Search Engine	Spreadsheets	Comp. Notebook
Time to learn			
Speed of performance			
Rate of errors			
Retention over time			
Subjective satisfaction			

Key Questions when Designing a UI

- Who are the users?
  - Novices, Intermittent, Expert
  - Want to pick an interface with appropriate learnability

- What are their tasks?
  - May vary by user

- A convenient way of thinking about users/tasks is via personas
  - Personas are distilled essences of real users
  - They are fictional characters, which you create based upon your research to represent the different user types that might use interface in a similar way.
  - Creating personas helps the designer to understand users' needs, experiences, behaviors and goals.

Users and Tasks: A Data Work Perspective

- **Data Consumers and Leaders**
  - Non-technical roles, but they consume data insights and analytics to make data-driven decisions.
  - **Commonly used technology and tools**
    - Spreadsheets, BI Tools
  - **Example job titles**
    - Chief Marketing Officer, Human Resources Manager, Head of Sales
- **Business Analysts**
  - Tying data insights to actionable results that increase profitability or efficiency
  - **Commonly used technology and tools**
    - Spreadsheets, BI tools, Relational Databases
  - **Example job titles**
    - Business Analyst, Financial Analyst

Users and Tasks: A Data Work Perspective

- **Data Analysts**
  - Responsible for analyzing data and reporting insights; combination of coding and non-coding based tools.
  - **Commonly used technology and tools**
    - BI Tools, Relational Databases, Spreadsheets, Python-based tools
- **Data Scientists**
  - Responsible for investigating, extracting, and reporting meaningful insights and building and deploying ML models (e.g., predicting customer churn, LTV); often work with large datasets
  - **Commonly used technology and tools**
    - Python-based tools, Relational Databases
- **Data/ML Engineers**
  - Responsible for massaging and moving data in the format needed for insight discovery and ML model building/deployment
  - **Commonly used technology and tools**
   - Python & Java/Scala-based tools, Relational Databases

So far…

- Usability 101: Key Axes

- Basic Questions

- Users and Tasks

- Next: Interaction Modalities

Primary Interaction Styles

- Direct Manipulation
  - Visual representation of the world of action
  - E.g., drawing tools, desktops, …
  - Rapid selection of a single option via action
    - Gesture, point, move, …
  - Less recall, more recognition & fewer clicks
  - Appealing for novices & easy to remember for intermittent users
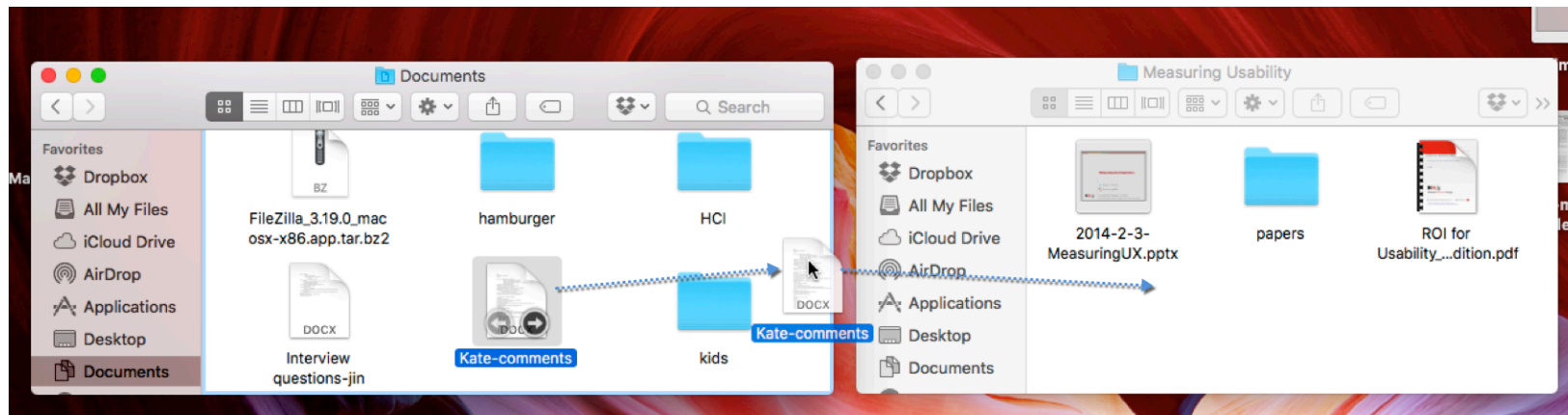
Primary Interaction Styles

- Navigation and Menu Selection
  - Review choices, pick one, observe effect
  - Clear structure to decision making
  - Appealing for novices/intermittent users, and with careful design can be good for experts
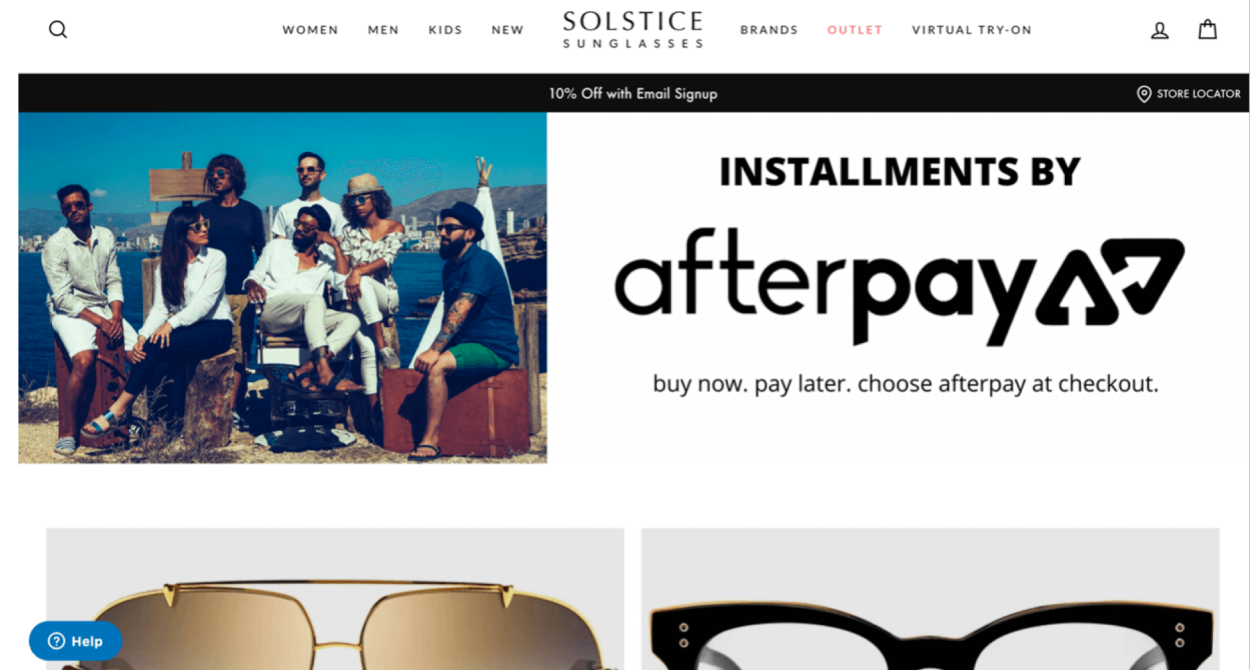
Primary Interaction Styles II

- Form Filling
  - Data entry in specific fields
  - Users must know the permissible values
  - Better for knowledgeable intermittent/frequent users

- Command Language
  - Best for frequent/expert users: strong feeling of control
  - Small # of keystrokes to accomplish complex tasks
  - Error rates high, training needed, retention is poor
  - Easy to retain history of scripts/repeat actions

So far: The Spectrum

An example of progression toward more direct manipulation: less recall/more recognition, fewer keystrokes/fewer clicks, less capability to make errors, and more visible context.

>MONTH/08;DAY/21

a. Command line

MM/DD 08/21

b. Form fill-in to reduce typing

MM 08 DD 21

c. Improved form fill-in to clarify and reduce errors

Month AUG Day 21

JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

d. Pull-down menus offer meaningful names and eliminate invalid values

August

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

e. 2-D menus to provide context, show valid dates, and enable rapid single selection

Figure from "Designing the User Interface" Book

Primary Interaction Styles III

- Natural Language
    - (Outside of the spectrum)
    - No need to learn syntax
    - Hard for novel situations not encountered by NL before
    - May need many rounds of error correction

Primary Interaction Styles IV

- Can also blend interaction styles
  - Spreadsheets allow for direct manipulation but also: navigation & command language
  - A form-filling interface can include
    - Accepted options as a menu selection interface
    - Direct manipulation to select a calendar date

- New emerging interaction styles: sensors (wearables/IoT/AR-VR), speech, touch, gestures

OK…

- So far we've talked about users, tasks, and interactions
  - Usability 101: Key Axes
  - Basic Questions
  - Users and Tasks
  - Interaction Modalities

- Now about the process of design
- First, let's talk about how to think about interaction with a system: good design principles and avoiding bad designs

A Few Terms You'll Encounter

- *Mental/Conceptual Model*: How a given person thinks about the abstraction underlying the system
  - A gap between the mental model and actual behavior of system could lead to confusion and errors
- *Affordances*: What are "knobs" that the user can operate on to control the behavior of the system (think interaction styles)
- *Signifiers*: What are the indicators that there are affordances?
  - E.g., the presence of a free text field, or a tab called Menu
  - Lack of signifiers is a problem, e.g., you need to right-click to learn the existence of a different editing menu
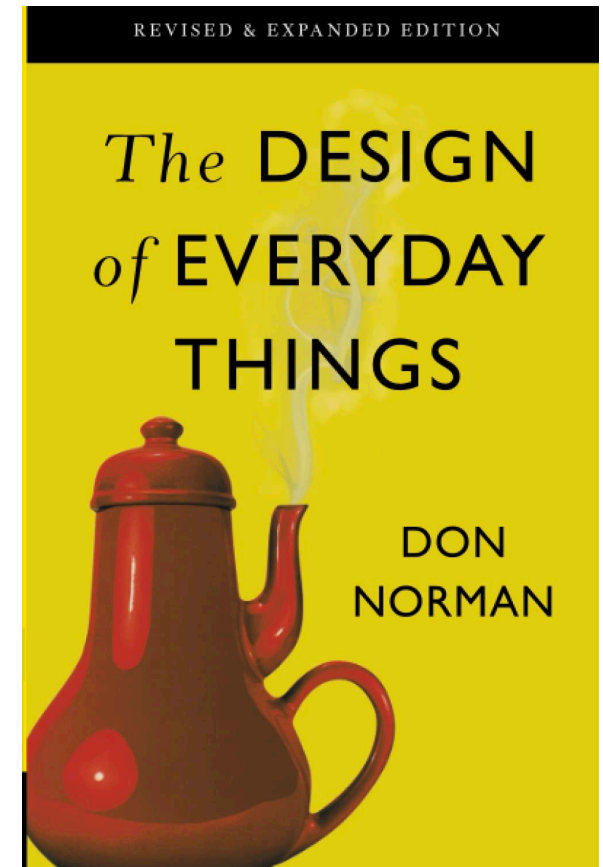
Good Design: Stages of Action Model

Gulfs in both execution and evaluation can lead to problems!

Four low-level principles of good design:
- State and action alternatives should be visible
- There should be a good conceptual model and a consistent system image
- The interface should reveal interplay between stages
- Users should receive continuous feedback

From Don Norman, the Design of Everyday Things
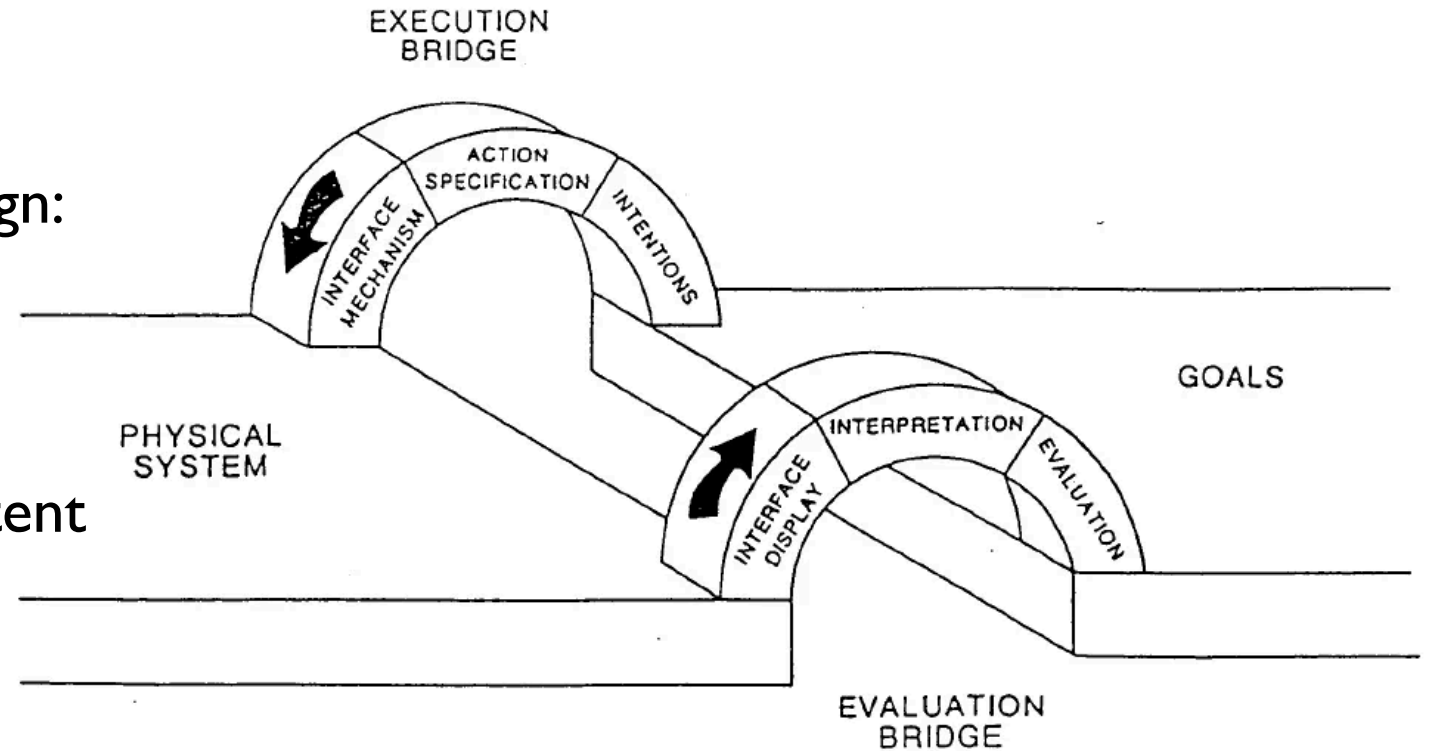
1 Visibility *of* System Status

Designs should *keep users informed* about what is going on, through appropriate, timely feedback.

Interactive mall maps have to show people where they currently are, to help them understand where to go next.

Jakob's Ten Usability Heuristics

2 Match between System and the Real World

The design should speak the users' language. Use words, phrases, and concepts *familiar to the user*, rather than internal jargon.

Users can quickly understand which stovetop control maps to each heating element.

3 User Control *and* Freedom

Users often perform actions by mistake. They *need a clearly marked "emergency exit"* to leave the unwanted action.

Just like physical spaces, digital spaces need quick "emergency" exits too.

4 Consistency *and* Standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. *Follow platform conventions*.
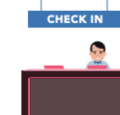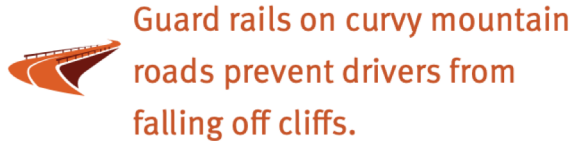
Check-in counters are usually located at the front of hotels, which meets expectations.
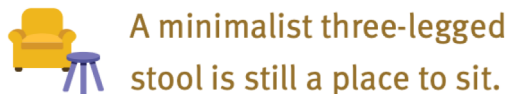
5 Error Prevention

Good error messages are important, but the best designs carefully *prevent problems* from occurring in the first place.

Guard rails on curvy mountain roads prevent drivers from falling off cliffs.

6 Recognition Rather Than Recall

Minimize the user's memory load by making elements, actions, and options visible. Avoid making users remember information.

People are likely to correctly answer "Is Lisbon the capital of Portugal?".

7 Flexibility *and* Efficiency of Use

Shortcuts — hidden from novice users — may *speed up the interaction* for the expert user.

Regular routes are listed on maps, but locals with more knowledge of the area can take shortcuts.
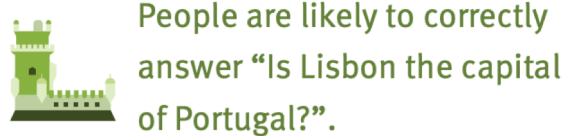
8 Aesthetic *and* Minimalist Design

Interfaces should not contain information which is irrelevant. Every extra unit of information in an interface *competes* with the relevant units of information.
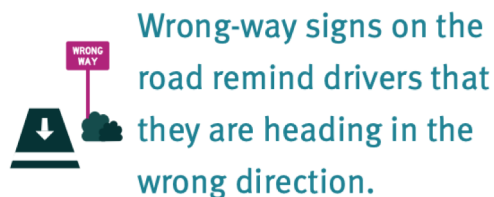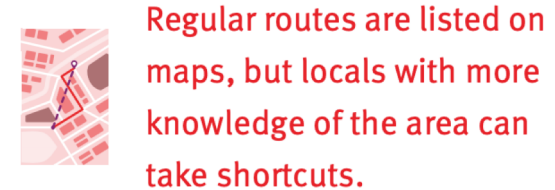
A minimalist three-legged stool is still a place to sit.

9 Recognize, Diagnose, *and* Recover from Errors

Error messages should be expressed in plain language (no error codes), precisely indicate the problem, and constructively suggest a solution.
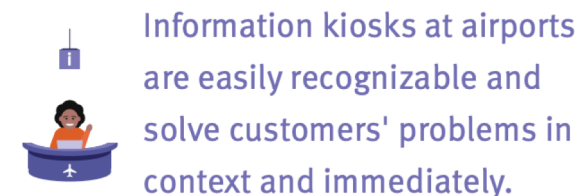
Wrong-way signs on the road remind drivers that they are heading in the wrong direction.

10 Help *and* Documentation

It's best if the design *doesn't need* any additional explanation. However, it may be necessary to provide documentation to help users complete their tasks.

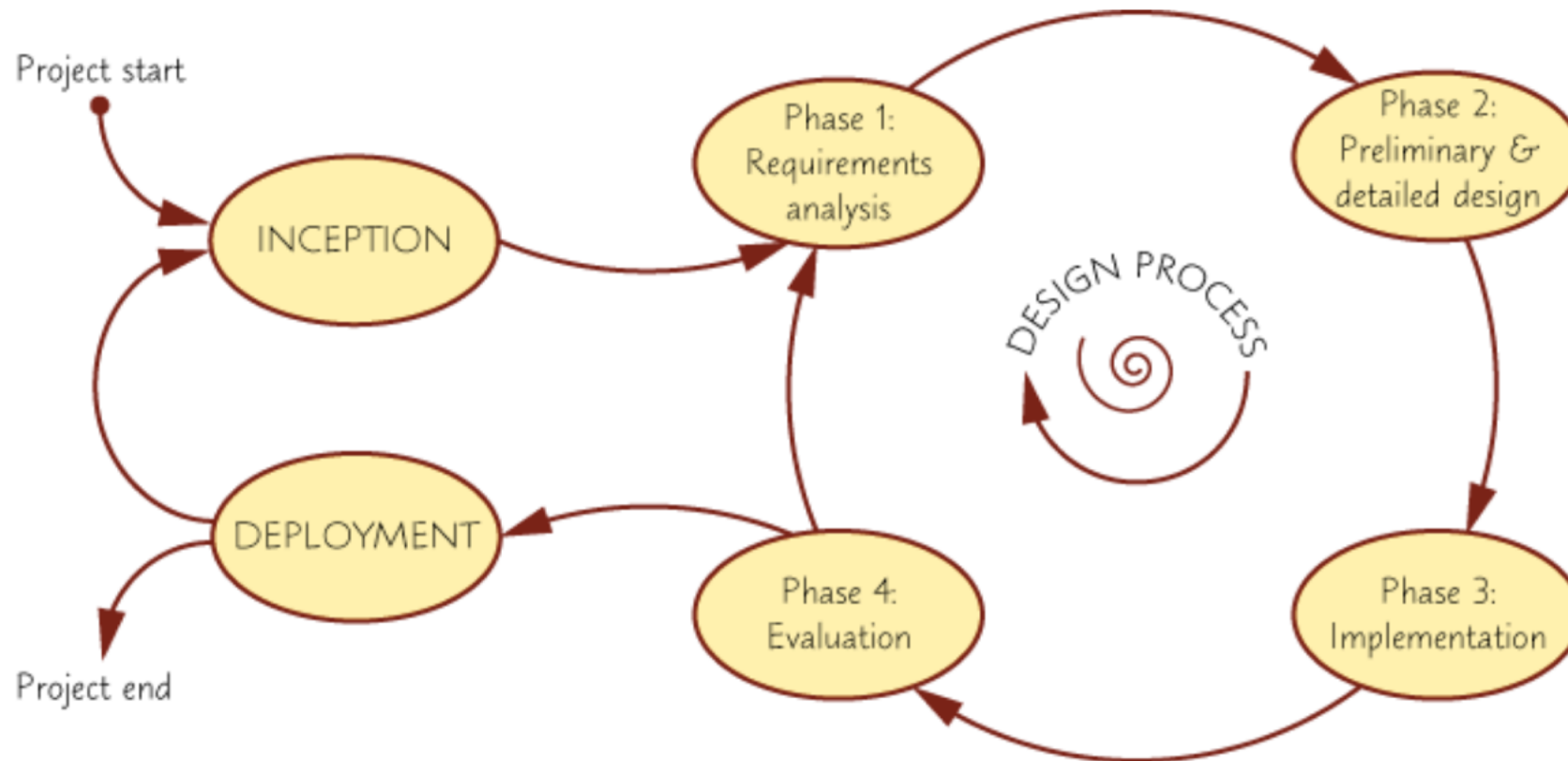Information kiosks at airports are easily recognizable and solve customers' problems in context and immediately.

So Far …

- Usability 101: Key Axes
- Basic Questions
- Users and Tasks
- Interaction Modalities
- Design: Stages of Action Model
- Design Heuristics

- Now, the process of design

The Stages of Design

Various Flavors of Design

- User-Centered Design
  - *a design process that primarily takes the needs, wants, and limitations of the actual end users into account during each phase of the design process*
  - Ensures that you don't solve the "wrong problem" – but finding and involving users who can clearly articulate needs is hard
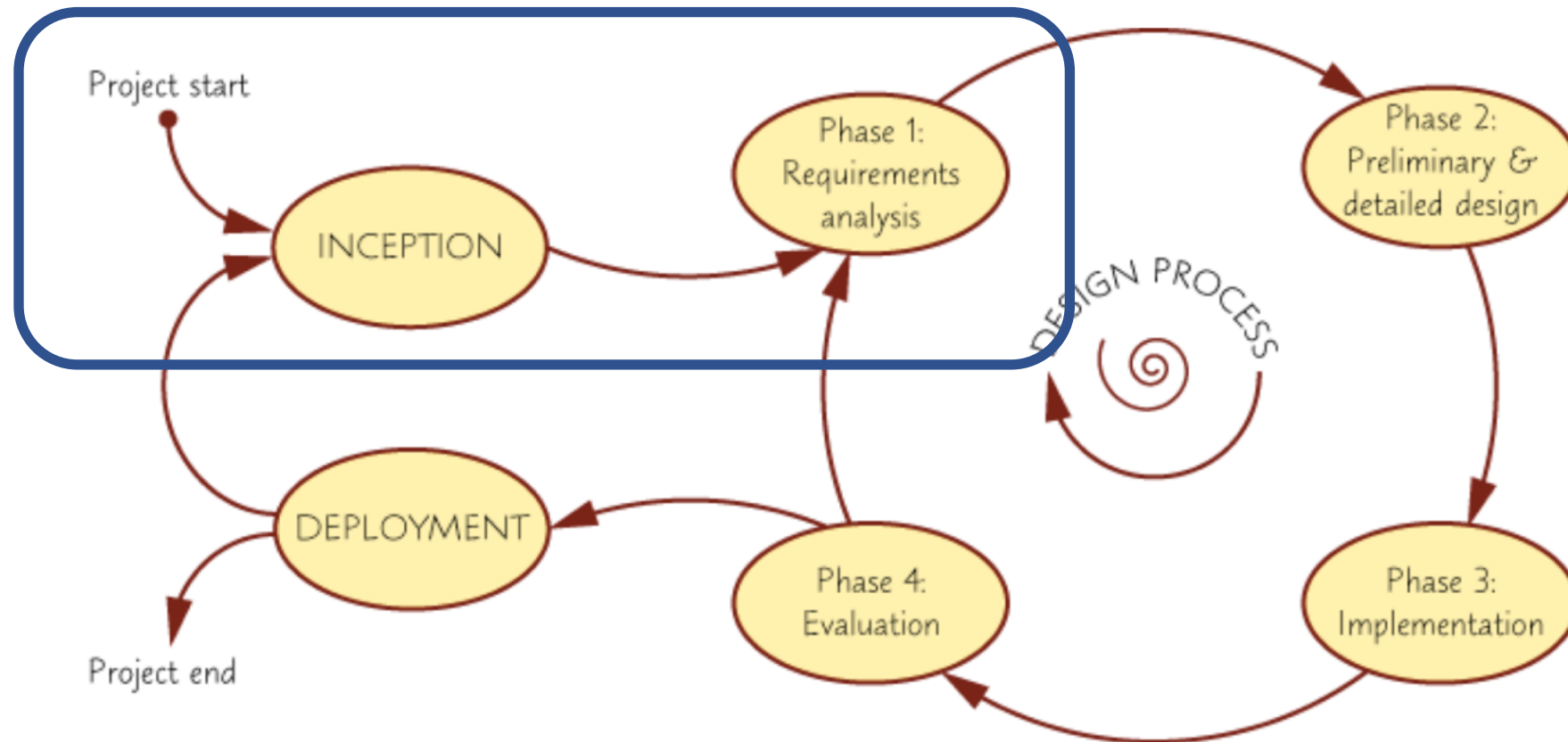
- Participatory Design
  - Takes UCD one step further in involving users in the design process
  - Possibly takes longer, more costly, but may lead to more meaningful outcomes

- Agile Design
  - The use of low-fidelity prototypes/wireframes/mock-ups…
  - Quickly abandon bad ideas, iterate on good ideas

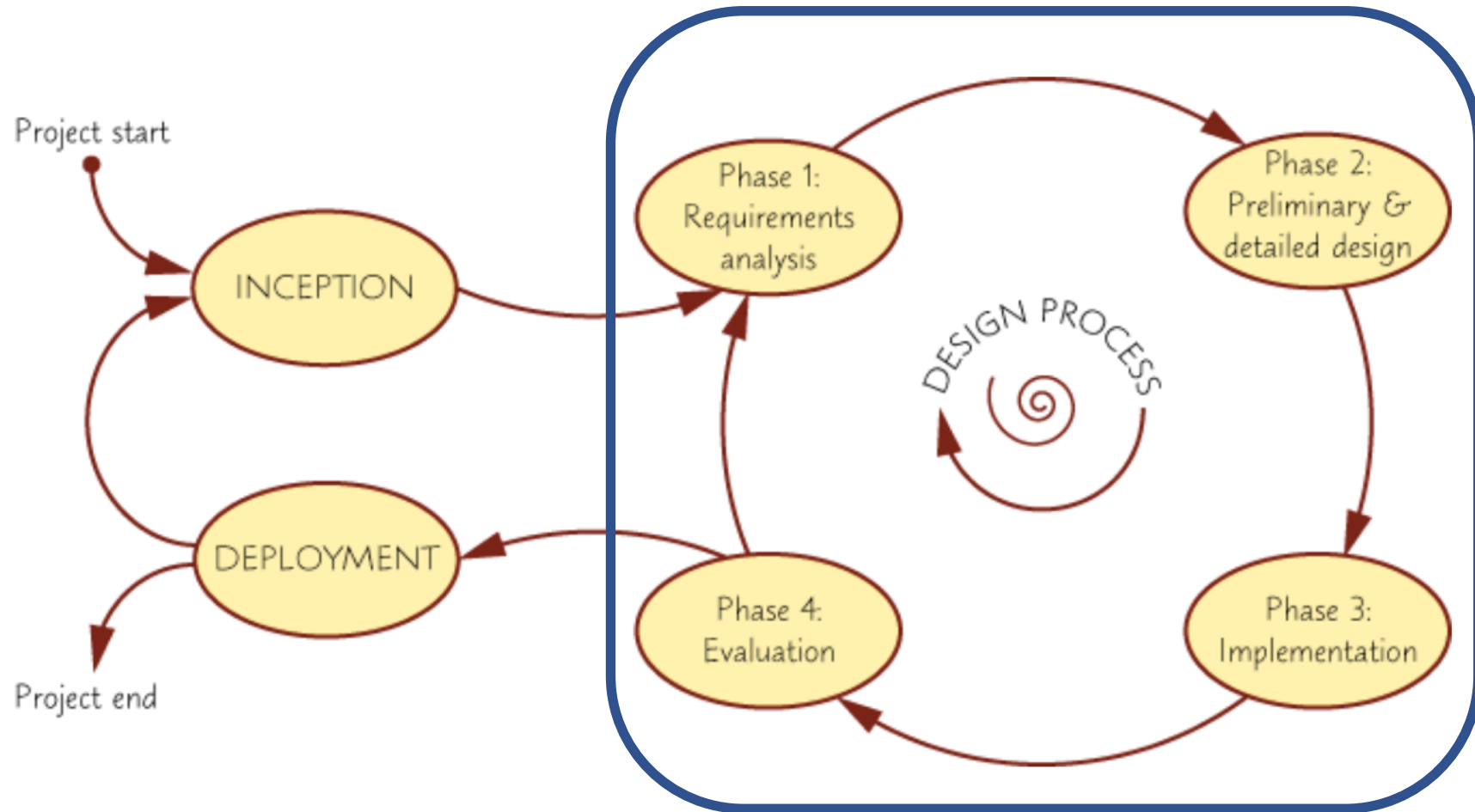# The Stages of Design: Early Stages

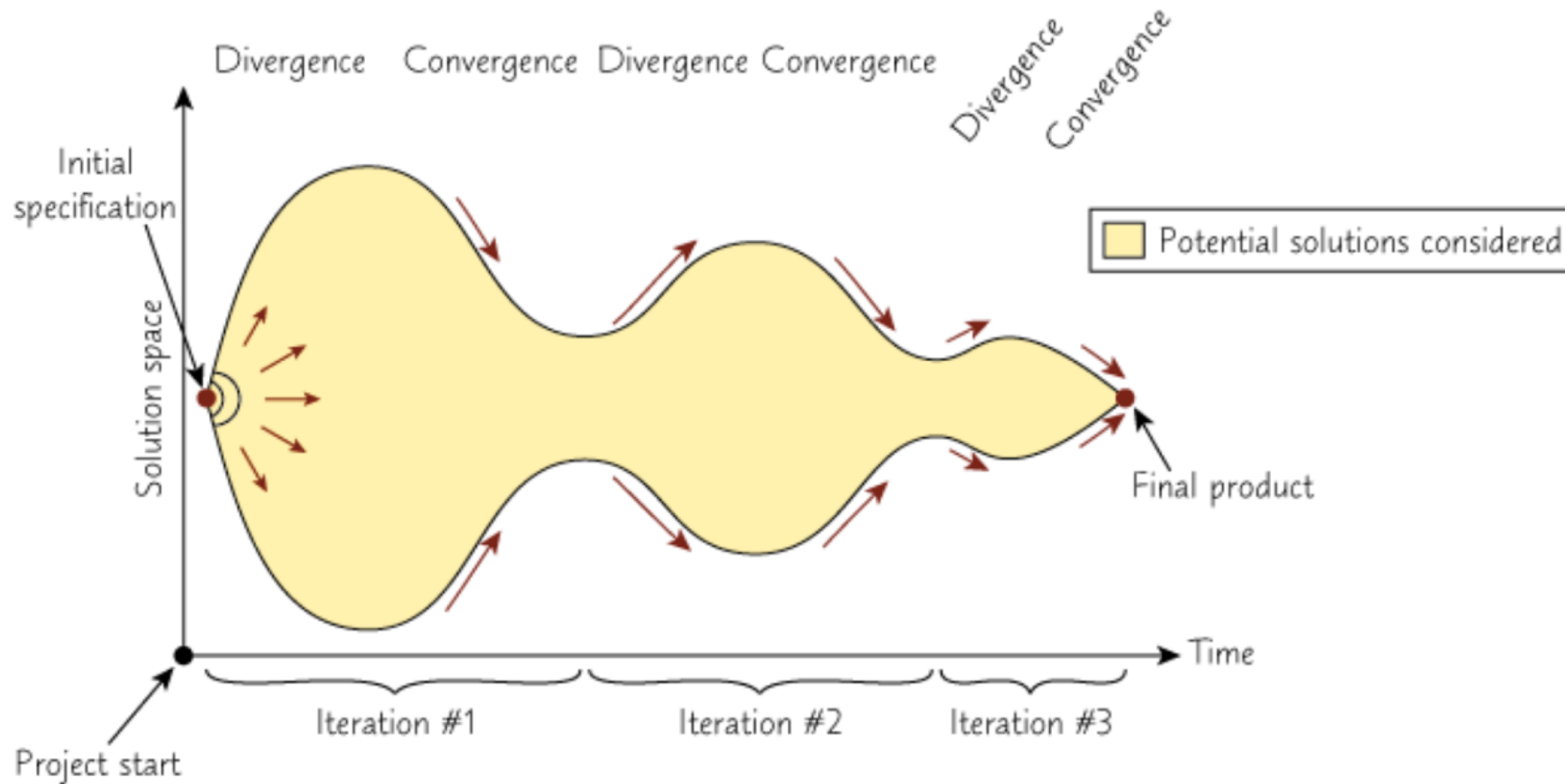# During Early Stages of Project: Needfinding

- Surveys, Interviews
  - Asking people to describe their workflows & challenges
- Ethnographic Observation
  - Observe and participate in people doing their work (immersion)
- Contextual Inquiry
  - Both interviews + ethnography

The Stages of Design: The Loop

Typical Process of Ideation During Design

Activities During Design

- Storyboarding
  - Building up a scenario for how an interface is used

- Prototyping
  - Testing ideas (often cheaply and quickly)
  - Often "paper protoypes" or mockups
  - Lower fidelity is fine!
  - Tools: Powerpoint, Figma, Adobe Illustrator

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- Design Heuristics
- Process of Design: Design Loop

- Now, Evaluation

Evaluation

- Heuristic Evaluation: Experts evaluate system using heuristics
- Lab-based Evaluation: Within subjects or between subjects

Within-Subjects Design
The same participant tests all conditons corresponding to variable.

Between-Subjects Design
Different participants are assigned to different conditions corresponding to a variable.

Within subjects is easier, fewer participants, less noise, but more learning effects & potential bias

What do you evaluate?

- Back to Usability 101
  - Time to learn
  - Speed of performance
  - Rate of errors
  - Retention over time
  - Subjective satisfaction
- Quantitative metrics as well as qualitative surveys (usually Likert scale questions)

Things to think about for Evaluation

- Ecological Validity
  - Wikipedia definition: **ecological validity** *is often used to refer to the judgment of whether a given study's variables and conclusions (often collected in lab) are sufficiently relevant to its population (e.g. the "real world" context).*
  - The tasks, datasets, workflows must be representative of the real world
  - Ensure diversity on all fronts!

- Inclusion Criteria for Participants
  - Have strict rules for which participants to include in your study – not just whoever "is convenient"

- Submit an IRB (Institutional Review Board) form prior to your study
  - Ensures that studies are not "harmful"
  - This is a must if you want to publish your results

- Have a script
  - Follow the exact same process for all participants to ensure rigor and reproducibility

Post-Hoc: After the Evaluation

- To analyze quantitative results: easy, traditional aggregation measures
- To analyze qualitative results, employ *coding*
  - Identification of themes and key phrases in your data
  - These can be done top-down (verifying hypotheses), bottom-up (identifying new ideas), or a mix thereof
  - Codes → Concepts → Categories →.Theory
  - Goal is to usually develop a new *theory* for behavior in this setting.

The Process of Design
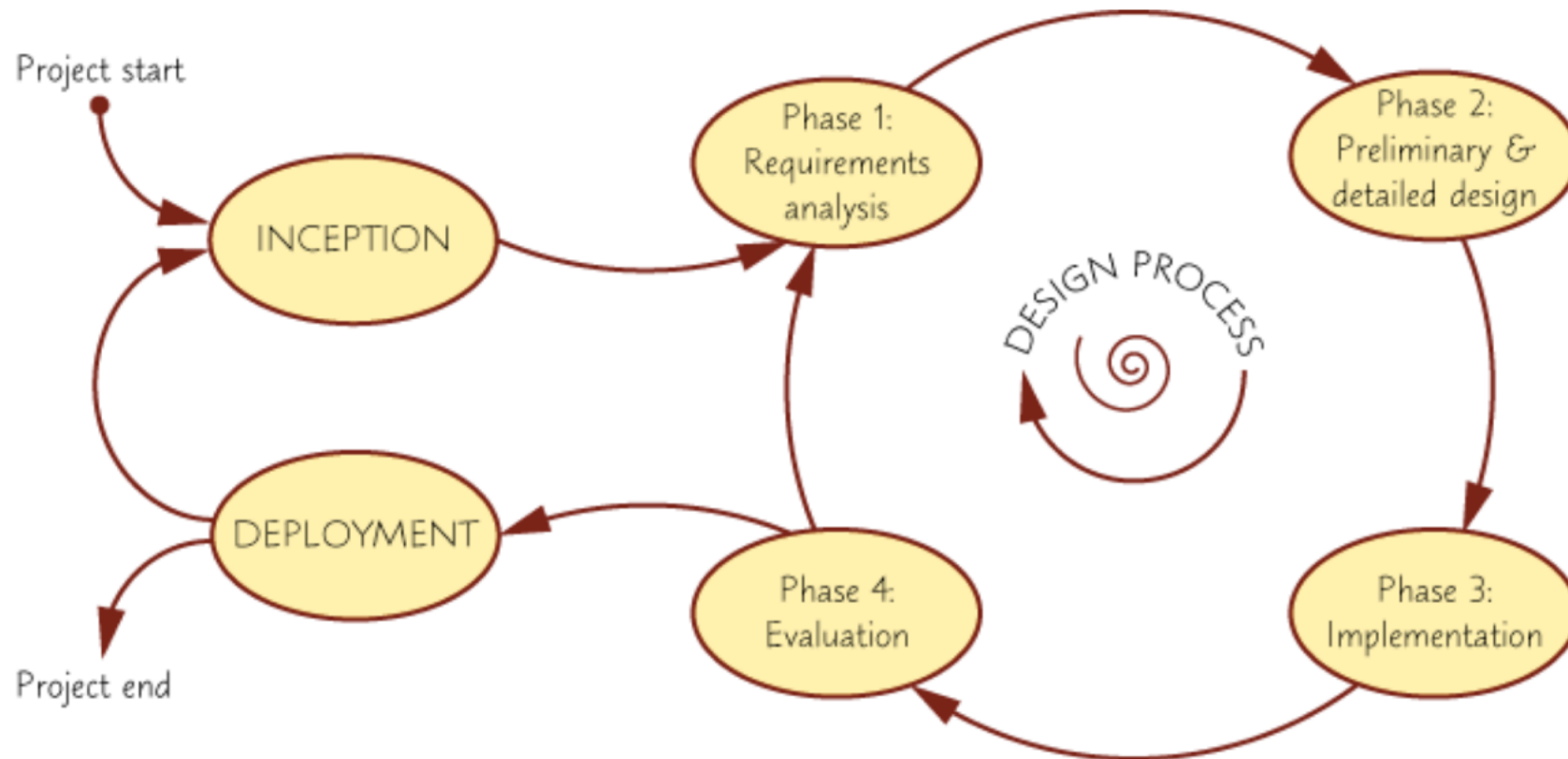
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- Process of Design: Design Loop

- Evaluation