1. Usability & User Experience Goals, Heuristics and Design Principles

1.1 Interaction design process

- Establishing requirements → Developing alternatives → Prototyping → Evaluating
- Users involved, specific usability & user experience goals, iterative
- Help designers understand how to fit users' needs
    - one size not fits all, e.g. teenagers & grown-ups;
    - Identify incorrect assumption, e.g. not all old people needs big fonts
    - Be aware of both people's sensitivities & capabilities

1.2 Usability

- Easy to learn, effective to use & enjoyable experience
- Optimise the interaction with a system into effective, usable, useful ways
- Involve users in the design process

1.3 User Experience

- Cannot design a user experience but design for
- Usability, functionality, aesthetics, content, look, feel, sensual, emotional appeal, fun, health
- social capital (social networks, shared values, goals, & norms)
- cultural identity (age, ethnicity, race, disability, family status, occupation, education)
- Sensual, emotional, compositional, spatio-temporal thread
- Satisfying, enjoyable, engaging, fun, helpful, enhance sociability, motivating, surprising, pleasurable, exciting…
- Boring, frustrating, annoying, childish, making one feel guilty or stupid, unpleasant, offensive

1.4 Usability goals

- **Effectiveness** (how good a product is at doing what it is supposed to do)
    - Is the product capable of allowing people to learn, carry out their work efficiently, access the information they need, or buy the goods they want?
- **Efficiency** (the way a product supports users in carrying out their tasks, less steps & time)
    - Once users have learned how to use a product to carry out their tasks, can they sustain a high level of productivity?
- **Safety** (protecting the user from external dangerous conditions & undesirable situations)
    - avoid the dangers of carrying out unwanted actions accidentally
    - Avoid the perceived fears users might make errors
    - Preventing making serious errors (e.g. quit near to delete button; virous means to recover)
    - engender confidence to explore new operations
    - provide undo & redo button, or trashcan (recycle bin)
    - What is the range of errors that are possible using the product and what measures are there to permit users to recover easily from them?
- **Utility** (the right kind of functionality so that users can do what they need or want to do)
    - high utility - accounting software provides a powerful computational tool
    - low utility- drawing tool cannot use freehand but mouse
    - Does the product provide an appropriate set of functions that will enable users to carry out all their tasks in the way they want to do them?
- **Learnability** (how easy a system to learn, for both everyday and infrequent use)
    - pop-up tutorials, step by step, hands-on exercise
    - how much time spend to learn
    - Is it possible for the user to work out how to use the product by exploring the interface and trying out certain actions? How hard will it be to learn the whole set of functions in this way?
- **Memorability** (how easy a product is to recall)
    - Reduce relearning after a long time; Easy to handle obscure, illogical, or poorly sequenced operations
    - Through meaningful icons, command names, and menu options, structuring & categorizing them
    - What kinds of interface support have been provided to help users remember how to carry out tasks, especially for products and operations they use infrequently?

1.5 Heuristics (Usability principles)

- **Visibility of system status**
    - keep informed what is going on, through appropriate feedback within reasonable time
- **Match between system and the real world**
    - concepts familiar to the user, not system-oriented, information appear in a natural & logical order Use metaphors wisely: understandable, applicable, translatable
- **User control and freedom**
    - Support back, undo and redo, can exit operations by mistakes
- **Consistency and standards**
    - Use similar & consistent words, colors, or operations. Follow platform conventions
- **Error prevention**
    - prevents error from occurring in the first place, confirmation option
- **Recognition rather than recall**
    - Minimize memory load by various means, not need to remember information from one to another, visible Instructions
- **Flexibility and efficiency of use**
    - Allow users to tailor frequent actions, for both expert & novice
- **Aesthetic and minimalist design**
    - no irrelevant information, diminishes extra information
- **Help users recognize, diagnose, and recover from errors**
    - Error messages in plain language (no code), precisely indicate the problem, and constructively suggest a solution
- **Help and documentation**
    - Help documentation should be easy to search, focused on tasks, list concrete steps to be carried out, and not be too large

1.6 Design Principles (used by designers to aid their thinking)

- **Visibility**
    - Helps the user understand what to do, provide clues about how to interact
- **Feedback**
    - Reacts to user input, signal back, same direction to use knob, click is audible
- **Constraints**
    - Constraints limit the possibilities
    - Physical, shape of key, handle, round hole of recycling bin to put the cans
    - Semantic, required shared knowledge, care drive
    - Cultural, socially acceptable, learn rules, traffic light, red triangle for warning
    - Logical, common sense, logical relationship of layout, e.g. plug keyboard & mouse
- **Mapping**
    - Spatial relationship between controls and the outcome, e.g. light switches, cook tops
    - Control buttons are mapped better onto the sequence of actions of fast rewind, rewind, play and fast forward
- **Affordance**
    - Fundamental properties, give strong clues to the operations of things, how to use
    - Perceived affordances, better mappings
    - Physical, door's pull and push, button-push, switch-flip, knob-rotate; Virtual, recycle bin, low battery

1.7 Cost-Justifying Usability

- Why justifiable? No one by release 1, most customers expect release 3
- Usability Is Just Common Sense
- Good Intentions and an Awareness of the Importance of the User Is All You Need
- More Capabilities Means More Novice Users
- An unusable Web site can cause an organization to fail

1.8 Gap-between what customers want online and what they get

- Good Ux can help companies plan and develop successful Internet customer experiences that drive revenue and profitability.
- short term, bad user experience → no trail; long term, sustainable competitive advantage

2. Whole User-centered design process Part A

2.1 Design Stage (based on Assignment 2)

- PDS → focused group → Persona & Scenarios → Gathering requirements (functional & nonfunctional) → Ethic Consent Form → Questionnaires → pilot & actual interview → Analysing data → Iterating document → Paper prototype → Usability Test Plan → Usability Test & Record issue table → Interpreting outcomes & reflection → review & iterate design → Poster & presentation

2.2 Pre- design stage

- **PDS:** Roundly 30 words, meet the users goals, clear, need to mention main functions & focused group
- **Stakeholder**
  - Primary (likely to be frequent hands-on users)
  - Secondary: occasional, who use the system through an intermediary, manage direct users, receive output from the product, make purchasing decisions
  - Tertiary: affected by the introduction of the system or who will influence its purchase, government
- **Personas**
  - Market-typed, motivations; Interactive, usage behaviors
  - Demographic / Age, Gender, First Name, Photo, Goals, feelings, Online activities, at least 3
  - Create empathy to guide design but disappear when not believable
- **Scenarios**
  - Context / activity scenarios, main characters, narrative story, non-technical, define requirements, goals & needs, a daily life, no specific like press the button, user-focused not system focused
  - Why use context? Provides a snapshot of the critical points, Keeps context in the tasks carried out, Helps to get into the users' shoes, Provides a means to envisage workflow
  - Person(Who), Action(What), Sequence(when), goals(why), context(where)
  - Goal-directed, key-path task scenarios, often used to envision new system or devices, evaluate existing situation, try to understand the purpose of what people currently doing
  - Not focused on surface, but what, why, how they achieve
  - Hierarchical Task Analysis (HTA): break down to subtasks, group as plans, focused on physical & observable actions. E.g. Borrow a Book; plan 0: do 1-3-4. If book isn't on the expected shelf, do 2-3-4.
  - HTA limitation: not well complex, parallel or overlapping tasks; Cannot model task interruptions

2.3 Requirements

- **Functional** (Specific behaviours or functions; What a system is meant to do)
- **Nonfunctional** (Qualities of a system – usability, accessibility, How a system is meant to be)
  - **User:** performance, security, usability, compatibility, accessibility, flexibility, disaster recovery
  - **Term:** Maintainability, portability, reusability, testability, naming convention, tech stack, monitoring
  - **Business:** Time to market, cost, flexibility, speed
- **Components of interface**
  - **Information, Interactive, visual**
  - Information meaning/usefulness, Structure of data, Hierarchies, Relationships)
    - Entity Relationship Diagram (ERD) , UML class Diagram, User Case

2.4 Questionnaires & Interview

- **Questionnaires**
  - **Open**: easier to construct + more flexible for respondent, more difficult to record and score
  - **Closed:** have a predetermined answer format, more difficult to construct and reduces respondents choices so less accurate, more commonly used
  - **Mail questionnaires:** good for personal topics, self-explanatory, limited to text, target specific users
  - **Online questionnaire:** large numbers, lower costs, quicker and easier to analyse data, can include graphics, help-screens, pop-up screens, & can enforce rules such as one selection only
  - Both mail & online have No control, Response bias
  - **Structure:** Order, carefully chose wording (not ambiguous or offensive, use familiar words, no jargon, avoid leading questions, need clear instructions for use), clear instructions, not too long
  - Layout (easy to understand, asthetically pleasing, numbering, balance)
  - Rating scales – Likert scales – semantic scales – 3, 5, 7 or more points?
  - use the Desirability Toolkit, checklist of adjectives, to avoid bias
- **Interviews**
  - **Consistency**: same questions, same wording, same order; avoid ordering effects, leading questions, jargon and long questions; accurate records, comfortable, Written consent & ethics approval
  - Introduction → Warm-up → Main body → cool-off period (use easy questions to defuse tension at the end) → Closure (thank you, signal the end, e.g. switch recorder off)
  - **Unstructured**: Open-ended questions, not pre-determined, cannot replicate, rich data, difficult to analyse
  - **Structured**: Closed questions, pre-determined, standardized procedure , replicable but may lack richness. Used when study goals are clear, need a pilot study
  - **Semi-structured**: Both closed and open questions, start with preplanned questions, then probe for more details – Broadly replicable, provides a good balance between richness and ability to replicate
  - **Group interviews:**
    - access to more participants, less intimidated, build on each others ideas;
    - difficult to find convenient time, need a skilled facilitator, harder to analyze from tape
    - social sciences research, 3 to 10 users chosen as a representative sample of target population of interest
    - Trained facilitator needs to guides discussion, preset agenda, but unanticipated issues can be explored, less active participants, discourages participates to talk too much
    - Allows diverse and sensitive issues to be raised
    - Enables people to put forward their opinions in a supportive social environment
    - Can be used in requirement gathering to identify conflicts in terminology or expectations between different users.
  - **Personal interview:** Good control over sequencing ; Unclear questions and answers can be clarified – More details obtained; More costly; Interviewer bias
  - **Telephone interview:** High response rate; Easy to administer; Participants are more accessible; Less personal; Interviewer and selection bias
- **Observation**
  - **Direct observation in the field:**
    - Structuring frameworks used to guide observation
    - Degree of participation (insider or outsider)
    - Ethnography : where observers immerse themselves in the culture that they study
  - **Direct observation in controlled environments**: Think-aloud technique
  - **Indirect observation:** tracking users' activities; Diaries; Interaction logging
  - 6W1H
- **Key issues when Data gathering (**both to develop requirements and for evaluation purposes**)**
  - Setting goals: Decide how to analyze data once collected
  - Relationship with participants: Clear and professional, Informed consent when appropriate (ethics)
  - Multiple approaches
  - Pilot studies: Small trial of main study
  - Depends on The focus of the study; The participants involved; The nature of the technique; The resources available
- **Ethnography**
  - Traditionally used in social sciences
  - a set of techniques including questionnaires, interviews, observations
  - immerse themselves in the culture that they study
  - Allows one to understand people's real needs. Can thus design products that fit intuitively into people's lives

2. Whole User-centered design process Part B

2.5 Ethic & Consent Form

- **Why ethic?**
  - process may contain personal details or sensitive information; Often record information as transcripts, audio, video recordings
  - Cannot persuade unwilling person, Need participant consent
  - Confidentiality, not too much or too little information to explain
  - for fairness of control group (potentially worse, frustrating and unusable application)
  - Ensure participate to understand the purpose of the session and understands exactly what kind of observation and recording is taking place
  - Ensure no judgement & Ensure they not feel uncomfortable, (physically or mentally)
- **Consent Form**
  - Comments to record; Ensure participant's identity remains confidential; allow quit at any time
  - **Introduction** (describe study)
  - **Body(**Description of any recordings or observers, data use, contact**)**
  - **Conclusion** (Signatures)
- **Before**
  - Plan the interview or session in advance, develop a written protocol (what will be achieve)
  - Consider the duration
  - Prepare consent documentation
  - Prepare any other documentation (background, prototypes, questionnaires)
  - Find participants
- **During**
  - Welcome (Make them feel comfortable) → Give an introduction of purpose → Provide an opportunity to ask questions → 2 copies of consent form to complete
  - Inform them that their participation is voluntary and that they may terminate at any time
  - user interface for prototype, using comments to better understand how to improve
  - Polite, provide questions & support at any time, Be conscious of time
- **After**
  - opportunity to ask questions, Ensure copy of consent form, thank them
  - Analyse results, prepare the next interview

2.6 Basic Statistics

- **Why?** Need to score or code the responses; somehow summarise findings (Frequency distributions listing the number of respondents in each category can be useful; For rating scales (and other interval data) can use measures of central tendency (e.g. mean); Avoid percentages if sample very small)
- **Validity:** Do respondents respond according to beliefs; Avoid Misleading statistics, (mean, mode, median)
- Quantitative: data are numbers, numerical methods to ascertain size, magnitude, amount
- **Qualitative:** difficult to measure sensibly, expresses the nature of elements and represented as themes, patterns, stories

2.7 Evaluation

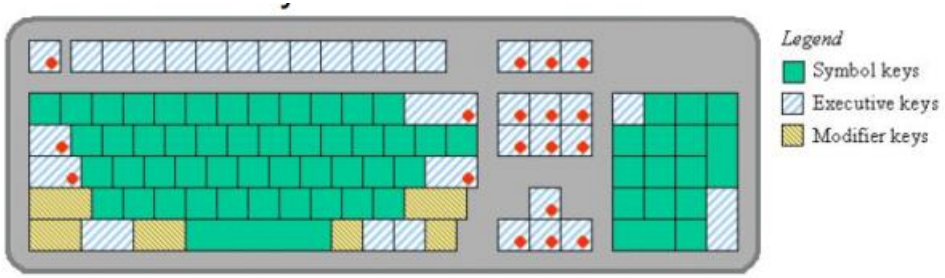
- **Usability testing phases**
  - Planning the sessions → test preparation → Running the sessions/test → After the test → analyzing, documenting, and presenting the results
  - Setting goals: learnability, efficiency, memorability, minimal errors, satisfaction;
  - Nature of the application determines goals and criteria
  - measurable, objective, and concrete (number of errors per task; number of errors per hour; length of time to complete task (relative, not absolute measure))
  - Acceptability: Usability exceeds / meets / below expectations
- **Usability test plan**
  - Documentation, sufficient discussion before the test, what to be tested, tasks involved, all resources, different aspects, contact details, consent forms
  - Test roles, Test co-Ordinator, Test facilitator, Observer(s), Camera/equipment operator
- **Why test?**
  - Ensure application can be used
  - Ensure application works as expected
  - Ensure application meets particular criteria
  - Measure productivity gains between using this application and another
- **What to test?**
  - Part of an application
  - All of an application
  - Competing designs
  - Icons/graphics
  - Online help
- **When to test?**
  - Prototypes (starting early)
  - Alpha/beta code
  - Deployed application
  - Ethical issues: this is a test of the software not of them; can stop at any time; performance and opinions will be kept anonymous
- **What to measure**
  - Initial reactions; Users exploration; Successful completion of tasks; Timely completion of tasks; How well tasks are supported; Users satisfaction; Errors
  - Time required to learn; Time required to complete tasks ; Number of errors; Severity of errors; Amount of assistance required; Ratings and comments, 20% of the functions used 80% of the time
  - What to test, Problematic or critical functions, difficult to design, document, teach
  - Related to Task Scenarios
  - How many users? 4-5, trends emerge, stop; not emerge, continue
  - Problems found(i) = $N(1 - (1 - L)^{i})$ i = number of test users, N = = total number of usability problems, L = probability for finding any single problem with any single users
- **Where to test?**
  - Labs: Facilities in place, Many ways to capture data, Higher quality results, Minimises interruptions, Shows commitment to usability; Expensive, May be overkill, Requires users to travel, Artificial environment, Can be intimidating
  - Users' work area: Captures true context of use; Most convenient to users; Inexpensive Moving equipment; Environment may be inappropriate
  - Other sites: Flexibility in location of users; Cost effective; Minimizes interruptions; Difficult to organize from off-site; Moving equipment; Contextual information is minimal
  - Indirect observation: Diaries, Interaction logging, Remote testing (web, teleconferencing)
- **Scientific methods**
  - Evaluate/refine → observe/analyze → envision/design; results/conclusion → aims/conceptualization → Methods / Experiments
  - **Experimental research**:
    - To evaluate user performance in order to improve usability design
    - Measure time to complete tasks and number and type of errors
    - Conducted in real world environment
    - Discover knowledge, Many participants (that represent the target population), Results validated statistically, Must be replicable, Strongly controlled conditions, Experimental design, Scientific results reported to scientific community
  - **User testing**:
    - To discover new knowledge or answer a research question
    - Observe relationship between two variables
    - Controlled environment, can be replicated
    - Improve products; Few participants; Results inform design; Usually not completely replicable; Conditions controlled as much as possible; Procedure planned; Results reported to developers

2. Whole User-centered design process Part C

- **Factors to consider in Scientific methods**
  - Control of extraneous factors (E.g. User's level of experience, Hawthorne effect, Ordering effect)
  - Sampling, experimenter, Double blind setup can be used
  - Representative sample (or random) – Generalisation from sample to population? – Sample size
  - Reliability - can the same results be obtained time and time again with the same subjects?
  - Validity - are you measuring what you hoped to measure?
  - consistent and repeatable procedure
  - Significance level - How certain are you that your results were not obtained by chance?

2.8 Quantification

- Assumption: Users have appropriate cognitive skill; They are expert users not novice
- Hierarchical task analysis (HTA)
  - breaking down the task into sub components; very low level interactions
- Goals Operators Methods Selections (ruls) (GOMS)
- **Key Action Model (KAM)**
  - Descriptive; Test keyboard & shortcut, help reduce chance of firing wrong commands
  - Keyboard buttons can be categorized into: Symbol keys, Executive keys and Modifier keys



- **Keystroke Level Model (KLM)**
  - predict the time to accomplish a task, expert errorfree task
  - quick and easy to use system design tool
  - No deep knowledge of psychology is required
  - can be predicted without building a prototype & testing on users, which can save time and money
- **Fitts' Law**
  - predicts the time required to move to a target area, help locate the best place & size of buttons
  - Effect of Size on timing: size has more effects
  - Effects of direction: Horizontal or vertical is better than oblique
  - How to decrease mouse move duration? Bigger size, Horizontal move, prefer corners

Example

Two different ways to delete a file for an average skilled user.

Design A: drag the file into the trash bin	Design B: use the keyboard key "Delete"
1.initiate the deletion (M) 2.find the file icon (M) 3.point to file icon (P) 4.press and hold mouse button (B) 5.drag file icon to trash bin icon (P) 6.release mouse button (B) 7.point to original window (P)	1.initiate the deletion (M) 2.find the file icon (M) 3.point to file icon (P) 4.press mouse button (B) 5.release mouse button (B) 6.move hand to keyboard (H) 7.press Delete key (K) 8.move hand back to mouse (H)
Total time	Total time
3P + 2B + 2M = 3*1.1 sec + 2*.1 sec+ 2*1.35 sec = 6.2 sec	P + 2B + 2H + K + 2M = 1.1 sec + 2*.1 sec + 2*.4 sec + .2 sec + 2*1.35 sec = 5 sec

Fitts' Law

To predict the time, we use Shannon formulation.

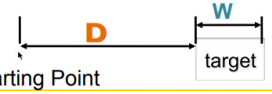
$MT = A + B * \log_2(D/W + 1)$

D = distance between start and target

W = size of target

A is the intercept and B is the slope. They are constants that are determined empirically by regression analysis.

For example, Raskin uses A=50, B=150.



Different, same, matched participant design

Design	Advantages	Disadvantages
Different	No order effects	Many subjects & individual differences a problem
Same	Few individuals, no individual differences	Counter-balancing needed because of ordering effects
Matched	Same as different participants but individual differences reduced	Cannot be sure of perfect matching on all differences

Different data collection techniques

Technique	Reactivity	Face Validity	Control	Measure detail
Task analysis	Zero	High	---	---
Observations	Low	High	Zero	Low
Surveys	Medium	Medium	Low	Medium
Experiments	High	Low	High	High

2.9 Prototype

- one manifestation of a design that allows stakeholders to interact with it and to explore its suitability
- emphasize one set of product characteristics and de-emphasize others; can be anything
- based on user centered design activities: Product objectives, User research, Scenarios, Information design
- **Storyboards**
  - sequence of interactions, help visualize the order of activities and events
  - Screen layouts will be used in the storyboard images
  - review any flow charts, key-path Scenarios
- **Card board:** used often when developing websites Each card represents one element of the interaction
- **Wizard of Oz:** PinTrace, a robotic system that helps surgeons & identify gestures for full body interaction with digital games
- **3D object, Electronic mock up…**

Compare pros and cons each of paper Prototyping and Electrical prototyping

	Pros	Cons
Paper Prototyping (low fidelity)	• Everyone can draw • Focused user testing • Easy iterations, fast • Paper mock-ups are quick and inexpensive to produce and change' • Can establish terminology (and logical) flaws very early in design	• Less useful near the end of a production cycle • Cannot convey specifics as well as electronic (colours, measurements, etc) • Can't do proper timing measurements • Don't account for the same level of interactivity as the final application
Electrical prototyping (high fidelity)	• Specific, realistic • More valuable to developers than paper • Realism can help project success • Can incorporate technologies that Paper cannot (multi-touch, animation, etc.)	• Slower to iterate (depending on toolset and competence) • Information Overload if used too early • Costly (skillsets, time - cost rises with precision) • Can be unreliable as interactivity is added

3. Accessibility & more user-centered considerations

3.1 Accessibility

- **Why important?**
  - Many disables, Potential customers, Disabilities increase with age
  - Accessible sites are more usable for all users
  - Good Reputation if a company considers it
  - Legislation, government makes it as priority, Anti-discrimination laws

- **Universal access:** Access to everyone, all people to have equal opportunity to access a service or product regardless of their social class, ethnicity, background or physical disabilities
  - **Disabilities:** Visual, Auditory, Physical, Cognitive / learning, Literacy
  - **Technology:** Slow connection, No sound card, Older browser/technology, No plug-ins

- **Accessibility:** making user interfaces perceivable, operable, and understandable for people with a wide range of abilities. This includes temporary conditions such as broken arms, to more permanent visual, physical, speech, and neurological disabilities

- **Accessibility support:** technologies, products, or services must be designed in a way that user agents including assistive technologies can access all the information they need to present the content to the user

- **Assistive technologies**
  - **Screen readers:** interprets what is displayed on a screen and directs blind people either refreshable Braille or speech synthesis
  - **Screen magnification software:** for low vision, magnifies a portion of the screen
  - **Variety of keyboard/mouse options:** provide an alternate way of creating keystrokes that appear to come from the standard keyboard. (e.g. keyboard with extra-small or extra-large key spacing & on-screen keyboards, eye gaze keyboards, sip-and puff instrument)
  - **Others:** Voice input/voice recognition software, Head pointers, Braille displays

- **Some interaction design considerations**
  - **Labels and controls:** ensure properly placed, place-holding characters explain what is to be entered
  - **Dynamic content:** ensure that equivalents for dynamic content are updated when changed
  - **Tables:** identify row and column headers, don't use tables for layout unless it makes sense when linearized
  - **Screen flickering:** Allow to control flickering, or don't cause flicker; Avoid blinking text or scrolling text (difficult to understand, and not necessarily readable by screen readers)
  - **Frames:** Title each frame to facilitative frame identification and navigation

- **Information design considerations**
  - Provide keyboard shortcuts to important links
  - Provide mechanism to allow users to skip repetitive navigation links
  - Use the clearest and simplest language appropriate for a site's content
  - Provide summaries for tables
  - Appropriate to use flash, PDFs, javascript, pop-up windows

- **Presentation considerations**
  - Text equivalents for every non-text element, Consider ALT tag written style
  - For multimedia presentations, synchronize equivalent alternatives (e.g., captions)
  - A long text description tag, or use longdesc to describe graphics
  - Provide auditory descriptions for important information of a multimedia presentation
  - Provide redundant text links for each active region of an image map
  - Provide alternatives to color coding (e.g., visited links)
  - Clearly identify target of each link (not just 'click here')

- **Evaluation techniques**
  - Automatic validation tools – verifying that the syntax of the pages
    - W3C validators & Web Accessibility checker – checks for conformance with accessibility standards
    - Automatically - checks document for access barriers and identifies problems
    - WAVE - visual tool displaying the reading order of a page
  - Human review methods (different browsers, Turn off graphics, sound, style sheets, frames, scripts…)
    - colour contrast in grayscale, font size, assistive technologies, keyboard-only navigation
  - Usability testing with disabled users
    - Same usability testing principles apply, use electronic prototypes
    - use electronic prototypes, Blind user is difficult to conduct a paper based walkthrough

3.2 Experts versus Novices

- **Experts:**
  - large amount of knowledge and experience base, had extensive practice
  - **Pattern learning and memory:**
    - Chunk large amount of meaningful information & better memories of patterns
    - Huge domain-specific knowledge, recognize a large number of familiar patterns
    - navigate through a menu; remember shortcuts; use a complicated interface they've used
  - **Problem representation and categorisation:**
    - instantly recognize and categories a problem & build a detailed problem representation
    - group problems together, Focus on deep principles
  - **Problem solving strategies**
    - use prior knowledge or schema based strategies to solve problems, working forwards
    - lots of feedback or details can be redundant and irritating, need less information
- **Novice:**
  - little knowledge or experience within a domain
  - **Pattern learning and memory:**
    - Need system features to support learning eg. menus, prompts, help screens
    - Need simple tasks with small no of options & informative feedback
  - **Problem representation and categorisation**
    - focus on surface similarities
  - **Problem solving strategies**
    - little prior knowledge or schemas
    - use search based strategies, mean-ends-analysis, working backwards
    - need more details, meaningful cues and feedback, presented in an integrated format
    - Need system features to support learning eg. menus, prompts, help screens
- **Intermediates**
  - In reality most users are intermediates: Don't stay beginner for long; High level of expertise in all aspects of system is unusual; but don't have time to learn more about the program, like Ski slope
  - Rapidly and painlessly get beginners to intermediacy, Avoid obstacles for intermediates who want to become experts, Keep perpetual intermediates happy
  - Want access to tools, but don't need scope and purpose explained to them
  - Tooltips are useful -> focus on function; On-line help useful -> can access when needed
  - Want regularly used functions easily available -> easy to find and remember
  - know advanced features exist, but rarely use them
- **Practical applications**
  - **Expert version:** more options, features and short-cuts, but not be as easy to learn to use
  - **Novice version:** limited options, but be easier to learn to use
  - For Instance: Game software, As level of expertise increases, things speed up, less cues
  - Expert web users are skilled at using search engines and locating information on the web, thus need to be teaching novices basic web search skills
- **How to Increase in difficulty:**
  - Making location choices less obvious, more locations to choose from
  - creating complicated instructions, many rules to remember, using unfamiliar names & contexts

4. Visual design, Web & App design

4.1 Visual Design

- **Visual Design context**
  - requirements sorted, who are your users, Not too early
  - Form factor (phones or desktops)
  - Posture (how much attention, what response)
  - Input methods (user access limits)
- **What screen users want?**
  - orderly, clean clutter free appearance
  - obvious indication of what is being shown and what should be done with it
  - Expected information located where it should be
  - clear indication of what relates to what, indicating options, headings, data and so forth
  - Plain, simple English, no terminology
  - A simple way of finding out what is in the system and how to get it out
  - clear indication of when an action can make a permanent change in the data or system
- **Layout**
  - have some relationship to the users workflow, Order elements so that match the workflow
  - Everything we place increasing the cognitive load
  - Understand the tasks, Study the ordering of the tasks, Consider visual groupings
  - Symmetry, Instability, Balance, Asymmetry, Regularity, Irregularity, Sequential
- **Principles**
  - Avoid visual noise and clutter, Too much clutter increases search
  - Keep things simple, Redundant info uses up limited processing capacity
- **Alignment**
  - Reduces visual noise, Make it easier to scan information, Assist with visual orientation
  - Make the window visually pleasing
- **White Space**
  - provides a separation between elements, Helps reduce visual clutter
  - help organize and structure related items, Can assist with balance, clarity
- **Group Boxes**
  - A line drawn around a series of elements, label associated
  - Use sparingly as the line may add to the visual noise
  - Use contrast, similarity, Proximity and layering to distinguish and organize elements
  - Use color, spatial or shape contrast
- **Squint Test**
  - Close one eye, Squint at the screen, what elements stand out and what fuzzy, and group together
- **Color**
  - used sparingly, integrate well into the other elements
  - Can draw attention to important items, Indicate relationships, Communicate status
  - **Schema:** Red Green Blue (RGB), Cyan Magenta Yellow Black (CMYB), Hue Saturation Brightness (HSB)
  - Primary, Secondary and Tertiary Colours, Cool & warm
  - **Colour Harmony:** Engages the viewer, Creates a balance in the visual experience, Delivers visual interest and a sense of order, Figure-ground principle
  - **Formulas:** Analogous, Complementary, Triadic, Colours found in nature
  - **Simulating vision impairments:** checking for colour vision deficiency
- **Color Tips:**
  - Use to enhance a design not a design depend on colour
  - Design for monochrome first, then add colour
  - No more than four colours should be used
  - Use colours found in nature (particularly lighter colours)
  - Similar colours imply relationship, distinct colours can show structure
  - Warm colours imply action, response required, spatial closeness
  - Cool colours imply status, background information, spatial remoteness
- **Menus**
  - **Grouping:**
    - Order contents by frequency, related commands within a menu
    - Use separators between logical groupings
    - Group items related to functions, then determine descriptive menu title
    - Don’t nest too deep
  - **Patterns:**
    - same verb tense across the menus
    - Make menu titles and commands consistent when used in multiple windows
    - Disable non-functional items by greying them
    - In drop-down menus, ensure label differs from title
    - Ellipses (…): indicates that an app needs additional user input to execute the command
  - **Style:**
    - **Flat menus:** good at displaying a small number of options at the same time and where the size of the display is small; have to nest the lists, more steps, tedious to previous one
    - **Expanding menus:** Enables more options to be shown, More flexible navigation, allowing for selection in the same window, Most popular are cascading ones
    - **Contextual menus:** Provide access to often-used commands in a current task, Appear when pressed control key, Helps overcome navigation problems of cascading menus
    - Hamburger menus: Mobile navigation, Hiding navigation behind an icon
  - **Card Sorting**
    - hierarchical groupings, Identify the topics (50-100), topics on index cards
    - Number cards back, Arrange on a large table, Explain the process and objectives
    - Blank cards can be used as new categories are identified
    - If too many groupings, ask the user to arrange the groups hierarchically
- **Windows**
  - invented to overcome physical constraints of a computer display, enabling more info
  - Need to organize windows to support tasks, Put related info. in same window, Minimise no
  - Multiple windows can make it difficult to find desired one, so Listing, iconizing, shrinking
  - Can act as an external memory and so make it easier to switch between tasks
  - Make sure window is large enough to present all relevant and important info, not too crowded
  - Dialogue boxes used for infrequently used or needed info.
- **Icons**
  - Icons are assumed to be easier to learn and remember than commands
  - Can be designed to be compact and variably positioned on a screen
  - designed to be very detailed and animated making them both visually attractive and informative
  - GUIs now highly inviting, emotionally appealing, and feel alive
  - mapping between the representation and underlying referent can be similar, analogical, arbitrary
  - Most effective icons are similar ones
  - Text labels can be used alongside icons to help identification for small icon sets
- **Human Interface Guidelines**
  - Available for most of the main graphical user interface environments
  - Describes generally how to use controls and widgets properly, in order to maintain consistency
  - Tend to focus on the look and feel, Can be detailed down to the pixel dimension

4.2 Web & App

- **Principles**
  - Screen size & real estate: increasing with desktops and fluctuating with mobiles, • More screen space != more content, Less is more,
  - Font/Layout: One font throughout, websafe font, One set of styles, Consistency
  - Colours: Maximum of 4 colours, Primary for links/highlights, Secondary alternate things
  - Navigation: One at most, Order by most used not alphabetically
  - Mobile: Bandwidth, Images vs. Text, Accessibility, Scroll, Size of screen
  - Responsive design: Simple content, Complex content: dedicated display
- **Concepts**
  - CSS: separate visual design from the information
  - Bootstrap, Design Patterns, iOS HCI, BlackBerry HCI, boo.com

5. Collaborative Design, Internationalization

5.1 Collaborative Design

- **Why study?**
  - As social being, We are sensitive and responsive to social cues
  - Because social interactions are not limited to only face-to-face interactions anymore
  - Technology has introduced different mediums to connect people together. To design effective and efficient systems we need to study and apply the rules of natural social interactions
- **Social Interaction**
  - the process we act and react to people around us, including people perform toward each other and the responses they give in return
  - **Context:** the immediate physical and social setting in which people live
  - **Status:** relative rank, attendant rights, duties, and lifestyle, social hierarchy based upon honor or prestige
    - Ascribed status: Age, sex, race, family relationship
    - Achieved status: education, occupation, marital status, accomplishments
  - **Roles:** the behaviors expected of people in a certain status, help make social interaction smooth and possible (e.g. Child & Parent, Students & teachers, Shopper & cashier)
  - **Norms:** informal understandings that govern the behavior of members of a society
  - **Communication:**
    - **verbal:** Text, Voice, Audio visual
    - **Non-verbal:** Facial expression, Body gestures, Postures, Eye-gaze, Vocalization, Clothing
  - **Perception & Personal Characteristics:**
    - Forming impression about others dispositions and intentions
    - Personality, Emotions, Mood, Belief & Behaviour
  - **Cultural issues:**
    - Speak with different languages; Not all norms are universal; use different signs/signals
    - High-context: relies heavily on nonverbal communication and deep cultural knowledge to convey meaning; Asian, Arab, South European, African, South American
    - low-context: depends largely on words themselves; Swiss, German, American
  - **Social Media:**
    - Pervasive, Portable computing devices, Widespread internet access
    - Greater need for remote communication and collaboration
  - **Social computing:**
    - A multi-disciplinary field: Computing & Social psychology & Communication science
    - can be used to support social interactions, connecting people together, facilitating collaborations & potentially predict social outcomes
    - Ongoing Challenges:
      - Understanding context (Hashtags), roles/status, norms (Online/offline status)
      - Making communication (NLP), Reading social cues (Emoticon)
      - Automatic emotion recognition, sentiment analysis, mood recognition, personality recognition
      - Understanding cultural differences
  - **Collaborative Computing:**
    - subgroup of social computing, focuses on group rather than individual problem solving and decision-making tasks necessary to accomplish business and scientific objectives
    - provides an environment people can share information without time space constraints
    - **Benefits:** Flexible working (time/place), Leverage of distributed talents, Increasing productivity
    - **Challenges:** Building trust Quality, Coordination mechanisms, Social translucence
  - **Crowdsourcing:**
    - An institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call
  - Goals: Develop better social software to facilitate interaction and communication; Computerize aspects of human society; Forecast effects of changing technologies and policies on social behavior.

Social interactions in time and space

	same time	different time
same place	• Face-to-face • classroom tech. (Clickers) • Text chat • video-games	• Bulletin boards, cork boards • Graffiti • Displays • Search-and-discovery (Foursquare)
different place	• Telephone • Video call (Skype) • Text chat	• Postal system • Email • Social networks (Facebook) • Text messaging

Collaborative Computing

Collaborative computing across time and space

	same time	different time
same place	• Blackboards/ whiteboards • Sharing documents • Presentation systems • Shared screen	• Sharing documents • E-mail • Video messaging
different place	• Audio/video conferencing • Shared screen • Electronic document sharing (Google doc)	• E-mail • Video message • Electronic document sharing

- **Major application areas:**
  - Computer-supported online communities
  - Intelligent entities in interactive entertainment
  - Business & public sector applications
  - Forecasting systems

5.2 Internationalisation

- **Why important?**
  - International sales to other countries can be quite significant ()
  - Not all languages are read from left to right and top to bottom, which affect the layout of interface Left to right (Australian) , Right to left (Arabic)
  - Local customs may be quite different
- **Why cannot just translate?**
  - Translation alone may not be enough since Text is used in a variety of places in software
  - Length of words in different languages is different!
  - Danish novice users did not see the difference between the two phrases since they did not look significantly different; Turn Grid On (Med net) / Turn Grid Off (Uden net)
  - translated menu items s when tested as a static menu item appeared to be well understood interactive element (ie. working GUI menus) users were found to make more mistakes
  - require the expertise of a person who is familiar with the local customs and expressions
  - locale in recent times & briefed about the design rationale to give them background information
  - Translation often gone wrong
- **International Usability**
  - Avoid complicated language, examples overly dependent on local culture, Involve international representatives in product design (from early stages)
  - Worldwide-recognized Graphics? e.g. International traffic signs, In Au, Green man to cross street/Red to wait (Noise); In US: White man to cross street/Red hand to wait (Silent)
  - In Japan the cross indicate NOT, but we consider crosses & ticks can interchangeable
  - Owl means wisdom and knowledge in amarican, bu witchcraft and black magic in Central America
  - **Calendars & dates**
    - Seasons are not the same between north and south hemispheres
    - Gregorian calendar used in US, Australia, most of Europe
    - Arabic, Jewish and Chinese calendars refer to lunar cycles
    - Japanese calendars may reference the reign of specific Emperors
    - Different date formats
  - **Units**
    - US Imperial (inches, feet, miles), Rest of the world (metric), Celsius VS Fahrenheit
  - **Keyboard Layout**
- **Internationalisation vs Localisation**
  - Internationalisation: process of designing, preparing and developing your application for localization
    - enable the creation of localised versions
  - Localisation: processes of adapting an internationalised application to local and cultural conditions
    - specific changes to the user interface (Text messages; Icons / Images; Sounds / media)

6. Cognitive Psychology Part A

6.1 Memory

- **Why cognitive psychology?**
  - Interacting with technology is cognitive, need to take the processes and limitations into account
  - provide knowledge about what users can and cannot be expected to do
  - help identify and explain the nature and causes of problems, Supply theories, modelling tools
  - use knowledge to design technologies both extend human capabilities and compensate for weaknesses
  - To understand the strengths and limitations of human cognition and memory and apply these to the design of more usable interfaces that do not cognitively overload users
- **Information processing approach:**
  - Cognition: acquisition of knowledge, knowledge is important
  - Cognitive processes overlap and don't occur isolation
- **Sensory memory:**
  - original sensory form for a very brief period of time, very limited in duration but not capacity
  - Sperling's experiment, test the rate of forgetting from sensory registers
- **Perception:**
  - how information is acquired from the environment
  - via the different senses, and transformed into experiences of objects, events, sounds and tastes
  - active & integrating process, Visual illusions → heavily influenced by context
  - Gestalt principles: Proximity, Similarity, Closure, Symmetry and Continuity
  - Use Colour
    - Powerful way of dividing display into separate regions
    - Useful for search tasks
    - More effective with inexperienced users
    - Less time to locate items, Grouped using border compared with using color contrast
  - Applications:
    - Present information be perceived easily
    - Sounds should be clear and audible
    - Bordering and spacing are effective visual ways to group information
    - Icons and other graphical representations should be easy to interpret
    - Text should be legible and distinguishable from the background
- **Attention:**
  - very limited mental resource, some are selected for further processing and the rest are excluded
  - concentrate on at a point in time from the mass of stimuli
  - filter model of attention: works like a filter allowing us to which incoming sensory information
  - Shadow experiments: Different but continuous message given to each ear; listener can occasionally report information from unattended channel; Suggests attention not totally all or none process
  - heavy were more prone to being distracted than those who infrequently multitask & easily distracted and find it difficult to filter irrelevant information
  - Attention grabbing techniques, these should be used sparingly: colour, bold, underlining, animation, flashing text, reverse video, auditory warnings
  - Can be guided using categories and meaningful groupings and by using appropriate spacing
  - Applications:
    - Important information should be in a prominent position
    - Information not need very often (eg. help), should only be displayed on request. Avoid cluttering the interface
    - Reminder prompts should be displayed for routine background tasks that are easily forgotten eg. saving a file
- **Automatic & Controlled processing:**
  - no conscious control, effortless, fast and difficult to alter or suppress once learned, no attention or awareness, parallel in nature, virtually unaffected by working memory load
  - Expert use automating basic skills and processes, Highly practiced skills are often difficult to suppress eg. Key press sequence, The Stroop effect exists of a result of automation
  - Controlled processing is on the contrary
- Working memory
  - Often referred to as consciousness, limited in both capacity and duration
  - Span of attention - the largest number of items one can recognize in a single glance, count dots
  - Memory span - the number of items one can remember after reading a list once, list numbers
  - Use Chunking to improve memory
  - active process, temporary storage buffer for the processing of current information
  - Focus on the parallel nature of information processing
  - the number of unfamiliar items we can store in WM is actually 4 and not 7 (more recent)
  - **3 subsystems**
    - Phonological loop stores and rehearses speech-based or auditory information
    - Visuospatial sketchpad allows people to temporarily hold and manipulate visual imagery
    - Central executive processor controls the operations of working memory and allocates resources to the other two subsidiary systems
- Stages in information processing:
  - **Encoding**
    - information is rehearsed at a superficial level, repeated without thinking about it
    - Elaboration: information is rehearsed by meaning and linked to other stimulus at the time of encoding
    - Organisation: material that is well organized, meaningful groups will be better encoded
  - **Retrieval**
    - Context & emotional state can serve as cues in the retrieval
    - physical situation or related information
    - Tip-of-the-tongue-phenomena, are aware of information, but cannot retrieve it
    - Recall: involves retrieving information from memory, short essay
    - Recognition: selecting previously learned information from existing options, multi-choice
    - Recognition is easier than recall as Recognition uses context
    - E.g. Command-based interfaces, GUIs provides visually-based options
    - Web browsers, MP3 players provides URLs to help recognize memory
  - **Retrieval application**
    - Recognition is easier than recall (Use of menu based systems over command based)
    - Use retrieval 'cues' to aid in the recall (Help systems)
    - Naming conventions Use names meaningful, distinguishable, and consistent
    - When training users, try to make the context and the cues as similar as possible
    - Provide users with many ways of encoding information (eg. files, emails, images, icons)
  - **Schema**
    - cognitive structure in memory to help organise information
    - patterns of thought, or organized knowledge structures, that render the environment relatively predictable
    - Schema allow us to filter, organise and process large amounts of information quickly and economically → reduces the burden on our limited working memories
    - aid learning, remembering, understanding and problem solving
  - **Mental model**
    - Internal constructions of part of the external world enabled predictions and inferences
    - Well designed interactive systems are → appropriate mental models of the system
    - Useful feedback in response to input; Intuitive ways of interacting with system; Clear and easy to follow instructions; Appropriate online help and tutorials; Context-sensitive guidance for users; set at their level of experience
- **How to improve memory?**
  - Elaboration
  - Organising materials, Summaries, Advance organisers, Stories
  - Automating skills, Computational offloading & Annotating
  - Chunking, Acronyms, Linking new information to previously mastered
  - Imagery
  - external memory aids eg. diaries, shopping lists, to-do lists, calendars etc

6. Cognitive Psychology Part B

6.2 Problem Solving

- finding a path (or solution) that overcomes some obstacle, permitting us to reach a desired goal state
- Problem space includes initial, goal state & problem solving operators, transform one problem into another
- **Diagrams**
  - more concrete and explicit, visualize the whole problem all at once
  - improve understanding, reduce the load on WM
- **Creating sub goals**
  - involves decomposing a problem into smaller, more manageable components
  - Working backwards from the goal
  - look at what the goal is, and try to figure out how to get back to the start state.
  - tend to use this strategy in unfamiliar domains
- **Random search**
  - also known as generate and test
  - is essentially a trial and error procedure
- **Hill climbing**
  - Often more reliable than random search but can lead you astray as sometimes have to move further away from the goal in the process of solving a problem
- **Means-ends strategy**
  - the problem solver compares the current problem state with the desired goal state and tries to find problem solving operators that will bring them closer to the goal state
- **Means-ends analysis**
  - is a useful problem solving strategy for novices. However, it is not a very good learning strategy
- **Analogy**
  - Success in using an analogy depends on recognizing the similarity between the two problems as well as recalling the solution of the analogous solution, e.g. fortress – tumor, roads – surrounding tissue
- **Why problems may be difficult?**
  1. difficult to represent in a solvable form, → Interface needs have the appropriate background knowledge, and so can adequately represent the problem, Analogies and tutorials can be helpful
  2. Functional fixedness: a mental block against using an object in a new or unconventional way to solve a particular problem, Duncker's candle problem
  3. Unwarranted assumptions are made about moves that are or are not legal**,** Nine dot problem
  4. set effect occurs when we solve problems in a certain way influenced by previous experience, when updated a system, it's easier to continue doing things the way used
  5. Goal state is inadequately defined
  6. Problem solving space is too large, Too many options, Create subgoals to reduce search space size
  7. Lack of prior knowledge
  8. Memory limitations, Too much information that needs to be considered at once, & not properly encoded into long-term memory

6.2 Cognitive Load Theory

- Our cognitive architecture: Huge Long-term memory, Limited Working memory
- **Schemas** allow us to bypass the limitations of WM by chunking large amounts of information together
  Automation helps to reduce the burden on WM with minimal use of our limited WM capacity
- **Two functions:** Allow us to store information in LTM in an efficient form & Reduce the burden on limited WM
- **Worked out example & means-ends analysis**
  - A useful but not particularly good learning technique as it is very cognitively demanding
  - New system should create a 'worked out example' or a tutorial to demonstrates how to use
- **The Split Attention effect**
  - Structured information requires mentally integrate information that is split
  - Mutually referring sources of information should be physically integrated to frees up cognitive capacity & WM
  - Text referring to a diagram, Related text in the same page should not force users to recall from another screen**,** Integrated training packages & Web navigation, not split
- **The Redundancy effect**
  - If information is not essential for understanding, redundant & better to omit
  - Minimal computer manuals, Screens should be designed to only contain essential information
  - navigation information should only appear once on any screen
- **Interaction between the Split Attention and Redundancy effects**
  - Whether redundant depends on nature of the materials and the level of expertise
  - When knowledge level of your users is unknown, better assume less knowledge
- **Expertise reversal effect**
  - What is a good presentation format for novices learners, may not be an ideal format for experts
  - Novices need to avoid the split-attention effect, but experts need redundant information removed
  - Novices need lots of worked out examples, while experts benefit from many given problems
- **Reduce Search**
  - Searching is cognitive demanding, we can reduce by
    - Not putting too much information on a single screen
    - Integrating related information
    - Using a consistent screen layout
    - Highlighting important information, colour, fonts, bold
    - Making all web pages accessible from the Home Page
- **The Modality effect**
  - WM has partially separate processors for handling visual and auditory information, thus presenting information in both an auditory and visual mode can increase the capacity of WM
  - Audio-visual materials are most useful as a method of eliminating the split attention effect
  - audio is a useful way of presenting error messages, however if the messages are presented in both an auditory and visual format, the visual component becomes redundant
  - avoid an excessively large or complex auditory component, Timing of the audio
- **Animations**
  - Be careful when and how you use animation, can be distracting if redundant
  - Often need to include user control and interactivity
  - Most useful for more knowledgeable users
  - Good for depicting human movement based tasks, Better if more realistic
- **Transient Information Effect**
  - transient information should be used sparingly online, for learning,
  - Audio content not too long or complex, Animations should be used with caution
- **Cognitive Sources:**
  - **Extrinsic/extraneous**: instructional design, Can be modified by reformatting the information, Want to reduce and keep to a minimum
  - **Intrinsic:** type of materials one is dealing with -> materials vary in terms of their intellectual complexity, Cannot be modified
  - **Germane:** instructional design, associated with the effort to learn, Results in resources being devoted to schema acquisition and learning, increase the germane load so can improve learning
- **Interaction between format of instruction and task complexity**
  - Task complexity depends on a person's prior knowledge and schemas
  - consider: The complexity of the materials, The users' level of knowledge, The structured format

6.3 Link to Heuristics

- Visibility of system status – reduces to search information & save cognitive resources
- Match - Designing a system uses familiar terminology and concepts, so prior knowledge & schema
- User control and freedom – by allowing control, cognitive resources can be focused on
- Consistency and standards – once familiar, easy to find information, more easily acquire schemas
- Help users recognize, diagnose and recover from errors - Effective and useful feedback increases the chances users will learn from their mistakes and integrate new knowledge into their existing schemas
- Error prevention - If errors can be avoided, cognitive resources can be focused on the task, lead fast learning
- Recognition rather than recall - less information to remember, less burden,
- Flexibility and efficiency of use - Accelerators would require extra processing capacity for novices who are still learning to use the system, so it is good to make them invisible
- Aesthetic and minimalist design – reduces reductant effect
- Help and documentation - makes it easier to learn how to use the system, less cognitive resources

7. Input & Output device and WH&S

7.1 Input & Output

- **History of computer displays**
  - Teletype Monitor, ENIAC (Punch Cards), Blinking Indicator Lights, CRTs (Black & white)
  - graphics (1981 - 1987), first graphical operating system (Xerox Star 1981)
  - Flat Screen → Foldable and flexible displays
- **Touch screen**
  - **types**
    - **Capacitance:** based on capacitive coupling, measure conductive things
    - **Resistive:** two flexible resistive materials, air gap, stylus pen and gloved finger can touch
    - **Optical:** finger disrupts light ray of the camera
    - **Wave:** works by sound waves that are created by touching the surface
  - **Usages:**
    - Monitors, Tablets, Mobile phones, Cameras, Game consoles 3DS or switch, ATM Machines, Payment terminals, Self-serve kiosks, Interactive Video projectors, Interactive displays, Smart boards, Home appliances, Interactive Tables, 3D Map Table
- **Volumetric Displays**
  - **Types**
    - Laser light: visible radiation in solid, liquid, or gas
    - Physical and mechanical movements
    - Transparent display
- **VR & AR**
  - **VR:** computer technology, simulated environment, inside an experience, interact with a 3D world
  - **AR:** blended & can interact with with virtual contents in the real world, can distinguish them
    - **Benefits:** Solve the issue with use of the mouse, Feel the material we are touching; See information everywhere, See an object in its future location
    - **Haptic feedback gloves:** let users to have a better interaction with objects in AR; enable in addition to sense their size and solidity
  - **Similarity:** aim to engage users in a virtual world
  - **Differences:** With AR, users continue to interact with real world. With VR, user is isolated from the real world while covered in a world that is completely fabricated
  - **Special design principles for VR & AR:**
    - **Discoverability:** giving users enough freedom to discover what they can do with platform
    - **Scalability:** how well gestural interactions work with different sizes, e.g. the sun in hands
- **Motion sensing**
  - High quality 3D scans, Stroke recovery to provide games and feedback, Translate sign language,
  - Select information without being at the screen, Make any surface a touch screen, Virtual clothing fitting, Control Robots with body movement
- **Brain-computer interfaces**
  - directly communicate between an enhanced or wired brain and an external device)
- **Wearable devices**
  - Projector phones, Foldable phones, Smart watches)
- **Skin Input:**
  - projector provide a direct graphical & bio-acoustic sensing to localize finger taps on the skin
- **Intelligent device:**
  - any type of equipment, or machine that has its own computing capability
  - Personal assistants: Phones, Computers, Tablets, Smart Speakers
  - Medical assistant, Smart cars
- **Robotics**
  - Medical surgery, War, Space, Manufacturing, Helping human
  - Recognize Images, Have speech interaction, Walk, Build/destroy, Mimic human behavior
- **How to select an appropriate input & output method, ask 4 questions**
  - **What input method is appropriate for the target user?**
    - Considering their needs and limitations
  - **How to transfer input to outputs that are useable for users & how well to support natural input?**
    - E.g. Speech recognition & Text to speech
    - **Ubiquitous computing:** connecting electronic devices to communicate information, Devices use it to have constant availability and are completely connected
    - Main focus: creation of connected smart products & making communication and exchange of data easier
  - **How to filter above information for different usages?**
    - Aggregating information by using dashboards, which are summary output of different information sources that help users get an overview of important information
    - Considering mapping principle in dashboards for buttons around the screen
  - **How can we increase users' input and engagement? (**Use Game based designs)
    - **Game inspired design:** is a user **interface** that **mimic** from games' artwork
    - **Gamification:** use of video game mechanics in non-game contexts to encourage and engage users in the context by making sense of playfulness and fun, e.g. Human resource, Health care & sport, e-Learning, Data collection, Online community, Software popularity
    - **Serious game:** similar to normal games but are developed with the purpose of training a concept to a specific group of users, e.g. teaching, simulators, meaningful & purposeful
    - **Differences:**
      - Game inspired (game thinking, fun + no gameplay) < Gamification (above + game elements, purpose + no gameplay) < Serious game (above + game play, purpose + gameplay) < game (above + just for fun, gameplay)

7.2 Workplace Health & Safety (Liability for design)

- **Hazards & risks in the workplace:** Things that can cause harm such as injury or ill health
- **Duty of care**
  - **For Employers**: to ensure health, safety and welfare of people at work including contractors & visitors, Minimize and manage risks, Prevent, where possible, any harm to workers; **For Workers:** To act with care – to property, themselves and others
  - **Risks of computer use**
    - Injury: Improper or prolonged keyboard use, eye strain: long time viewing display
    - back, shoulder & neck pain: poor posture
    - Overuse of mouse, trackball or keyboard can harm thumb, index finger, wrist or shoulder
  - **Risks of mobile use**
    - Cancer from radio frequency (handsets), Health effects such as brain activity and sleep changes, Electromagnetic interference with medical devices. Like: Artificial heart
    - Traffic accidents, Eye strain
- **Personal health & safety while using computers**
  - Ergonomically sound workstation: like good seating, good posture, layout of keyboard, and monitor
  - Proper working environment: like proper lighting, and freedom from noise
  - Ergonomically sound working habits: take breaks from keyboard and screen, vary postures & tasks
  - Find the discomfort situations early enough; Address what is causing the pain; Stop it
- **Repetition Strain Injury (RSI) or Occupational Overuse Injury (OOS)**
  - Caused by Repetition or overuse, Static loading, hold one position too long, Non-neutral postures of limbs & joints, Localized pressure, Use of high force, especially with small muscles
- **Workstation design**
  - Heights of desk and chairs: good ergonomic chair, sufficient clearance underneath desk, footrest
  - Layout of workspace: Set screen at right distance, Put document holder at same depth as screen, Put equipment within easy reach
  - Environment: appropriate general lighting + task light, noise free, consider: more light available, Glare, direct and reflected, brightness contrasts, viewing distance, readability
  - Correct postures (sitting & standing position & working with laptop)
- **Keyboard & Mouse Design**
  - appropriate Keyboard: hands as straight and flat as possible called neutral posture, Split keyboard
  - Appropriate mouse: right size to support hand, keep wrist straight, not be too slippery on mousepad
  - 2 button + wheel + tilt VS whale, inclined, Anir/3M Renaissance, Quill