Interaction Design

Definition: Designing interactive products to support the way people communicate and interact in their everyday and working lives

Core characteristics: 1. users should be involved.2. specific usability and user experience goals should be identified,documented at the beginning3.iteration

usability goals: 1. **Effective to use** (effectiveness) – how good it is 2. Efficient to use (efficiency) – how easy / fast it is 3. Safe to use (safety) 4. Have good utility (utility) 5. Easy to learn (learnability)→ **is more objective: how useful or productive a system is from its own perspective**

User experience: safisfying/enjoyable/helpful/boring/unpleasant→**is more subjective: how users experience an interactive product from their own perspective**

The process of interaction design:

•four basic activities: 1. **Discovering requirements** for the interactive product. 2. **Designing alternatives that meet those requirements**. 3. **Prototyping** the alternative designs so that they can be communicated and assessed. 4. **Evaluating the product and the user experience** it offers throughout the process.

•interaction design lifecycle model & double diamond of design(a framework for analyzing problem space)

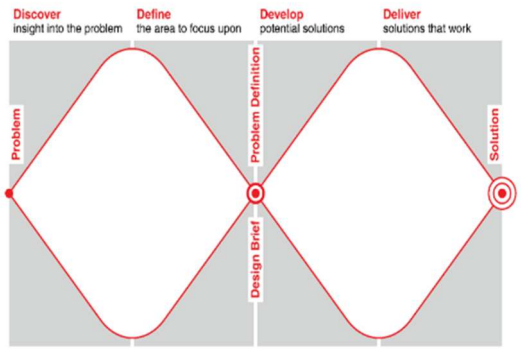
double diamond of design : Are there problems with an existing product or user experience? If so, what are they? **discover**2. Why do you think there are problems? **define** 3. How do you think your proposed design ideas might overcome these? **develop** 4. If you are designing for a new user experience, how do you think your proposed design ideas support, change, or extend current ways of doing things? **deliver**

Practical issues with interaction design

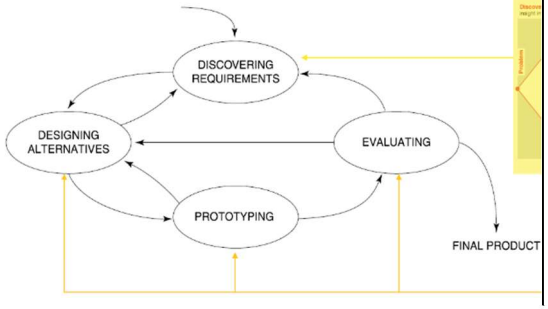
user-centered approach(3 principles): 1. **early focus on users(user/stackholders) and tasks**: directly studying cognitive, behavioral, anthropomorphic, and attitudinal characteristics(Users' tasks and goals, Users' characteristics, who are users?/what are their needs?Users are consulted throughout development from earliest phases to the latest) 2.**Empirical measurement**(users' reactions and performance to scenarios, manuals, simulations, and prototypes are observed, recorded, and analysed). 3.**Iterative design**: when problems are found in user testing, fix them and carry out more tests

Users&Stackholders: **Users** are not always obvious(Many products are intended for use by large sections of thepopulation, so user is "everybody) **Stackholders**(The individuals or groups that can influence or be influenced by the success or failure of a project/ Larger than the group of direct users)

Goals' needs: Users rarely know what is possible→instead, **Explore the problem space**/Investigate **who are the users**/I**nvestigate user activities** to see what can be improved/**Try out ideas with potential users** → Focus on **peoples' goals, usability, and user experience goals**, rather than expect stakeholders to articulate requirements



→ Exemplifies a user-centered design approach



Discover requirements

different forms and level: Atomic requirement shell/user stories

Functional: As a video game, it will be challenging for a range of user abilities(what system should do) **non-functional:** : As a video game, it can run on a variety of platforms.(the characteristics of product 我们的软件同时支持手机端和手表端)

Six types of requirements: **Functional / Data**:What kind of and How will they be stored / **Environment / Users characteristics** (novice?expert?frequent)/ Usability goals / User experience goals

requirement gathering techniques: **the key to successfu**l data gathering is to ask the right questions and to listen carefully to the answers: Observation (direct and indirect)/Interviews (individual and group)/Diaries/Surveys/questionnaire/Think-aloud evaluation/Working prototype evaluation/Studying documentation/Evaluating other systems/research similar products/Ethnographic study/Usability tests

Bring requirements to life:

Personas: capture **characteristics** of **typical users** that are **relevant to the product**(name,characteristics,goals,personal background)under development,Synthesised from real people based on user research→develop a small set of personas with one primary(用一个主要角色开发一组人物角色)

Scenarios: define when, where and how the story of the persona takes place. The scenario is the narrative(情节)that describes how the persona behaves as a sequence of events 比如：异地好友难过时，tony 点击佛祖头，播放音乐来安抚好友

Design 2

interaction types: Instructing(users **instruct a system and tell it what to do**,instructing supports quick and efficient interaction,Good for **repetitive kinds of** actions performed on multiple objects →Tell the time, print a file, or save a file)/Conversing 对话(**search engines,advice-giving systems,适用于服务类 app，好友端的小猫内置了进行对话安慰功能**? 优 Allows users, especially novices, to interact with a system in a way that is familiar to them 缺 Misunderstandings can arise when the system does not know how to parse what the usesays)Manipulating(Involves **dragging, selecting, opening, closing and zooming actions on virtual objects** 用户主动操控虚拟对象 physical controllers (e.g., Nintendo Switch) or air gestures (e.g., Microsoft Kinect)**direct manipulating**:Rapid reversible actions with **immediate feedback** on object of interest(Drag and drop to move files)新手 novice 好上手，能快速得到反馈，获取信心，使用鼠标拖动可能比较慢，不适用于重复性任务)Exploring(**moving** through virtual or physical environments→Virtual museum exploration with a map)!!!Responding(take the initiative to alert user to something that it "thinks" is of interest 是**系统主动行为**，当检测到用户情绪突然变化,软件可以主动通知用户这种变化,并给出相应的提示或建议（如深呼吸、放松等）)(Alerts the user of a nearby coffee bar where some friends are meeting → User's fitness tracker notifies them of a milestone reached)

interaction: A description of what the user is doing when interacting with a system/

interface: The kind of interface used to support the interaction

Ideation	Low fidelity paper sketches
Conceptual design	Low fidelity paper sketches, storyboards
Intermediate design	Low to medium fidelity wireframes
Detailed design	High fidelity wireframes, programmed prototypes

Design 1

Accessibility: the extent to which an interactive product is accessible by as many people as possible. Focus is on people with **disabilities**

inclusiveness: making products and services that accommodate the widest possible number of people.(regardless of their disability, education, age, or income)(关注所有用户群体)

Design principles: **Visibility**(电梯按钮需刷卡显示) / **Feedback**(Sending information back to the user about what has been done, like sound,highlighting,animation) / **Constraints** (Restrict the possible actions that can be performed)/**Consistency**(Design interfaces to have similar operations and use similar elements for similar tasks 电梯-1 的按钮和其他按钮隔开 bad design) 1)Internal consistency (design operations to behave the same within application) 2) External consistency (across apps and devices)3)Aesthetic consistency(the style and appearance is repeated) 4)Functional consistency(meaning and action are consistent 交通灯总是先黄后红) **Affordance**:allows people to know how to use it 看到这个设计知道怎么使用吗(滚动条用于上下移动)**Mapping**:Relationship between controls and their effects

Shneiderman's 8 golden rules: **Strive for consistency**(Consistent sequences of actions should be required in similar situations,includeWorkflows/Functionality/Appearance/Terminology)/**Enable frequent users to use shortcuts**(专业用户 hope use 快捷键)/**Offer informative feedback**/**Design dialog to yield closure**(Sequence of actions should be organized into groups with a beginning, middle, and end 点开窗口，发消息，窗口关闭)/**Offer simple error handling**(error prevention,detect the error and offer hints for handling error)/**Permit easy traversal of actions**(errors can be undone 撤回功能 no interference with workflow, more freedom for user, single-action undo/action history)/**Support internal locus(控制中心) of control**(make users the initiators of actions rather than the responders, 如 The user commands, the system obeys/ Strongly relies on the informative feedback)/**Reduce short-term memory load**(displays be kept simple, multiple page displays be consolidated(整合), window-motion frequency be reduced,)

Alternative designs:

How to generate alternatives:**'Flair and creativity': research and synthesis** (可通过研究现有产品的优缺点结合用户反馈，提出多种不同的界面布局)/**Cross-fertilization of ideas from different perspectives**(结合教育学、心理学、工业设计和机械工程的知识/不同专业？)/**Users can generate different designs**(让用户直接提供设计方案)/**Product evolution based on changing use**(发现某个功能使用频率很高，但用户体验不佳，遂对该功能进行优化)/**Seek inspiration: similar products and domain, or different products and domain**

How to choose among alternatives: 1.**Interaction design focuses on externally-visible and measurable behavior.** (可用性测试：通过实际测试，观察用户如何与产品交互，记录他们的行为和反馈/性能指标：如任务完成时间、点击率、错误率等)2. **Technical feasibility**. 3. **Evaluation with users and stakeholders**(使用 protopyte 给用户体验进行测评 not static document, behavior is the key). 3.**A/B testing**(同时发布两个版本（A 版和 B 版），通过分析用户行为数据，选择用户反应更好的版本). 4.**Quality thresholds**(需要考虑不同利益相关者的质量标准，Usability and user experience goals lead to relevant criteria)

Prototype1 comonalities: cheaper&faster/easier to communicate/direct feel

Reasons/goals

why prototype: Evaluation and feedback are central to interaction design/Stakeholders can see, hold, interact with a prototype more easily than a document/Prototypes answer questions, and support designers in choosing between alternatives/Team members can communicate effectively/test out ideas/reflection

(why)prototype can help you understanding: 1.**understand design alternatives**: design many to know if it possible, don't be sure 2.**understand strategy**: make your design from intangible to tangible to know their pros and cons(can complete with other design). 3. **understand user-centered processes**(Prototype could build empathy 共鸣 between designers and users with concrete ideas, 使用 empathy map 和 user journey map,更好的站在用户角度) Prototype could help you to communicate with: **In same language**(视觉化的沟通方式，使得不同背景的人用相同的方式理解和讨论)/to **different stakeholders**(user:elderly(caring)/child(warmth/male or female(cost?)))/**No "maybe"**(could save efforts in determining style, size, colour, and interactions through observable objects and peer discussion 能够明确表达设计意图和功能，使得讨论和决策基于具体的、可见的内容)

help to test and reflect on (examine and improve current design): **hypotheses and assumptions**:when we begin the design, we have to make assumptions no matter how hard we try to understand users. The only way to find the answer is to let them play with a mock system, like you need to practice before the presentation. **other's comments**:The prototype is an opportunity for you to present and promote the idea to peers, and reflect on the availability and values from different perspectives

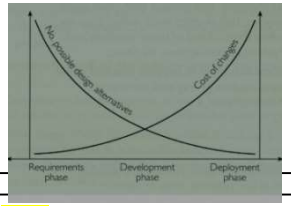
Fidelity: Denifition: refers to how it conveys the look-and-feel of the final product(level of detail and realism), Select the right level of fidelity in prototyping is the key to the success of design process.

Low-fidelity Prototyping: Uses a medium which is **unlike the final medium**(paper/cardboard), 优点:**Is quick, cheap and easily changed** like sketches of screens(草图,use pencil and pen)/Index cards (用于website development/app)/storyboards(used with scenarios,used in early design, showing how a user might progress through a task using the device)/Wizard-of-Oz (developer is responding to output rather than the system)

High-fidelity prototyping: Uses materials that you would **expect to be in the final product**. **It has disadvantages: For software-based prototyping maybe there is a slow response/sketchy icons/limited functionality.**Compromises in prototyping :all prototypes involve compromises(must not be ignored): **horizontal**: provide a wide range of functions, but with little detail /**vertical**: provide a lot of detail for only a few functions **(There are costs and trade-offs with raising or lowering fidelity in any dimension)**

Lower fidelity may be useless(more detail?), higher fidelity may be time- and money-consuming→**fidelity is a spectrum(频谱),no clear separations**

Teams are prone to over-engineering a prototype prematurely, leading to wasted effort



Continuum: is a continuous sequence or whole in which no portion differs noticeably from its neighboring sections.

Spectrum: is a range that is a continuous, infinite, one-dimensional set

Prototype 2

Five dimensions in prototyping: Visual: **how real does it look**, It is **the most direct dimension** that user feels about the prototype; Refers to the **devotion**(投入) and **granularity**(粒度) put into the design for visual interfaces and physical objects.; **Actions / procedures/ concepts for early stage**; **Accessibility/touch/visual details for later stage**; The big, obvious **problem** involves **jumping to high visual fidelity too early** in the process; Designers should **sometimes intentionally keep visual fidelity low** to encourage the kind of communication and feedback they want. Interaction is about **How real does it feel**? It refers to the **objective degree of exactness with which real-world interactions can be reproduced**(Users can **click, tap, and swipe through screens and get the feel**.); It allowed the team to quickly and cheaply test hundreds of variations. Breadth is about **the number of features covered**? Choosing **where to draw the lines of your prototype's edges** sets up its breadth. Depth: **At a given level of breadth, the degree of functionality? /if the interactions are shallow** (details)(voice assistant 限制在 weather 领域(breadth),can ask anything related to weather→deep, can only inquire in major cities→less depth) Content: the degree of realism for the content(内容是否真实)(High-fidelity content is realistic and relevant to the final application, while low-fidelity content typically uses placeholders or dummy data 虚拟数据或占位符)

it is COMPLICATED (slow, expensive) to prototype multiple dimensions at once →modularity of prototyping

physical design (涉及具体和详细的界面设计和实现细节，将 Conceptualizing design 转化为具体的界面布局(widget)和交互细节,Iteration between physical and conceptual design)**Menu design/Icon design**(Meaning of icons is cultural and context sensitive→always draw on existing traditions or standards,concrete objects or things are easier to represent than actions)**Screen design**(Frustration if too many simple screens→How to split across screens: Splitting functions across screens /Individual screen design: Draw user attention to salient point 突出的点,like animation and good organization)**Information display**(Relevant information available at all times, Different types of information imply different kinds of display)

Types of prototyping: **throw-away**(only serves to elicit user reaction, creation must be rapid)/**incremental**(product built as separate components (modules) and each component prototyped and tested, then added to the final system)/evolutionary(prototype altered to incorporate design changes,finally becomes the final product)/**evolutionary**(prototype altered to incorporate design changes, eventually becomes the final product)

Rationalize cost-value tradeoffs → Do not **oversell** - capabilities that can't be delivered, development completeness **→** Do not **overbuild** – "good enough" as a prototype

Design 3

Conceptualizing design: (通过概念化设计，可以将一些初步、模糊想法具体化，评估它们在实际应用中的可行性，通常是抽象的不涉及具体的视觉元素或实现细节)

why: To scrutinize(仔细查看) vague **ideas and assumptions** about the benefits of the proposed product in terms of their feasibility→**Assumption**:Taking something for granted when it needs further investigation(people will want to watch TV while driving)**claim**:stating something to be true when it is still open to question(a multimodal style of interaction for controlling GPS — one that involves speaking while driving is safe)

Benefits: Orientation(Enables design teams to ask specific questions about how the conceptual model will be understood 设计团队可以针对设计模型提出具体的问题，例如"用户如何理解这个功能？"或"这个界面是否符合用户的使用习惯？")**Open-minded**(Prevents design teams from becoming narrowly focused early on)**common ground**(Allows design teams to establish a set of commonly agreed terms).

conceptual model:a high-level description of how a system is organized and operates, enables designers to straighten out their thinking. **Core components**: Metaphors and analogies that convey to people/Concepts to which people are exposed to through the product/ Relationship and mappings between these concepts.

interface types: command line(Commands such as abbreviations 缩写 typed in at the prompt to which the system responds,Efficient, precise, and fast. Large overhead to learning set of commands, **Consistency is the most important design principle** → For example, always use first letter of command)Graphical user interfaces(Design principles of **spacing 间距, grouping 分组, and simplicity** should be used →window:/ icon: (text labels 可以与图标一起使用，以帮助识别小图标集,大型图标集,采用鼠标悬停(hover function)在图标上时显示工具提示或说明→小动物头顶的佛祖头，详细直观 intuitional 有吸引力,用 musical note 来代表放音乐，两个小人头就代表好友列表)/menu: Mega menus 大型菜单 are easier to navigate /pointing device:)Multimedia(Combines different media within a single interface,like Graphics, text, video, sound. Can provide better ways of presenting information than can any media alone 设计考虑: Provide hands-on interactivities and simulations that the user has to complete to solve a task → Provide quizzes, electronic notebooks, and games)

Virtual reality(have a higher level of fidelity with objects, How best to navigate through them(first/third person)/control interactions and movements/ interact with information)Website design(making pages distinctive, striking, and aesthetically pleasing)mobile interface(Space needs to be big enough for all fingers to press accurately,手动设置心情设置了三个图标, 间距足够大, 使用了 Fitts' law,确保 right spacing)Appliances 电器(design as transient interfaces with short interactions,simple interfaces)Voice user interface(can recover easily from errors/guide those who have vague requests)Pen-based devices/Touchscreens(whether size, orientation, and shape of touch displays effect collaboration)Gesture-based systems(involve moving arms and hands to communicate,need to be presented sequentially)Haptic interfaces(where to put/when to buzz and how intense)Multimodal interfaces(multi-sensor input 多模态,Much harder to calibrate these than single modality systems)Shareable interfaces(support group working,can be used by many users,显示器大小方向)Tangible interfaces(When a person manipulates the physical object/s, it causes a digital effect to occur)Augmented reality(need to be align with real world objects)Wearables(comfort/hygiene 卫生/ease of wear/usability)

robots/Brain-computer interfaces/smart interfaces

Prototype 3

Processes:

where to start?The minimum viable product: A product with enough features to attract early-adopter customers and validate a product idea early in the product development cyclestep(4 步): 1.**Understand your users and identify the problem**→2.**Write down the user flow(**flow chart/storyboard)**;→3.Use the prototype to optimize the user flow**;→4.**Test, refine, iterate.**/generate different solutions? Explorations: Focusing on exploration makes you spent more time in thinking rather than doing To Find the right issue to solve/Find solutions/Identify where we are now. step(3 步)1**Brainstorming about issues/solutions→2. Clustering and categorization(commonality/singularity,link cluster with assumptions),→3.Priority check**(high value and low effort→top priority,high...high..-->high risk).-/Communicate or advocate for a certain direction?specific audience:Focusing on specific audience makes you maintain a smooth communication with different stakeholder.step(3 步)1.**Identify your audience, purpose, and fidelity(**designer:low fidelity for ideas and high for details/customer/developer(low for architecture and high for implementation)**;→2.use tools for different stakeholders**;→3.**Present the prototype to them**(record the feedback and be a bridge between different stakeholders)/have a question or assumption to test?assumptions step(4 步) **1.Understand your audience, issues, and assumptions→**2.**Choose fidelity**(concepts, terminologies:low fidelity;completion,visual details:high fidelity)→3. **Make a plan for testing**(考虑 purpose and assumption(how will they use..); target user(introverted person?); question(have you ever unwilling to express feeling?); task:(what you will do with/what character you will use to represent emotion/what types of activity will be involved)/Make and test(make prototypes and do nothing in guiding the user)

Digital prototyping: 特征:Screen; Responsive design (mobile/desktop); Interaction types **(Design 3)**; Accessibility; Animation (Design as earlier as possible to create space for designers to implement)

Physical prototyping:

Evaluation 1

Questionnaire: **Structure**: be **closed-ended** (are easier to analyze, may be distributed and analyzed by computer) or **open-ended**. They can be administered to **large populations**. **Caution**: The impact of a question can be influenced by **question order**/may need **different versions of the questionnaire for different populations/Provide clear instructions** on how to complete the questionnaire/**Avoid very long questions**; /Decide on whether phrases **will all be positive, all negative, or mixed(是否愿意自动检测?是否不愿意增加 dual mode?)**/Strike a balance between using white space and keeping the questionnaire **compact(紧凑)**/promise **anonymity/**make sure **the purpose of study is clear**. **Format**:**Yes and No check boxes**/Check boxes that **offer many options**/Rating scales/Open-ended responses. **Pros**: Can collect data **from a large number of people**, at a relatively **low cost**/Can **get an overview** of a population of users **in a short amount of time**/Surveys **do not require any special equipment**/ Surveys are generally **approved by institutional review boards** because they are typically non-intrusive. / They can be used to collect quantitative data, such as user preferences or behaviors, or qualitative data, like user opinions or suggestions?. **Cons: good at getting shallow data** from a large number of people, **not good at getting "deep"data**/are usually **self-administered**, it is usually **not possible to ask follow-up questions/** can lead to **biased data** when the questions are related to patterns of usage, or feelings about a previous experience(记忆模糊)(每个人对于'经常'的定义不一样), **rather than clear factual phenomena**. **Deploy**: **Plan the timeline** -> **Design the questionnaire offline** -> **Program/complete online survey** -> **Test the survey** to make sure that it behaves as you would expect -> **Test it with a group that will not be part of the survey** to check that the questions are clear -> **Recruit participants**

Interview: **Types**: **Unstructured**: Not directed by a script. Rich but not replicable./**Structured**: Tightly scripted, often like a questionnaire. Replicable but may lack richness. **/Semi-structured**: Guided by a script, but interesting issues can be explored in more depth. Can provide a good balance between richness and replicability.(how do you think of our app?/ "What functionalities would you like to have in an emotion-recording app?)/**Focus groups**: A group interview. **question types**: 'C**losed questions'** have a predetermined answer format, 'yes' or 'no'(are easier to analyze) **'Open questions'** do not have a predetermined format.**Caution**: Avoid Long questions/split compound sentences into two/Jargon(行话) and language that may not be understood/Leading questions / Unconscious biases. **Deploy**: **Introduction:** Introduce yourself, explain the goals of the interview, ethical issues, ask to record, and present the informed consent form. -> **Warm-up:** Make first questions easy and non-threatening. Build rapport(融洽). -> **Main body**: Present questions in a logical order. -> **A cool-off period:** Include a few easy questions to defuse tension at the end. -> **Closure:** Thank interviewee, signal the end. **Pros**: **Go deep**: encourage reflection and consideration; **Flexible**: open-ended and exploratory. **Cons: Skill to manage/Time and resource intensive/Data analysis**/Recall problems

Evaluation 1 continue

Choosing and combining techniques: **Focus** of the study/**Participants** involved/**Nature** of the technique(s)/**Resources** available/**Time** available

Technique	Good for	Kind of data	Advantages	Disadvantages
Interviews	Exploring issues	Some quantitative but mostly qualitative	Interviewer can guide interviewee if necessary. Encourages contact between developers and users.	Artificial environment may intimidate interviewee. It also removes them from the environment where work is typically being done.
Focus groups	Collecting multiple viewpoints	Some quantitative but mostly qualitative	Highlights areas of consensus and conflict. Encourages contact between developers and users.	Possibility of dominant characters.
Questionnaires	Answering specific questions	Quantitative and qualitative	Can reach many people with low resource requirements.	The design is key. Response rates may be low. Unless carefully designed, the responses may not provide suitable data.
Direct observation in the field	Understanding context of user activity	Mostly qualitative	Observing gives insights that other techniques don't provide.	Very time-consuming. Huge amounts of data are produced.
Direct observation in a controlled environment	Capturing the detail of what individuals do	Quantitative and qualitative	Can focus on the details of a task without interruption.	Results may have limited use in the normal environment because the conditions were artificial.
Indirect observation	Observing users without disturbing their activity; data captured automatically	Quantitative (logging) and qualitative (diary)	User doesn't get distracted by the data gathering; automatic recording means that it can extend over long periods of time.	A large amount of quantitative data needs tool support to analyze (logging); participants' memories may exaggerate (diary).

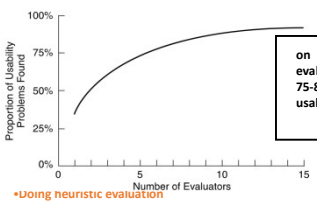
Five key issues of data gathering:

Setting goals: What information to collect; How to analyze data once collected/**Identifying participants**: Decide from whom to gather data and how many/**Relationship with participants**: should be clear and professional; Informed consent when appropriate./**Triangulation**: Look at data from more than one perspective; Collect more than one type of data, for instance, **quantitative data(定量) from experiments and qualitative data(定性) from interviews./Pilot studies**（试点研究，在进行正式研究前小规模研究）

Heuristic evaluation and walkthrough

•**(Nielsen's heuristics)**: **Visibility of system status**(always keep users informed about what is going on,**through appropriate feedback** within a reasonable amount of time)**Match between system and real world**(**should speak the users' language.** Use words, phrases, and concepts familiar to the user) **User control and freedom**(a clearly marked "emergency exit" to leave the unwanted action)**Consistency and standards Error prevention Recognition rather than recall**(Minimize the user's memory load by making elements, actions, and options visible,比如搜索历史)**Flexibility and efficiency of use**(shortcuts 快捷键 for expert,allow users to tailor frequent actions) **Aesthetic and minimalist design**(Google's minimalist 极简 homepage was tailored to user's primary action – search)**Help users recognize, diagnose, recover from errors**(Error messages should be expressed in plain language)**Help and documentation**

•**Number of evaluators and problems**



on average five evaluators identify 75-80 percent of usability problems

•**Doing heuristic evaluation**

Briefing session to tell experts what to do→Evaluation period of 1-2 hours in which: Each expert works separately; Take one pass to get a feel for the product; Take a second pass to focus on specific features**→Debriefing session(总结会) in which experts work together to prioritize problems**

•**Advantages and problems**

Few ethical and practical issues to consider because users are not involved /Can be **difficult and expensive to find experts/**优点:**Best experts have knowledge of application domain and users/Important problems may get missed**/Many trivial problems are often identified, such as false alarms/**Experts have biases.**

•**Cognitive walkthrough(one evaluation method)** 适用于早期设计阶段，可以在没有真实用户参与，Simulating how users go about problem-solving at each step in a human-computer interaction→ Focus on ease of learning) **step: 1.preparation(**Identify and document the characteristics of typical users.→ Develop sample tasks→ Produce a description, mock-up, or prototype of the interface to be developed, along with a clear sequence of the actions needed for the users to complete the task)**2. A designer and one or more researchers come together to do the analysis.3. The researchers walk through the action sequences for each task, placing it within the context of a typical scenario, try to answer three questions**(Users know what to do/Users know how to do it/ Users understand the feedback)4. **Compile a record of critical information**. 5. **(Check with real users and) Revise the design to fix the problems presented**

Evaluation 2

Why, what, where and when to evaluate: **Why**: To check users' requirements and confirm that users can utilize the product and that they like it. **What**: A conceptual model, early and subsequent prototypes of a new system, more complete prototypes, and a prototype to compare with competitors' products. **Where**: In natural, in-the-wild, and laboratory settings. **When**: Throughout design; finished products can be evaluated to collect information to inform new products.

Different types of evaluation methods: (1)**Controlled settings that directly involve users** → For example, **usability and research labs**(2)Natural settings involving users → For instance, online communities and products that are used in public places → Often there is **little or no control over what users do**, especially in in-the-wild settings

(3)Setting that does not directly involve users → **consultants and researchers critique(评判) the prototypes**, and may predict and model how successful they will be when used by users

Practical challenges of evaluation (1)**Participants need to be told(get consent) why the evaluation is being done,** what they will be asked to do and informed about their rights. An informed consent forms provide this information and act as a contract between participants and researchers (2) **Interpreting data(数据分析)**: Reliability: Does the method produce the same results on separate occasions? Validity: Does the method measure what it is intended to measure? Ecological validity: Does the environment of the evaluation distort the results? Biases: Are there biases that distort the results? Scope: How generalizable are the results?

Usability testing [controlled setting]: Users are **observed** and timed; **Data is recorded on video, and key presses are logged;** The data is used to calculate performance times and to identify and explain errors; **User satisfaction is evaluated using questionnaires and interviews**; Field observations may be used to provide contextual understanding; **Involves recording performance of typical users doing typical tasks. [5-10 users for 30min each]** • Quantitative performance measures: (Number of users successfully completing the task/Time to complete task/ Number and type of errors per task..)

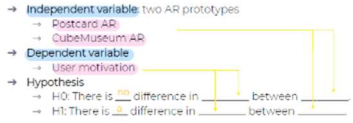
Usability Testing and Experiments: **Usability testing** is applied experimentation/Developers check that the system is usable by the intended user population by collecting data about participants'performance on prescribed tasks(system usability score). **Experiments test** hypotheses to discover new knowledge by investigating the relationship between two or more variables

Usability Testing	Experiments for Research
→ Improve products	→ Discover knowledge
→ Few participants	→ Many participants
→ Results inform design	→ Results validated statistically
→ Usually not completely replicable	→ Must be replicable
→ Conditions controlled as much as possible	→ Strongly controlled conditions
→ Procedure planned	→ Experimental design
→ Results reported to developers	→ Scientific report to scientific community

Experimental design:

(1)test **hypothesis** on controlled settings/Predict the **relationship** between two or more variables/**Independent variable** is manipulated by the researcher/**Dependent variable** influenced by the independent variable

•**Types of hypotheses**: **Null hypothesis**: typically states that there is no difference between experimental treatments. **Alternative hypothesis**: a statement that is mutually exclusive(相互排斥) with the null hypothesis ➔ The goal of an experiment is to find statistical evidence to reject the null hypothesis in order to support the alternative hypothesis



Goal: to investigate **which AR prototype can better motivate users** in learning cultural heritage

(2)**experimental designs**: **Between subjects design**(Different participants; Single group of participants is allocated randomly to the experimental conditions(每个条件都是不同的一组参与者,); Advantage: No order effects; Disadvantage: Individual differences) **Within subjects design**: Same participants; All participants appear in both conditions(一共一组，参与所有实验条件); Advantage: Few individuals, no individual differences; Disadvantage: Counter-balancing needed because of order(先进行哪个条件:ABCD/DABC/CDAB/BCDA?)

(3)**Experimental design lifecycle**: **Identify a research hypothesis(h0,h1)→Specify the design of the study→Run a pilot study(试点研究) to test the design, the system, and the study instruments→Recruit participants→Run the actual data collection sessions**:(Preparation, Greet participants, Introduce the purpose of the study and the procedures, Get consent, Assign participants to a specific experiment condition, Training task(s), Actual task(s), Participants answer questionnaires (if any), Debriefing session, Payment)→ **Analyze the data(sample size/mean value/standard deviation)→Report the results.**

Evaluation 3

Observation(natural/controlled): **Direct observation(In the field)**: How involved you will be/How to gain acceptance/ How to handle sensitive topics like culture, private spaces/How to collect the data. **Direct observation(In controlled environments)**: Think aloud techniques/ Tracking users' activities; Video, audio, photos, and notes are used to capture data in both direct and indirect observations. **Indirect observation**: Tracking users' activities/Diaries/Interaction logging/Video and photographs collected remotely

Field study**(natural setting)(e.g:goal is to understand how painpad was used in the natural environment)(Seek to understand what users do naturally and how technology impacts them)**: (1)Field study used to: **Identify opportunities for new technology**; Determine design requirements; **Decide how best to introduce new technology**; Evaluate technology in use(2)Do field study: identify goal -> Data collection and participants -> Data analysis and presentation

Analytics(without user): A variety of users' actions can be recorded by software automatically. **Advantages**: It is unobtrusive(不显眼) provided the system's performance is not affected; Large volumes of data can be logged automatically and then explored and analyzed using visualization and other tools. **Disadvantages:** It raises ethical concerns about observing participants if this is done without their knowledge.

A/B testing**(without user)**: A **large-scale experiment** (thousands of participants or more)/Offers another way to evaluate a website, application of app running on a mobile device/Often used for **evaluating changes in design** on social media applications/Compares how two groups of users perform on two versions of a design/**May create ethical dilemmas** if users don' t know they are part of the test. [A/B 测试确实涉及大量用户群体参与，但这不意味着用户明确知道他们在参与测试]

Predictive models**(without user)**: Provide a way of evaluating products or designs **without directly involving users, less expensive than user testing;/Use formulas to derive various measures of user performance**;/Usefulness **limited to systems with predictable tasks**, for example, voicemail systems, smartphones, and dedicated mobile devices.

double diamond: (version 1)**discover**:现有软件缺陷:existing apps have limitations as they often target specific groups rather than the general public. 通过文献调查,there is a significant interest among the public in tracking their moods, indicating that even those without mental health issues want to improve their emotional well-being **define**: narrow down to identify the core problems-->want to understand the emotional states of family and friends through the app. Interest in understanding one's own emotions(the need for better self-awareness and social interaction features in emotional tracking apps.)通过 open-ended questionnaire 发现确定用户需求 **develop**: 1. understand your own emotions(Automatically detect emotions or manually set emotion or combine) 2.interact with your friends or family("poke" feature/ a messaging function for friends/and interactive activities on "Dynamic Island"/Feed virtual pets to friends/Dispose of emotions in a trash can)3. represent emotion(use icon/Express emotions through posting text or images) **deliver**:combine automatic detection with manual detection/social interaction with friends and using animal icons to represent emotions/"poke" feature, a messaging function for friends, and interactive activities on "Dynamic Island" as the three friend interaction features 【**Evaluating**: target users are individuals who show an interest in apps designed for tracking emotions,the majority of users have responded that **our prototype design should include more features for tracking their mood**.This suggests that our current software design lacks sufficient emphasis on self-awareness of emotions.-->着重 emotion recording(Write mood journals at any timeV/Show mood at different time of the dayV./Record moods over a week or a monthV/Record emotion by voice./Record emotional moments through text and pictures)】

design principles: **visually(Ensures that users can see the available options and understand what actions they can take.)**: all critical features such as the facial expression of animals were easily accessible and visible on the main interface, allowing users to quickly understand how to use the app. 手动设置心情的界面和显示心情条的 HRV 条都很显而易见(Learning Mall page has a well-organized navigation menu that is easy to find and use, can locate necessary resources quickly. sections like lectures, assignments, and announcements are displayed and easily accessible.) **consistency**: All screens within the app use similar layouts, color schemes(black background), and icon styles(cute animal icon), making it easy for users to navigate and understand different sections.(Imo:layout/background/all buttons for downloading materials or submitting assignments should look and behave the same way.) **feedback**: When users log an emotion, the app provides immediate visual feedback such as highlighting the selected emotion icon, indicating that their action has been successfully recorded. **mapping**:When interacting with friends, the controls for sending messages or "poking" are placed in a way that clearly indicates their effect, such as an icon that lights up when the action is taken

5 prototyping dimensions: Visual(high)/ Interaction(low, **the page is relatively static,** interactivity is low. User interaction is primarily about **browsing information and viewing visual charts of different emotions**, without involving complex user input or dynamic actions)Breadth(high,Including personal emotion tracking, friend emotion interaction, emotion visualization, friend interaction activities,)Depth(low,In the friend interaction feature, users can express emotions by clicking on an icon, but the interaction is simple)content(low, In the user's mood log, all entries use placeholder text, with no actual user data, Fictitious data is used for names and emotional states in the friends list)

evaluation method: controlled usability testing: **Objectives**: Assess the usability of the emotion tracking feature and ease of use of the social interaction functionalities./**Participants**: Selected 10 participants representing our target users, including individuals interested in emotion tracking and mental wellness. **Tasks**: Created tasks such as "Record your current emotion," "View your emotion history," and "Interact with a friend's emotion update."/**Observation**: Monitored participants as they performed the tasks, noting any difficulties or confusion. Think-Aloud Protocol: Asked participants to verbalize their thoughts and feelings while using the app. **Recording**: Used screen recording software to capture user interactions and audio recordings for verbal feedback./ **Convert SUS(system usability score) responses to numbers**, 1 for "Strongly Disagree",and 5 for "Strongly Agree".Based on research, a SUS score above a 68 would be considered above average and anything below 68 is below average

Method	Controlled settings	Natural settings	Without users
Observing	√	√	
Asking users	√	√	
Asking experts		√	√
Testing	√		
Modeling			√

Method	Controlled settings	Natural settings	Without users
Examples	repeat ! ✓ Usability testing ✓ Experimental design	✓ Field study	✓ Heuristic evaluation ✓ Analytics ✓ A/B testing ✓ Predictive models