Human and organizational factors in accident investigation and engineering practices

What are they and how can we find them?

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Who are we?

Consultancy and research in risk prevention concerning
the interaction between

• HuMans (M)
• Technologies (T)
• Organisations (O)
MTO – design for humans and usability!
MTO – influences on human behavior

**Organisation**
- Housekeeping
- Goals
- Rules and practices
- Education and training
- Communication
- Knowledge
- Psychology
- Physiology

**Technology**
- Technology and equipment
- Work environment
- Attitudes and values

**Human**
MTO – a system safety view

MTO > M + T + O
Texas City 2005

- Discussion based on the film
- Film sequence approx 15 min

- Discuss
  - What happened?
  - What were the causes?
  - Look for M, T and O
Anatomy of a Disaster

www.csb.gov
Summary – What MTO is about

• System safety view
• Knowledge on human behaviour
• Methods and tools
  – Application in **reactive** work: accident investigation
  – Application in **proactive** work: Human Factors Engineering
Human and organisational factors in accident investigation
What is wrong and why?
Why do accidents and errors occur?

- Latent failures (in different parts of the system) creates error/producing conditions
- Unsafe acts och circumstances
- Problems in the interaction between Man Technologies and Organisation
- Lack of protection; barriers/defences or existing defences being broken

OFTEN COMBINATIONS IN WELL DEFENDED SYSTEMS
Why accidents occur
(Reasons "Swiss cheese" model)

**Organisation**
- Rules and procedures
- Planning
- Training
- Communication
- Housekeeping
- Maintenance

**Technologies**
- Design
- Equipment
- Tools
- Work environment

**HuMans**
- Competence
- Knowledge of task
- Motivation
- Work satisfaction

**ACCIDENT**
Why investigate? (1)

- Organizational learning
- Safety improvements
- Help prevent the damage from happening by finding the systemic causes in order to make systematic changes
- Provide information to the part of the organization that can make safety improvements
- Make sense of what has happened in order to make safety improvements and make a collected account on what has happened
Why investigate? (2)

- Explain
- Predict, prevent
- Find safety enhancing measures
How to perform an accident investigation

• Data collection

Analyse:
• Events
• Deviations
• Causes
• Barriers
• Consequences
• Make recommendations/suggest safety enhancing measures
Parts of the analysis (1)

1) WHAT happened?

2) HOW did it happen?

3) WHY did it happen?

4) Which BARRIERS existed?
Parts of the analysis (2)

5) Possible CONSEQUENCES

6) Give RECOMMENDATIONS - to prevent recurrence

7) FOLLOW UP the recommendations

8) FEEDBACK to the involved staff
    to management
How to apply the MTO view in an investigation

• Understand the peoples actions in relation to the circumstances and the situation

• Understanding based on knowledge from the behavioural sciences

• Understand the relation to management and organisation

• Understand the relation to regulators and society
"Human error"

Events

- Human errors: 80%
- Equipment errors: 20%

Human errors

- Organisational errors: 70%
- Human errors: 30%
What is "human error"?

- Humans design, build, operate, maintain, manage and regulate all system therefore everything is "caused" by human actions
- Most actions are not "errors"
- Humans are resources within systems
- If there are no human actions – there will be no system in operation, no new building etc.
Examples of causes or error-producing factors

- Time pressure
- Sleepiness/work hours
- Poor ergonomics
- High vigilance and mental demands
- Poor training
- Problems with rules and procedures (many varieties)
Examples of causes or error-producing factors

• Work environment – untidy work place
• Problems in communication
• High workload and stress
• Problems in planning and control
• Inadequate allocation of resources
• Management
• System goals incompatible with safety
Event Schedule

Root cause → Contributing factor

Direct cause

Event 1 → Event 2 → Event 3

Normally

In this case (deviation)

Broken barrier
Examples – Accidents in all areas of industry

- Nuclear; TMI, Chernobyl
- Oil; Piper Alpha
- Sea; Zebrugge, Estonia
- Railways; Clapham Junction, Kings Cross fire, Paddington, Åsta
- Medical; Radiotherapy accidents
Swedish military flight incident
Military Flight Incident – Example

MTO analysis chart

1. Planning of flight
   - Planning does not consider weather conditions
     - Tools, procedures & competence
2. Heavier load longer duration than planned
3. Crew thinks the fuel meter value is wrong
4. Engine failure on one motor
5. No fuel in main tank
6. Landing on one engine

- Rules & procedures
- Management; monitoring and feedback processes
- Lack of tools & procedures
- Crew lack of trust in fuel indicator
- Equipment: Fuel meter had not been repaired
- Two engines
- Management; monitoring and feedback processes
- Rules & procedures
- Lack of tools & procedures
- Crew lack of trust in fuel indicator
- Engine failure on one motor
- No fuel in main tank
- Landing on one engine

Tools, procedures & competence

Equipment: Fuel meter had not been repaired

Two engines
Analys av säkerhetskulturen i Försvarmsmaktens helikopterverksamhet, 2008
Kollision mellan Gotland och Gotlandia II, 2009
Conclusion

Human and organisational factors are always important
Look for the causal chain
Apply the system safety view
Use knowledge on human and organisational behaviour
Human Factors Engineering

- proactive work for enhanced safety and efficiency
Why MTO in design and construction work?

• Purpose to optimise the technical system with regard to human health and safety aspects

• Possibility to gain many advantages:
  – To optimise work tasks
  – To reduce unnecessary work, enhanced efficiency
  – To reduce the probability for incidents and accidents
Application of MTO analysis

- Design process
- Rules and instructions
- Education and training
- Organisation and manning

The different areas need to be developed together

Important to identify the links between the different parts and assess the interaction between them
<table>
<thead>
<tr>
<th>Planering &amp; analys</th>
<th>Utformning &amp; konstruktion</th>
<th>Verifiering &amp; validering</th>
<th>Implementering &amp; drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTO ledningssystem</td>
<td>Utformning av människa- teknikgränssnitt</td>
<td>Verifiering och validering avseende mänskliga faktorer</td>
<td>Implementering av lösning</td>
</tr>
<tr>
<td>Erfarenhetsåterföring från drift</td>
<td>Framtagnings av rutiner och instruktioner</td>
<td></td>
<td>Uppföljning av mänsklig prestation</td>
</tr>
<tr>
<td>Identifikation av funktionella krav och funktionsallokering</td>
<td>Utveckling av utbildningsprogram</td>
<td></td>
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</tr>
</tbody>
</table>
0.0 Övervaka industrivatten

1.0 Övervaka industrivattnet kontinuerligt

2.0 Kommunicera kontinuerligt mellan vattenverk och DC för info om tex. planerade serviceåtgärder

3.0 Utföra periodiskt underhåll

4.0 Hantera larm

4.1 Kontakta personal i anläggningen som berörs av larmet

4.2 Kontakta driftpersonal på vattenverket för felsökning

4.3 Kontakta underhåll, VA (vatten och avlopp)

4.3.1 Skapa felanmälan i underhålls-systemet

4.3.1.1 Skapa arbetsorder

4.4 Utföra underhåll

4.4.1 Skapa handlingsplan

4.4.2 Utföra underhåll

4.4.3 Dokumentera i kvalitetssystemet för erfarenhetsåterföring

4.5 Tillfråga extern hjälp

4.5 kan komma att exkluderas

4.2 och 4.5 utförs vid behov

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### Task analysis

#### 1.0 Övervaka industrivattnet kontinuerligt

<table>
<thead>
<tr>
<th>Utförs av</th>
<th>Operatören i DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beslut som ska fattas</td>
<td></td>
</tr>
<tr>
<td>Informationsbehov och källa</td>
<td>DC ska ge tillräcklig information om systemets status.</td>
</tr>
</tbody>
</table>

**Återkoppling**
Gränssnittet i DC ska ge tillräcklig information för att DC-operatören ska kunna förstå och uppfatta vad som händer i systemet genom trender, larm osv.

**Kommunikation**

**Verktyg och hjälpmedel**

**Layout**
Design av DC måste vara användaranpassad.

**Möjliga felhandlanden och konsekvenser**

**Strategi för att undvika felhandlanden**
Användbar DC, lättförståeliga trender och information i DC. Utbildning för att kunna tolka information.
Invite to usage

• With the design show how to use it and how not to use it

• Design the product so that users easily can translate what he/she wants to do to how the product physically can be operated

• Give feedback

• Standardization
Logical?
Verification and validation

VALIDATION:
To control how efficient the developed product is in the real user situation.
Does the system work?

VERIFICATION:
To control if the developed product is designed according to specification.
Was the right product developed?

- Real work situation
- Design specification (Style guide)
- Developed product
- Comparison
Thank you for your attention!

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