Humans in Complex Systems
Analyses of strategies and domain-specific knowledge
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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
Data and conceptual levels

- Data collecting methods
  - Video analyses
  - Verbal protocols
  - Logging of interaction & activities
  - Questionnaires and interviews
- Same data on different conceptual levels
  - Domain-, task-, & strategy analyses

The order of the analyses

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

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
Strategies 1

- AH-DH is used to conduct analyses of a certain work domain, a map of the object
- Decision ladder is used to conduct analyses of control tasks, what to do within the domain
- The tools for analyses of operators strategies are information flow maps, how the control tasks are executed

Strategies 2

- An important result from studies of how operators work is that they use different strategies depending on the size of the work strain/overload
- Maps of information flows is used to identify different types of diagnostic search strategies

Search strategies 1

- Topographic search
  - The use of an idealized process representation to generate different types of trouble shooting alternatives
  - Is based on models of normal function and the physical process as such
Strategies at Forsmark

High-speed ferries

Design of test bed
Strategy and time

Search strategies 2
- Symptomatic search
  - The point of departure here is the information content in different observation reports
  - Three different types of symptomatic search strategies
    - Pattern recognition
    - Decision tables
    - Hypotheses-and-test

Traffic control strategies
The new control strategy

- Train Traffic Controllers
- Re-Planner role
- Executor role

- Decision Support System/plan verification
- Operator/Process Interface
- Time-Distance diagram
- Track diagram

- Real-Time Data Base
- Traffic Plan
- Process Status

- Train Traffic Process

The new interface

- Presents dynamic traffic data:
  - Operator has always “full control”
  - Supports situation awareness
- Support planning ahead
- Early detection of conflicts
- Visualize possible solutions
- Integrated information presentation
- Minimize cognitive load
Search strategies 3

- Strategies are independent from the observer/actor
- Design that supports the operators
  - Realize that operators generate spontaneous strategies from case to case
  - Replace cognitive demanding strategies
  - Enhance and augment the use of adaptive strategies
- Realize the fact that the operators must be in charge, be "in-the-loop", and have situation awareness
- The operators must be able to switch between different strategies when the situation changes

Tool for strategies?

Tool for strategies!
Intensive care
Conclusions chpt. 9

- Maps of information flows are not descriptions of cognitive activities, but idealized categories of task procedures
- Information flow maps are based on context-specific contents

Rasmussen’s SRK-model

- Decision-making at two levels
  - General human characteristics in terms of abilities and limitations
    - Working memory limitations affect the ability to browse among process pictures
  - Domain-specific competence in terms of expertise within a certain domain
    - Train-drivers must have route-knowledge in order to stop smoothly at the platform
### SRK: Knowledge

- **Problem space = mental models**
  - Whole-parts relations
  - Means-ends relations
  - Causal relations
- **Process-rules in terms of:**
  - Rules of thumb
  - Model development
  - Transformation of models
  - Matching between abstraction levels
  - Cognitive walk-throughs

### SRK: Rules

- **Problem space = implicit rules**
  - Rules in terms of matching between impressions and actions
  - Action-response models (implicit)
- **Process-rules in terms of:**
  - Situation-based rules (if-then)
  - Actions directed toward physical or symbolic objects in the work context

### SRK: Skills

- **Problem space = internal dynamic models about closest surrounding**
  - Closest surrounding and the own body
- **Process-rules in terms of:**
  - Not relevant here, behavior is controlled by fluctuations in the nervous system
**SRK: Levels of signals**

- Knowledge level – Symbols are the units on which knowledge-based behavior is based
- Rule level – Signs lead to rule-based behavior, if-then situations
- Skill-level – Signals lead to automated actions, pattern-matching

**SRK: Supports expertise**

- The advantage with the SRK-model is that it gives possibilities to design dialogues and process pictures with the level of expertise in mind
- This is especially important in contexts where domain-specific knowledge is a precondition for a decision adapted to the context and situation

**The operators’ design**

- Operators will always change and adjust the system interface in order to make it as efficient as possible
- Some changes are permanent, indicating bad design from the beginning
- Other changes will be temporary, the use of alarm systems is an example
Conclusions chpt. 11

- General human characteristics
- Domain-specific expertise
- Organize work after a process model
  - User-centered systems design
    - Analyzing representative work tasks
    - User participation in design and evaluation of interfaces and process pictures
    - Exploring possible ways to develop work together with users
Organization & Cooperation

- For this part, Vicente uses the same analyses once again, but the focus is now on identifying responsibility and roles.