People Oriented Computing

- Computer science is a broad field that has ever increasing impact no our lives and our world
- Humans shape the direction of computing as individuals, as groups and as a collective society
- Computing in turn shapes what we do, how we work, how we engage with friends and family, how societies function

Lecture 1

Learning Goals Lecture 1

Understand the concept of interaction as communication

Have familiarity with historical paradigm shifts in interaction with technology

Be familiar with key systems and figures associated with technology paradigm shifts

Interaction and Interaction Paradigms

Communication as Interaction

- Means, ability, and channels of expressing intent, state, or information
- Means, ability, and channels of receiving input
- Enough shared understanding to interpret what is being communicated and respond appropriately

Interaction Paradigms

"Successful approaches to interactive systems that have helped make it easier to use technology"

Time Sharing (1950s-1960s)

Batch session

- This was the previous approach
- Individual programmers submitted complete jobs on punched cards or paper tape to an operator
- Operator ran individual jobs on a computer

Time Sharing

Because of Hardware advances in the 1940s and 1950s -> massive increase in computing power

- (Mechanical relays -> vacuum electron tubes -> transistors -> integrated chips)

New hardware improvements necessitated parallel advancements in how to harness this power in use, Time Sharing was just taking advantage of the newly gained power

J.C.R. Licklider at ARPA financed research on how to apply computing technology

Benefits of Timesharing:

- A single computer could support multiple users at once
- Programming became an interactive activity
- Gave rise to the “hacker” who could create increasingly complex programs
- Shift from programming as a pre-planned set of instructions for a computer to an exchange between programmer and computer

The main difference between **Multiprogrammed Batch Systems** and **Time-Sharing Systems** is that in case of Multiprogrammed batch systems, the objective is to maximize processor use, whereas in Time-Sharing Systems, the objective is to minimize response time.

Video Display Units (1950s-1960s)

Research was initially done for the military regarding Video Display Units.

Breakthrough in 1962 with Ivan Sutherland’s **Sketchpad** program, developed at MIT

- Allowed data to be presented visually, abstracted, manipulated, and changed
- Enabled truly visual interaction
- A more human way of interacting with data
- Computer adapting to human’s way of thinking rather than vice versa

Programming Toolkits (1960s)

Previous thinking:

- Computers are complex technology that can only be used by a few experts and specialist.

Douglas Engelbart’s vision - to enable humans to use computers to learn

Created programming tools that allow people to create complex programs more easily

Small programming components can be combined to create larger ones, known as **bootstrapping**

Personal Computing (1970s-1980s)

- The notion of computing for the masses
- No need for substantial computing skills in order to benefit from computers

Analogy: Giving each person a CERN Hadron Collider for their home

Seymour Papert created a programming language for children called LOGO

- Powerful tools can also be used by novices
- The graphical turtle

- **Illustrated that the ease of use makes a system more powerful**

Alan Kay believed the future of computing was small, powerful, machines dedicated to single users - personal computers

- Shift away from mainframe computing and time sharing
- With other PARC researchers, created **Smalltalk**, a simple but powerful visually based programming environment especially for Personal Computing
- Wrote **Dynabook** in the 70s, a handheld personal computer for children

Windows and Wimp (1980s)

- Advent of personal computing led to focus on increased usability of single-user interaction with computers.
- Previous interfaces were command-line based

- Put the Human at Control
- Allowed multitasking
- Supporting multiple threads of interaction in conventional command line interfaces became complicated and difficult to manage.
- Window-based systems supported physical and logical separation of tasks.

- The Xerox Star (1981) introduced the first commercial WIMP interface
- Interface based on Windows, Icons, Menus, and Pointers

Interface Metaphors

- Metaphors help people learn new concepts by putting them in terms of known concepts
- Metaphors can reduce the perception of complexity or difficulty.

Window and Wimp real-world metaphors

- Windows
- Buttons
- Menus
- Palettes

Xerox Star:

- Desktop
- Folders
- Trashcan
- Etc.

Metaphors are naturally limited as it is not possible to completely map one set of concepts onto another.

Mismatches

- Folders within folders

- Dragging media into trash to eject

Direct Manipulation (1980s)

Traditional command line interfaces provided verey limited feedback in interactions. Advancements in displays allowed for rapid audio and visual feedback with every interaction.

- Giving the feeling to directly interact with the system
- Command line no response but visually a lot of hinting, enabling, highlighting etc.
- Rapid feedback facilitated an interaction technique called direct manipulation (Ben Schneiderman)
- Created the illusion of operating directly on data and objects, rather than giving commands to a computer

Features of direct manipulation

- **Visibility** of all objects of interest
- Incremental action at the interface with **rapid feedback** on all actions
- **Reversibility** of all actions so that users can explore without severe penalties
- **Syntactic correctness** of all actions so that possible actions is a legal operation
- Replacement of complex command languages with actions to **manipulated visible objects** directly.
- It shows the **state of things**
- Gives more control or the **feeling of control**
- **Transparency**

First commercial success of a direct manipulation interface was the Apple Macintosh (1984)

- Made files and directory structure visible to the user
- Drag and Drop
- Impossible to formulate a syntactically incorrect command
- Continual visual feedback is provided while the operation is being carried out
- Created the illusion that the user is acting upon the objects represented in the interface, rather than giving commands.

End of Lecture 1 (16.9.19)

Lecture 2

Learning Goals Lecture 2

Have familiarity with key interaction paradigm shifts, including associated systems and people

Have an understanding of basic interaction frameworks

Be familiar with the basics of human sensory channels as input and output channels for interaction

Have an understanding of foundational concepts of human memory

Hypertext (1940s-1960s)

Due to the explosion in data gathered around WW2, Vannevar Bush proposed to build **„memex“**

Memex:

- Desk Apparatus
- Store & Produce big amounts of photocopies
- Keep a meaningful linkage between documents
- **Revolutionary** to not only store information but associations among information

Ted Nelson (1960s) inspired be Bush‘s work created **Xanadu**

- retrieval system
- non-linear text (not a book but single pages)
- coined term „hypertext“ to distinguish non-linear structure of media storage and presentation
- underlying structure for World Wide Web

Multi-Modality

- Allows People to engage in multiple tasks
- Allows use of human „channels“ to interact
  - Visual Channel
  - Audio Channel
  - Haptic (touch) channel

- Flexible use of multiple communication channels would be combining gestures and voice commands

The World Wide Web

- revolutionary paradigm
- lowered barrier for access -> no IT knowledge required
- Heavy lifting is hidden from user
- led to explosion of content creation
- opened up many new use cases

Computer-Supported Cooperative Work

- in the 60s Computer networks that communicated with each other
- networks for collaboration
- Transition from systems for **individual** use to systems for **group and organizational** use
- Email is an example
- Stepping Stone for tools now a days and social media

Agent-Based Interfaces

- A departure from direct manipulation
- some resemblance to Command Line (you tell the system what to do)
- Entity that does heavy lifting
- Illusion that someone is working on your behalf to perform task, like a human assistant
- Mostly for repetitive tasks, responds to events and learn from user actions
- Agents are simple actions that follow commands are are intelligent and proactive
- **Eager** helped devs when writing HyperCard
- Interaction Language has always been a challenge
- Nowadays apple siri or online support systems

Ubiquitous Computing (1990s-2000s)

- Xerox PARC (1980s) attempt to move computing into everyday life
- **Mark Weiser (1991)** had a vision of ubiquitous computing -> was right
- Seamless interaction with computers during the entire day

Previously:
Sit down alone to compute -> then return back to normal life (no computing)

Computer Ratio:

- Many people share one
- one to one
- one person has 10 computers

Sensor-based and Context-aware Interaction

- computing happens invisible and seamless
- gathering information through context
- with data give functionality (recommend on YT)
- Question about Data Privacy
- About AI

AR / VR

Ivan Sutherlan‘s „Sword of Damocles“ (1965) first VR System

Interactive systems

- Tell a computer your intent
- Computer processes it
- Computer provides output

Traditionally interactive system’s purpose is to aid a user in accomplishing a goal within an application domain

Domain
- Area of expertise and knowledge, consists of concepts

Task
- Operation to manipulate concepts within a domain

Goal
- A desired output form a task or sequence of tasks

Four major components of an interaction
- The system
- The user
- The input
- The output

System has its own language so does the user
Manipulation of the system through user input
State of system only through output -> to the user

An interactive system’s interface can be thought of as the combination of the input provided by the user and the output provided by the system

The interface serves as the “translator” between the system and the user

The Interface

- The user needs to be able to articulate their goals and tasks in the input language specified by the interface

- The input needs to be translated into stimuli for the system upon which the system can perform
- The new state of the system must be presented as output as specified by the interface
- The output must be observed and interpreted by the user

ZVV Example
- Domain: ticket purchasing for public transit
- Tasks: selecting destination, choosing fares, making payment, etc.
- Goals: e.g., purchase a half-fare ticket from current destination to Zürich HB for immediate use using a debit card
- Input: Onscreen button presses, insertion of payment card, physical button presses, removal of paper ticket
- Output: Interactive screens in a logical sequence, confirmation messages, instructions, queries and prompts, buttons for making selections, progress bar with status message, illumination of ticket repository, etc.

An Interaction Framework
- Mostly very system centric

Input-Output Channels

The Model Human Processor (**Card, Moran, Newell**)
- Considers the human as input-output machine that processes physical stimuli and produces a physical response

The 7 Stage Model of Interaction (**Don Norman**)
- Splits Human in Execution and Evaluation Phases

Both from a human perspective

Our Inputs are our **senses**
Out Outputs are mostly motor controls

Different types of output, head movement, voice commands, facial gestures

Vision - Movement

See Slides!

Human Memory

More than a processor that takes a stimulus and gives a response

Memory Stores
- Factual knowledge

- Procedural knowledge
- Experiential knowledge

Types of memory
- Sensory (small buffer for incoming sensory input)
- short term memory/working memory
- Long-term memory

Sensory Input
- Iconic memory - visual stimuli
- Echoic memory - aural stimuli
- Haptic memory - touch stimuli

Most of memory decays/ filters out and lost

Short-term Memory
- subject to recency effects
- different channels for different types of information
- repetition and rehearsal -> transfer to long-term

Long-term Memory
- Main repo for memory
- Stores factual, experiential and procedural knowledge
- „big capacity“, slow access time

- Two types
  - Episodic - memory of events and experiences in a serial form
  - Semantic - structured record of facts, and skills, structured as a network

End of Lecture (23.9.19)

Lecture 3

Information Visualization Basics

Learning Goals Lecture 3

Have a foundational understanding of the field of information visualization

Because of more data generated each day it becomes harder and harder to have an overview -> **Information Overload**

That brings the following challenges:

- How do we understand and make sense of data?
- How do we extract meaning and value from data?
- How do we communicate data?
- How can we use data to gain new insight and knowledge

The use of computer-supported interactive visual representations of abstract data to amplify cognition

- Stu Card et al., 1999

Reasons to analyze:

- record Information
- analyze Information
- present and communicate information
- discover new information and gain insight
- (W.S. Cleveland 1985) Data can yield conclusions to questions not even originally asked
    - the cost of analyses smaller than collection of data

InfoVis	SciVis
• Abstract data with no physical correspondence	• Scientific data corresponding to physical phenomena
• Free mapping of data to 2D or 3D space	• Fixed positions in space for visualizations

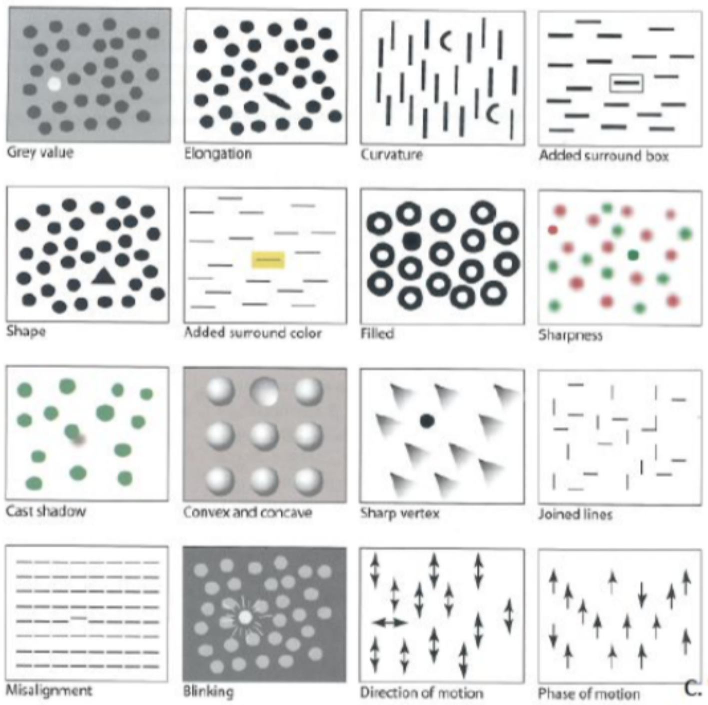
Challenges in InfoVis

- Creating meaningful and useful mappings of abstract data onto 2D or 3D space
- Representing extremely large sets of data in a finite amount of space
- Representing diverse types and forms of data within a visualization
- Be familiar with key examples of effective and ineffective real world visualization examples

Have a basic understanding of visual features, visual search, and human processing of visual information

Pre-attentive Processing

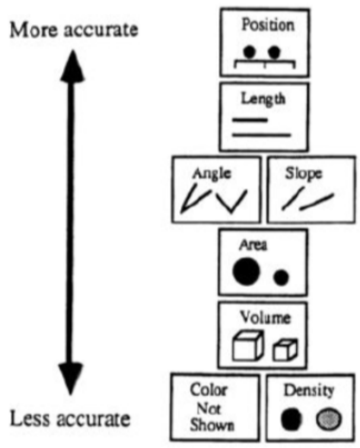
Psychologist Anne Treisman - What makes patterns easy to find
Targets vs. Distractions



Be familiar with basic principles and guidelines for information visualization design

Gestalt Laws (do things belong together)

- Proximity
- Similarity
- Connectedness
- Continuity
- Symmetry
- Closure



Tufte's Principles of Graphical Excellence

Graphical excellence

- The well-designed presentation of interesting data - a matter of substance, statistics, and design
- Consists of complex ideas communicated with clarity, precision, and efficiency
- Gives the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space / efficiency
- Is nearly always multivariate / shows different aspects

Graphical integrity

- The representation of numbers, as physically measured on the surface of the graphic

itself, should be directly proportional to the numerical quantities represented
- Clear, detailed, and thorough labeling should be used to prevent distortion and ambiguity
- Show data variation, not design variation
- Graphics should not quote data out of context
- The number of information-carrying (variable) dimensions depicted should not exceed the dimensions of the data

Process Oriented
- Above all else show the data
- Maximite the data-ink ratio
- Erase non-data-ink
- Erase redundant data-ink
- Revise and edit

Smallest effective distance

Pictures - in infographics and if a culturally defined image is available
Symbols when large number of data points represented
Words space available

Be able to identify strengths and weaknesses of information designs and justify arguments using concepts and principles of information visualization

End of Lecture 3 (30.9.19)

Lecture 4

Principles for Design

Have a fundamental understanding of the role of design (in interactive interfaces)

Usability - Is a system or object easy to use

Usefulness - Does a system or object serve a function that is valuable to me?

Fundamental Ideas
- Everything that is not fully created in nature has been designed
- Someone made decisions on how it should look, work, service etc…
- Design may be carefully thought through or informal and lacks any obvious principle of organization

Design considers how things work, how they are controlled, and how people interact with them, affects the human experience. Bad design can lead to bad consequences.

Fields of Design

Industrial design	**Interaction design**	**Experience design**
Focuses on function and appearance of products and systems, often physical	Focuses on how people interact with technology, in particular, understanding how to use it	Focuses on quality and enjoyment of experience, particularly of services, environments, and events

Human Centered Design - Design Approach
- Human capabilities and behaviour central, design to accomodate to humans
- Communication between person and system at its core

Understand the notions of conceptual models and system images

Conceptual Model: An explanation, usually highly simplified, of how something works.
- Might not totally accurate or complete
- Different person might have different conceptual models of the same system
- Is something people have in their mind
- Develops from experiences

    - Inferred from the system
    - Learning from others
    - Through interaction with the system
    - Manuals and instructions

System Image
All the information that can be communicated to the user
- Appearance of the system
- Instructions
- Information from salespeople and ads
- Articles about products
- Product website

Good Design
Facilitates communication of the designer's conceptual model via the system image to the user
Enables user to develop a good conceptual model

Can be incomplete, contradictory, can foster good or poor conceptual model for user, only way designer can communicate with user

Be familiar with key concepts and principles of design, including

Affordances
- Refer to the relationship between a physical object and a person (or for that matter, any interacting agent, whether animal or human, or even machines and robots)
- Determines how the object could possibly be used
- Depends on both the properties of the object and the capabilities of the person
- Affordances need to be perceivable to be effective

Signifiers
- Signifiers communicate where the action should take place. Refer to any mark or sound, any perceivable indicator that communicates appropriate behavior to a person. (Affordances show what is possible,signifiers communicate what to do)
- Can be deliberate in design or unintentional
- Important for fostering discoverability
- (sometimes misleading or superfluous)
- Perceived affordances often serve as signifiers
- Not all signifiers are affordances
- Simple systems and objects shouldn't need signifiers or instructions/manuals

Constraints
- Providing physical, logical, semantic, and cultural constraints guides actions and eases interpretation.
- Makes certain operations impossible or prevents them
- There's a need for backwards compatibility -> lack of constraints in systems

- **Interlock**: enforces particular sequence
- **Lock-ins**: keeps an operation active preventing it from being ended prematurely
- **Lock-outs** - prevents an unwanted event from occuring
- Cultural Constraints - embedded guidelines and cues for acceptable behavior
- Semantic Constraints - prevents incorrect actions by relying on the meaning of the situation
- Logical Constraints - no other option exists or makes sense

Visibility

Discoverability

- The extent to which the design allows the user to discover what it does, how it works and what operations are possible

Mappings

- The relationship between the elements of two sets of things.
  Natural mapping leads to immediate understanding:
- Taking advantage of spatial analogies
- Be careful of cultural differences.
- Relationships between two sets of elements, devices and their controls
- Natural mappings -> spatial relationships
- Can take advantage of the Gestalt Principles (Grouping and Distance)
- Valuable for fostering discoverability and good conceptual models

Feedback

- Some way of letting you know that the system is working on your request;
- Communicating the results of an action
- Must be immediate and informative
- Should be in an unobtrusive manner
- Prioritized feedback should indicate importance of information

Be able to apply these concepts in critiquing or analyzing a design or system

(End of Lecture 4 7.10.19)

Lecture 5

Interaction Models

Have an understanding of what an interaction model is and why they are important

- Tools for modeling and thinking about how humans interact with objects or systems
- Different models enable different types of thought, task, explanations

Potential uses (with systems/objects/design**):**

- Predict Human performance
- Understand the interactions and interaction cycles

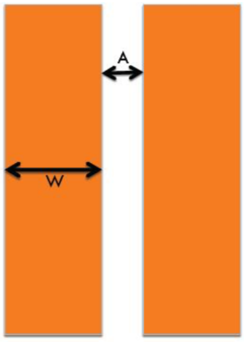
- Explain physical and cognitive processes
- Examine individual parts of the interaction
- Diagnose breakdowns
- Examine mapping between user language and system language

Be familiar with several types of interaction models, the differences between them, and what purposes each serves

Fitt's Law

Movement Time is proportional to distance and target size

Movement Time (MT) is proportional to the Index of Difficulty (ID) of a selection task
-> the harder the selection task is, the longer it will take



The movement time for a well-rehearsed selection task:

- Increases as the distance A to the target increases and decreases as the size of the target W increases

Index of difficulty

$$ID = \log_2(2A/W)$$

Applications

- Used for predicting performance on low-level physical actions
- For "automatic" tasks and actions
- For tasks with minimal cognition - don't have to "think" about them
- Useful for early interface testing, comparing alternative interface layouts

Keyboard-level Model (KLM)

- Introduces human cognition to the model
- Developed by Stu Card 1983
- Decomposes tasks into low-level elements with time values -> Calculates prediction for total execution time
- Best approach for automated behaviour

- Calculate time required for individual generic actions
- Decompose tasks into individual actions
- Calculate the total time for a task as a sum of the time for each action

- Can be used to compare different methods of executing a task
- Does **not** take time for cognition into account
- Not appropriate for tasks that require complicated decisions or cognition
- Only covers conventional input devices

GOMS Model

- Developed in 1980s by Card, Moran and Newell
- **G**oals, **O**perators, **M**ethods, and **S**election rules
- Attempts to model the knowledge and cognition processes involved when users interact with system

Goal
A particular state the user wants to achieve
Refer to a particular state the user wants to achieve
(E.g. find a website on interaction design, goals are obtained)

Operators
The cognitive processes and physical actions that need to be performed in order to attain goals
Refer to the cognitive processes and physical actions that need to be performed in order to attain those goals
(E.g. Decide which search engine to use, operators are executed)

Methods
Learned procedures for accomplishing goals. Consist of the exact sequence of steps required
Learned Procedures for accomplishing the goals
(Sequences of operators)

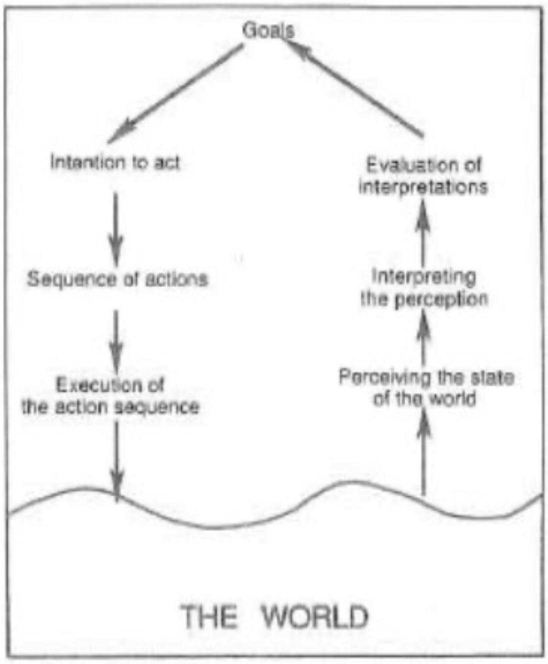
Selection rules:
Determine which method to select when there is more than one available for a given stage of a task
Used to determine which method to select when more than one is available for a given stage of task

Seven-Stage Model of Interaction

Execution

Forming the Intention: What does the person want to do in this step?
Specifying an Action: What are the exact steps the person decides to take to address the intention?
Executing the Action: Actually doing the steps that have been chosen, this acting upon the world

Evaluation
Perceiving the state of the world:
The person must physically perceive the current state of the world, whether changed or unchanged (see, hear, feel)
Interpreting the state of the world:
The person must figure out what the perceived changes mean, i.e. what just happened?
Evaluating the outcome:
The person must come to a conclusion about whether the original goals has been addressed



Gulfs
Execution: Do the actions provided by the system correspond to the intentions of the user?
Evaluation: Does the system respond in a way that the user can perceive and interpret?

Gulf of Execution is small
- Actions of system match intentions of the user
- Actions can be executed without extra effort

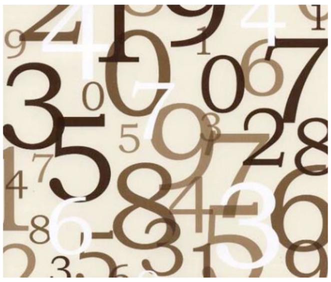
Gulf of Evaluation is small
- System provides info about its state, and is easily accessed and interpreted
- The system's state matches the way the user thinks about the system

Bridging the Gulfs
- Good discoverability
- Natural mappings
- Provide clear feedback
- Make use of constraints
- Provide perceivable affordances, meaningful signifiers

Model Human Processor
"Human as a Computer"
- Three systems: **perceptual, cognitive** and **motor**
- Each system has **processor** and **memory**
- Each system has **principles of operation**

MHP Perceptual System

- Create internal representation of physical sensations
  - Stores temporary information buffers
    - Auditory Image Store, Visual Image Store
- Transfers information in buffers into working memory



MHP Perceptual Processor

- Cycle time: time between when stimulus is presented and when it is available in buffers
- Multiple similar stimuli can combine during one cycle
- Principle: Cycle time varies inversely with stimulus intensity

MHP Cognitive System

- Connects inputs from Perceptual System to outputs of Motor System
- Handles learning, remembering, and problem solving
- Includes working memory (WM) and long term memory (LTM)
  - WM: limited, symbolic, an activated subset of LTM
  - LTM: a person's available knowledge, can be treated as unlimited

MHP Cognitive Processor

- Recognize-act cycle: contents of WM trigger actions in LTM which modify WM
- Principle: CP cycle time is shorter when greater effort is induced by task or information. Cycle time diminishes with practice

MHP Motor System

- Thought is translated into physical (muscular) actions
- Motor system corrections require cycles of perceptual and cognitive systems

Model	What it represents	Features
Fitts's Law	Automated physical actions	- Predictive of performance - Quantitative - Assumes no cognition
KLM	Interaction sequences with a computer system	- Predictive of performance - Quantitative - Takes low-level mental processes into account
GOMS	Tasks, processes, and associated knowledge	- Accounts for decisions - Represents knowledge about tasks - Low and higher level processes
MHP	Human Input, Cognitive Processing and Output	- Perceptual, Cognitive, and Motor systems - Includes rules - Accounts for memory
Seven-Stage Model	Tasks and interactions including human and world/system	- Accounts for cognitive processes and decision making - Helps identify breakdowns

Be able to apply various models for predictive or evaluative tasks

Be able to determine which interaction model(s) would be most useful depending on your goal

Lecture 7

After this lecture you should have foundational familiarity with the topic of Computer-Supported Cooperative Work (CSCW)

A field of research concerned with understanding social interaction and technologies supporting social interaction in groups, organizations, and communities.

Basic definitions, terminology and history

"In its most general form, CSCW examines the possibilities and effects of technological support for humans involved in collaborative
group communication and work processes"
- Bowers and Benford, 1991

CSCW is "computer-assisted coordinated activity such as communication and problem solving carried out by a group of collaborative individuals"
- Greif, 1988

CSCW is "a generic term which combines the understanding of the way people work in groups with the enabling technologies of computer networking, and associated hardware, software, services, and techniques."
- Ellis, 1991

Two important parts:

technology in software and hardware	group work and social phenomena

What does CSCW do?
- Core understanding of group processes and work
- Explicit understanding of technology support for collaboration

Groupware - technology that arise from CSCW research

Early CSCW Efforts
Face to Face (richer interaction going down)
- Written
- Communication
- Phone
- Videoconferencing
- Holodeck

Moving the focus away from trying to simulate face-to-face interaction, including
- Asynchronous communication
- Anonymous communication

- Automatic archiving of communication

Principle: The goal should be to support the functions of collocation rather than the form (Bob Kraut)

Categories and examples of technologies

Computer-mediated communication – systems that support the direct communication between participants

- Usually support remote communication
- Can be asynchronous (often text based) or synchronous

Examples

- Email
- Bulletin boards/online forums

Meeting and decision support systems – systems that capture common understanding

- May impose structure on the process of the meeting
- May support brainstorming and voting processes
- May provide support for group decision making, e.g., prioritization of projects, tracking of arguments
- May support shared editing of documents or artifacts
- May provide shared surfaces, e.g. electronic whiteboards, shared tabletops

Examples

- Argumentation tools
- Meeting Rooms
- Shared Surfaces

Shared applications and artifacts – systems that support participant interaction with shared work objects – the artifacts of work

Shared editors

- Editing applications (for text or other data) that are collaboration aware
- Can be used synchronously or asynchronously
- E.g. version control software, shared document editors, change tracking

Examples

- Google Docs, Google Calendar

Awareness applications – systems that promote awareness of individual and group status

- Attempt to recreate aspects of face-to-face awareness among people who are distributed or remote
    - i.e., who is around, what people are doing, what activities are going on
- Video walls attempt to connect two remote spaces through video link
- Micro level awareness cues, such as status indicators on messaging clients

Models and frameworks for thinking about CSCW, as well as basic application

CSCW Time/Space Matrix

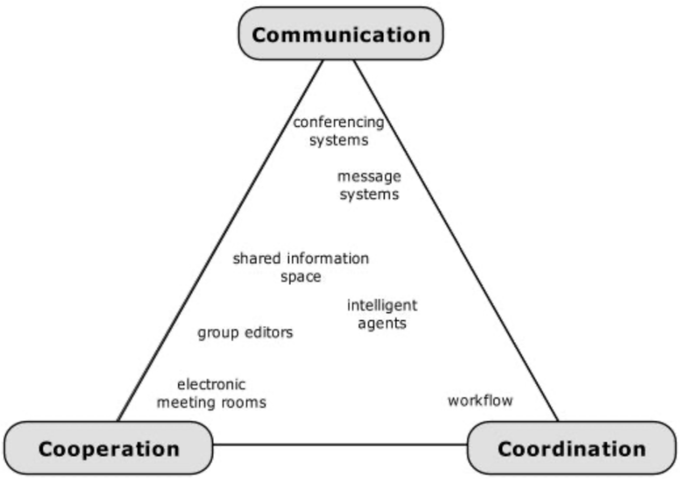
- Considers groupware in terms of temporal and spatial parameters of use
- Does not classify based on intended function or purpose

	Same time synchronous	Different time asynchronous
Same place co-located	**Face-to-face interactions** decision rooms, single display groupware, shared tables, wall displays, roomware	**Continuous task** team rooms, large public displays, shift work groupware, project management
Different place remote	**Remote interactions** video conferencing, instant messaging chats, virtual worlds, shared screens, multi-user editors	**Communication + coordination** email, online forums, blogs, group calendars, version control, wikis

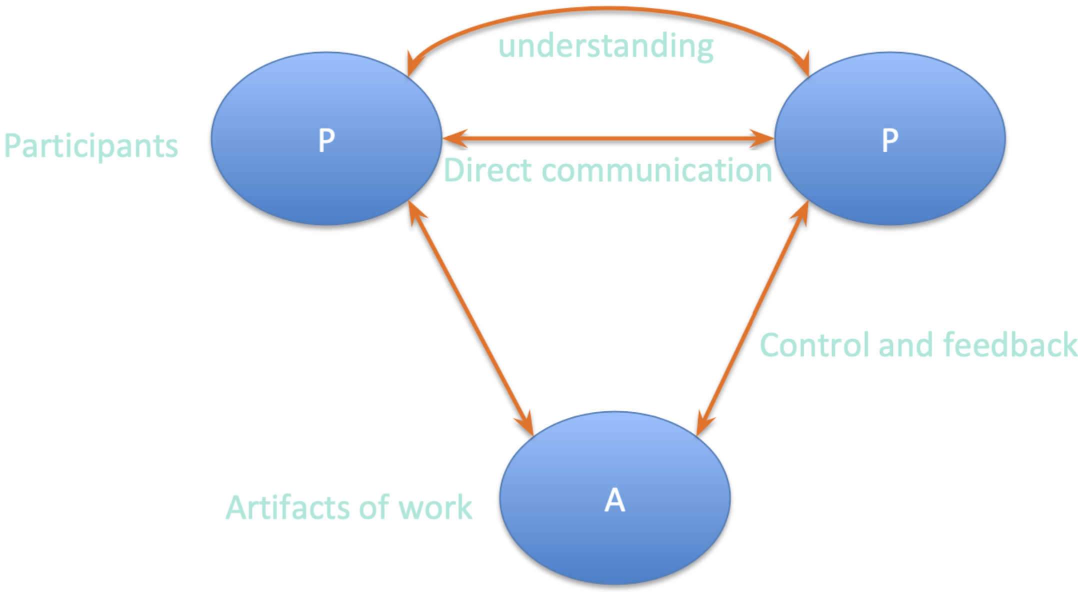
Groupware 3c Model

- Considers three dimensions of support
- Classifies groupware in space based on combinations of dimensions

Cooperative Work Framework



- Also known as "People-Artifact Framework"
- Based on the entities involved in cooperative work
  - Participants in the work
  - Things upon which they work (artifacts)
- Participants are engaged in common work
- Participants interact with shared tools and products to do work



Challenges to the success of CSCW

It is really hard to have a good CSCW.

- Groups and organizations are complex
- People don't understand the technology
- End users aren't the only people affected by the technology, multiple stakeholders (Primary, secondary, tertiary, facilitating)
- Ofter require additional work from individuals, that can bother some people
- System needs a critical mass of user to be useful
- Can lead to activities that violate certain taboos or structures
- Adaptation can be hard

Lecture 8

Be familiar with basic methods and approaches for informing CSCW design and evaluation

How to address challenges of CSCW?

- It requires complex approaches
- Should be appropriate for complex groups and organizations
- Methods should involve multiple stakeholder groups
- Provide inputs of others to decision makers

Ethnography

- Studying work practice live and at the place
- “Work can only be understood if it is observed while it is happening”
    - (asking won’t yield the truth)
- Recording interaction among people and between people and the environment
- Takes an unbiased view and open-ended view of the situation
    - Goal is to describe the situation not necessarily to look for solutions

Contextual Inquiry

- Similar to ethnographic but focuses on interpretation and system design
- Studies work in time and place, as an apprentice to learn about the user’s work
- Uses observations and interviews

Develops models to represent knowledge about the work environment, this data is interpreted and used to shape design:

- **Task models** – specify required steps for work tasks
- **Physical model** – represents physical work environment and its impact on practice
- **Flow model** – shows lines of coordination and communication between people
- **Cultural model** – reflects influences of work culture and policy including official and unofficial codes of behavior and expectations
- **Artifact model** – describes structure and use of artifacts within work processes

Participatory Design Method

- Involves entire design cycle
- Users are members of the design team not just subjects or consultants
- Users are treated as experts in their domain
- Processes used:
    - **Brainstorming** – involving participants in pooling ideas an informal and unstructured process
    - **Storyboarding** – creating representations of users’ day-to-day activities
    - **Workshops** – focused activities to fill in missing knowledge and allow for
    - mutual inquiry between designers and users
    - **Pencil and paper exercises** – creation and discussion of designs with low overhead and low risk

Have an understanding of the field of ubiquitous computing and its origins

Technology and Societies served as base for ubiq comp.

- Ubiquity of devices
- Abundance of data being collected and generated
- Concerns about data access and privacy
- Expectations about connectedness and communication
- Impact on work and study expectations
- Impact on social relationships
- Expectations regarding access to information
- Blurring of work and free time

"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."
- Mark Weiser (1991)

Vision for Computers

- Pads, Tabs, Boards
- High ratio of devices per user

Expected impact of ubicomp

"Machines that fit the human environment instead of forcing humans to enter theirs will make using a computer as refreshing as a walk in the woods."

"We wanted to put computing back in its place, to reposition it into the environmental background, to concentrate on human-to-human interfaces and less on human-to-computer ones."

Often called "off-the-desktop" computing, not one single workstation anymore

- Mobile Devices
- Large interactive screens
- Voice, vision, gestures
- Interactive, sensor-based interactions

Be aware of current directions for the development of ubicomp technologies

What is necessary to realize the human-centered vision of ubicomp?

1. **Defining the appropriate physical interaction experience**
   What **form** does the interaction take? How do we interact with the system?

   New approaches to input and output

   Implicit input
   - Becoming more diverse and increasingly implicit
   - Non active input
     - Trackers in the background
     - Recognize activity/present

   Multi-scale and distributed output
   - Novel output technologies
   - Beyond simple displays but aesthetic and considered products
   - Ambient display, different scale of displays, audio output

   Seamless integration of physical and virtual worlds
   Attempts to merge computational artifacts with physical artefacts
   - Incorporating physical objs. And digital objs. (**tangible interfaces**)
   - Overlaying digital information on the real world (**augmented reality**)

2. **Discovering general application features**
   How should the technology work? How does it function and what does it support?

   Functions that support daily activity
   - **Context-aware computing**
     Using implicitly sensed context from physical and electronic environment to determine the correct behavior of a service

     Intended to make interactions with services more seamless and less distracting from everyday activities

     Use of different types of information
     - Where/ Who / When / What / Why

   - **Automated capture and access**
     Automated recording of information from events has long been regarded as both valuable and dangerous

     Focuses on preservation and recording of live experiences for review or access by user in the future as well as access interfaces

   - **Continuous interaction**
     Providing continuous interaction moves computing from localized tools to constant, ubiquitous presence
     - Focuses on informal daily activities

Challenges: Sub tasks, concurrency, interruptions, no clear start/end

3. **Theories for designing and evaluating the human experience**
   How do we understand the problems we are trying to address? How do we understand the impact and effects of the technology?
   Ubicomp system use “knowledge in the head” and “knowledge in the world”

   Activity Theory
   - Focuses on goals, actions and operations
   - Based on the changing state of the world
   - Emphasizes the transformational properties of objects that carry knowledge and traditions

   Situated Action
   - rejects the notion of pre-planned goals
   - Emphasizes the improvisational nature of human behavior based on the changing world
   - Evaluation of systems would emphasize real-time observation and reject post-hoc explanation

   Distributed Cognition
   - de-emphasizes internal human cognition
   - Treats humans as a part of a larger system in which the knowledge is distributed among the components, including humans and objects
   - Ubicomp systems informed by distributed cognition would focus on larger system goals rather than individual interactions or appliances and focus on how information is encoded in objects and transmitted

   Ethnography
   - Descriptive approach based in anthropology that focuses on observation of everyday practices in situ
   - Recognizes that people’s conscious conceptions of what they do are incomplete and inaccurate
   - Used to inspire design rather than as a way of finding solutions

   Cultural Probes
   - Gaver: way of gathering rich data from people, small notepad, recorder without the intrusion of observation
   - Used to understand what is significant for the people in the environment and to convey aspects of the environment’s culture to designers

Have a fundamental understanding of appropriate approaches for ubicomp design and evaluation

Evaluation of Ubicomp systems is also more challenging than evaluation of single user-single machine interactions

- Ubicomp often relies on cutting edge or novel technology that are not yet reliable and robust
- Hard to test systems in real world deployments

- Often long-term use in “living laboratories” or real world settings are necessary to understand their real impact

Lecture 9

Be familiar with background concepts pertaining to smart homes

Originally conceived of as the application of technologies in the home, often with the intention to increase efficiency or reduce work.

*"Domestic environments in which we are surrounded by interconnected technologies that are, more or less, **responsive to our presence and actions**."* – Edwards & Grinter, 2001

*"A home [that] **adapts to inhabitants**"* – Brush et al, 2011

*"Homes that **cleverly support** their inhabitants"* – Mennicken et al, 2014

All definitions have a strong emphasis on the inhabitants of the home.

Strict Definition:

- Homes learn about inhabitants implicitly
- Homes respond to inhabitants' activities
- Homes adapt and develop behaviours based on inhabitant activities

Less Strict Definition:

- Possibly rule based, not that intelligent

Aspects to consider:

- Efficiency
- Safety
- Entertainment
- Communication
- Comfort
- Coordination
- Health and wellness

Smart home components:

- Sensors
- Actuators
- Cameras
- Microphones
- Displays
- Speakers
- Robots
- Appliances

Have knowledge of some early smart home research as well as later systems

Living Laboratories

- Research laboratories designed to look like a living space
- Infrastructure expensive and difficult to deploy in real homes
- Meant to simulate real world conditions, unsure what the real impact is
- New approaches and technologies easy testable as lab environment

  Georgia Tech Aware Home (1998)
  - Sensing & control infrastructure
  - Built on top of infrastructure with emphasis on health and wellness
  - Emphasis tech to support aging in place
  - Tech to support caring for disabled children

  MIT House (2002)
  - Sensing tech everywhere
  - Applications on top of sensors collecting information
  - Learning what can be sensed in a home, testing new tech, study behaviours

Digital Family Portrait
- Georgia Tech House
- Focus on aging, informing children of state of parents
- Intended to support privacy in communication and daily awareness
- Emphasis on **wellness** and **privacy** -> move away from simple efficiency in Home Tech

Current Technologies
- Alexa
- Smartfridge
- Roomba
- Philips Hue

Be aware of classic challenges to domestic technologies

- Domestic environments are extremely diverse and challenging to understand
- Questions go beyond technology to sociology, culture, politics, and psychology
- Technologies that prescribe procedures or practices are generally undesirable

The “Accidentally” Smart Home
- infrastructure for ubiquitous computing not available in homes
- Requires specific outfitting with technologies
- Update and interoperability between systems problems

Impromptu Interoperability
- Interconnectability between devices is desired **but** hard to know tech of the future and how they connect and interact with each other
- Can lead to frustration or poor home interaction

No Systems Administrator
- Tech leads to system admin knowledge to keep the system live
- Challenge that tech requires no on site expert to maintain

Designing for Domestic Use

- There is a lack of understanding of domestic environments to inform the design of smart home technology
- Real technology use can differ greatly from its intended use
- Classic example – initial vendors of the telephone did not regard it as having a social function
- Predicting the ways in which technology will affect and disrupt the home environment is extremely challenging so studies of routines and practices are necessary

Social Implications of Aware Home Technologies

- Privacy, collecting data constantly can be an issue
- Machines for automating work may change expectations and shift the burden of work without reducing work
- Increased access to media and communication has changed the activities of children and the responsibilities of parents
- Technologies alter routines in ways that cannot be predicted and have massive impact on the home and society

Reliability

- Reliability becomes increasingly challenging when systems are embedded in the home environment
- It can be difficult to patch or upgrade devices in the field
- If systems are interconnected, designers also need to take care that a
- failure in one component does not bring down the rest of the systems
- Evidence of this challenge in the transition from conventional phones and televisions to digital counterparts

Inference in the Presence of Ambiguity

- Systems that attempt to understand what the inhabitants are doing have long been a goal but have met with mixed success in reality
- How smart should a home be? How much inference is required for a smart home to be successful? How to fix incorrect interpretations?
- Challenge is to figure out what functions of the home are only possible through inference, what can be achieved with limited inference, and what requires an "oracle"

Have a familiarity with approaches to address the complexity of smart home technologies

PervasiveCrystal

- System designed by Vermeulen et al, University of Hasselt
- Keeps track of recent events in smart homes
- Presents list of available "why" or "why not" questions depending on recent events
- Automatically generates responses by linking smart home events to triggers
- Allows users to "teach" the system by invoking undo or fine grained control to adjust system behavior

Jigsaw Puzzle

- Interface for end-user programming by Humble et al. at Swedish Institute of Computer Science and University of Nottingham
- Provided a simple interface for specifying the behaviors of technologies in the home, i.e., programming with little programming knowledge

Identified three types of “transformers”
- Physical to digital transformers – turn physical effects into digital effects
- Digital to physical transformers – transforms digital information to drive a physical device
- Digital transformers – act upon digital information and effect digital information to allow for more complex behavior

CAMP Interface
- Created by Truong et al. at Georgia Institute of Technology
- Offered a simple interface for end-user programming of smart home technologies, specifically for capture and access purposes
- Relied on magnetic poetry metaphor, required little to no programming skill

Lecture 10

Have a basic understanding of the concept of universal usability

Designing with the goal of making things **as widely useful and usable as possible**

- Accommodate the widest array of abilities possible
- Accommodate the widest range of conditions possible
- Optimize for equal utility for all (to the extent possible)
- Not just for elderly and people with impairments but also for gender, culture, etc.

Have an understanding of the relationship between gender and computer use

- Design can be gendered unintentionally
- Universal usability – fixing problems for a specific segment of the population can improve a system for everyone
- Software users and consumers are equally distributed across genders – why design for only half of your customers?

Many known differences have been studied and found:

- Perceptual differences
- Attitude differences
- Behavioral differences
- Performance differences
- Suggests that technology design should take these into account to be maximally inclusive (maximally effective)

Be familiar with studies that uncover gender-related differences in computer use

Field of View Experiment
Navigating in a flight simulator conducted by researchers at Microsoft, on normal and on ultrawide displays.
Performance gap of females was eliminated with ultrawide displays.

Optical Flow Experiment
Conducted at Microsoft, evaluated the effects of providing optical flow cues on navigating virtual environments.

Participants were led trained on paths, allowed to practice, and then tested

- Method encouraged spatial rather than symbolic learning of paths ○ “Have you been in this room before?”
- Forward and backward navigation of paths

Implications for Universal Design (adding optical flow cues and wider field of vision):
- Benefits males and females
- Narrow the gap between male and female performance
- No Detrimental effects to any performance

Self efficacy: a person's self-judgment about their own ability to carry out a task to achieve a goal

Problem Solving Study
Males and females given two types of spreadsheet software
- Low cost: allowed for quick annotations and changes
- High support: required more interaction to make changes, offered more explanations

Asked to test formulas to find and fix bugs

Implications for Universal Design
- Even spreadsheet software is not gender neutral
- How to design software that encourages female tinkering and prevents over-tinkering by males?
- Tools that promote effective tinkering would improve performance by both males and females

Understand how software can pose issues for gender inclusivity

Is Software Inherently Gendered? (Assumptions):
- Females and males have different capabilities
- Females and males have different attitudes towards technology
- These capabilities and attitudes affect how they use technology and their performance with it

Can gender-inclusive software be designed to help optimize performance for all genders while minimizing disadvantages to a specific gender?

--> If so need to be able to identify gender-inclusiveness problems. But how?

Be familiar with the GenderMag method for assessing gender inclusivity of software

GenderMag
Method designed by Oregon State University
GenderMag: **Gen**der-Inclusiveness **Mag**nifier
- Allows software developers to identify gender-inclusiveness issues in their software

quickly and inexpensively
- Can be applied during the design and development, or as evaluation

Considers five known facets of gender differences:
- **Motivation** – females are motivated by what they can accomplish with technology, males by enjoyment of technology
- **Information processing style** - Females process new information comprehensively, males process information as it comes
- **Computer self-efficacy** – females often have lower computer self-efficacy
- **Risk aversion** – females tend to be more risk averse than males in decision making
- **Tinkering** – females are less likely to playfully experiment than males with software features, are more likely to reflect during the tinkering process

To create software that is gender-inclusive, you have to create software that accommodates differences in these facet values

GenderMag provides f**our archetypes** – personas intended to serve as representative members of segments the user population, **they only differ in aspects related to the five facet values**

Cognitive Walkthrough
Method to identify potential usability issues by answering a set of questions about that action. Evaluators are given a use case with a goal, subgoals, and a script of actions to achieve the goal

If an issue arises that such that success of use is related to a facet, then it is subsequently going to affect gender inclusiveness

Improving Gender Inclusivity
- Making GenderMag more exclusive
- AI image recognition of gender
- Gender question in collecting data

Why Gender Computing is important
- Design can be gendered unintentionally
- Universal usability – fixing problems for a specific segment of the population can improve a system for everyone
- Software users and consumers are equally distributed across genders – why design for only half of your customers?

- We know gender-inclusiveness issues can be identified so it should be possible to address them

Lecture 11

Be familiar with Pervasive Healthcare as a subset of health technologies

“Pervasive healthcare refers to the set of technologies designed to seamlessly integrate health education, interventions, and monitoring technology into our everyday lives, regardless of space and time.” – Tentori et al., 2012

Interactive systems in support of healthcare, that should increase coverage and quality of care and increase focus in both research and industry.

What it should do:

- Ease **recording, tracking, and monitoring** of health information
- Allow **communication, collaboration, and coordination** among stakeholders
- Encourage **clinical adherence** and **disease prevention**
- Support nomadic work of clinicians and **integration of digital and physical worlds**
- Enable the development of **novel medical devices**

Builds upon Mark Weiser’s vision and the field of **ubiquitous computing**

- Taking advantage of heterogeneous interconnected devices
- Uses these technologies and approaches:
  - Context-Aware Computing
  - Automated Capture and Access
  - Artificial Intelligence
  - Wearable and Embedded sensing
- “Anytime and anywhere” healthcare

Stakeholders
Impacts multiple stakeholders:

- Patients
- Healthcare providers
- Family members
- Caretakers

System often involve multiple stakeholders, Patient captures heart rate -> caretakers takes a look.

Be familiar with three primary domains of pervasive healthcare

Human-Centered Model of Healthcare
Preventative Care

- Targets behavior and lifestyle choices (e.g., smoking, diet, inactivity) to prevent disease or injury, rather than treating or curing them

- Many chronic diseases and premature deaths are linked to common preventable risk factors
- Preventative care reduces burden on hospitals and healthcare sectors

Hospital Care
- Supports coordination and collaboration to care for patients
- Technology for managing and sharing health information and supporting decision-making
- Making hospital workflows more efficient to improve patient care and reduce costs

Chronic Care
- Considers impairments or deviations from the norm that last three or more months
- Most common among elderly people, but affect all ages
- Prevalence of chronic diseases is growing, straining healthcare workers, family members, pharmaceutical industry, medical technology, and insurers

Be familiar with several classes of technology support associated with pervasive healthcare

Preventative Care
- As life expectancy increases, prevention of chronic illnesses becomes a greater priority
- Preventative care programs encourage healthy behaviors in an attempt to reduce healthcare costs on a large scale
- Focus on issues such as medication compliance, health monitoring and documenting, and social health issues
- Goals to prevent cognitive decline, and maintain physical and psychological well being

Technology

Automated and selected capture and access
- Takes advantage of computing to record relevant health information
- Makes information available and accessible to important stakeholders
- Can use fully-automated capture of information (e.g., activity trackers) or user-triggered capture of information

  Examples:
  - Estrellita (Selective capture and access system for parents of premature infants, Communication, data aggregation -> to show to experts, vitals)
  - Foodprint (photo-based food journaling, Supports communication between patients and experts)

Persuasive and self-monitoring technologies
- Technologies encourage people to take responsibility for setting health goals or making positive changes in behavior
- Many commercial applications and devices available for fitness and wellness
- Persuasive games can be used to discourage unhealthy behaviors or encourage healthy behaviors
- Focuses on behaviors such as exercise, diet, smoking, alcohol consumption,

physical activity, leisure activity

Examples:

- UbiFit Garden (encourage regular physical activity through aesthetic images, be fit garden grows else dies)
- Quitty (support smoking cessation, Tailors messaging to cessation progress)
- Mood disorders (detect potential mood disorders and predict changes in mood , social anxiety, seasonal affective disorder)

Social support for health

- Research shows that social ties and social integration are beneficial in maintaining physical and psychological well-being
- Virtual communities can support communication among patients, or between patients and clinicians
- Can lead to reduced stress, social satisfaction, increased access to information, and increased communication

  Examples:

  - pHealthNet (support communication between patients and specialists, Aimed at promoting healthy lifestyle for people with chronic degenerative diseases to prevent further disease)
  - Spaceship Launch (Leverages Fitbit data, targeted at low-income families to encourage physical activity)

Hospital Care

- Supports coordination and collaboration to care for patients
- Technology for managing and sharing health information and supporting decision-making
- Making hospital workflows more efficient to improve patient care and reduce costs
- Healthcare is often slower than other industries in adopting new information technologies
- Hospitals are deploying technologies to improve patient care, reduce costs, and prevent errors
- Hospital work conditions are substantially different from typical office conditions
- Hospital similar to office
  - Demands close coordination and collaboration among specialists distributed over space and time
  - Clinicians continuously move around the space to access people, knowledge, and resources
  - Information is often distributed in different locations

Primary goal is to make information available and allow people to access relevant information when and where they need it

Context-Aware Services and Awareness

- Make use of computing to collect context information to determine how a system should behave
- Focus on keeping clinicians aware of current situation and work status and providing information where and when it is relevant

Examples

- FlowerBlink (LED that blink if patient pees, or pee bag is full)

Pervasive Groupware and Collaboration Support

- Supports collaboration between colleagues for patient care
- Can support cross-department or even cross-hospital interaction
- Can enable synchronous or asynchronous meetings and shared access to medical information

Examples

- Activity-Based Computing (supported teleconferences between clinicians that allowed them to physically “roam” while engaged,)

Record-keeping and Note Taking

- Support recording of data with minimal interference to the ability to engage in an activity or interaction
- Challenging because clinician activities often require the use of both hands so they cannot use them to record information
- Often uses automated capture and access approaches

Examples

- Activity Theater (voice activated systems takes notes, images, recordings automatically and serves them in a palette than can then be used to create necessary documents.)

Handling Multiple Activities and Supporting Rapid Context Switching

- Hospital work is highly fragmented
- Clinicians switch activities every 90 seconds on average
- Requires switching between several systems frequently, many interruptions

Examples

- Activity-Based Computing (supported teleconferences between clinicians that allowed them to physically “roam” while engaged)

Chronic Care

- Considers impairments or deviations from the norm that last three or more months
- Most common among elderly people, but affect all ages
- Prevalence of chronic diseases is growing, straining healthcare workers, family members, pharmaceutical industry, medical technology, and insurers
- Focuses on health conditions or diseases with long-term effects
    - E.g. Cancer, asthma, diabetes, high blood pressure
    - E.g. Alzheimer’s, autism, affective disorders
- Often require a variety of pharmaceutical and behavioral interventions to monitor and maintain patient health over time
- Remote patient monitoring often more desirable than hospital care
- Chronic conditions can lead to lower perceived quality of life and self-care abilities
- Can lead to the need for regular assistance for performance of Activities of Daily Living (ADL) (e.g., feeding, bathing, or dressing oneself, walking, etc.)
- Extensive support from caregivers can help, but also hamper independence,

engagement in society, and self-image
- Caregivers can experience strain and decreased quality of life as well

Focus on supporting ADLs, self management, communication with health providers, and caregiver support

Pervasive Monitoring
Monitoring systems that can track basic metabolic and behavior information
- Vital signs
- Activities
- Social interactions
- Sleep patterns
- etc.

Often make use of wearable or embedded sensors

Examples
- CareLog (Capture and access audio/video application to help caregivers assess the behaviors of children with autism + analytics)
- **Monarca** (management of affective disorder, specifically bipolar disorder, collects info -> caregivers & clinicals, analysis and self reflection)
  Serves multiple purposes
  - Collection of vital data
  - Provides clinicians with access to more data
  - Helps patient learn about condition and patterns
  - Supports prediction of mood
- Visualization for Glucose Monitoring (Support for patients with Type II diabetes, Varied context information, text, symbols, colors to help patients better understand and manage the disease)

Social Connectedness and Communication Support
Strong social networks may enhance quality of life for people with chronic illnesses
- Improves health
- Reduces chances of developing cognitive decline
- Prevents earlier death

But people with chronic conditions experience additional challenges in accessing and maintaining social networks, increasing isolation

Examples
- Family Portrait (Communication of elderly to children without feeling watched)
- Vlogging on Youtube, interacting with community

Assisted Navigation and Wayfinding Support
- Mobility can be a substantial challenge for people with chronic illnesses and cognitive disabilities
- Problems with working, driving, walking, or taking transit
- Problems with orientation indoors or outdoors

- Technologies can help support navigation of environments

Examples
- Robotic Walker (Walking support device that includes a robot to physically guide elderly patients in assisted living facilities, with AI for path planning, collision detection)
- Light Guiding (Track to guide patients with dementia)

Prompting and Reminders
- Aimed at assisting cognition for people with cognitive disabilities, memory impairment, or attention problems
- Provide guidance and management services to remind people how to execute activities
- Caregivers are often overburdened and stressed, so systems provide additional support

Examples
- Coach (assist people with severe dementia who have difficulties remembering the proper sequence of ADLs, analyzing with video then helps with audio steps)

Be aware of several examples of technologies that embody these classes of technology support

See above

Have a basic understanding of the challenges to the design and success of pervasive healthcare technologies

Challenges
- Privacy of sensitive health information
- Reliability of sensor-based technologies
- Overhead of introducing new systems and reluctance to move from analog to digital technologies
- Difficulties of testing and evaluating the effects of technologies on health and wellness

How to assess success
- Improved health metrics
- Improved quality of life
- Less time in hospital
- Fewer readmissions to hospital
- More/better information for clinicians
- Better understanding of own health
- More independence
- Low burden
- Greater efficiency

- Lowered need for treatment
- Etc.

Many approaches from CSCW and UbiComp are appropriate
- Participatory Design
- Contextual Inquiry
- Distributed Cognition
- Activity Theory
- Cultural Probes
- Etc.

... but concrete measures of effectiveness remain a challenge

Difficult to measure behavior change
- Difficult to measure effects of social factors
- Ethical challenges of deploying experimental technologies that affect health
- Long-term empirical studies with measurable results are challenging to deploy
    - Legal and safety compliance
    - Cooperation of health organizations

Lecture 12

Basic understanding of the major environmental impacts of ubiquitous computing

- Energy/resource consumption
- Electronic waste

Technological Efficiency != Sustainability

Argued that technological advances in coal use efficiency would not lead to an overall reduction in demand for coal, but instead to an increase

Known as “Jevons Paradox” or “rebound effect”

“Technological improvements increase the efficiency with which a resource is used; total consumption of that resource may increase rather than decrease.” (Tainter, 2009)

E-waste – trash produced by the disposal of electronic devices (Electronic waste production grew from 20 million tons (2005) to 42 million tons (2014)) -> Sent to Africa and Asia

Obsolescence
Rapid advancements in technology leads to technology obsolescence and frequent replacement of devices

Planned obsolescence – the intentional design or engineering of technologies to become obsolete

- E.g., software designed only to run on new devices
- E.g., circuits designed to lose performance over time

Energy consumption and e-waste

- Complex problems without easy solutions
- No one party is responsible
    - Policy makers
    - Manufacturers
    - Consumers
    - Engineers
    - Designers
    - Governments
    - Etc.

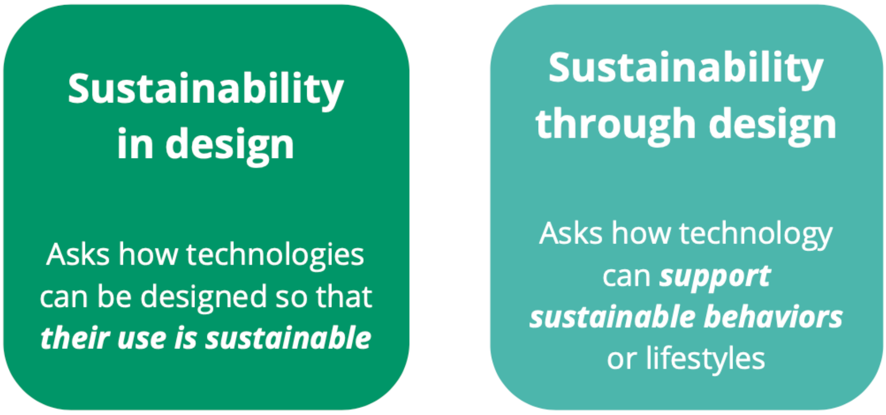
- Advances in computer science have contributed greatly to these problems
- A very real impact of computing on society
- Political, environmental, health, social, technological implications

- Computer science and related fields need to consider how to contribute to solutions

Clear understanding of the distinction between sustainability in design and sustainability through design

- Engineering technologies for efficiency alone is not enough to achieve sustainability.
- Need to consider design, and how people interact with technologies
- How can design lead to more sustainable technology use?
- How can technologies themselves promote sustainable behaviors and practices?

Sustainable HCI - Field of research since 2007, Considers the relationship between humans and tech in the context of sustainability



Basic understanding of approaches to sustainable design and the fundamental concepts they embody

Sustainable Interaction Design - (Eli Blevis 2007)

- The perspective that sustainability can and should be a first-class focus of design, like robustness, usability, etc.
- Blevis defines design as “an act of choosing among or informing choices of future ways of being”

Blevis’s Rubric

Rubric for understanding and assessing the sustainability of particular instances of design in terms of use, reuse, and disposal
(Approximately ordered from greatest to least negative impact)

1. **Disposal**
   Does the design cause the disposal of physical material, directly or indirectly and even if the primary material of the design is digital material? (Cameras that eventually print images)
2. **Salvage**
   Does the design enable **the recovery of previously discarded physical** (tech that runs on waste) material, directly or indirectly and even if the primary material of the design is digital material?
3. **Recycling**
   Does the design make use of recycled physical materials or provide for the future

recycling of physical materials, directly or indirectly and even if the primary material of the design is digital material?

4. **Remanufacturing for reuse**
   Does the design provide for the renewal of physical material for reuse or updated use, directly or indirectly and even if the primary material of the design is digital material?
5. **Reuse as is**
   Does the design provide for the transfer of ownership, directly or indirectly and even if the primary material of the design is digital material? (ebay)
6. **Achieving longevity of use**
   Does the design allow for long term use of physical materials by a single owner without transfer of ownership, directly or indirectly and even if the primary material of the design is digital material?
7. **Sharing for maximal use**
   Does the design allow for use of physical materials by many people as a construct of dynamic ownership, directly or indirectly and even if the primary material of the design is digital material? (eScooters)
8. **Achieving heirloom status**
   Does the design create artifice of long-lived appeal that motivates preservation such that transfer of ownership preserves quality of experience, directly or indirectly and even if the primary material of the design is digital material?
9. **Finding wholesome alternatives to use**
   Does the design eliminate the need for use of physical resources, while still preserving or even ameliorating qualities of life in a manner that is sensitive to and scaffolds human motivations and desires?
10. **Active repair of misuse**
    Is the design specifically targeted at repairing the harmful effects of unsustainable use, substituting sustainable use in its place?

Blevis Principle for Design
Linking invention and disposal
When designing a product or technology, it is as important to design what happens after it is out of use as it is to design how it will be used

Take-back and recycling not sufficient
- Incentives for shared use
- Modularity or upgrade-ability
- Construction from enduring materials

Promoting renewal and reuse
The use of software to upgrade and renew older devices (Share Platforms)

Promoting quality and equality
Looking at what can motivate people to reuse as is, achieve longevity of use, share for maximal use, and achieve heirloom status for objects

De-coupling ownership and identity
Concerns issues of fashion, security and privacy, and sense of self in the construct of

identity

- These motivate relationship to objects of consumption
- Hinder possibilities for sharing for maximal use

Using natural models and reflection

Promoting imitation of use of resources in nature and the design method for doing so

- Connected to achieving longevity of use, sharing for maximal use, achieving heirloom status, finding wholesome alternatives to use, and active repair of misuse

Cradle to Cradle Design (McDonough and Braungar)

Perspective on how things should be designed

Argues against “cradle to grave” design

Considers the “cherry tree” metaphor

- Tree produces thousands of blossoms with the “goal” that one pit might grow a new tree
- Fruit nourishes birds, people, other animals
- Fallen blossoms decompose and re-nourish the soil
- “waste” equals “food”
- “eco-effective” vs. “eco-efficient”

Two closed loop “metabolisms”

- **Biological metabolism** – for biological nutrients; components that can biodegrade or be safely thrown away to be consumed again
- **Technical metabolism** – for technical materials that can be reused in the same form (e.g., metals and high-quality plastics

Avoidance of “monstrous hybrid” materials that prevent return of nutrients into the metabolisms

Echoes Blevis’s rubric about use of natural models and active repair of misuse

Knowledge of technology approaches to supporting sustainable behaviors and practices

Eco-Feedback Technologies

Technologies that present feedback about individual or group behavior with the intention of reducing environmental impact

Ambient awareness

calm computing - tech that reside in the background of your attention

Intended to create awareness of the environment or behaviors

Can make use of

- Devices and physical artifacts
- Visualizations
- Instrumented environments
- Intelligent agents

Persuasive technology
The predominant genre of sustainable HCI technologies

- Systems that attempt to convince users to behave more sustainably
- Vary in terms of whether the persuasion is passive or active
- Vary in terms of whether the user is intended to be conscious of the persuasion or not

Pervasive and participatory sensing

- Sensors are increasingly being used to monitor and report on environmental conditions (e.g. air quality displays on highways)
- Participatory sensing involves non-experts in the collection of data
    - Also known as "citizen science"
- Intended to help collectively create a rich set of data
- Also intended to empower and inform non-experts

Focus on Consumer vs. Focus on Designer

- Affecting consumer or end-user behavior is limited in impact
- Consumers may be motivated to change practices but technologies need to allow for more sustainable behaviors
- Currently ongoing work on how to motivate and support designers in incorporating sustainability into technology systems and products

Sustainability and Profitability

- Value of durable goods
- Shift from physical objects to services, software, content
- Reclaiming materials can save money

Sustainability is an Ongoing Problem

- Technologies and approaches presented are all problematic and unlikely to yield complete solutions
- Many proposed solutions potentially create new problems
- Problems of environmental sustainability, and negative environmental effects of ubiquitous computing cannot be solved by informatics alone
- Solutions are difficult to test and evaluate

Exposure to examples of various technology approaches to supporting sustainable behaviors and practices

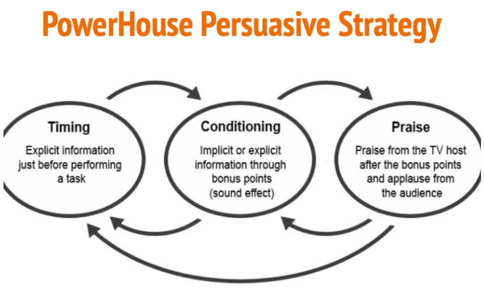
Power Aware Cord (Ambient awareness)

- Reflects energy use of objects and appliances
- Intended to inform and provide information without requiring attention or interaction
- Changes based on current energy consumption

7000 Oaks and Counting (Ambient awareness)
Dynamic display of visualizations reflecting energy consumption in office building over time

The PowerHouse (Persuasive technology)

- Interactive game intended to teach teenagers about how to be more energy efficient in the home
- Intended to engage them and get them to think explicitly about saving energy
- Provides persuasion through suggestions, points, and praise
- Goal is to persuade teens to change their behavior in the real world through interaction with the virtual world



UbiGreen (Persuasive technology)
Update a visualization on phone to reward green transportation choices, based on phone sensors

UpStream (Persuasive technology)

- Displays affixed to home water taps to display a variety of feedback about water consumption
- Compared individual water use with household water use

Spectacle Computing (Pervasive and participatory sensing)
Workshops teach citizens of a community to assemble sensor-augmented balloons to collect data about air pollutants

Lecture 13

Basic history of the development of computer ethics

1940s and 1950s
MIT guy created anti aircraft cannons to shoot down warplanes
Insights:

- Computers might be able to sense information
- Machines could be built to perform complicated tasks

He identified a key ethical question for computing
Predicted second industrial revolution
Predicted radical changes for workplaces, laws, regulation, businesses, professional orgs, psychology, and philosophy

1960s
Donn Parker began to study unethical and criminal use of computers by computer professionals

Developed first Code of Professional Conduct for the ACM (Association for computer machinery)

1970s
Weizenbaum created ELIZA, a program that could imitate a psychotherapist to interact with a patient

Psychiatrists believe computers would soon provide automated psychotherapy
Scholars became emotionally attached to the program
Fears that science would treat humans and machines as equal

Walter Maner begins to use the term “computer ethics”

- Developed university course
- Published Lecture Starter Kit for computer ethics
- Increased interest in the field

1980s
Social and ethical impacts of computing become public issues

- Computer-enabled crime
- Disasters caused by computer failures
- Invasions of privacy via databases
- Major lawsuits over software ownership

First international conference on computer ethics takes place, bringing together computer professionals, philosophers, sociologists, psychologies, lawyers, business leaders, government officials, etc.

Key challenge areas for computer ethics

Computers in the Workplace

- Potentially replace people in their jobs or reduce them
- Creating new jobs
- Alter the nature and responsibility of a job
- Impact health and job satisfaction

Computer Crime
- Proliferation of fraud, viruses, spying, hacking
- Internal crimes such as embezzlement
- New policy and approaches needed to handle security and computer crime

Privacy and Anonymity
- Computers and networks can gather, store, search, compare, retrieve and share personal information
- People can no longer keep information fully confidential
- Lack of transparency about who has access to personal information
- Changing expectations and definitions of privacy

Intellectual Property
- Challenges concerning ownership of software and media
- Need for policy to mandate what is protected, e.g., code, algorithms, underlying ideas
- Strong financial interest in protection of software and other intellectual property

Professional Responsibility & Globalization
- Global networks and conglomerates connect people and information worldwide
- Affects global laws, global business, global education, global information flows
- Increasing “digital divide” between rich and poor nations
    - Educational opportunities, employment opportunities, medical services, and other necessities move into the digital realm, increasing the gap between rich and poor

Selected codes of conduct for computing and computer use

- Organizations and groups attempt to define codes of conduct and ethics that members should follow
- Impossible to cover all ethical issues; codes are tailored to organizations' priorities and focus
- Mirror some legal policy but are not law
- Challenging to regulate and enforce

Code of Fair Information Practices (1973)
Purpose to secure privacy and rights of citizens in regard to personal information
Computer Ethics Institute (1991)
Purpose to guide ethical use of computers
Association for Computing Machinery (1992)
Purpose to specify conduct by computing professionals

Foundational ethical concepts for studies involving human participants

- Protect your study participants
- Protect yourself and your organization
- Protect the data you are collecting

Participant has a **right to be informed**

- Purpose of the activity
- Procedures
- Use of information collected
- Incentives for participation
- Participant's rights
- Risks, discomforts, adverse effects

Basic understanding of informed consent and how to obtain it

Informed Consent Forms

- Provide the potential participant with enough information that s/he understands what s/he is agreeing to
- Participant signs a form acknowledging understanding of the activity and agreement to participate

Purpose

- Provide a high-level description of the research activity and its purpose
- Make participants comfortable with the study and data collection

Procedure

- Provide a description of what the participant will be required to do
- Provide a description of what the researcher will be doing, if appropriate (i.e., taking notes, recording audio, etc.)

Confidentiality
How will participant information be protected

- Anonymization of data

- Pseudonyms or participant codes
- Blurring of faces in images of videos
- Removal of personally identifying data

How will participant information be stored

- E.g., password protected computer, locked cabinet

Who will have access to data?

- E.g., only the researchers involved in the study

How may participant information be used

- E.g., internal and external presentations, papers

In what form will data be stored?

- Where will data be kept?
- Who will have access to data?
- How long will data be kept?

Right to Withdraw

- Participants should not be coerced into participating
- Participants should not be penalized for withdrawing
- Incentives should be made explicit up front and should not be reduced as a result of withdrawal

Risks and Benefits

- May include risks from physical activity
- Benefits may include compensation, incentive gift, helping to improve a product

! Overall Guidelines for Study Ethics !

- Minimize risks to participants
- Collect only as much personal information as necessary
- Inform participants about their participation and data use
- Provide incentives that are proportional to effort
- Allow participants to withdraw

Basic understanding of vulnerable populations in studies involving human participants

Participants who may not be able to give full, voluntary informed consent

- Prisoners
- Children
- Persons with mental or physical disabilities
- Persons with economic or educational disadvantages
- People who are very ill
- People who are institutionalized