Humans in Complex Systems
Normative and descriptive analyses
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Conclusions chpt. 1
- Socio-technical systems
  - Different groups of users
  - Deficiencies in goal-related effectiveness
  - Overconfidence in the technological development
- Vicente’s message:
  - More focus on goal-related effectiveness!
  - The operator is an expert!
  - Self-control and autonomy are important!
  - Design for unexpected events!

The CWA-framework

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Conclusions chpt. 2

- Socio-technical analyses
  - The traditional, cognitive perspective
    - The cognitive characteristics are the main issue!
  - The new, ecological perspective
    - The contextual contingencies first!
- Vicente's strategy:
  1. The contextual characteristics should be dealt with first
  2. Also considering cognitive characteristics

Inferences

- Operators and users have to make conclusions and decisions from inferences
- Three contextual characteristics that are particularly difficult to handle:
  - Complexity
  - Dynamics
  - Non-transparency

A complex context
A dynamic context

A non-transparent context

Task analyses

- Normative models
  - How must the system interaction work?
  - What procedures and rules do we need?

- Descriptive models
  - How does the interaction work in practice?
  - How can technology be adapted to the current use?

- Formative models
  - What constraints do we need to identify, in order to make the system interaction work?
  - What information must always be present?
Normative models
- The purpose is clear instructions
  - Prescribing through rules and regulations how and what an operator must do in different moments
  - Uncertainties are handled through assumptions
  - One disadvantage is that such analyses don't comply with reality
  - Humans cannot be controlled in detail

Descriptive models
- The purpose is to give an as correct picture of the work situation as possible
  - What is actually going on
  - Unique circumstances are seen as extra valuable information
  - One disadvantage is that such analyses do not reveal enough for new design
  - Resistance toward changes is common

Formative models
- The purpose is to define the constraints to consider in design cases
  - They describe structures in the context, as well as cognitive characteristics in humans, that have to be considered
  - Contexts are categorized and analyzed in terms of behavior-shaping constraints
Normative analyses 1

- Delimitation: Unexpected events cannot be anticipated
- Must always be used as a complement to other analyses
- Two different types of analyses
  - In terms of constraints
  - In terms of instructions

Normative analyses 2

- Three different levels
  - Input – Output Analyses
    - Belongs to the constraint analyses
  - Flow diagrams
    - Belongs to the instruction-based analyses
  - Flow diagrams with time stamps
    - Belongs to the instruction-based analyses

Normative analyses 3

- Important differences
  - Constraint-based models
    - The degree of freedom for the operator is greater in terms of self-control
    - Better preparations for adaptation
  - Instruction-based models
    - Detailed instructions in terms of procedures to be followed
    - The ability to handle deviations and rare problems is limited
Normative analyses 4

- More advantages with constraint-based normative models
- More opportunities for variations, which is a pre-condition for learning
- A greater independence relative to the equipment (Vicente uses the term device-independence)

Conclusions

- Instructions and procedures are possible in closed-loop systems where procedures and events are possible to anticipate and predict
- Most socio-technical systems are open-loop systems, which demands learning how to manage unexpected situations and events
- Constraint-based normative analysis models give better opportunities for adaptation and a higher degree of freedom for the operators

Train driver context
A new ATP-interface

Analogy: Map as an example

- Direction
  - Knowledge in terms of procedures
  - No problem as long as one is on the right route
  - Problems occur when you deviate from the tour

- Map
  - Knowledge in terms of overview (model)
  - Detailed instructions is missing, but the information can be acquired
  - If you get lost, you can always return to the map

Descriptive analyses 1

- Most sufficient as instruments for documenting dynamic actions and domain-specific use-cases
- Has evolved as an reaction to the normative models
- Delimitation: Not too much of support when new technology is put into practice
Descriptive analyses 2

- Examples
  - Socio-anthropological studies of the use of copy-machines showed that menus and procedures were not used at all
  - Field-studies within decision-making showed that pilots and operators did not act according to classical decision theory – they did not choose among alternatives

Descriptive analyses 3

- More examples
  - Studies within activity theory showed that the use of computers in workplaces is affected by social and cultural factors – a critique against traditional HCI
  - Studies within distributed decision making and cognition show the lonely problem-solver is a myth. Group activities with a high degree of communication are important

Descriptive analyses 4

- Two main contributions:
  - Work-descriptions from representative and real contexts are valuable contributions when it comes to understand the work practices
  - Conclusions are general across several application domains
Common things

- Context-contingent variation is important for the learning process
- Work has often a stronger social profile than anticipated by designers
- Longer periods of analytical problem solving is not very common
- History and culture affect work
- Operators develop efficient strategies and methods in order to avoid cumbersome cognitive strain

Disadvantages

- Still, Vicente claims that descriptive analyses is not enough
  - There is always new ways to explore and change the way you work in order to develop work in a more efficient way
  - Descriptive analyses will not reveal these potentials
  - Current practice is stuck with current technology!

Conclusions

- Descriptive analyses contribute a lot in terms of realistic conceptions about the role of the work context
- The problem is that the intrinsic constraints for the work to be done cannot be revealed until you get rid of current technology
Prototypes / Iterations

Main idea:

- Using prototypes for fast and efficient evaluation of design concepts through an iterative design process
- A good method for successive adaptation of current work practice to new a technology/platform
Prototype: ATP-interface

Scenario-based design

Main idea:
- Using scenario for fast and efficient evaluation of design concepts through an iterative design process
- A good method for visualizing how work practice can be developed

Prototypes and scenarios

Vicente’s critic:
- Two serious delimitations:
  - The connection to the technology that is used to build the prototypes, or to visualize the scenarios, is too strong (device-dependence)
  - Too limited possibilities to test representative tasks. Difficulties in realizing what is most important
Conclusions

- Prototypes and scenarios are data-driven (bottom-up) activities, building upon induction, which means limited knowledge.
- What is needed is a conceptual strategy (top-down) that is independent from present work practice and technology.

Consequences for CWA

- Five dimensions of analyses
  - A work domain analysis in order to handle deviations and unexpected events
  - A constraint-based task analysis in order to achieve sub-goals in a flexible way
  - An analysis of efficient strategies
  - An analysis of organizational and social factors
  - An analysis of domain-specific knowledge and expertise