New Jersey Institute of Technology

Department of Industrial and Manufacturing Engineering

IE 662 Cognitive Engineering

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Today's Outline

- Introductions
- Course Mechanics
- History of Human Factors
- Definitions
  - What is Cognitive Ergonomics, User Experience?
- Observations from Don Norman's Psychology of Everyday Things
- Usability: What Is It?
- Importance and Impact: Examples
- Class Exercise

Goals

- Application of human factors and cognitive psychology to user interface design of Information Technology (IT)
- IT includes, but not limited to, traditional computers
  - Communications, Internet, groupware, handheld devices, complex control systems (factories, power plants, etc.)
- Methods of User Centered Design
- Methods of Usability Testing
- Coverage of Current Technology Topics:
  - Human-Computer Interaction
  - Internet and Web Design
  - CSCW, Intelligent Agents and Intelligent Systems
  - Handheld Devices, Information Appliances
  - Telecommunications
  - Speech Technology

History / Background of the Field (1)

- Pre-War
  - William James: Applied Psychology
  - Gilbreth: Time and motion studies
- Post War 1945-1960
  - Late 1940s: Engineering Psychology at US Air Force and US Navy
  - Ergonomics Society 1949, Human Factors Society 1957
  - Military application dominant until 1960s

History / Background of the Field (2)

- Expansion into Industry 1950s-1970s
  - 1951: Karlin founds User Preference Research Department at Bell Laboratories
    - Began with behavioral science involvement in assessing voice quality of network
    - Evolved to other applications of behavioral science (military work still formed a part)
    - Example: studies to determine the impact of transition from exhange dialing to 7-digit “all number” dialing
  - Other industry begin to development behavioral science groups as well: computers, automobiles, consumer products
  - Late 50s early 60s: Deininger uses human performance studies to make engineering decisions on touch-tone keypads

History / Background of the Field (3)

- 1980s: Safety and health issues achieve visibility
  - Human factors professional become involved in product liability and personal injury litigation, repetitive stress injury
  - Tragic accidents have human performance components
    - Three Mile Island
    - Human Carbide disaster in Bhopal, India
    - Therac-25 medical accidents
    - Chernobyl
    - Airplane crashes
- 1980s and 1990s: Rise of computer and information technology

History / Background of the Field (4)

- 1980s - 1990s Usability becomes prominent in personal computer industry
  - First Windowing systems and mouse pioneered in Xerox PARC
  - Apple launches Lisa then MacIntosh, makes reputation on usability of systems
  - MS Windows propagates throughout Industry
  - Information technology companies begin to conceive of usability as a market “differentiator”

Definition of Terms

- Human Factors
- Ergonomics
- User Interface
- User Interface Design
- User Centered Design
- Software Ergonomics
- Cognitive Ergonomics
- User Experience

Definitions

- Application of the knowledge concerning the characteristics of human beings to the design of systems and devices of all kinds (HFES)
- Cognitive ergonomics: Application of cognitive science and its methods to design (HEB)
- Cognitive engineering (narrow definition): “The multidisciplinary area of research that is concerned with the analysis, design, and evaluation of complex sociotechnical systems” (Vincente, 1999) a form of work analysis based on cognitive constraints

More Definitions

- User Interface: all aspects of the relationship between a product or service and the end user
- User-system dialog: the exchange of messages and commands between the end-user and a product or service
- User Experience - Useful, usable, and aesthetic
  - beyond the user interface, the user experience includes product support, setup, customer service, documentation, installation, etc.
  - beyond just usability, experience has aesthetic aspects and has a dim
  - usefulness: the fit with the needs and tasks of the user

Multidisciplinary Approach to HCI

- Ergonomics and human factors - anthropometrics, human performance
- Cognitive psychology - human behavior and mental processes
- Social psychology, sociology - behavior in social context, social impact and communication afforded by computer technology, CSCW
- Organizational psychology - applied social psychology to business issues
- Anthropology - long-term ethnographic observations of consumers
- Linguistics
- Computer science and artificial intelligence
- Engineering and design - design process, software engineering

Observations on Technology

- Don Norman (1988) The psychology of everyday things.
- *Visibility* - show what part operates and how, appropriate cues and feedback
- *Mapping* - relation between controls (user actions) and results (system behavior)
  - *Natural mappings* - are immediately apparent to the user
- *Affordance* - perceived and actual properties of a artifact (system, device), properties which suggest how a thing is used
- *Conceptual model* - human's mental model of a device which is used to 'simulate' the behavior of the system - problems occur when users mental models do not match the actual system

Norman's Seven Principles

1. Use both knowledge in the world and knowledge in the head (models, manuals)
2. Simplify the structure of tasks
3. Make things visible: bridge the gulfs of execution and evaluation
4. Get the mappings right
5. Exploit the power of constraints, both natural and artificial
6. Design for error
7. When all else fails, standardize

What is "Usability"?

- Usability: The degree to which a product or service is easy to use, easy to learn, and optimized for efficiency
- ISO 9241-11 "Guidance on Usability"
  - Extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction
  - Effectiveness - Accuracy and completeness with which users achieve specified goals
  - Efficiency - Resources expended in relation to the accuracy and completeness with which users achieve goals
  - Satisfaction - Freedom from discomfort, and positive attitudes towards the user of the product