AUTOMATED FUNCTIONS IN TRAIN TRAFFIC CONTROL - PROBLEMS AND SOLUTIONS

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Agenda

- What is train traffic control (TTC)?
- Automation in TTC
- Automation problems
  - General
  - In TTC
- Non-autonomous automated systems
- Tests and experiences in Swedish TTC
Train traffic control in Sweden

- 8 regional traffic control centres
- Swedish Railway Administration
- Many traffic operators (~60)
- Total track 11 904 km
  - Single 8 099 km
  - Double and more 3 805 km

A traffic control centre today
Automated systems

- Automated systems are common and necessary.
- Different types, e.g.
  - In switchboxes
  - Inside the control system
  - In separate systems
- Different functionality, e.g.
  - Based on train identification
  - Based on time-tables
  - First in – first served

What is automation?

Purpose:
- "To achieve a proper relationship and distribution between the behaviour and tasks of the technology and the human operator"

Strategy:
- "Replacement of human labor (physical or mental)"
Proper relationship?

- MABA-MABA........
  - (Men/Machines are better at...)

- Degree of automation

| Human must do all | Machine ignores the human |

Proper relationship?

Authority?

- Who is in charge?
- Does the human operator know what is going on?
- Can/shall the system ”take over”?
  - Can be good and necessary
  - Can cause incidents and accidents
Problems with automation

Situation awareness requires that the operator can
- Observe (past/present status)
- Comprehend (past/present status)
- Project (future status)

Automated functions can reduce situation awareness and cause automation surprises.

Problems with automation

- Designing automated functions requires a complete model of the system to be controlled.

- Very complex and dynamic systems are often underspecified.
- I.e. automated functions can (sometimes or often) be incorrect or inappropriate.
Problems with automation

- In order to be in-the-loop and have full control, the human operator often turns the automated functions off.
- This is common in disturbed and problematic situations, i.e. when help is most needed.

"The irony of automation"

Decision support systems

- DSS can be considered as automated systems
- Different types, e.g.
  - Optimizing algorithms for optimal solutions to traffic conflicts
  - Supply the operator with decision relevant information
- Different modes, e.g.
  - Suggest solutions
  - Executes with or without informing operator
Automation in Train Traffic Control

- The work (dispatching, control) is very complex
- The human operator must be supported
- But how?

Automation in TTC today

- There are many problems related to automation, e.g.
  - Automated systems are often turned off in order to obtain full control (avoid surprises)
  - Decision support is not used, because of incomplete models, lack of transparency, time etc.
A new approach

- The human operator (traffic controller, dispatcher) must be supported, otherwise the tasks are impossible
- Efficient support without disturbing
- Support when it is most needed
- Let the human operator always
  - be focused on the most important
  - be "in-the-loop"

Autonomy

- Autonomous automates
  - Act independently and can change the operator’s plan
  - Decision is inseparable from execution

- Non-autonomous automates
  - Only execute what is planned, actions are always transparent
  - Decision is separated from execution
    - Decision at one time
    - Execute when appropriate
A new control strategy

- Traffic control through real-time *re-planning* of a *traffic plan*

- Automatic execution of the continuously updated traffic plan
  (AEF=Automatic Execution Function)

- Automated functions are made completely predictable, by being non-autonomous
**The new user interface**

- Supports situation awareness
  - Dynamic traffic data
- Automated functions can never change the plan
  - The AEF only executes exactly what is planned (non-autonomous)
- Decision support
  - Detect and show conflicts
  - Show possible solutions

**Detection of conflicts**

Station track conflict

Line track conflict
Display of automation (AEF) aspects

Indicates the actions of the AEF

Status of the AEF for each station (of/off)

AEF turned off at one station
Conclusions

Evaluation of 9 months of operative tests shows that:

- Non-autonomous systems support the human operator in all situations
- There are no "surprises" or uncertainties
- The human operator can focus on solving conflicts and plan traffic
- The Automatic Execution Function (AEF) executes the plan when appropriate
- If there are remaining conflicts the plan is not executed
- The interface shows what the AEF is doing and when

Conclusions

- Using non-autonomous systems we can reach a high degree of automation without problems
- Using autonomous systems even a low degree of automation will cause problems
- Automating decisions does not work in practice
- Supporting decision making by improved information will increase efficiency
More information about our research can be found at:

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