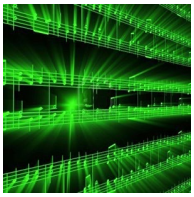
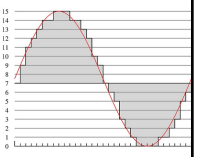
Penn Engineering

ESE





Lecture #23 – User Interface 2

ESE 150 – Digital Audio Basics

1

Lecture Topics

- **Where are we on course map?**
- **User Interface**
  - Motivation
  - Issues and Principals
  - Developer vs. User
  - Design Choices
  - Approaches and Prototyping
  - Advancing/Enabling Technology
- **Next Lab**

2

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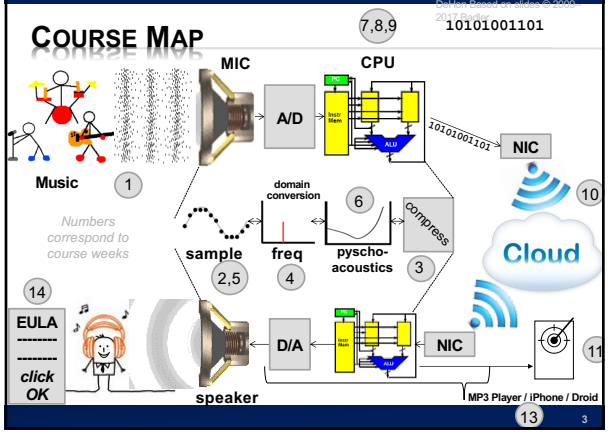
Course Map



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3

Review

4

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User Interface

- **When a user sees a product**
  - See the interface
  - Not the underlying design
    - ….and that's the way it should be
- **Interface determines if the user can get job done**
  - …or will walk away frustrated
- **Successful interface**
  - Make it easy, pleasant to use
  - Hide all the complexity that makes it work

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Most Product Returns are Usability Failures

- **Most Returned Products Work Fine:** Study Says Only 5 percent of returned products are genuinely defective: Yardena Arar, *PC World*, June 2, 2008 4:00 pm
- **Only 5 percent of consumer electronics products returned to retailers are malfunctioning --**yet many people who return working products think they are broken, a new study indicates.
- The report by technology consulting and outsourcing firm Accenture pegs the costs of consumer electronics returns in 2007 at **$13.8 billion** in the United States alone, *with return rates ranging from 11 percent to 20 percent*, depending on the type of product.

http://www.pcworld.com/article/146576/most_returned_products_work_fine_study_says.html

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User vs. Implementer

- **Thesis:** Engineer who implements something is seldom the right person to judge the goodness of the user interface
  - Knows how should work
  - Has a mental model of inner workings
  - Motivated to reduce implementation complexity
- Contrast user
  - Doesn't know how works – shouldn't have to!
  - Benefit from reduced use complexity
    - Reduced cognitive load

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Approach

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Issues need to address (goals)

- **Time to learn**
- **Easy to figure out how to use**
- **Time to perform task**
- **Safety**
- **Clarity of what happened**
  - Why something didn't happen
- **Ease of recovery**
- **User stress**

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How use Principles and Goals?

Principles are generally:

- **Descriptive, comparative and analytical (i.e., how alternatives compare; test and refine paradigm)**
  - Give us some idea how to evaluate a UI
- **Not constructive (i.e., do not define the process of developing user interface design)**
  - No automated (good) interface design tools exist (e.g., that could have predicted the iPod user interface design)

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Principles Must Be Considered in the Context of User Population

- **Principles define an optimization problem where the (target) user population is not uniform in skill, cognitive ability, needs, experience, learning style, or motivation.**

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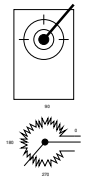
Preclass 1

- **How did servo know when it needed to rotate right or left?**



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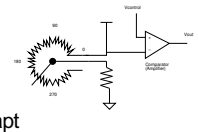
Design Iterative

- **Design is usually an iterative process based on feedback**
- **If we have goals/metrics,**
  - Can, at least, evaluate how doing relative to metric
- **Then refine design (hopefully to improve)**
  - And re-evaluate metrics
- **Like servo feedback**
  - Could measure if we were above/below target
  - Apply adjustment, remeasure, adapt



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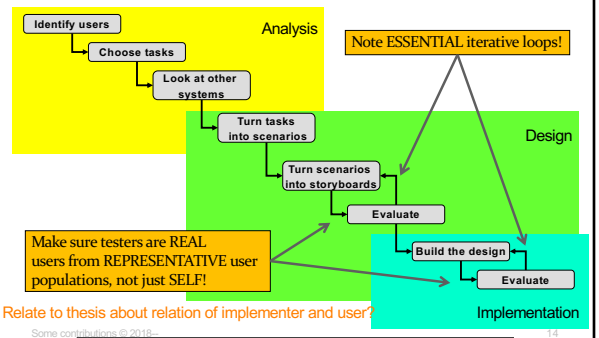
Task-Centered Design



http://www.comp.rgu.ac.uk/staff/sw/materials/cm2006/Interface%20design_1.4.ppt

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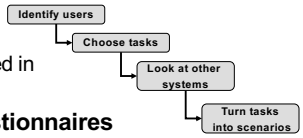
Analysis Techniques



- **Task analysis**
  - Models the steps involved in completing a task.
- **Interviewing and questionnaires**
  - Asks the users about the work they do.
- **Ethnography**
  - Observes the user at work.

Ian Sommerville: Software Engineering, 7th Ed., 2004

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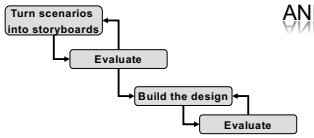
Prototyping and User Testing



23

User Interface Prototyping

- **Aim:** allow users to experience the interface.
- **Without direct experience,**
  - it is impossible to judge the usability of an interface.
- **Prototyping often a two-stage process:**
  - Early: paper prototypes
    - Don't wait until have completely implemented to start getting feedback!
  - Refine to increasingly sophisticated automated prototypes

Ian Sommerville: Software Engineering, 7th Ed., 2004

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Paper Prototyping

- **Work through scenarios using sketches of the interface.**
- **Use a *storyboard* to present a series of interactions with the system.**
- **Paper prototyping to get user reactions to a design proposal.**
- **If you cannot draw it, you cannot build it.**

Ian Sommerville: Software Engineering, 7th Ed., 2004

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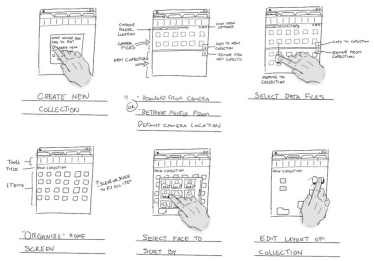
STORYBOARD



From Microsoft Hilo Chapter 4:
https://msdn.microsoft.com/en-us/library/windows/desktop/ff800706.aspx

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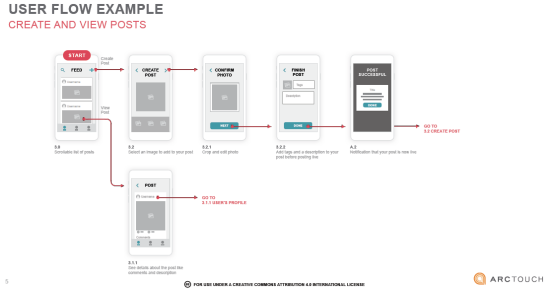
STORYBOARD



- Arctouch arctouch.com

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PROTOTYPING TECHNIQUES

- **Use PowerPoint as a substitute for an editable script.**
  - Can include links to different slides/displays
- **Internet-based prototyping**
  - Use a web browser and associated scripts.
- **Script-driven prototyping**
  - Develop a set of scripts and screens using a UI design tool. When the user interacts with these, the screen changes to the next display.
- **Visual programming**
  - Language designed for rapid development such as Visual Basic.
  - Python+GTK ← will use in lab

Ian Sommerville: Software Engineering, 7th Ed., 2004

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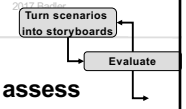
USER INTERFACE EVALUATION



- **Evaluate user interface design to assess its suitability.**
- **Full scale evaluation is very expensive and impractical for most systems.**
- **Ideally, an interface should be evaluated against a usability specification.**
  - However, it is rare for such specifications to be produced.
- **Can evaluate against a "design principles" or goals list.**

Ian Sommerville: Software Engineering, 7th Ed., 2004

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ISSUES

- **Time to learn**
- **Easy to figure out how to use**
- **Time to perform task**
- **Safety**
- **Clarity of what happened**
  - Why something didn't happen
- **Ease of recovery**
- **User stress**

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ISSUES → QUANTITATIVE GOALS

Ideally create concrete, quantitative metrics for each relative to the product and user base:

- **Time to learn**
- **Easy to figure out how to use**
- **Time to perform task**
- **Safety**
- **Clarity of what happened**
  - Why something didn't happen
- **Ease of recovery**
- **User stress**

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PRECLASS 2

- **How can we use a focus group to evaluate if met user interface goals?**
  - E.g. new user accomplish task in 30s

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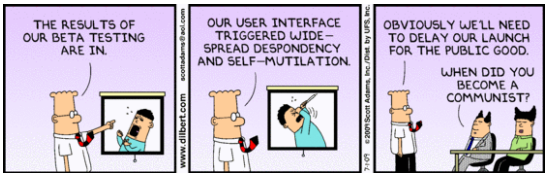
USER TESTING



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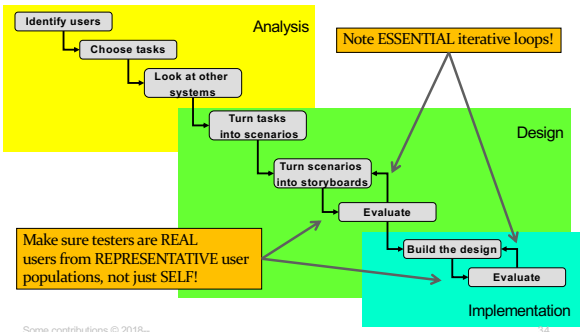
TASK-CENTERED DESIGN



http://www.comp.leu.ac.uk/staff/sw/materials/cm2006/Interface%20design_L4.ppt

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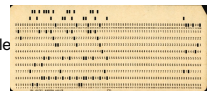
Part 2

TECHNOLOGY CHANGE

35

UI AND MOORE'S LAW

- **Theme:** We should spend computation to ease human interaction
  - **Past:** had to ask human to accommodate computer
    - Give it input in a way it could understand
      - E.g. punched cards
      - (pix from https://commons.wikimedia.org/wiki/File:6161).jpg)



  - **Future:** should have computer do more to accommodate human in interaction
    - Reduce what human needs to do
    - Move interface closer to natural interaction for user

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PRECLASS 3

- **How many instructions should we be willing to execute to save a second of human time?**
  - Cost of second of human time?
    - Assume $300K/yr., 250 days/yr, 8 hours/day
  - Given Energy cost:
    - 10^{-15} cents per instruction
  - Number of instructions cost same as human-second?

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IMPACT

- **Can afford to spend computation to bridge between natural user view (interaction) and underlying implementation view**
- **Energy/op has reduced over time**
  - Increasing this ratio
- Can afford to spend **more** computation now than in past

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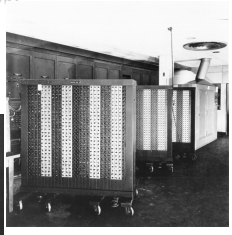
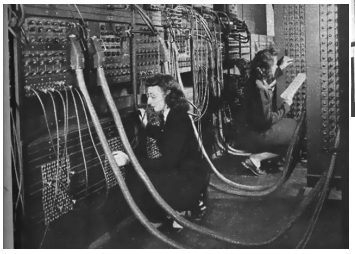
EVOLUTION OF INTERACTION

- Dedicated Buttons and Knobs





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EVOLUTION OF INTERACTION

- Dedicated Buttons and Knobs
- Keyboard
  - With character display

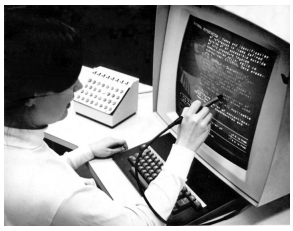

Image source: https://commons.wikimedia.org/wiki/File:HypertextEditingSystemConsoleBrownUniv1969.jpg

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EVOLUTION OF INTERACTION

- Dedicated Buttons and Knobs
- Keyboard
  - With character display
- Mouse, graphics

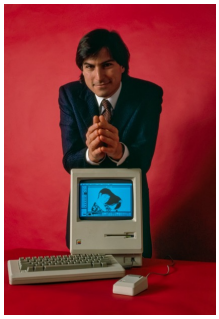

Image Src: https://en.wikipedia.org/wiki/Macintosh#/media/File:Steve_Jobs_and_Macintosh_computer,_January_1984,_by_Bernard_Gotfryd_-_edited.jpg

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EVOLUTION OF INTERACTION

- Dedicated Buttons and Knobs
- Keyboard
  - With character display
- Mouse, graphics
- Touch Screens

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EVOLUTION OF INTERACTION

- Dedicated Buttons and Knobs
- Keyboard
  - With character display
- Mouse, graphics
- Touch Screens
- Accelerometers
- Audio, video, …
- Augmented Reality

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Evolution of Platforms

- Dedicated Buttons and Knobs
- Keyboard
  - With character display
- Mouse, graphics
- Touch Screens
- Accelerometers
- Audio, video, …
- Augmented Reality

Platforms shrinking

- What's the implication of smaller platforms?
  - How is it driving the evolution on the left?
  - E.g. What size limit does a full-size mechanical keyboard impose?

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Evolution of Platforms

- Dedicated Buttons and Knobs
- Keyboard
  - With character display
- Mouse, graphics
- Touch Screens
- Accelerometers
- Audio, video, …
- Augmented Reality

Platforms shrinking

- Rooms and Racks
- Desktops
- Laptops
- Tablets/phones
  - No physical keyboard
- Watch
- Glasses?

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Demand and Opportunity

- Demand
  - Shrinking platforms demand move beyond full-sized keyboard
  - Portability also demands less bulky inputs
- Opportunity
  - New sensors
  - …with cheap processing to "understand" complex/noisy signals
  - Direct computer with movement, voice, direct interaction with world

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Rise of Voice Control

- **Siri**
- **Ok Google**
- **Alexa**
- **Voice Remote**

- **Locally recognize "wake words"**
  - Ship off to server farm for bulk speech recognition

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Preclass 4

- **How GPS data ease data lookup for bus stop, schedule?**
- **Compared to what must do without GPS data?**
  - (what does Google Maps do?)

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Context Awareness

- **Sense context**
  - Can reduce information need to explicitly gather from user
  - Prioritize/reorder data presented
    - Know more about likely common case
- **Principle:** don't ask user for information can obtain automatically.
- **Other context examples?**

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Natural(?) Input

- Audio and Voice processing
- Vision, Radar
- Location
- Motion (e.g. fitbit, iWatch)
- Biometrics
- Coupled with signal processing, cheap computation
- Opportunity to take input from natural interactions

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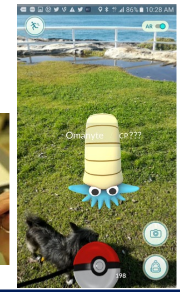
Augmented Reality with Portable Devices (Smartphone)

https://mashable.com/2016/07/10/john-hanke-pokemon-go/#edHFGDBS1kql

- Use the embedded camera and overlap synthesized images and animation.
- Pokemon Go
- Need real-time feature tracking for registration.

"Invisible Train": Schmalstieg and Reitmayr, 2004

Overlaid Directions



http://www.youtube.com/watch?v=zOS5Mbk_Iuc

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Augmented Reality

(Doctor Who fans: search for augmented reality tardis)

https://blippar.com/en/resources/blog/2017/11/06/welcome-ar-city-future-maps-and-navigation/

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UI and Moore's Law

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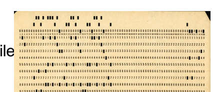

  - **Future:** should have computer do more to accommodate human in interaction
    - Reduce what human needs to do
    - Move interface closer to natural interaction for user
      - Voice, movement, vision, ….

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Big Ideas

- **User Interface essential**
  - And worth designing carefully and deliberately
- **View should match user goals, not internal design**
  - Spend computing cycles to ease human interaction
  - Make simple, safe, intuitive
- **Implementer seldom a good judge of interface goodness**
  - Knows too much about how should work
  - Conflict of goals
- **Important to test and get *representative* user feedback**

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Next Labs

- Lab 11 – today
  - Actuators and WiFi
  - Prelab to get setup; including on AirPennNet-Device
- Lab 12 – following Wednesday
  - Develop and analyze User Interface(s) for internet-connected devices
    - Networking to control
    - Develop GUI
  - More user-friendly interface than the engineer-friendly one we will use for Lab 11

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LEARN MORE @ PENN

- **Courses**
  - ESE543 – Human Factors Engineering

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REMEMBER

- **Feedback**
- **Lab today**
  - Bring kit
  - AirPennNet-Device

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READING

- *The Design of Everyday Things*, Donald Norman -- a classic book on design for usability (broader than just hardware and software)
- *The Inmates are Running the Asylum*, Alan Cooper -- a manifesto calling out computer/software industry for poor design
- *Set Phasers on Stun: And Other True Tales of Design, Technology, and Human Error*, Steven M. Casey -- a series of anecdotes (case-studies) on how bad design and interfaces can go wrong, perhaps even killing people.

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