An example

- Train driving – safety barriers
- Train traffic control
- From today’s system to something new and better.

Train driving
Human error (reliability)

- Human errors:
  - Slips (e.g. wrong action)
  - Mistakes (e.g. wrong interpretation of information)
  - Violations (e.g. breaking of rules)
- If it is possible to make an error, it will happen – sooner or later!
- If somebody makes an error – who is to blame?

Barriers

- Two different approaches
  - Prevent the operator from doing wrong
  - Help the operator to act correctly (e.g. "resilience engineering")
- Technical
- Informational
- Competencies
- Organisation (Culture)

Technical barries – train protection (ATP)

- Balises in the track gives information about position, signals and max speed.
- ATP-computer calculates break curve.
- ATP-computer "takes over" if the driver do not break in time.
- The driver can not (?) drive against red or drive too fast.
- The driver manually enters train parameters.
Information barrier

Does not show decision relevant info

Train traffic control

- Today’s systems and interfaces
- A new control strategy
- Future operator interfaces
- Implementation of a new system

A traffic control centre
Today’s control system

The graph
The problems.....

- Lack of overview
- Many separated information systems
- Focus on control of the technical infrastructure, not on the traffic
- Conflicts and disturbances are detected too late
- Lack of precision in data
- Observability problems, data missing
- Controllability problems, timing of actions
- Complexity induced by autonomous automatic functions
- Time consuming communication with train drivers
- Dispatchers lack efficient support when this is most needed!!

Domain and user analysis

- The analysis was based on many observations and interviews
- The GMOC model was used to describe, analyse and design
- Active work groups of skilled professionals supported the work
- Ideas and prototypes were developed iteratively.

GMOC analysis

- Goals...
- Models....
- Observability....
- Controllability....
A new control strategy

- Traffic control through real-time re-planning of a traffic plan
- Automatic execution of the continuously updated traffic plan
- A complete plan from start to stop
- Possibilities to optimize better
- Manual execution when necessary
- Automatic functions are made predictable
  - Can not change track usage or train order
- Improved communication between trains and control centres, train drivers are made aware of the plan
- Better information to passengers

The new control strategy

- Presents dynamic traffic data
- the operator is always “in full control”
- supports “situation awareness”
- Supports planning tasks
- Supports early detection of conflicts
- Shows possible solutions
- Integrated information presentation
**Design of systems and interfaces in process control**

- Control systems and operator interfaces must support efficiency, safety, a good work environment etc.
- I.e. they must have a high *usability* for the operators.

**Interface design principles**

- Interface design can not be separated from design of control strategies
- Design for skilled users and high efficiency
- Support control by awareness
  - Show dynamic information
  - Support understanding of the process
  - Support building mental models
- Efficient visualisation and interaction
  - Support overview
  - Show information simultaneously
  - Show much information!!
  - Efficient information coding
  - Minimize input activities
- Make the design complete, minimize manipulation
- Make it error tolerant, allow experiments
- Supportive alarms

**Time-Distance diagram**

(re-planning tool)

- **Actual Plan:**
  - Time Table
  - Track Usage
- **Prediction**
  - Deviation
  - Conflict detection
- **Plan verification and test**

**Track Diagram**

- line, station, track, train;
- track usage, train routes,
- actual position; track work

**History, time distance graph**

- Train information

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Dept of Information Technology

Human-Computer Interaction

http://www.it.uu.se/research/hci/
Prototype environment at Uppsala University

Operator environment
The interface is generated by projectors.

Image and sound is recorded during experiments...

For later analysis...

Detection of conflicts

Station track conflict

Line track conflict
Re-planning in the graph

- Available tracks and track usage
- Planned graph for selected train
- Departure time, track usage etc can easily be changed here
**STEG, an operational test system**

- A “sharp” implementation in order to test and evaluate the concepts in a real traffic control centre.
- To obtain knowledge for decisions about future national control systems (STRATEG).
- Developed in close collaboration between researchers, the rail administration and developers.

**The test traffic area**

**The workplace**
From research to implementation

- The importance of a solid knowledge base
- The close collaboration between researchers and the rail administration
- The user centred approach
- Collaboration in all phases (research, specifications, development, deployment, evaluation)
- Focus on efficiency and work environment