IT-systems and Human Factors

Situation awareness

Humans and automation

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Agenda

- Human control of complex dynamic systems
  - Control work, Operators, examples
- Situation awareness
- Humans and automation
- Some examples
Some examples of complex dynamic control situations

- What is “complex”?
- What is “dynamic”?
- What is “human control”?
Train traffic control
Train traffic control
Train drivers
HSC ship control
Other examples

Forest harvesters
Other examples

Stone crushers
More examples....
Are there problems?

- Systems are complex and dynamic.
- Control is indirect, via a control system and an interface.
- Demands are high (speed, accuracy, quality, safety, ...).
- Control systems and operator interfaces sometimes provide inadequate support.
- Operator performance not always satisfying (optimality, errors...).
- Work environment problems.
- More.....
Situation awareness

- Situation awareness (SA) – to always be “in control”, “in the loop”.

Situation awareness

- Three parts:
  - *Perception* (observation)
  - *Comprehension* (understanding the significance of the information – what is going on?)
  - *Projection* (prediction, evaluation of actions – what will happen?)

- Perception means *observation*
- Comprehension means *model*
- Projection means *dynamic information and model*
SA cont.

- Examples of SA?
- Examples where we do not have SA?
Humans in complex systems
SA cont.

- Two different approaches to control:
  - Control by exception
  - Control by awareness

- An operator can not work (properly) without SA

- An operator will always try to obtain SA
  - This can, if not properly supported, be extremely cognitive demanding and lead to stress, safety problems, cognitive overload etc.
E.g.:

- Instead of static information:

  \[
  85^\circ
  \]
Show dynamic information
Humans in complex systems
Automation problems

- Automation:
  - “Mechanical or electronic replacement of human labour (physical or mental)”
Problems with automation

- Automation surprises (hinders SA)
  - Difficulties to understand, predict...

- The irony of automation
  - No help when it is most needed...

- Allocation of functions (human vs. machine)
  - MABA-MABA analysis
  - Authority dilemmas (e.g. in aviation)
“Autonomy”

The problems with automatic systems (autopilots etc). Two alternatives:

1. The **non-autonomous** automatic systems does exactly what it is told to do.

2. The **autonomous** automatic system has its own plans. This can cause severe problems!
Autonomy

- Example – operators turn the automatic system off in order to be “in control”. (Irony of automation).

- Non-autonomous systems only do exactly what they are told.

- All automatic systems should be transparent (show what they are doing).
Example:

“The correct level of automation often is the one the pilot feels the most comfortable with, depending on his/her knowledge and experience of the aircraft and systems, skills and confidence.”

(Airbus: Standard Operating Procedures Operations Golden Rules)
Air Inter A320 accident, near Strasbourg France, 20 Jan 92

- While on approach into Strasbourg, the aircraft [F-WWDP] impacted the side of a mountain. The cause of the crash was found to be a faulty design in an autopilot mode selector switch which led the flight crew to inadvertently select a 3,300 foot per minute descent rate on the approach instead of the desired 3.3 flight path angle.

- Fatalities: 87 / Occupants: 96
Air Inter A320 accident


While trying to program the angle of descent, "-3.3", into the Flight Control Unit (FCU) the crew did not notice that it was in HDG/V/S (heading/vertical speed) mode.

- The commission considers that the ergonomic design of the auto-pilot vertical modes controls could have contributed to the creation of the accident situation. It believes the design tends to increase the probability of certain errors in use, particularly during a heavy workload.

Operators need

- To be in “full control”, i.e. have a high and continuous situation awareness.
- This often means to show *much* and *dynamic* information.
Humans in complex dynamic work situations.....
Humans in complex systems 

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...need complex dynamic information
Research and experiences tell us that...

- They need much information
- They need dynamic information
- They often lack overview
- They are forced to concentrate on the *tool*, not on the *work tasks*
- They make errors
- Actions not allowed to be automated
- Cognitive “tunnel-view”
- Skills develop slowly
Research and experiences tell us that.

- Much information is not a problem – if efficiently visualized
- Bad design and visualization is often a major problem
- Visualization must support
  - development of mental models
  - automation of actions
  - pattern recognition
Evolution has made us...

- Prepared for complexity, if....
- Able to handle unlimited information in real time, if....
Visualization and design is a key factor

E.g.: from this...

To this....

How??
Information overload..

- ...comes from *too little* information!
- ...or bad visualization/design!