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

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

Monday, 12 Sept. 2011
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 exercise

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?

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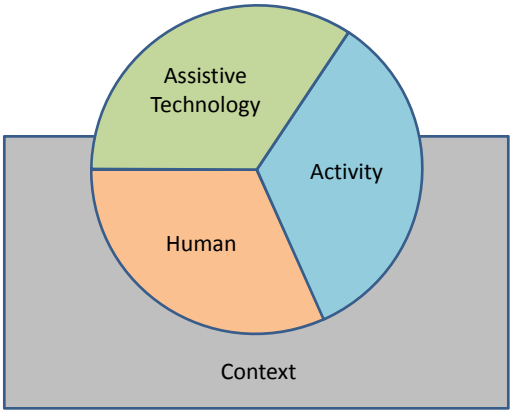
HAAT Model

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

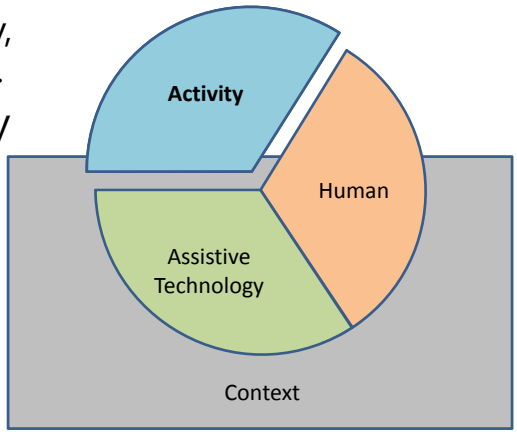


Abstraction

- 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 concepts: interfaces, combination, multiple levels of abstraction, hierarchy
- For more, see 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)

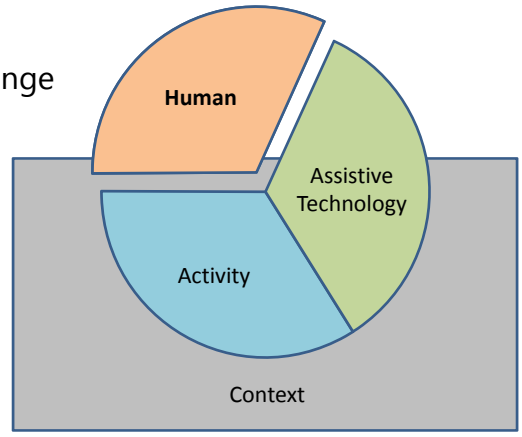


Tasks: Elements of Activities

- 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

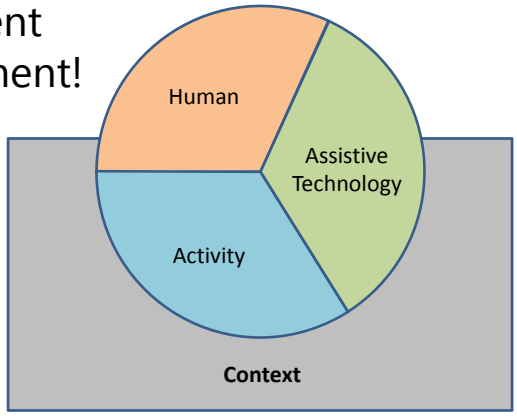
- Goals accomplished through *motor outputs*
  - Communication, mobility, manipulation
  - Each requires *motor skills, sensory function*, and *information processing*
- AT can replace or augment each of these:
  - Motor skills (examples?)
  - Sensory function (examples?)
  - Information processing (examples?)
- 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

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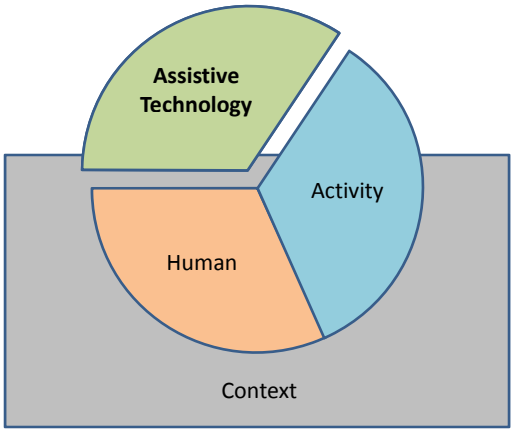
Assistive Technology Elements

- 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

- Device abandonment phenomenon:
  - 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; groups depart at 315pm
- Wednesday lecture
  - MIT Assistive Technology Information Center (ATIC)
- Wednesday lab:
  - Reflection on mobility exercise (~1 hour)
  - Team formation and client matching (~1 hour)
- Friday lecture:
  - Prof. Miller on user analysis and contextual inquiry
- Reading for next week
  - C&H Ch. 2