**HCI with Software Engineering**

Introduce the Topic

* What It Is
  + HCI (human computer interaction) 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
    - It is a science of design - it seeks to understand and support human beings interacting with and through technology
  + A graphical user interface (GUI) is how human interacts with a computer, and HCI goes beyond designing screens and menus that are easier to use and also studies the reasoning behind building specific functionality into computers and the long term effects that systems will have on humans
* It is a broad discipline that encompasses different specialties with different concerns regarding computer developer:
  + **Computer Science** is concerned with the application design and engineering of the human interfaces
  + **Sociology and Anthropology** are concerned with the interactions between technology, work and organization and the way that human systems and technical systems mutually adapt to each other
  + **Ergonomics** is concerned with the safety of computer systems and the safe limits of human cognition and sensation
  + **Psychology** is concerned with the cognitive processes of humans and the behavior of users
  + **Linguistics** is concerned with the development of human and machine languages and the relationship between the two
* As computers become more and pervasive in culture, designers are increasingly looking to ways to make interfacing with devices easier, safer and more efficient

History

* Though there are earlier instances Engineering Psychology had roots in World War I but gained momentum during World War II as simple design flaws of aircraft controls and escape hatches caused aircraft losses and thousands of personnel casualties
  + Two computing legacies of WWII were the respect for the potential of computing (code-breaking) and interest in behavioral requirements for design.
    - During WWII, aviation engineers, psychologists, and physicians formed the Aeromedical Engineering Association to discuss and examine these issues.
* After WWII, the terms “human engineering” and “human factors” came into use (ergonomics was primarily used in Europe)
* ENIAC (1946)
  + First electronic general purpose computer that was Turing-complete, digital, and capable of being reprogrammed to solve a “large class of numerical problems”
    - Originally designed to calculate artillery firing tables for the US Army.
    - Heralded as the “Giant Brain” that took up and entire room and was debugged by programmers crowing inside the structure and finding bad tubes
  + Interaction was limited to engineers and scientists manually turning function tables and knobs
* Punch Cards
  + In the 1950’s and 60’s, the new development to interact and input information into computers used was punch cards
    - Took punched cards, operator fed the cards to the machine and pressed “RUN”, wait for printed output.
    - Operators interacted directly with the system via a teletype: Typed commands interleaved with computer responses and status messages were printed on paper that scrolled up one line at a time
* The Mother of All Demos
  + Bart Engelbart, December 9, 1968
    - Showed the oN-Line System
      * 90-minute live presentation in which Engelbart demonstrated a monochrome presentation using the first ever mouse, a live video conference, keyboard, text document, desktop to show the possibility for graphical user interface
* As personal computers became more pervasive, the need for people-oriented systems became an important concern.
* Software Psychology
  + The goal was to establish the utility of a behavioral approach to understanding software design, programming and the use of interactive systems, and to motivate and guide system developers to consider the characteristics of human beings
    - Inaugurated a variety of technical projects pertaining to usability of systems and software
      * Assessing the relative complexity of syntactic constructions in programming languages
* The Great Divide
  + Two roles assigned to software psychologists were problematic and resulted in a division of labor
    - Researchers were mainly in universities and developed general descriptions of users and framed them as general guidelines
    - Human-factors specialists in industry tried to apply these guidelines in specific projects
  + This approach created unrepresentative situations and researchers created outrageous contrasts and psychologists grew frustrated trying to get the industry to use their guidelines
* Origins of HCI in software psychology posed two central problems:
  + To better describe design and development work and to understand how it could be supported
  + To better specify the role that psychology –particularly social and behavioral science- should play in HCI
* HCI arose as a field from intertwined roots in computer graphics, operating systems, human factors, ergonomics, industrial engineering, cognitive psychology and the systems part of computer science
* Computer graphics was born from the use of CRT and pen devices very early in the history of computers
  + This led to the development of several HCI techniques
* Out of this line of development came a number of important building blocks for HCI
  + Some of these building blocks include the mouse, bitmapped displays, personal computers, windows, the desktop metaphor, and point and click editors

Present details about it (including code and non code based examples)

* Impact of HCI on Society, the economy and culture
  + History shows that past computer makers where unaware and not focused on HCI
    - made their product non human friendly
    - make it hard to use
    - limit the amount of people having access to a computer
    - make it hard to understand and use/manage the computer
  + Now companies and corporations spend millions on research into how they can improve their HCI
    - Provide a better experience for the user
    - Allow mostly anyone easy use of the device
  + Society
    - Has a huge impact on HCI
      * HCI designers and developers making and improving computers, tablets and mobile phones
    - Modern electronics don’t require the user to have much training in order to control the functions of the computers
      * Whereas past generation, users has to use command line interfaces
    - The main impact that HCI has had on society is improving the ease of use of computers and other devices
    - User interfaces on consumer products such as computers, mobile phones, tablets or televisions are designed with ease o use in mind
    - UI designers try to ensure that the input and output processes are as simple and easy for the user as possible
    - Example: touch scree technology
      * Last 5 years, it has become very popular in portable devices like mobile phones and tablets
    - These developments are designed to move towards making electronics devices more friendly to users
    - Specifically, people who are not experienced with devices like this and usually find them too complicated to use
    - These developments are designed to make these devices more accessible for these people and to increase the amount of people that are able to use these products
    - There have also been developments designed to help people with disabilities or impairments to use electronic devices
    - Text to speech technology on computers and audio descriptions on televisions exist for people who have sight problems
    - Developments have also been made for military applications
    - Remote control drones can now be used for reconnaissance, search and destroy or searching collapsed buildings
    - This is a much safer way to go about these missions than sending in real people
  + UI Designers
    - Main focus is to make sure the input and output processes are as simple and easy for the user
    - Ex: touch screens and voice recognitions
      * Allows uses to command the phone like a personal assistant with just their voice
  + Pros
    - Affected the usability of products and make them easier to use
    - Help the economy
      * Ex: companies using voice input to direct the caller to a representative
        + Save time and money
    - Help the culture
      * Ex: household appliances change how culture work and live
        + Simple idea of adding wheels to the vacuum cleaning makes it easier to use
    - Easier to communicate with people via the internet
      * Reduce the need to talk face to face
  + Cons
    - Youngsters using and learning from touch screen will prevent them to understand how to operate a physical keyboard effectively
      * Will feel lost when trying to use a computer in the workplace
    - With voice command, limit the ability to find information themselves
      * Will become dependent on technology to do their thinking and other tasks
    - Will limit their creativity and thinking process
    - Not being able to talk face to face lead to the loss of professionalism
  + Economy
    - HCI impacted the economy by improving peoples productivity in the work place
    - Improvement of robotics
      * Allowed manufacturers to have full robotic operated factories that carry out manual labor for free, fast and efficiently
    - Communication between companies are easily transferable and exchanged through the internet
    - Development in HCI technology has increased people’s productivity massively
    - Advances in both computers and robotics means that many manufacturing tasks can now be completely automated
    - Factory machines are in many ways easier to use than human workers on production lines for things like cars
    - The distribution of documents and other files has become much easier thanks to technologies like email and text messages
    - Smartphone technology takes this further since documents can be edited and sent while the user is on the go
    - Many companies have now set up E-Commerce websites which allow them to sell their items online
      * this has many advantages over a regular retail store
      * now they can simply visit the website, browse the products available and purchase whatever they want
    - many types of input can be sped up with HCI development
    - things like barcodes need to be read faster for more efficient operation in a shop
    - HCI development have allowed for newer barcode readers that can scan them much quicker than before
      * Without this kind of speed, much more time would be spend at the checkout of a store
  + Culture
    - HCI impacted the culture by taking down the language barrier
    - Helpful for having a conversation with someone from a difference tongue
    - Helps companies communicate to other international when making business deals or checking on reports and manufacturing
    - Don’t have to wash clothes with our hands since machines such as washing machines are available
    - Younger children exposed to a lot of technology don’t play a lot with toys that older generation used to
    - Hard books are being taken over by electronic version that will never damage the book
    - Greatly changing our culture due to the way that electronic devices are becoming a bigger part of our everyday lives, with more features than ever to help us during the day
    - Moore’s Lay states that computer power will double every two years
      * This means that the amount of tasks that electronic devices will become more varied and complex as time goes on
      * They will continue to become more and more integrated into our lives
    - Example: advancement of smartphone technology
      * Today’s smart phones are incredibly capable, being able to perform things that only computers could do several years ago
      * Smartphone now does everything they need an electronic device for and they no longer have need for a proper computer
      * Mobile internet on smartphones allows for easy communication over services like Twitter or Facebook
      * Entertainment is also easily accessible with services like Netflix
    - There are positive and negative impacts of HCI on the culture of developing nations
    - New technology can help people communicate and be entertained but it can also negatively affect their exiting culture and way of life
* HCI Design Approaches
  + Eberts describes 4 HCI design approaches that may be applied to user interface designs to develop user friendly, efficient, and intuitive user experiences for humans
  + 4 approaches are:
    - Anthropomorphic Approach
    - Cognitive Approach
    - Predictive Modeling Approach
    - Empirical Approach
  + One or more of these approaches may be used in a single user interface design
  + **Anthropomorphic Approach**
    - It involves designing a user interface to posses human like qualities
    - Ex: an interface may be designed to communicate with users in a human to human manner, as if the computer empathizes with the user
      * Interface error message is written in a way that human can understand
        + “We’re sorry, but that page cannot be found”
    - Affordances
      * Human affordance are perceivable potential actions that a person can do with an object
      * Ex: pleasant sounds are used to indicate when a task has completed
        + This signals that the user may continue with the next step in a process
    - Constraints
      * Constraints complement affordance by indicating the limitations of user actions
      * Ex: a grayed out menu option and an unpleasant sound indicate that the user cannot carry out a particular action
      * Affordance and constraints can be designed to non verbally guide user behaviors through an interface and prevent user errors in a complex interface
  + **Cognitive Approach**
    - it considers the abilities of the human brain and sensory perception in order to develop a user interface that will support the end user
    - Metaphoric Design
      * Using metaphors can be an effective way to communicate an abstract concept or procedure to users, as long as the metaphor is used accurately
      * Metaphors rely on a user’s familiarity with another concept, as well as human affordances, to help users understand the actions they can perform with their data based on the form it takes
        + Ex: user can more a file or folder into the “trashcan” to delete it
      * Benefit of using metaphors in design is that users who can relate to the metaphor are able to learn to use a new system very quickly
        + Ex: Mac computers use the icon of a trashcan on the desktop while PCs have a recycle bin

The recycle bin does not actually “recycle” the data

Instead it behaves like the Mac trash can and used to permanently delete files

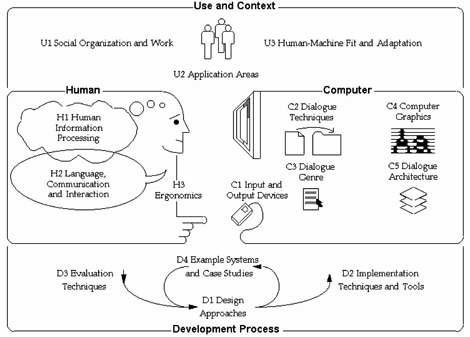
* + - Attention and Workload Models
      * It is important to consider the user’s attention span, which many be based on the environment of use, and the perceived mental workload involved in completing a task
      * Typically, users can focus well on one task at a time
        + Ex: designing a web based form to collect information from a user
        + The form may be divided into “Contact Information” and “Billing Information”, rather than mixing the two and confusing users
      * By “chunking” this data into individual sections or even separate pages when there is a lot of information being collected, the perceived workload is also reduced
      * User may become overwhelmed by the amount of work that needs to be done to complete the form if there was one single form that makes the user scroll the page to complete
    - Human Information Processing Model
      * Describes the flow of information from the world, into the human mind, and back into the world
      * The accuracy of information recall is based on the environmental conditions and the way that information was initially encoded by the senses
      * If a human is in a similar sensory experience at the time of memory recall as he was during the encoding of a prior experience, his recall of that experience will be more accurate and complete
  + **Empirical Approach**
    - Is useful for examining and comparing the usability of multiple conceptual designs
    - Often, users will appreciate specific elements of each design concept, which may lead to the development of a composite conceptual design to test
    - Human Task Performance Measures
      * Measuring user’s task performance is important for determining how intuitive and user friendly a web page is
      * A researcher who is familiar with the tasks the web page has been designed to support will develop a set of test tasks that relate to the task goals associated with the page
    - A/B Testing
      * If two or three design concepts were rated highly during user testing, it may be advantageous to conduct an A/B Test during post production
  + **Predictive Modeling Approach**
    - Goals, Operators, Methods and Section Rules (GOMS) is a method for examining the individual components of a user experience in terms of the time it takes a user to most efficiently complete a goal
    - Goals are defined as what the user desires to accomplish on the website
    - Operators are the atomic level actions that the user performs to reach a goal
    - Methods are procedures that include a series of operators and sub goals that the user employs to accomplish a goal
    - Section Rules refer to a user’s personal decision about which method will work best in a particular situation in order to reach a goal

Provide Pointers to additional material on the topic for interested readers

* CU Boulder Course about HCI
  + <http://hcc.colorado.edu/courses/>
* ACM Conference on Human Factors in Computing Systems (CHI)
  + Series of academic conferences and is considered the most prestigious in the field of human computer interaction
  + One of the top ranked conferences in computer science
  + Held annually in spring each year
  + http://chi2016.acm.org/wp/

Example of HCI

* developing a prototype of an interface that is evaluated and then rebuilt and reassessed iteratively until the final interface has been designed
* the user is seen as being integral to this process
* many issues are highly debated such as: methods that are most effective or economical, the point at which these methods should be applied or the value of prescribing a methodology at all
* Three major design approaches within HCI
  + User centered design
  + Cognitive modeling
  + Participatory design



* Interaction between users and computes occurs at the user interface, which includes both software and hardware
* Figure shows how the humans interact with the computers
  + From computer science perspective, the focus is on interaction and specifically on interaction between one or more humans and one or more computational machines
  + The classical situation that comes to minds is a person using an interactive graphics program on a workstation
  + Because HCI studies human and a machine in communication, it draws from supporting knowledge on both the machine and the human side
  + On the machine side, techniques in computer graphics, operating systems, programming languages, and development environments are relevant
  + O the human side, communication theory, graphic and industrial design disciplines, linguistics, social science, cognitive psychology, and human performance are relevant
  + Of course, engineering and design methods are relevant

Why should software developers care about this topic?

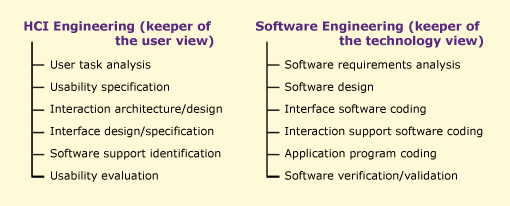
* Software engineering must work together with HCI to produce a product
  + methodologies should reveal the relevant points of contact between the disciplines
* Methodologies produced by the two disciplines vary greatly in their effectiveness in providing direction for combining methods (or techniques) from both disciplines
* HCI is seen as useful for the development of the software requirements
* Software Engineering, Usability and Programming Languages is a multi-perspective group focusing on a single problem: how to help people develop software that is effective and accurate
* Interaction with human beings is increasingly recognized and promoted as an important aspect of software systems and products
* More and more professionals in the computing industry call for integrating HCI engineering with software engineering

Software Development and the integration of HCI

* Integrating HCI into preexisting software development life cycles presented a problem as many of the life cycles did not include HCI elements
  + Waterfall has well known steps as engineer, analyse, design, code, test and maintain. None of the these steps directly relate to the development of the interface.
  + Prototyping builds a sequence of prototypes until a good understanding of the software requirements are developed
    - Recognizes that iterations of design steps are a normal part of the process
      * The HCI specialist is a contributor to only the requirements phase of the developmental cycle
  + Spiral presents the software engineering process ina business context where managers make decisions about the feasibility of a project.
    - Four steps: planning, risk analysis, engineering and customer evaluation
    - HCI methodology is used in later cycles
* There are proposed methodologies that are related to the HCI specialist
  + Waterfall: Task analysis, user modeling, formal interface specifications, dialogue design tools, formal evaluation techniques and standards
* **HCI Methods**
* User Centered
  + USE Methodology
    - Rapid prototyping
    - 11 steps to a practical and economical process for user interface design
      * Major emphasis on knowing the user and the tasks the user must perform
        + 1. Know the User
        + 2. Competitive Analysis
        + Setting Usability Goals
        + 4. Parallel Design
        + 5. Participatory Design
        + 6. Coordinated Design of the Total Interface
        + 7. Apply Guidelines and Heuristic Analysis
        + 8. Prototyping
        + 9. Empirical Testing
        + 10. Capture Design Rationale
        + 11. Collect Feedback from Field Use
    - Many of the methods in usability engineering are derived from other disciplines such as Psychology or Marketing
      * Combination of qualitative and quantitative techniques
* Cognitive Modeling
  + Emphasis of cognitive modeling is to understand and model an activity as it is understood by the user
    - Cognitive modeling experts assert that if you can get this model right then you can use it to create a design that will be intuitive to the user
      * Interested in why users behave as they do or why one design is better than another
        + Not focused on methods and does not advocate any particular methodology although there are some methods like GOMS (goals, Operators, Methods and Selection Rules)
    - Anti-methodology is the shift from developing methodology to understanding design rationale
* Participatory Design
  + No Particular Methodology
    - Participatory Design (PD) advocates do not see methodology as central to producing a good product
      * PD methods do exist
    - Methods are resources for designers to use as the deem appropriate and are not gathered into a coherent framework
  + Emphasis on communication
    - The most important issue is communication between users and designers
      * Especially important in participatory design because the user is a peer in the design process
        + PD advocates work to describe the types of communication desired and to develop methods that can help users and designers move closer to a better design
    - 6 different communication enhancing categories
      * IMAGE
* Projects that require a user interface are usually more difficult to build and can add stress for the software engineering methodologies
  + There is often a fundamental different between the approaches taken by software engineers and HCI specialists
    - HCI specialists are user-centered and software engineers are system-centered
      * SE methodologies are good at modeling certain aspects of the problem domain
        + Method have been developed to represent data, architectural and procedural aspects of a software system
        + Deal with managerial and financial issues as well
        + Useful for specifying and building the functional aspects of a software system as well
      * HCI emphasizes developing a deep understanding of user characteristics and a clear awareness of the tasks a user must perform
        + Test design ideas on real users and use formal evaluation techniques to replace intuition in guiding design
      * Inadequate HCI methodologies do not clarify the role of the SE process relative to the HCI process
        + Neilsen’s usability engineering approach is typical of HCI methodologies that leave the relationship ambiguious

Other information

* Engineering Development Life – cycle with Added HCI Practitioners and Specialists
  + Task analysis, user modeling, formal interface specifications, dialogue design tools, formal evaluation techniques and standards for documents are used to produce useful interactive software
* The waterfall approach will not work for the development of user interfaces since a user interface can’t be specified without repeated testing with users
* An experimental approach is necessary because there is not a sufficiently firm theory of human cognition and behavior from which a theoretically based interface design could be constructed



* Many computer users today would argue that computer makers are still not paying enough attention to making their products “user-friendly”
  + However, computer system developers might argue that computers are extremely complex products to design and make and that the demand for the services that computers can provide has always outdriven the demand for ease of use

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