

CSCC10 – Human Computer Interaction

Fall 2018 Finals Notes – Naureen Nizam

Human Computer Interaction (HCI) is the study of how people interact with computers and to what extent computers are or are not developed for successful interactions with human beings

Human – the user of a program, device, or information technology

Computer – the device, artifact, or hardware that runs the program

Interaction – the communication between human and computer (direct/indirect)

Kegsworth Air Disaster 1989 plane crash that occurred, boeing 737 crashed due to pilot shutting down wrong engine

Air Inter Flight 148 air crash that happened because display screen was too small

HCI is primarily concerned with the **Design, Implementation** and **Evaluation** of interactive computing systems.

Goal is to develop or improve safety, utility, effectiveness and usability of systems which include computers

Usability: safely, effectively, efficiently and enjoyably

HCI Timeline and History

Eniac – 1943 the world's first all electronic numerical integrator and computer

Vannevar Bush – 1945 published "As we may think"

Ivan Sutherland – 1962 created the Sketchpad

Doug Engelbart – 1963 invented the mouse

This event symbolized the emergence of HCI

First HCI Study 1967 – A comparative evaluation of Mouse, Joystick, Lightpen, Grafacon, and Knee Lever

Independent variable was input method

Dependent variables was error rate, completion time

Tasks were to press spacebar, position and select targets

Mouse showed close to lowest time, and lowest error rate by far

Alan Kay – 1969 the creation of a prototype Dynabook, notebook computer

Xerox PARC – 1970s company which developed

The Alto, a personalized workstation with mouse and bit-mapped display

***The Xerox Star**, first commercial PC designed for business professionals (comprehensive GUI) led by **Alan Kay**

ACM SIGCHI – 1982 first (Special Interest Group on Computer-Human Interaction) conference

Psychology of HCI – 1983 published *by Card, Moran, Newell*

Apple Macintosh – 1983/1984 announced and launched

Usability

Is a quality attribute that assesses how easy user interfaces are to use. The word "usability" also refers to methods for improving ease-of-use during the design process

Jacob Nielsen is the King of Usability, one of the world's most influential designers. Ph.D. in HCI from TUD in Copenhagen

NN/g – **The Nielsen Norman Group**, one of the world's authorities on HCI and usability

Qualitative – how much satisfaction, how quickly we learn, how well we remember to use it next time

Quantitative – how quickly we complete tasks, how many errors

Usable Systems are – easy to **learn, remember, efficient** to use, **effective** to use, **safe** to use, and **enjoyable** to use

Usability is a **necessary condition for survival** online

Successful Designers have a thorough understanding of a diverse community of users and their tasks

*Usability Goals and Measures

Reliability actions must be as specified, data must be in database, appease mistrust, available, no errors, privacy, etc.

Standardization must adhere to industry standards where they exist

Integration the product should be able to run across different software tools and packages

Consistency compatible across product versions, related products

Portability allows the user to convert data across multiple software and hardware environments

*Nielsen's Five Factors/Usability Goals/Components

Learnability - How easy is it for users to accomplish basic tasks the first time they encounter the design?

Efficiency – Once users have learned the design, how quickly can they perform tasks?

Memorability – When users return to the design after non-usage, how easily can they re-establish proficiency?

Errors – How many errors do users make, how severe are these errors, and how easily can they recover from said errors?

Satisfaction – How pleasant to use is the design?

Interface Importance

Life Critical Systems – air traffic control, reactors, police dispatch systems, medical equipment, etc.

Reliability, effectiveness is required. Satisfaction is less necessary due to motivated users

Industrial and Commercial – banking, insurance, orders, inventory, reservation, billing, POS systems

Ease of learning, speed and error rates, speed of performance, efficiency, effectiveness

Office, Home, Entertainment – word processing, email, video games, etc.

Ease of learning, low error rates, satisfaction

Exploratory, creative, cooperative systems – web browsing, software development, music, etc.

Social technical systems – complex systems that involve people over long time (voting, id, crime, etc.)

Trust, privacy, responsibility, ease of learning, errors, etc.

Designers need to think about a lot of things, such as:

User Variances people can be difficult of sight, speech, hearing, touch, etc. Design is compromised or redesigned

Cultural and International Diversity

Personality Differences

Older users/children

Guidelines, Principles, Theories

Guidelines are low leveled focused advice about good practices and cautions against dangers

- Based on best practices
- Early Apple and Microsoft guidelines were influential for desktop interface designers

Examples

- Provide a text equivalent for every non-text element
- For any time-based multimedia presentation, synchronize equivalent alternatives
- Information conveyed with color should also be conveyed without it
- Title each frame to facilitate identification and navigation

Principles are mid level strategies or rules to analyze and compare design alternatives – more widely applicable, enduring

Fundamental Principles – Determine user skills (USERS), Identify the Tasks (TASKS)

***5 primary interaction styles**

- Command Line
- Form Fill-in
- Menu Selection
- Direct Manipulation
- Natural Language

***8 Golden Rules of Interface Design**

1. Strive for consistency
2. Cater to universal usability
3. Offer informative feedback
4. Design dialogs to yield closure
5. Prevent errors
6. Permit easy reversal of actions
7. Keep users in control
8. Reduce short-term memory load

Theories are developed by principles, they are **descriptive, explanatory, prescriptive, and predictive**

Foley and van Dam Four-Level Approach – design by level approach (conceptual, semantic, syntactic, lexical)

Norman's Seven Stages of Action – **Forming goal** and **intention, specifying** and **executing action, perceiving** and **interpreting the system state, evaluating** the outcome

Gulf of Execution – Mismatch between user's intentions and allowable actions

Gulf of Evaluation – Mismatch between system's representations and user's expectations

Consistency Theories – inconsistent action verbs take longer to learn, slow down users, and are less memorable

Micro-HCI theories – focus on measurable performance over seconds or minutes (Foley, Norman, consistency)

Macro-HCI theories – focus on case studies over weeks and months (contextual, dynamic)

UI, UXD and IxD

IxD is a process in which tech products are designed to center on human behavior and utilization of a product

UI focuses on anticipating what users might need and giving access to elements of interfaces that are easy to understand

UXD is process of enhancing customer satisfaction by improving usability, ease of use, and pleasure

The Design Process

Rosson and Carroll say that the design is a process, not a state. Nonhierarchical and radically transformational. Discovery.

Requirement Analysis → Preliminary and Detailed Design → Implementation → Evaluation

1. **Requirement Analysis** is gathering **Functional, Nonfunctional, and User experience** requirements
2. **Preliminary Stage** is where high level design or architecture happens
Detailed Stage is where the specifics of each interaction is planned out
3. **Building and Implementation** is where planning is turned into actual running code

4. **Evaluation** is when we test and validate the system to ensure it conforms to requirements

Design Frameworks

Participatory Design is the direct involvement of people in the collaborative design of the things/tech they use

User Centric Design takes the needs, wants and limitations of end users into account at each step of design process

Agile Interaction Design is the development methods of self-organizing and dynamic teams that are flexible and adaptive

User Centric Design – 3 Principles

Early Focus on users and tasks directly studying cognitive, behavioral and anthropomorphic characteristics

Empirical measurement users reactions and performance to scenarios, manuals, etc. are recorded and analyzed

Iterative design means when problems are found in user testing, fix them and carry out more tasks

Interviews -> Personas -> Storyboard Sketch -> Paper prototype -> Usability Test -> Hi Fidelity Prototype -> UT -> HFP

Users - nationality, education, tech proficiency, disabilities, etc.

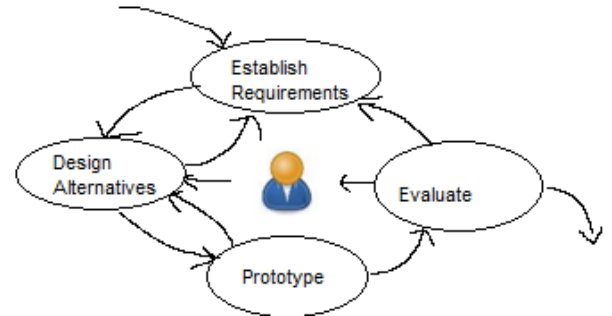
Personas – should not be real people but should be archetypes of users, captured a set of users

Task Descriptions – are informal narrative stories, assume interaction w/a system and abstract away the details

Data Gathering

Five Key Issues

1. Setting Goals – how to analyze data once collected
2. Identifying participants – who will be questioned
3. Relationships with participants – professional and consensual
4. Triangulation – cross check data from different research strategies, and look at data from multiple viewpoints and collect different types (qual vs quant)
5. Pilot studies – a small trial of a main study



*Four Main Ways of Data Gathering

Interviews – labor intensive but yield more accurate and high quality responses

Structured – tightly scripted, like a questionnaire

Unstructured – not directed by a script

Semi-structured – guided by script but can be off-scripted and certain issues can be delved into

Focus Groups – group interviews that can give insight to areas of conflict or consensus views but can be dominated

Questionnaire/Survey are closed or open questions, can be large populations, may need diff versions, less detailed

Observation no stakeholder time, good source of data on regular usage

Direct structuring frameworks, ethnography, degree of participation

Indirect diaries, interaction logging, video and photography by drones/etc.

Designing and Prototyping

Prototype – small model - storyboard, ppt, video, cardboard mock-up, etc.

- Technical issues
- Workflow/task design
- Screen layouts and information display

Evaluation and Feedback are central to **User Centered Design**

Low Fidelity Prototype – uses medium unlike final medium (paper, cardboard), is quick, cheap and easily changed

Sketching

Storyboarding

Card based prototypes cards could be screens, usually used in web dev

***Wizard of Oz prototyping** is when users think they're interacting with a computer but it's a human doing output trying to understand user's expectations of the system

High Fidelity Prototype – uses materials more like final product, but dangerous that users may assume complete system

Medium Fidelity Prototype / Wireframe – standardized elements but has sketchy navigation and low detail

Conceptual Design an outline of what people can do & what concepts are needed to understand and interact w/product
Consider metaphors and questions to ask

Concrete Design the actual colors, icons, buttons, accessibility, etc. of the design

Using Scenarios expressed through proposed or imagined situations – can generate storyboards

Evaluation

Informed consent form users need to be told risks, why evaluation is necessary, their tasks, and rights

Controlled Settings involving users in tests, labs, etc.

Living labs/Experiments - test a hypothesis by manipulating certain variables while keeping others constant.

Usability Testing in laboratories

Surveys/Interviews/Focus groups

Natural Settings with users in the field/wild seeing usage in the real world

Eye tracking software

Case studies

Field studies are evaluation studies that are carried out in natural settings to discover how people interact with technology in the real world

Settings not involving users being consultants, researchers, using models, heuristics, walkthroughs, models & analytics

Cognitive Walkthroughs walk through the design prototype with scenarios guided by 3 questions

- Will correct action be sufficiently evident enough
- Will user notice that correct action is available
- Will user associate and interpret response from action correctly

Analytics are evaluating user traffic through systems

Heuristic evaluation review guided by a set of recognized usability principles – **recommends 3-5 evaluators**

*Nielsen's 10 Evaluations of Usability Heuristics

- | | |
|---|---|
| 1. Visibility of system status. | Know what's going on (loading, etc) |
| 2. Match between system and real world. | Speak user's language – convention, natural ordering |
| 3. User control and freedom. | Support undo/redo |
| 4. Consistency and standards. | Users shouldn't wonder if words mean different things |
| 5. Error prevention. | Design that prevents errors is better than error msgs |
| 6. Recognition rather than recall. | Minimize the memory load of an user, don't remember |
| 7. Flexibility and efficiency of use. | Accelerators speed things up for pro users |
| 8. Aesthetic and minimalist design. | Necessary stuff only, diminishes relative visibility |
| 9. Help users recognize, diagnose, recover from errors. | Error messages should be in plain language, not codes |
| 10. Help and documentation. | Should have help even if program is self-documenting |

Weaknesses to above:

- Few ethical and practical issues to consider b/c users are not involved
- Experts have biases
- Important problems may be missed / trivial items identified

Considerations for data interpretation

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?

Data Analysis – should NOT overstate the evidence

***Quantitative** – numbers, numerical methods to ascertain size, magnitude, amount (averages, percents, graphs, etc.)

***Qualitative** – difficult to measure as numbers, expressed nature of elements, themes, patterns, stories, feelings (sociograms, word clouds, charts, cluster analysis, etc.)

*Theoretical Framework

Grounded Theory - aims to derive theory from systematic analysis of data

Open – identify categories (word, phrase, sentences)

Axial – flesh out and link subcategories

Selective – form theoretical scheme (backbones of theory)

Distributed Cognition – the people, environment and artefacts are considered one cognitive system, analyzes collaborative work and focuses on information propagation and transformation

Activity Theory – explains behavior in terms of practical activity in the world, outlines activity and models role of artifacts

Case Studies

Iterative design of ATMs – time to complete entire tasks, eye tracker to analyze product, accessibility, etc

Apple iOS store design guidelines – follow key things, universal usability, consistent easy-to-use style

Volvo Big Data – good UI can result in successful conclusions from big data

Interfaces, Navigation and Devices

Command Based – fast, precise, efficient but large overhead to learning

WIMP and GUIs – Established by the Xerox Star

WIMP –

Windows – but switching attention/tabs/spacing etc is difficult

Icons – can be similar (file), analytical (scissors) or arbitrary (X for delete)

Menus – Gives ability to access things that are initially hidden, but sometimes obscures important info

Pointers – mice, etc.

GUIs – color, 3d sound, animation, toolbars, docks, rollovers

Dashboard – screenshots of data updated over periods of time to be read at a glance, data visualization

Web – need to deliver information but not overwhelm, navigation needs to be investigated too

Appliances – need minimal learning, short periods of usage,

Mobile – good, but small real estate, need to examine tradeoffs between physical and virtual, needs to be simple

Speech – needs to accommodate speech recognition, syntax, guided prompts, and examine voice actors, etc.

Pens – allow users to edit and annotate easily but can feel laggy and clunky, also obscures screen

Touch – support wide variety of actions but its more cumbersome and error prone

Air Based Gestures – How does a computer delineate gestures? Does holding controller feel more/less intuitive?

Multi-modal – uses different modalities, but needs to do more and doesn't offer much when combining modes

Sharables – multiple inputs, large workspace but needs to think about interaction, size, turn-taking, etc.

Virtual Reality – CGI and provides interesting insights and engrossment but unconformable and motion sickness

Augmented and Mixed Reality – when and where in physical environment, needs to be able to stand out but not distract from ongoing tasks

Wearables – Take into consideration comfort, hygiene, ease of wear, usability

Robots and Drones – How do we interact with robots? Moral implications of using remote-robots

Social Computing – the intersection between Social Behavior and Computational Systems

Examples: Blogs, Microblogs, Multiplayer Games, Wikis, IMs, OSS, etc.

Considerations about how real life interaction changes when we bring it online to computer systems

***VideoWindow System (1989)** – allowed people 50 miles apart to carry on conversations, 3x8ft picture window

People talked more with people in same room rather than other room

Telepresence – new technologies designed to allow people feel like if they were present in other locations

***Hypermirror (1998)** – allows people to feel as if they are in the same virtual place even though physically not

***Design considerations** of social computing

Cognitive Factors

– Social Cues

– Interruptions

Individual Factors

– Privacy

– Identity

– Trust and Reputation

– Motivation

Collective Factors

– Moderation

– Policies and Norms

Information Search

Searching is a task that explores digital libraries, directories, and unstructured collections to find items

***5 Phase Framework for Search UIs**

- | | |
|-------------------------|------------------------------------|
| 1. Formulation | expressing the search |
| 2. Initiation of Action | launching the search |
| 3. Review of Results | reading messages and outcomes |
| 4. Refinement | formulating next step(s) |
| 5. Use | compiling or disseminating insight |

Social search as “an umbrella term” describing search acts that make use of social interactions with others – reddit, YT

Data Visualization

***Data and View Specification** – visualize, filter, sort, derive

***View Manipulation** – select, navigate, coordinate, organize

***Process and Provenance** - record, annotate, share, guide

Challenges – importing and cleaning data, integrating data mining, viewing big data, universal usability, supporting casual users, dissemination and storytelling, device adaptation, etc.