Train traffic research
Uppsala University
Human-Computer Interaction
Bengt Sandblad
Arne W Andersson

http://www.it.uu.se/research/project/ftts/

About train traffic systems....

A traffic control centre
Another traffic control centre

and another....

The time-distance graph
The graph

Communication and cooperation

A complex organisation
Research background

- Human perception and cognition
- Human-Computer Interaction
- User interface design (usability)
- Human control of complex systems
- Situation awareness
- Automation problems
- Human error and barriers
- Human decision-making
- User centered development

FTTS - What are we studying?

- Analysis of today’s train traffic control strategies, tasks and technology
  - Many detailed interviews and observations
  - Analysis based on the GMOC model
- New high level control strategies
- “From (infrastructure) control to (traffic re-) planning”
- Need for new:
  - user interfaces
  - automatic support systems
  - decision support systems

Today’s control system
The problems.....

- Lack of overview
- 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
- Complexity induced by autonomous automatic functions
- Time consuming communication with train drivers
- *Dispatchers lack efficient support when this is most needed!!*

A new control strategy

- Traffic control through real-time *re-planning* of a *traffic plan*
- Automatic execution of the continuously updated traffic plan
- Manual execution when necessary
- Automatic functions are made predictable
  - Can not change track usage or train order
- Improved communication between trains and control centres

“Vision work” and active workgroups

- We have continuously cooperated with a group of experienced traffic controllers
- Ideas as well as evaluation have been developed in interaction with the group
- They had never been able to reach this result on their own.
- We had never been able to do so either!
The new control strategy

- A complex environment - Drivers
- Re-Planner role
- Executor role
- Decision Support System/plan verification
  - Operator-Process Interface
  - Time-Distance diagram
  - Track diagram

Future Train Traffic Control

- Executor function
  - Manual
  - Automatic
- Real-Time Data Base
  - Traffic Plan
  - Process Status
- Train Traffic Process

The new user interface

- 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

The new control strategy

Future Train Traffic Control

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
Prototype environment at Uppsala University

Operator environment

The interface is generated by projectors.

Image and sound is recorded during experiments...

...for later analysis...

...together with a software-recording of the user interface interaction.

Planning view

Track maintenance

Present time

History

Track diagram

Re-planning in the graph

Re-planning is made directly in the graph

Available tracks

Track usage

Planned graph for selected train

Departure time and track usage can be changed
Prototypes

- Overview of the interactive computer based graph

Steg user interface - example

New traffic plan
STEGER Background

STEGER – control by planning in a computerized time-distance graph.

- A "sharp" implementation in order to test the concepts in a real traffic control centre environment.
- The complexity of the real work situation can not be generated in a laboratory environment.
- A completely new role as "real-time re-planner" is introduced.
- To evaluate the concept.
- To obtain knowledge for future decisions about new national control systems.

STEGER Objectives

- To obtain knowledge for future decisions about new national control systems.
- To evaluate
  - Work procedures and control principles
  - Functionality and algorithms
  - User interface and interaction
  - Technical requirements and specifications
  - Risks
  - Cost benefit analysis

From research to implementation - Reflections

- 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
Steg user interface - example

The test workplace

The workplace (vision angles)
Evaluation of STEG

- Basic concept, control by re-planning in real time and automatic execution of the traffic plans, is working in practice and is accepted by the traffic planners.
- Some problems and obstacles:
  - Technical errors in old interlocking systems
  - Lacking information in the interface
  - Lacking integration with the ordinary traffic control
- Ongoing evaluation procedures:
  - Data analysis, observations, interviews, questionnaires and video recordings
- Remaining design and implementation questions
  - Train speed and position.
  - Communication with train drivers.

More information about our research can be found at:

http://www.it.uu.se/research/project/ftts