Humans in Complex Systems

Domain analysis and task analysis

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Formative analyses

- Vicente presents a structure for how to conduct a formative analysis. It contains four steps
  1. Identify conceptual differences
  2. Develop a set of methods
  3. Model the intrinsic constraints
  4. Go from analysis to design

Conceptual differences

- The first step in the formative analysis of socio-technical systems identifies five different conceptual levels
  - Work domain
  - Control- and sub-tasks
  - Operators strategies
  - Work organization and team-work
  - General cognitive characteristics and domain-specific competence and expertise
Work domains: Examples

- Nuclear power plant: Forsmark 1
- Train traffic control: TCC + District
- Train driving: Train + Route
- Paper mill (paper): Paper Machine
- Paper mill (pulp): Bleaching
- Air control: ATCC + Airspace
- Intensive care: Patients + Medical-technical equipment

Control tasks: Examples

- Train traffic control: Manage unexpected conflicts
- Train driving: Approaching a platform
- Paper mill: Re-start after sudden shut-down
- Air control: Each air-crafts planned route approaching the air-port
- Intensive care: New specimen every hour
- Office work: Register new customer

The order of the analyses

Ecological
- Work domain design
- Control tasks and sub-tasks
  - Strategies
  - Organizational aspects
  - Operators’ expertise

Cognitive
Consequences for design

- Work domain analyses
  - Sensors, models, databases
- Control task analyses
  - Procedures, instructions, (level of automation?)
- Analyses of strategies
  - Dialogues, process interfaces, large screen displays
- Organizational analyses
  - Roles and responsibility, flow of communication, level of automation
- Analyses of the operators expertise
  - Selection, training, some interface design

Todays lecture

- Chpt. 7 Domain analysis
  - Analyses of the domain in terms of objects and functional purposes
- Chpt. 8 Task analysis
  - Analyses of tasks and observable as well as cognitive actions

Model tool AH-DH 1

- Abstraction-hierarchy (AH)
  - Five levels of means-end relations
  - From overall, functional, purpose to physical form and characteristics
- Decomposition-hierarchy (DH)
  - From the complete system to small components
Model tool AH-DH 2

- The tool is a problem space onto which you can describe actions from verbal protocols
- The verbal protocols give us information about the operators cognitive states in different situations
- The problem space is a “map” onto which we can situate the cognitive states

More about AH

- Systems for process surveillance often need five abstraction levels
- Other types of systems may need other types and numbers of abstraction levels

AH in process surveillance

- Functional purpose
  - Purpose behind the system design
- Abstract functions
  - The causal structure of the process
- General functions
  - The main functions you are aiming for
- Physical functions
  - Components and couplings and their behavior
- Physical form
  - Design and form of components and couplings
AH in process surveillance

- Functional purpose
  - Deliver the right temperature, maintain a certain volume, deliver with certain quality etc.
- Abstract functions
  - Expressed in mass, energy, value, information etc.
- General functions
  - Expressed in flow/time unit, existing volume, capacity, speed etc.
- Physical functions
  - Parameter values, configurable parts
- Physical form
  - Place, wear & tear, size etc.

Domain analysis AH-DH

1. Draw a boundary to delimit the work domain of interest
2. Use matrix diagram for AH-DH as an overview
3. Start with DH. Describe the whole system and its parts
4. Verify DH with questions about level relations
5. Develop AH. Start with top and bottom levels, continue with middle levels, don’t mix with DH!
6. Remember differences between action means-ends and structural means-ends. AH is only about the latter
7. All nodes at the same AH-level must have the same modeling language
8. Evaluate all nodes in whole AH with relation questions
9. Make sure there are only whole-parts and means-ends relations in AH-DH, do not mix them
10. Remember what movements in the matrix means
11. Prepare for an iterative process
12. Compare with other AH-DH analyses

Task analysis

- The work domain is important.....
- ..... but in order to find out what to do, it is not enough
- Next conceptual level is task analyses
- This level deals with actions, not structure
Decision ladder 1

- Rasmussen’s decision ladder is a model tool for analyzing tasks
- The decision ladder identifies the types of actions that must be conducted
- The decision ladder means identification of flexible working styles
- The decision ladder is adapted to well known cognitive levels within humans

Decision ladder vs AH-DH

- AH-DH
  - Work domain analysis
  - The system that activities will be directed towards
  - Must handle all situations
  - Structural means-ends analyses

- Decision ladder
  - Task analysis
  - Activities that the system must handle
  - Goal-directed situations
  - Action-directed means-ends analyses