Design for Improved Patient Safety
Sociotechnical Systems Design and Resilience Engineering

Ida Bodin
Camilla Fröjd
Anders Jansson

Intensive care

- Communication needs
- Work distributed spatially
- Work distributed over time
- Automation failures
- Public safety
- Disturbances
- Many actors
- Cognitively demanding to interact with abstract UI's
- Presented information might be erroneous
- Poor control
Organizational safety cultures

- Emphasizing responsibility on management level
- Emphasis on blaming
- Emphasis on non-blaming
- Emphasizing individuals' responsibility

Work environment safety  Nuclear power safety
Construction safety  Environment protection
Product safety  Railway safety
Service sector safety

Maritime safety  Water protection
Traffic & Automotive safety  Fire safety
Patient safety  Fire safety
Electrical safety  Aviation safety


Agenda

- What design challenges are there, and how can we understand them from a patient safety perspective?
- What design challenges did we go for in this SPARC-project, and why?
- What is unique in our approach, and what methods do we use?
- Results from the field studies – so far
  - Sociotechnical systems design and holistic work support
  - Resilience engineering and proactive safety
- Future work
Haverikommissionen pekar på brister i hjärtintensivvården

För första gången har Statens haverikommission utrett ett dödsfall inom sjukvården. Det handlar om en kvinna som dog av ett hjärtstopp efter att ha placerats som satellitpatient på en hjärtintensivvårdsavdelning.

– Vi hade uppmärksammat att det fanns säkerhetsbrister och att det var många händelser inom sjukvården. Att det blev just dödsfallet vid Karolinska universitetssjukhuset var en tillfällighet och berodde på att fallet blev medialt uppmärksammad (Urban Kjellberg, Statens Haverikommission).

Swedish Accident Authority Report

The Authority concluded that factors at two different levels of the organization contributed to the evolvement of the accident.

• Latent errors at the blunt-end resulted in unclear instructions regarding the telemetric surveillance equipment, in turn creating uncertain conditions during transfer between divisions as well as when shifting staff. Despite the lack of clear instructions staff was forced to decide by themselves, since time did not allow consultation with colleagues or management.

• Event-related errors at the sharp-end. The staffs’ use of the telemetric surveillance equipment was not in accordance with the instructions since the alarm system resulted in a number of documented false alarms. This in turn resulted in reduced attention among staff, with the consequence that a correct alarm was rejected.

Level 1: Interaction design
Individual systems for specific tasks

“The interface I use when I interact with a specific system.”

Level 2: Sociotechnical systems design
Systems that make up the complete work environment for an individual user and the whole staff

“All the systems I use in an everyday work situation and the systems I share with my colleagues.”
Level 3: Resilience engineering

Systems on organizational level

“Me as part of a complete sociotechnical system caring for the patient”

Three human factors challenges

- **Interaction design**: Inadequate design of applications and apparatus
- **Sociotechnical systems design**: Insufficient integration of medical-technical equipment
- **Resilience engineering**: Limited follow-up on non-conformance reports
Resilience engineering – Limited or no follow-up on non-conformance reports

Sociotechnical systems design – Insufficient integration

Inadequate interaction design

SPARC – Two challenges to go for

Our approaches

CWA – Cognitive Work Analysis

GMOC – Goals, Models, Observability & Control
General method I: Cognitive Work Analysis (CWA)

Coelho, D. Manzey, A.B. Ünal, S. Röttger, and N. Merat (Eds.), Proceedings of the Human Factors and
Ergonomics Society Europe Chapter 2015 Annual Conference. ISSN 2333-4959 (online).

Work Domain Analysis (WDA)
An abstraction hierarchy

- Describing a work domain independent of tasks, actions, situations and persons
- The constraints shaping the work

(Rasmussen, 1994; Vicente, 1999)
General method II: Knowledge elicitation

Video recordings of the nurses’ work → Colleagues verbalize during video playback → Compare with other data


The first challenge
Example from train traffic control

Before

After

Decision relevant information?

No

Yes

Abstraction hierarchy

Introduction 3 interviews Observation

Subject Matter Expert A & B

Subject Matter Expert A & B

2 work shifts (dayshift & nightshift)

Data collection

Review

Modelling of the abstraction hierarchy
Abstraction hierarchy

Results
Treat, relieve symptoms, gain time for treatment & the effect of treatment

Results
How to use the results?

- The abstraction hierarchy contains information requirements and functions useful for design challenges.
- Ecological Interface Design (EID) is an approach for interface design for complex sociotechnical systems (process control, aviation, medicine).
- The goal is to make constraints and complex relationships in the work environment evident to the user - supports problem solving.

(Rasmussen & Vicente, 1989)

Ecological Interface Design

Propositional

Correspondence or Law-Driven

Analogy

Metaphor

Coherence or Intent-Driven
The second challenge

- Develop proactive safety procedures in order to enhance the organizational safety culture
- The goal is to develop a standardized method for barrier analysis and to avoid risky situations
- Develop the collegial verbalization method to discuss ‘bed-side’ work situations with nurses

### Method

**Collegial verbalization and ‘conspective’ protocols**

- Video films from “bed-side”
- Colleagues verbalize during video-playback
- Comparisons with other sources of data

- Analyses from a Human-Technology perspective, with focus on barriers

### Diagram

- Triangle with axes:
  - Goals
  - Efficiency
  - Organizational culture

- Axes:
  - Basics
  - Safety culture
  - Structure

- Other terms:
  - Norms
  - Policies
  - Ideas
  - Strategies

- Examples of situations:
  - Wrong medication to patient
  - Central Venous Catheter pulled out
  - Endotracheal Tube out of position
Method

- Collegial verbalizations in the form of ‘conspective’ protocols with nurses to be able to analyse risky events and behaviours (non-conformances)
- All together three subject matter experts (two enrolled nurses and one staff nurse)
- All together six verbalization sessions based on video-recordings from routine work tasks and situations
- This resulted in three retrospective protocols, and three ‘conspective’ protocols
- The plan is to include more situations and nurses

Preliminary results

<table>
<thead>
<tr>
<th>Categories of existing barriers</th>
<th>Technical</th>
<th>Administrative</th>
<th>Organizational</th>
<th>Staff expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveillance Systems</td>
<td>Check lists</td>
<td>Roles &amp; Responsibility</td>
<td>Monitoring equipment function and condition</td>
<td></td>
</tr>
<tr>
<td>Alarm systems and alarm levels</td>
<td>Procedures</td>
<td>Routines</td>
<td>Checking on patients’ status</td>
<td></td>
</tr>
<tr>
<td>Physical measures</td>
<td>Labelling measures</td>
<td>Collegial support</td>
<td>Overall situation assessment</td>
<td></td>
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<tr>
<td>Power supply</td>
<td>Medical protocols</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
The role of the designer is to create representations and by that facilitating for the user to carry out his/her work.

**The triadic approach to systems design**

- **Reality** → **Interface** → **User**
  - **Work Domain** → **Representation** → **Knowledge**
  - **Value** → **Interpretation**

**System and Interface Designers**

Future work

- Insufficient integration of medical-technical equipment → Application to FORTE
  - Enhanced sociotechnical systems design concept – holistic design
- Limited follow-up on non-conformance reports → Application to AFA, FORMAS
  - Collegial collaboration for proactive safety – a standardized method for barrier analysis
- Strengths
  - The bed-side perspective is unique
  - The CV-method offers unique possibilities
  - Theoretical models behind interaction design