

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

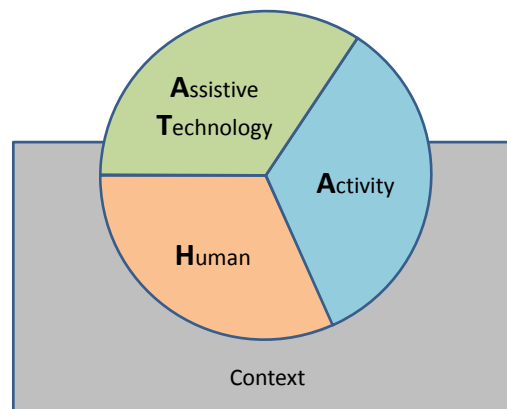
- Device?
- Operator?
- Activity?
- Context?
- Performance?
 - Qualitative?
 - Quantitative?



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HAAT Model

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

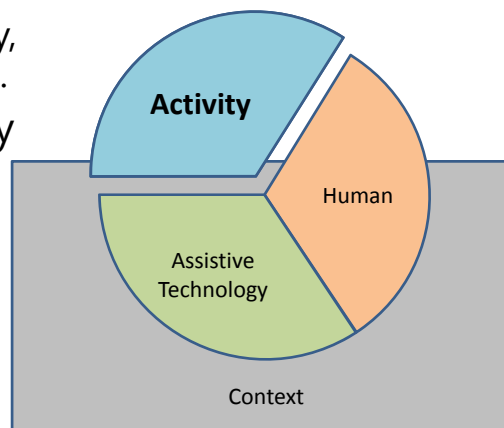


Abstraction

- 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 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)

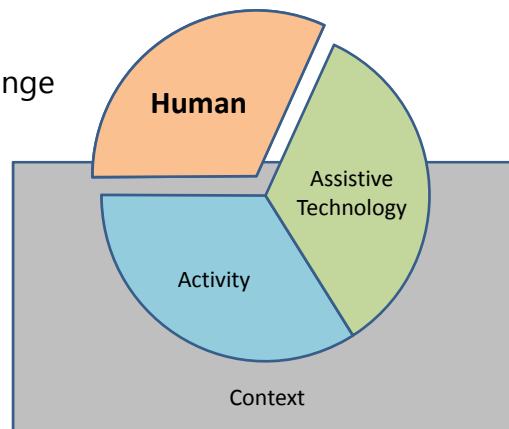


Tasks: Elements of Activities

- 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

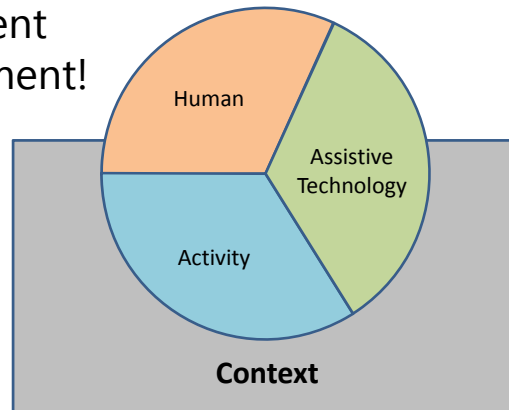
- Goals accomplished through *motor outputs*
 - Communication, mobility, manipulation
 - Each requires *motor skills, sensory function, and information processing*
- AT can replace or augment each of these:
 - Motor skills (examples?)
 - Sensory function (examples?)
 - Information processing (examples?)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

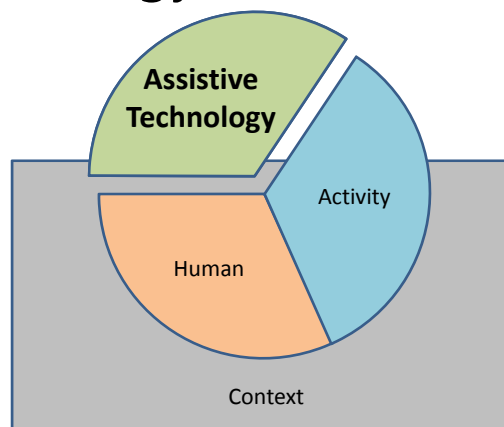
Marion's Communication

- 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