Prevention of "simple accidents" with major consequences

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Prevention of ”simple accidents” with major consequences

Associated professor, PhD
DTU Management Engineering
The program

1. Some figures
2. The question: are all accidents of the same kind?
3. The cause-consequence process
4. What we know and what we don´t know?
5. Safety barriers
6. INFO cards
7. How to create safety?
Eurostat data notified accidents x 1000 for 27 EU countries (Unknown not showed)

<table>
<thead>
<tr>
<th>Severity:</th>
<th>Fatal</th>
<th>Perm. Invalidity</th>
<th>1-6 months absent</th>
<th>4-30 days absent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 2009</td>
<td>4</td>
<td>99</td>
<td>541</td>
<td>1511</td>
<td>2,440</td>
</tr>
<tr>
<td>Year 2010</td>
<td>5</td>
<td>83</td>
<td>452</td>
<td>1251</td>
<td>2,059</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>182</td>
<td>994</td>
<td>2762</td>
<td>4,499</td>
</tr>
</tbody>
</table>
## Accident causes

<table>
<thead>
<tr>
<th>Cause</th>
<th>% of all Notified accidents</th>
<th>% of all fatal accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical probl., explosion, fire, etc.</td>
<td>11 %</td>
<td>23%</td>
</tr>
<tr>
<td>Technical equipment</td>
<td>22 %</td>
<td>38%</td>
</tr>
<tr>
<td>Falls</td>
<td>23 %</td>
<td>19%</td>
</tr>
<tr>
<td>Body movement and violence</td>
<td>42 %</td>
<td>13%</td>
</tr>
<tr>
<td>Other deviation not listed above</td>
<td>2 %</td>
<td>6%</td>
</tr>
</tbody>
</table>
The Accident phenomenon

It is normal to focus on the so-called high risk like fire, explosion etc.

While the simple risks has very little focus or awareness

98% of all accidents is “simple” looking at the deviation and the injuring agent

Most accidents is caused by risks we do not take serious or are special aware of and because of that we do nothing about it.
Is accident one of a kind

- Definition
- Frequency and seriousness
- Hazard information
- Accident investigation
- Blame and guilt
- Risk awareness and risk aversion

The definition can be used for all kind of accidents, but the condition for prevention for different type of accidents have major differences
The accident causation process

1. The injury and the victim,

2. Deviation and harmful agent

3. The work situation and the victims’ behavior.

4. Management conditions and processes delivering controls.

5. Management’s strategic prioritization and commitment.

6. Legislation, competition, market relations, stakeholder requirements etc.
The consequences

The accident event

The Injuries
- Fatalities
- Amputation
- Fracture
- Back pain
- Sprain and strain
- Wounds
- Poisoning
- Infections
- Electrical chock
- Burns and scalds

Injuries and losses
- Employee sick leave
- Constructions damages
- Technical equipment damages
- Production losses
- Quality failures
- Customer delays

Treatment and rehabilitation

Costs = average 5,000 Euro pr. accident

Kirsten Jørgensen,
WorkingonSafety 2014
The critical event

**Active Protection**
- Ability to observe
- Ability to react
- Ability to avoid

**Use of personal protection equipment**

**Use of technical protection devises**

**Separation in time and place**

**Passive Protection**

**Events**
- Falls, collapse
- Falling agents
- Collisions, flying objects
- Fire explosions
- Inappropriate movements
- Breakage, bursting
- Vaporization, overflowing
- Aggression

**Hazards**
- Sharp edges
- Moving parts
- High pressure
- Kinetic energy
- Potential energy
- Heath, frost
- Electricity
- Light
- Noise
- Chemicals
- Heavy lifting
- Radiations
- Violence
- Lack of oxygen

**Combination of conditions and situations**

**Suddenly and unexpected event**

**The injuring agent Hazards**

**Injuries and losses**
Immediate causes

Safety culture
- Belief, values
- Motivation, rewards, trust, expectations
- Dialog, communication

Risk awareness and control
- Visibility of risk
- Knowledge and competences about risk
- Ability and confidence to act

Behavioral failure
- Experience based
- Rule based, Knowledge based
- Conscious based
- Lack of motivation
- Lack of competence
- Lack of abilities to do otherwise

Situational failure
- Defect technology
- Lack of safety equipment
- Defect products
- Task failure in instruction,
- Collapse with other tasks,
- Lack of information
- Surroundings changes,
weather, light, sounds, interruptions

Combination of different Root causes

Critical event and hazardous situation

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The root causes

Behavioral safety barrier
- Lack of instruction and training
- Lack of procedures, standards
- Lack of communication and dialog
- Lack of planning

Technical safety barrier
- Lack of management
- Lack of the technological system

The Strategic causes
- Procedures, rules, plans, goals
- People with right competences
- Coordination, dialog and commitment

The Immediate causes
- Purchase safe equipment and workspace
- Secure safe use
- Maintain and measure safety

Lack of management
- Lack of technical safety
- Lack of maintenance
- Lack of cleaning
- Poor building sites
- Poor environment
- Lack of road safety
- Poor workspace

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Working on Safety 2014
Strategic causes

Management commitment
- Goals, values, beliefs
- Prioritization of safety
- Focus at decisions
- Ability to create trust

Organizational weakness
- Organizational control procedures
- Determination of limits for acceptable risks
- Corporation, dialog, involvement of middle managers and workers in decisions
- Rewarding safety system

External causes
- Lack of prioritization of safety
- Lack of Safety management
- Lack of middle managers training
- Lack of Organizational rules
- Lack of goal setting and evaluation

Strategic weakness
- Lack of inspections and audits
- Lack of rewards and consequences
- Lack of requirements towards technical safety
- Lack of planning
- Lack of employee involvement

Organizational climate change

Root causes

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External causes

The political and society agenda

- The political willingness
- Possibilities for decisions
- The public awareness and acceptance

Legislations and rules

- The authority control
- Certification
- Auditing
- Insurance
- Organizational agreements
- Research

External requirements, economical pressure,

Weak legislation and rules

- National rules
- International rules
- Informal rules
- The public opinion

Management causes

Completions and market conditions

- Branch norms
- Legal principle
- Market situation
- Salary conditions
- Recruiting conditions
- Customer requirements

Weak competitions and market conditions
What is known from research

Consequences

Critical event

Immediately causes

Root causes

Strategic causes

External causes

Combination of consequences, hazards and critical event

The frontline workers

The supervisors

The top managers

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What can be questioned

• Do the top manager know what risks problems the workers are facing doing their tasks?
• Do the middle managers and daily supervisors know how to identify risks and do they know how to manage those risks?
• Do the workers know how to identify his own risk situation and do he know how he can manage those risks?

Because hazards are not there always,

Risk occur in situations where combinations of causes are interacting,

It can be too late to act in the dangerous situation
The alternative to control the safety barriers

To be aware of safety barriers

To discover and manage the needs for safety barriers

To keep the safety barriers intact

To replace safety barriers with others if needed

To monitor and maintain the quality of safety barriers

Physical and behavioral safety barriers
The WORM project

The bow tie model

Safety barriers

The left side
cause event analysis

The right side
consequence analysis

The causes of the event

Consequences

Critical event

The WORM project

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WorkingonSafety 2014
# Hazard sources

## Safety barriers and PIE's

<table>
<thead>
<tr>
<th>Activity hazardous</th>
<th>Primary safety barriers</th>
<th>Support safety barriers</th>
<th>Evaluation criteria – PIEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work at placement ladders/ Risk of falling</td>
<td>1 Ladder strength</td>
<td>1. Type of ladder and its strength</td>
<td>Conditions of ladder steps</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inspection of ladder capacity and length</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maintenance and storage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cleaning</td>
</tr>
<tr>
<td></td>
<td>2. Ladder stability</td>
<td>2. Placement and protection of the ladder</td>
<td>Placement on the ground</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Placement at the top, angle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Protection against traffic</td>
</tr>
<tr>
<td></td>
<td>3. User stability</td>
<td>3. Ability of the user to stay on the ladder</td>
<td>Position on the ladder</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Personal condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Use of both hands to hold onto the ladder</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>External forces influence</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Appropriate movements</td>
</tr>
</tbody>
</table>

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The WORM system

**Human System**
- Management Delivery Systems
- Safety Barrier Tasks

**Technical System**
- Safety Barriers
- Prevent Loss of Control Events

**Barrier Failure Mode:** Loss of Control
- Undesirable transmission of energy/hazardous agents/deviant conditions (e.g. vibration, temperature)
- Failed physical conditions (e.g. structural integrity, strength)
- Hazardous agent/energy not separated from vulnerable target (e.g. distance of people from hazard)
- Presence, build-up, or release of the hazardous agent/energy

**Failure to Deliver:**
- Procedures
- Equipment
- Ergonomics
- Availability
- Competence
- Communication
- Motivation
- Conflict resolution
The cause analysis versus the risk analysis

Consequences

Critical event
Sleeping hazards

Immediately causes

Root causes

Strategic causes

External causes

Cause analysis

Risk analysis

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Situational awareness

How to evaluate

What to observe

What to do

Understanding

*Pictures
*Understanding processors
*Linguistic limitations
*Opinions and believes
*Possibilities
*Related mental models

Kompetences and motivation

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WorkingonSafety 2014
Three important elements

- Knowledge
- Motivation
- Abilities
Everybody has a responsibility

• Both employers and employees need to possess safety barrier awareness

• The employer have the responsibility in beforehand

• The employee have the responsibility in the situation where they very often are on their own
### For the employer

**Hazard**

**Barrierstyper**

<table>
<thead>
<tr>
<th>Observer/undersøg</th>
<th>Forstå/huk og vurder</th>
<th>Handle/udføre</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Udstyrets styrke</strong></td>
<td>Observer om udstyret er i orden, regnøst og vedligeholdt. Undersøg om det er behov for andet at komme til udstyret. Observer om medarbejdernes evne til at stå op ved stiger og stille. Observer om medarbejdernes evne til at holde fast ved udstyr. Vurder om medarbejdernes evne til at se på stiger og stille.</td>
<td>Song for mangel udbedres.</td>
</tr>
<tr>
<td><strong>Behov for rækkevidde</strong></td>
<td>Observer om rækkevidde er påvirket af værktøj eller udstyr. Observer om rækkevidde er påvirket af værktøj eller udstyr.</td>
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<td>Observer om medarbejdernes evne til at holde fast. Observer om medarbejdernes evne til at holde fast.</td>
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</table>

**Info Cards**

**Fare: Arbejde i højde**

Omfatter ophold og arbejde på alle former for stiger, stilladser, platforme, niveauforskelle, tage mv.

**Fare: Arbejde i højde med risiko for fald til lavere niveau**

Omfatter ophold og arbejde på alle former for stiger, stilladser, platforme, niveauforskelle, tage mv.

**Barrieretyper**

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**Info Cards**

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</tbody>
</table>
INFO cards in three levels

- **General level hazards**: For all kinds of hazards
- **Cross-cutting level hazards**: For subgroups of hazards
- **Specific level hazards**: For specific hazards

Numbers:
- 1
- 17
- 64
Subgroups of Hazards

<table>
<thead>
<tr>
<th>Subgroup of critical events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falls from heights</td>
</tr>
<tr>
<td>Falls from the same level</td>
</tr>
<tr>
<td>Being struck by falling objects</td>
</tr>
<tr>
<td>Being struck by fragments</td>
</tr>
<tr>
<td>Being struck by moving objects, becoming caught up/jammed, crushed.</td>
</tr>
<tr>
<td>Becoming buried</td>
</tr>
<tr>
<td>Violence</td>
</tr>
<tr>
<td>Being struck by moving objects, becoming caught up/jammed, cutting</td>
</tr>
<tr>
<td>Collisions</td>
</tr>
<tr>
<td>Electric shock</td>
</tr>
<tr>
<td>Burns</td>
</tr>
<tr>
<td>Poisoning, etching</td>
</tr>
<tr>
<td>Strain injuries</td>
</tr>
<tr>
<td>Electric shock</td>
</tr>
<tr>
<td>Fire</td>
</tr>
<tr>
<td>Suffocation, poisoning or drowning</td>
</tr>
<tr>
<td>Explosion</td>
</tr>
</tbody>
</table>
The general INFO cards for all kind of hazards

<table>
<thead>
<tr>
<th>Observewhether…</th>
<th>Evaluate the need for…</th>
<th>Act to ensure provision, use, maintenance and monitoring /improvement of safety barriers for…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safeguarding is provided and used by the employee</td>
<td>Better safeguarding</td>
<td>Safeguarding</td>
</tr>
<tr>
<td>Personal protective equipment is provided and used by the employee</td>
<td>Better personal protective equipment</td>
<td>Personal protective equipment</td>
</tr>
<tr>
<td>Operational control of the technical system is safely provided and managed safely by the employee</td>
<td>Better operational control system</td>
<td>The operational control system</td>
</tr>
<tr>
<td>Avoidance of the danger zone is provided for in the task and respected by the employee</td>
<td>Better avoidance of danger zone</td>
<td>Avoidance of danger zone</td>
</tr>
<tr>
<td>Emergency response is provided and able to be used by the employee</td>
<td>Better emergency response</td>
<td>Emergency response</td>
</tr>
<tr>
<td>The employee’s health condition is satisfactory and enables them to do the task safely</td>
<td>Better health monitoring and if it is necessary, changing the employee’s current tasks</td>
<td>Employees who are in poor health condition (change the task)</td>
</tr>
<tr>
<td>The employee has the right knowledge and skills and is using them correctly</td>
<td>More training and instructions</td>
<td>Competence (through training and instructions)</td>
</tr>
<tr>
<td>Information about risks and safety barriers is communicated to and understood by the employee</td>
<td>Better communication of information about risks and safety barriers</td>
<td>Communication about the risks and safety barriers</td>
</tr>
<tr>
<td>Safe equipment is provided and used by the employee</td>
<td>Improving equipment to be in a safe condition, right for the task and possible to use in a safe way</td>
<td>Equipment changed to a better and more safe product</td>
</tr>
<tr>
<td>Safety is integrated into plans and procedures for the task and followed by the employee</td>
<td>Improving plans and procedures so they are right for the task and possible to follow by the employee in a safe way</td>
<td>Plans and procedures adapted to be safe for the task and to the level of understanding of the employee</td>
</tr>
<tr>
<td>Equipment, technical devices, and the workplace conditions are provided in an ergonomic and safe design and used by the employee and maintained</td>
<td>Improving equipment, technical devices and workplace conditions so they are in a proper ergonomic condition</td>
<td>The ergonomic design of equipment, technical devices, work surroundings</td>
</tr>
<tr>
<td>Sufficient and qualified people are available for the routine and non-routine tasks when needed</td>
<td>More people or people with the qualifications for the tasks (including in the emergency and specialist tasks that are rarely wanted out)</td>
<td>The availability of qualified people for all the possible task demands</td>
</tr>
<tr>
<td>There is pressure to carry out the task in a quicker and less safe way due to conflict with operational goals or other tasks</td>
<td>Removing the conflict situation between tasks and goals so that the employee will choose to do his task the safe way and ensuring the employee is getting the right message from management about the importance of safety.</td>
<td>Reduction or removal of the conflict between safety and production, ensuring that safety is prioritised over production goals when they come into conflict</td>
</tr>
<tr>
<td>The employee is motivated to carry out the task in a safe way</td>
<td>Improving the employee’s motivation and awareness raising initiatives for carrying out the task in an acceptably safe way, including improving the effectiveness of motivational and awareness raising initiatives and maintaining alertness on a continuing basis</td>
<td>Motivation and risk awareness of the employee for carrying out the tasks in a satisfactory and enables them to do the task safely.</td>
</tr>
</tbody>
</table>

Safeguarding is provided and used by the employee

Personal protective equipment is provided and used by the employee

Operational control of the technical system is safely provided and managed safely by the employee

Avoidance of the danger zone is provided for in the task and respected by the employee

The employee’s health condition is satisfactory and enables them to do the task safely and is using them correctly

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The employee’s health condition is satisfactory and enables them to do the task safely and is using them correctly
Cross-cutting INFO cards for 17 sub-groups of hazards

<table>
<thead>
<tr>
<th>OBserve whether...</th>
<th>Evaluate the need for...</th>
<th>Act to ensure provision, use, maintenance and monitoring /improvement of safety barriers for...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength of supporting equipment or structures when working at height is in good order and clean</td>
<td>Checking and providing strength and cleanliness of the equipment or structures when working at height.</td>
<td>Making sure that structures that have to be worked on are strong enough to support persons and other loads. Maintaining or replacement of the equipment. Maintaining strength of structures for working at height.</td>
</tr>
<tr>
<td>There is a need for edge protection and if so that the edge protection is of good quality and correctly installed</td>
<td>Checking edge protection quality and correct installation/fixing in place</td>
<td>Maintaining or installing edge protection of appropriate safe design</td>
</tr>
<tr>
<td>The placing of equipment (including what it is placed on) and the possibility for it to be affected by external circumstances could affect its safe use.</td>
<td>Adjustment of how equipment is placed and the possibility for external circumstances which could affect its safe use</td>
<td>The secure placement of equipment. Maintaining safeguarding against external circumstances that could affect the integrity of the equipment</td>
</tr>
<tr>
<td>Competences for using the equipment or being at height is provided and used by the employee.</td>
<td>Instruction/training for working at height</td>
<td>Maintaining workers’ competences for working at height</td>
</tr>
<tr>
<td>Employee is motivated to use the equipment or work at height in a safe way</td>
<td>Motivation actions towards working at height</td>
<td>Maintaining the motivational activities for safe behaviour when working at height</td>
</tr>
</tbody>
</table>

Kirsten Jørgensen, WorkingonSafety 2014
## Specific INFO cards for 64 specific hazards

### Managers specific INFO card for falling from non-moving vehicle

<table>
<thead>
<tr>
<th>Observe</th>
<th>Evaluate</th>
<th>Act</th>
</tr>
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<tbody>
<tr>
<td>Observe whether…</td>
<td>Evaluate the need for…</td>
<td>Act to ensure provision, use, maintenance and monitoring/improvement of safety barrier for…</td>
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### Equipment strength

- **The vehicle is strong enough to support the weight**
  - Limitation of weight
  - Vehicle is strong enough for the weight

- **The vehicle is overloaded or loaded one-sidedly**
  - Changes to the loading method
  - The correct load and balanced loading methods

### Edge and access protection

- **Edge protection is absent, insufficient or has been removed or is broken**
  - Edge protection
  - Adequate edge protection

- **The vehicle and the load are safely accessible for the required activities**
  - Changing the access
  - Safe access to vehicle loads

### Equipment placement

- **The vehicle placement is stable**
  - Changing the placement of the vehicle
  - Stable placement of vehicle

- **Load configuration is stable**
  - Changing the load configuration
  - Stable load configuration

- **Load displacement/movement/loading or unloading threatens user stability or the stability of the vehicle**
  - Changing the displacement/movement/loading or unloading procedure
  - Displacement/movement/loading or unloading procedures to prevent instability

### Employer ability and competences

- **The employee is able to keep balance**
  - Prevention of loss of balance
  - Being fit enough to balance on the vehicle

- **The employee is able to work safely on the non-moving vehicle**
  - Changing the work conditions that might cause loss of balance
  - Work conditions for preventing loss of balance

- **The access behaviour is safe**
  - Changing access behaviour
  - Safe access behaviour

- **The surface conditions are safe for the activity, also with respect to access**
  - Changing the surface conditions that might cause loss of balance
  - Safe surface conditions for the activities, also with respect to access
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What has been demonstrated

Different hazards need different safety barriers and different management delivery processes.

Some safety barrier is generic but other are very specific.

Accident are not all of a kind because they relate to different hazards, different needs for safety barriers and different management deliveries.
The challenges for creating of safety

1. problem

• The top manager, the daily supervisor and the employee has many duties

• As long nothing has happen the everybody presume everything is OK

• Jens Rasmussen´s drift to danger is very difficult to observe in the daily routine
The challenges for creating of safety

2. problem

• The safety system and knowledge found for prevention initiative has been found in larger companies.

• Most enterprises is SME´s and most accidents happens in SME´s
The challenges for creating of safety

3. problem

• Very few actually understand how hard it is to create safety and keep the safety level on the top
How to create safety

1. proposal

• To see safety as an integrated part of creating a more efficient working process and making good economical results.

• To ensure that effectiveness includes safety and quality by making the easy way to perform a job to be the safest.
2. proposal

• To change the view of the meaning of being a professional for top managers, daily supervisors and all kind of employments.

• To be a professional in the job must include to make the job in a safe and quality right way.
How to create safety

3. Proposal

• To distinguish prevention methods for different hazards, prioritize and make prevention step by step.

• Accept there is no easy route, it is hard work.
The human factor

- People can work day in and day out in a hazardous environment.
- Through their thoughtfulness, ingenuity, attention and physical abilities they can compensate for poorly designed equipment, facilities and routines, and thus prevent the risks being triggered.
- Then one day in a few seconds someone loses his or hers attention and the accident happens.
- For that moment the human factor is recognized

*We have not many accidents because of the human factor – it is because of the human factor we have so few.*

Carin Sundström-Frisk 1982
Safety engineering

• Integration safety in technologies
• Integration safety in projects and processes
• Make safety the easy way and the easy way to be the safe

• Prepare instructions, maintenance procedures, clear and visible icons for what to remember
• The remaining risks or hazards, must be clear where and when and how to manage
The simple accidents are simple to analyze and understand when the accident has happened

But to observe the hazards and be aware of and take the risk serious are most difficult

To be a professional at all power level must include to carry out the job safely- that means to make sure all necessary safety barrier are in place
Thank you for listening