6.S196 / PPAT: Principles and Practice of Assistive Technology

Today: System Model, System Thinking for Assistive Technology [C&H Ch. 2]

Monday, 10 Sept. 2012
Prof. Seth Teller

Administrative Issue: Lab Schedule

- Please fill out circulating schedule chart with your name and availability for lab
- We may adjust lab times, if this will enable participation or team formation for some – without breaking anyone else’s schedule!
Today

• System models
  – Material drawn from C&H Ch. 2 and citations

• System thinking
  – Abstraction, specification, interfaces

• Lab (today from 3-5pm in 32-044)
  – Wheeled mobility and accessibility

Assistive Technology System

• Assistive technology:
  – A device facilitating performance of some task or activity in some context

• Assistive technology system view:
  – Assistive technology device
  – Human operator
  – Functional activity
  – All of which occur in some context
  – ... with human performance our key focus!
Case study: Marion

- Device?
- Operator?
- Activity?
- Context?
- Performance?
  - Qualitative?
  - Quantitative?

HAAT Model

- Someone doing something, somewhere, involving the use of an assistive technology
Abstraction

• Representation of some functional element in terms of its semantics or behavior, but without regard to its implementation
• Abstraction frames some set of details that are relevant from a specific perspective
• Key ideas: modularity, interfaces, means of combination, multiple levels of abstraction, hierarchy, architecture, implementation
• For more, see 6.00, 6.01, 6.02, 6.004, 6.033, ...

The Activity

• Daily living
  – Self-care, mobility, communication ...
• Work/productivity
  – Home, work, education ...
• Play/leisure
  – Self-expression, enjoyment ...
• Categories may overlap (as usual)
Tasks: Elements of Activities

• Activities can be broken down into tasks
• Individuals use their skills and abilities to complete tasks for functional outcomes
• Skills may require physical, cognitive or emotional abilities for completion
• Task selection or sequencing (i.e., means of combination) may also be necessary
• When an individual cannot complete a task, manner of completing task must change

Human Abilities

• Physical
  – Strength, dexterity, range of motion, balance
• Cognitive
  – Attention, judgment, problem solving, concentration, alertness
  – C&H view sensing as a subset of cognition
• Affective
  – Emotional elements (motivation, confidence...)
• ATP must understand, then match, the human’s abilities to the technology, to prevent... what?
Output-centric Perspective

- Goals accomplished through *motor outputs*
  - Communication, mobility, manipulation
  - Each requires *motor skills, sensory function, and information processing*

- AT can replace or augment each of these:
  - Motor skills (examples?)
  - Sensory function (examples?)
  - Information processing (examples?)

- Psychological *affect* influences performance
  - Motivation, self-efficacy, perceived activity value

Other Concepts (C&H Ch. 2)

- Abilities and skills
  - Skill development over time, transfer across tasks

- Performance and learning
  - Routinization of frequent motor sequences
  - Change in character of AT usage over time

- Strategies to enhance AT functionality
  - Highly dependent on context (how?)
The Context

• Difficulties arise as much from the environment as from the impairment!
• Barriers
  – Physical
  – Social/attitudinal
• ICF participation
  – Problem w/the environment
• HAAT model captures these factors as context

Multiple Contexts

• Physical
  – Natural and built surroundings; affordances
• Social
  – Stigmatization; expectations; assistance sources
• Cultural
  – Learned group patterns of behavior, interaction
• Institutional
  – Laws, policies, processes, procedures, religion
• Contextual supports/barriers key to AT dev’t
Marion’s Communication

- Give relevant aspects for each type of context; are they supports or barriers?
  - Physical
  - Social
  - Cultural
  - Institutional

Assistive Technology Elements

- Activity output
- Human interface
- Environmental interface
- Functional mechanism (C&H’s “processor”)
- AT sometimes called extrinsic enablers:
  - “Basis by which human performance is improved in the presence of disability”
Activity Output

• Communication
  – Transmission of information, mental states
• Mobility
  – Moving one’s body from place to place
• Manipulation
  – Special purpose vs. general purpose
• Cognitive activities
  – Memory aids, information access
• Higher-level activities
  – Abstraction! Example?

Human-Technology Interface

• Transmission of forces and information from human to device, and device to human
• Key design idea: the use of assistive technology “adapt[s] the skills required for the task to those of the human”
• Control interfaces (head/mouth/tongue/eyelid/eyebrow/hand/finger motion, sip&puff, neural)
• Display (visual, auditory, tactile, electrical)
Environmental Interface

• Link between device and external world
• Visual
  – Cameras
• Auditory
  – Microphones
• Sensation of pressures and forces
  – Transducers
• Transmission of forces or torques
  – Rigid or articulated mechanical linkages

Functional Mechanism

• C&H calls this AT element the “processor”
• Component that processes data and exerts control over device’s degrees of freedom
• Often a microcontroller with ability to control supplied voltages and/or currents
  – E.g. an audio chip driving a speaker or earbud, or a motor control board with attached servos
• But: could be a simple mechanical linkage
  – E.g. a reacher with handle, extension, gripper
Utility of HAAT Model

• For existing technology:
  – Selection
  – Configuration

• For development of new technology:
  – Research
  – Design
  – Implementation

• For either new or existing technology
  – Evaluation

Applying the HAAT Model

• Activity analysis and definition
• User perspective
• Environment characteristics
• Technology selection
• Function allocation
Activity Analysis and Definition

• What does activity mean to the individual?
  – Predictor of acceptance of alternate means
• What adaptations to activity are acceptable?
  – How it is completed
  – Who does it
  – When and how frequently it is undertaken
  – Stopping the activity
  – Substitution of one activity for another
• Key inquiry: identification of task demands
  – Physical, cognitive or affective skills or behaviors required for successful performance of activity

User Perspective

• User’s attributes, perceptions, preferences
• Individual choice
  – Which activities are important?
  – Perform alone, with AT, or with help from others?
  – How to adapt an activity?
  – Which assistive technology to use?
  – Connection to self-efficacy
• Constraints imposed by operational context
  – Connection to caregiver availability and skills
Environment Characteristics

• Single vs. multi-environment use?
  – May require portability, flexibility, configuration
  – Range of temperature, light/sound levels etc.
  – Differences in performance across settings?
  – Institutional policies? Access to technology?

• Setup and configuration
  – Complexity can conflict with portability

• Funding
  – Some schemes dictate setting (home, work)

Technology Selection

• Phenomenon of device *abandonment*:
  – Simple AT less likely to be abandoned by user
  – But: simplicity can force complexity elsewhere

• General premise
  – Develop/select AT that is as simple as possible while still meeting the client’s needs
  – But: may conflict with efficient development
Function Allocation

- Comparison/leftover task allocation:
  - Assign to human/device/aide based on skills
- Economic allocation
  - Compare aide training and payment to AT cost
  - Outcome depends on expected duration of use
- Flexible allocation
  - Client varies participation based on task, skills
  - As skills grow, AT role grows, aide role changes

Coming Up

- This afternoon's lab: wheeled mobility exercise
  - Meet in 32-044 at 3pm; departures starting ~315pm
- Wednesday lecture
  - The Human User
- Wednesday lab:
  - Reflection on mobility exercise (~1 hour)
  - Team formation and client matching (~1 hour)
- Reading for next week
  - C&H Ch. 2
- Monday lecture
  - Prof. Miller, Ethics