Humans in Complex Systems

Collecting data for the analyses

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Analysis models and data collection

Normative

Descriptive

Formative

Data collection methods

- Direct observation
- Indirect observation
- Verbal protocols
- Data logs
- Interviews
- Questionnaires
- Experiments
- Prototyping
- Participatory analysis and design
Information use in a train cabin

- What information must be presented?
- How much information can be presented in the cabin?
  - Under what circumstances?
- How shall it be presented?
- How is the information used in practice?

Direct observation

- We traveled with different kinds of trains, cabins, routes and drivers
  - Purpose: to get a representative picture of the train-driving task
  - Goal: to identify specific situations to study in more detail
  - Method: to travel with the drivers, ask questions, taking notes
**Indirect observation**
- Video-recording with three cameras
  - Purpose: documenting in detail different tasks conducted in the cabin
  - Goal: descriptions of work tasks that we could use later on for more detailed analyses
- Methods:
  - Recording of different routes / cabins
  - Editing the material – create raw data

**Verbal protocols**
- Drivers and colleagues comment their own and others driving
  - Purpose: to gain understanding of what the drivers are doing in different situations
  - Goal: descriptions of strategies and action-patterns that can be interpreted in relation to goals and sub-goals
- Methods:
  - Retrospective verbalization
  - Concurrent verbalization
  - Collegial verbalization

**Data logs**
- Logging the interaction with the ATP-system
  - Purpose: to control what the drivers actually did in terms of actions and activities
  - Goal: an objective picture of actions
  - Method: use of existing ATP-logging equipment
Interviews

- Follow-up interviews - the drivers explain what they are doing
  - Purpose: to get the complete picture of the working tasks
  - Goal: to get explanations of situations and events that are hard to understand
  - Methods
    - Open interviews
    - Structured interviews, specific queries

Questionnaires

- A large amount of drivers participated in a parallel questionnaire study
  - Purpose: to gain basic data about the drivers knowledge, behaviors and attitudes about the current system and the train-driving task
  - Goal: a survey of the general system knowledge that the drivers have of the system
  - Methods:
    - Questionnaires with:
      - Open alternatives
      - Settled alternatives

Experiments

- Controllable studies of existing and new train-driver interfaces
  - Purpose: elaborate measurements and investigations about different forms of interactions
  - Goal: to investigate if suggested changes have the expected effects
  - Method: Experiments with control conditions
For who are the results valid?

... or professional users?

Students acting as subjects in the experiments ....

Prototyping

Our model of analysis

To control a dynamic system, you need:

• goal (G)
• model (M)
• controllability (C)
• observability (O)

Goal
Model
Control
Observation
Process
Observation
### Problem formulation

The general purpose of the analyses is to reveal:

- How do users and operators transform goals and develop models as function of the available observability and controllability of the current system, and;
- How can observability and controllability be enhanced and augmented so that users and operators can explore and learn about the system.

### Drivers goals & models

**Goals**
- Drive safely
- Passengers
- Staff on train
- Staff along tracks
- Keep the time
- Drive smoothly
- Save energy

**Models**
- Route knowledge
- Knowledge about the ATP-system
- Different models for different parts of the route
- Braking models
- Slope of the tracks

### System observability and controllability

**Observability**
- Signals
- ATP-system output
- Instrument panel
- Communication with traffic control
- Communication with staff on train

**Controllability**
- Power system
- Different brake systems
- ATP-settings
- Communication with traffic control
- Communication with staff on the train