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## Promoting Safety in Ground Handling

Akselsson, Roland; Ek, Åsa; Hallberg, Mattias; Ternov, Sven

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**LUND UNIVERSITY**

Department of Design Sciences  
Ergonomics and Aerosol Technology

## Promoting Safety in Ground Handling

Roland Akselsson, Åsa Ek, Mattias Hallberg and Sven Ternov

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# **Promoting Safety in Ground Handling**

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**Roland Akselsson, Åsa Ek, Mattias Hallberg and Sven Ternov**

**Department of Design Sciences/Ergonomics & Aerosol Technology**

**Swedish Centre for Aviation R&D, Change@Work, LUCRAM**

**HFA**

**Supported by the Swedish Civil Aviation Administration**

**Staffan Karlsson**

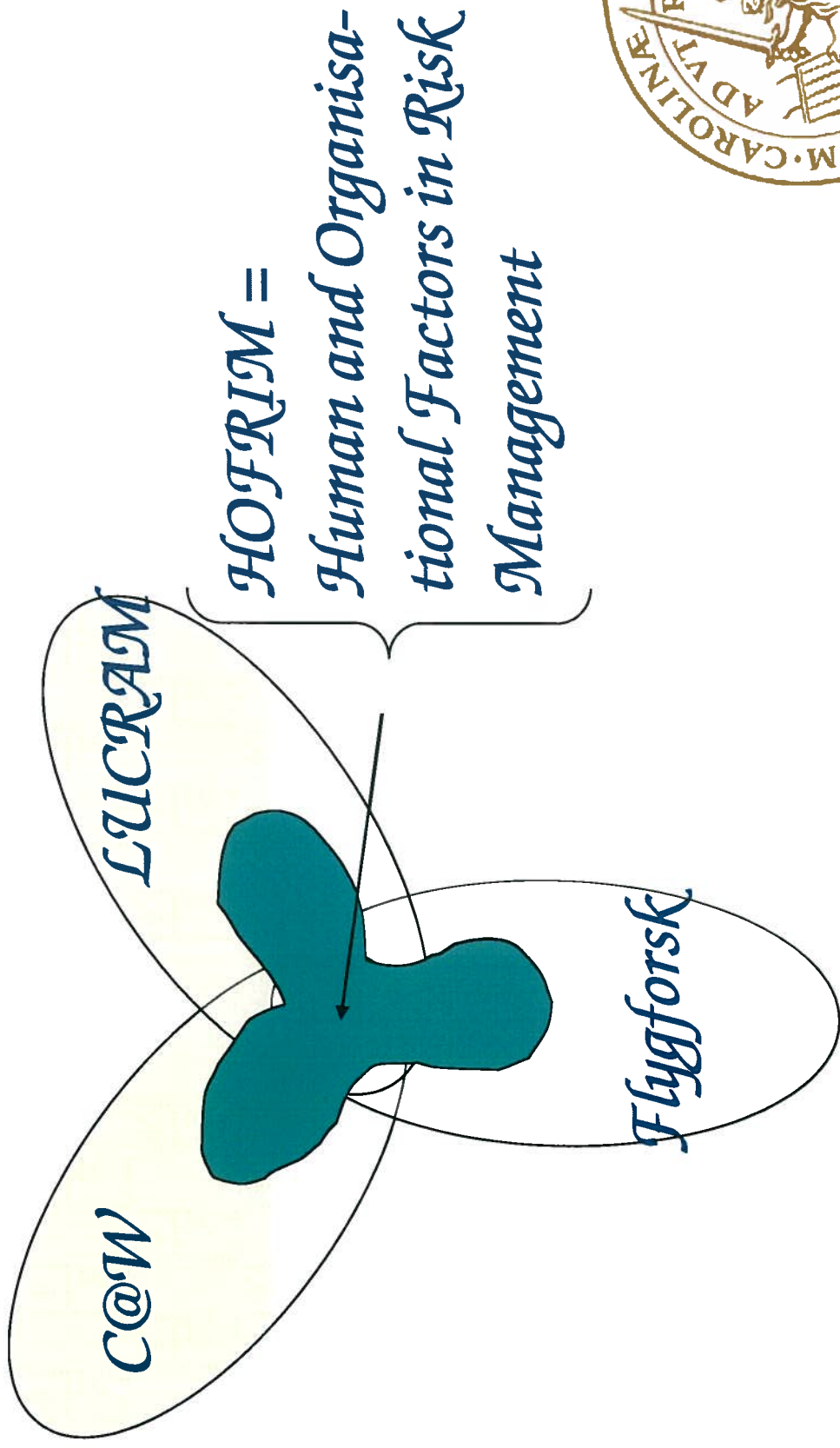
# **OUTLINE**

## **Promoting Safety in Ground Handling**

- **The group HOFRIM and its programme**
- **Goal and method**
- **Ground handling**
- **Measurement of Safety Culture**
- **Investigation of System Weaknesses**
- **Results and discussions**



# The Lund HOFRIM group I



# The Lund HOFRIM group II

## Professors

**Roland Akxelsson**

**Curt R Johansson**

**Clemens Weikert**

**Lars Fredholm**

**Göran Jense**

## Experts and assistants

**Bengt Erik Stenmark**

**Anders Jacobsson**

**Johan Jönsson**

## PhD students

**Marcus Arvidsson**

**Nicklas Dahlström**

**Åsa Ek**

**AnnSofie Fyhr**

**Lidia Kovatcheva**

**Max Mejia**

**Sven Ternov**

**Master students**



# Ergonomics I

**Lund University**

**Lund Institute of Technology**

**Dept of Design Sciences  
Ingvar Kamprad Design Center**

**Ergonomics and Aerosol Technology**



# Ergonomics II


Professors associates	Research areas	PhD students
Roland Akselsson	HOFRIM; Ergonomics in Design; Physio-erg	8
Gerd Johansson, Roy Davies, Joakim Eriksson	User interface; VR; Rehabilitation ergonomics	3
Per Odenrick	Organisation development, SMEs	2
Ingvar Holmér Jan 1, 2003 --	Indoor climate and physiology	(2)
Jan Erik Rendahl	Change management	2
Mats Bohgard, Anders Gudmundsson	Aerosols	3
Matts Ramstorp	Cleanroom technology	







# The Lund HOFRIM group III

## Some basic principles

- 

To err is human.  
Design for safety
- 

A systems approach.  
Involvement by all
3. Latent conditions,  
Safety barriers,  
Situational factors
4. Proactive risk mgmt
- 

5. Safety Culture  
A learning  
organisation
6. Continuous improvements.  
Change processes.
7. Naturalistic or dynamic  
distributed decision making.
8. Psychosocial and physical  
work environment
9. Comparative studies  
between different  
trades



# 1. To err is human. Design for safety.

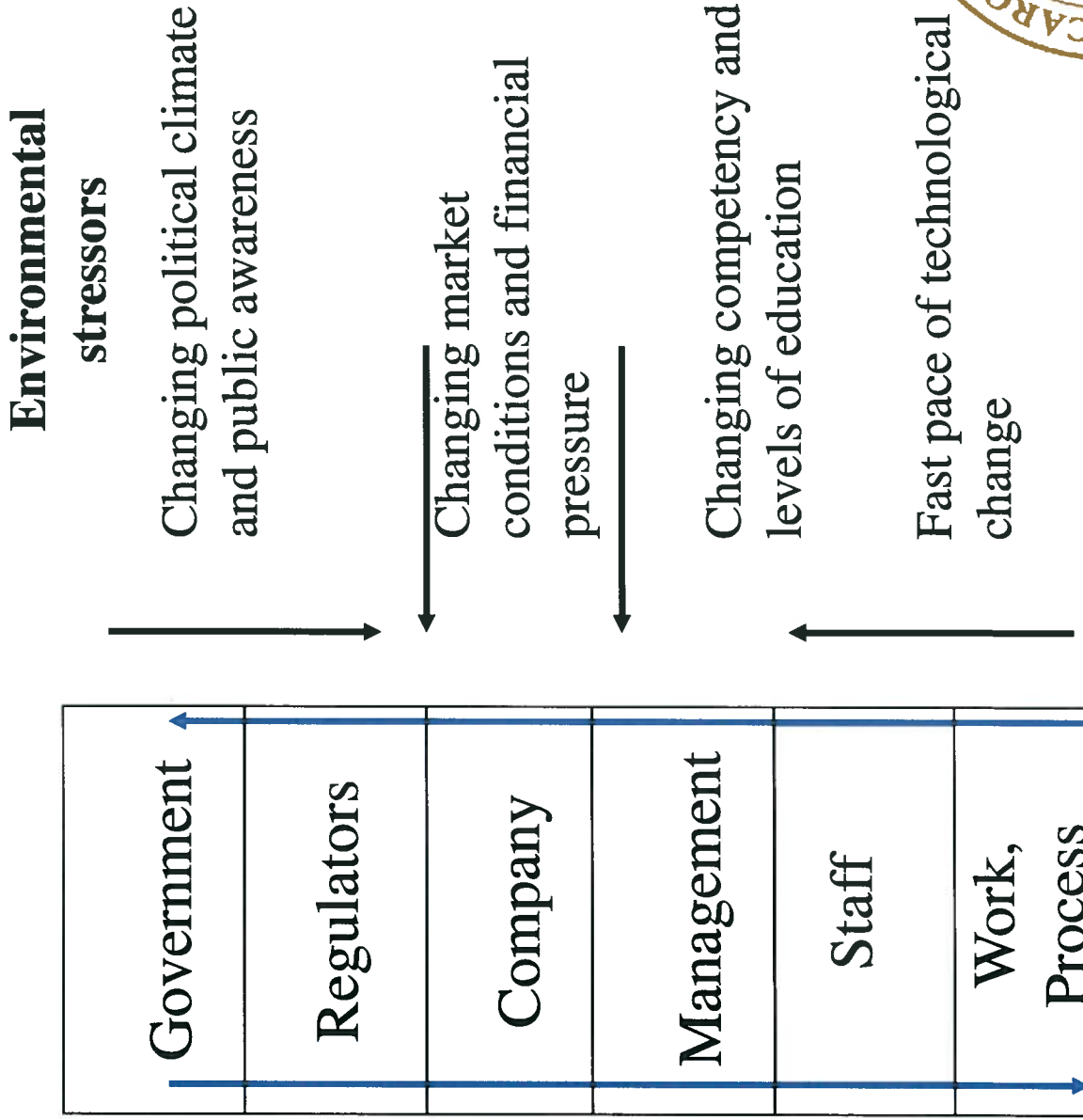
- Design forgiving systems
- Consider the typical and atypical users
- Consider normal and atypical use
- Consider the environment
- Diffusion and the design envelope
- Visibility, Affordance, Mapping, Feedback
- Usability (Relevance, Efficiency, Attitude, Learnability)



**Test early with real users**



# 2. A system view



Rasmussen 1997

# The Socio-Technical System

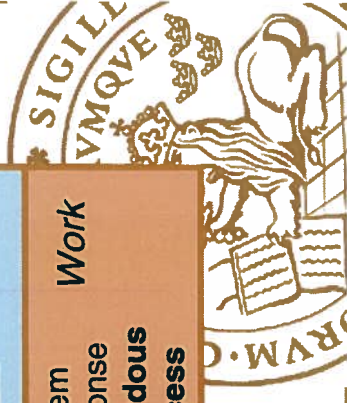
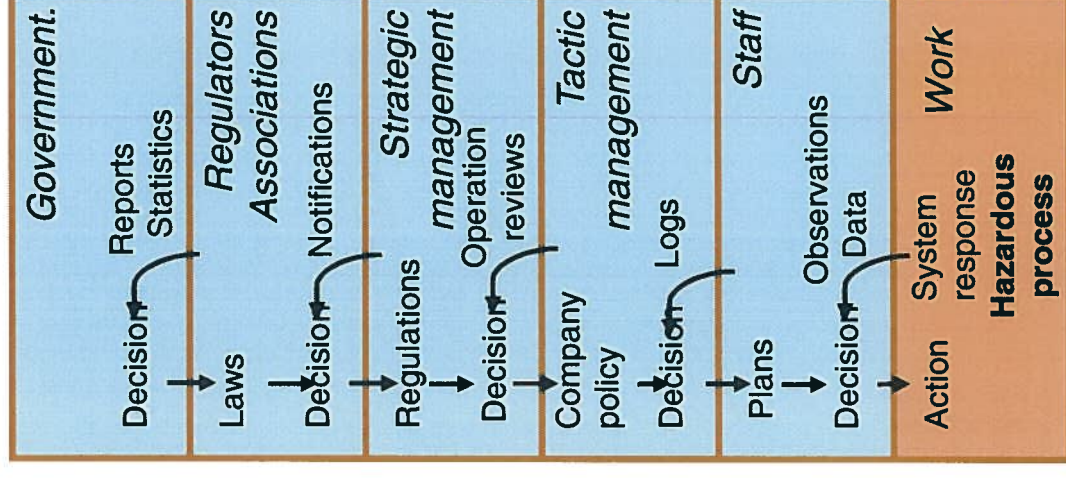
Nested levels of decision-making involved in Risk Management and regulatory rule making.

The control processes can be described in terms of – and supported by – closed loop feed back of information

Accident and work analysis should focus on these conditions for control and dynamic learning during every day work



**Picture from Inge Svedung**



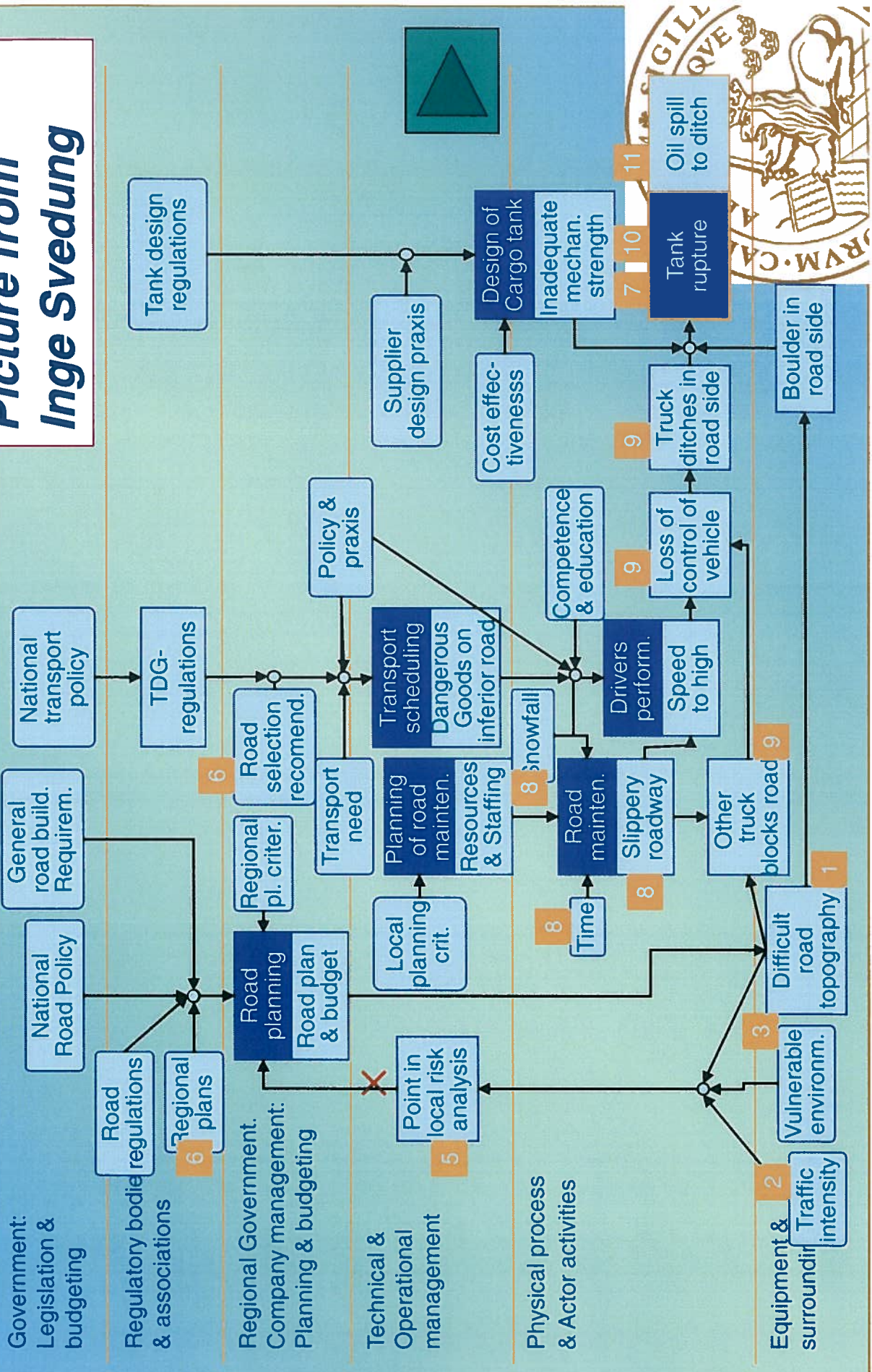
Mapping of Functions and Preconditions

# An "AcciMap"-example

## System: Transport of Dangerous Goods by road

### SYSTEM LEVEL

Picture from Inge Svedung



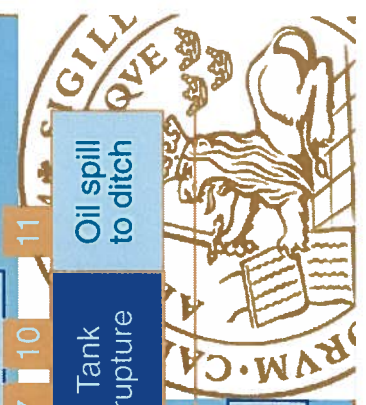
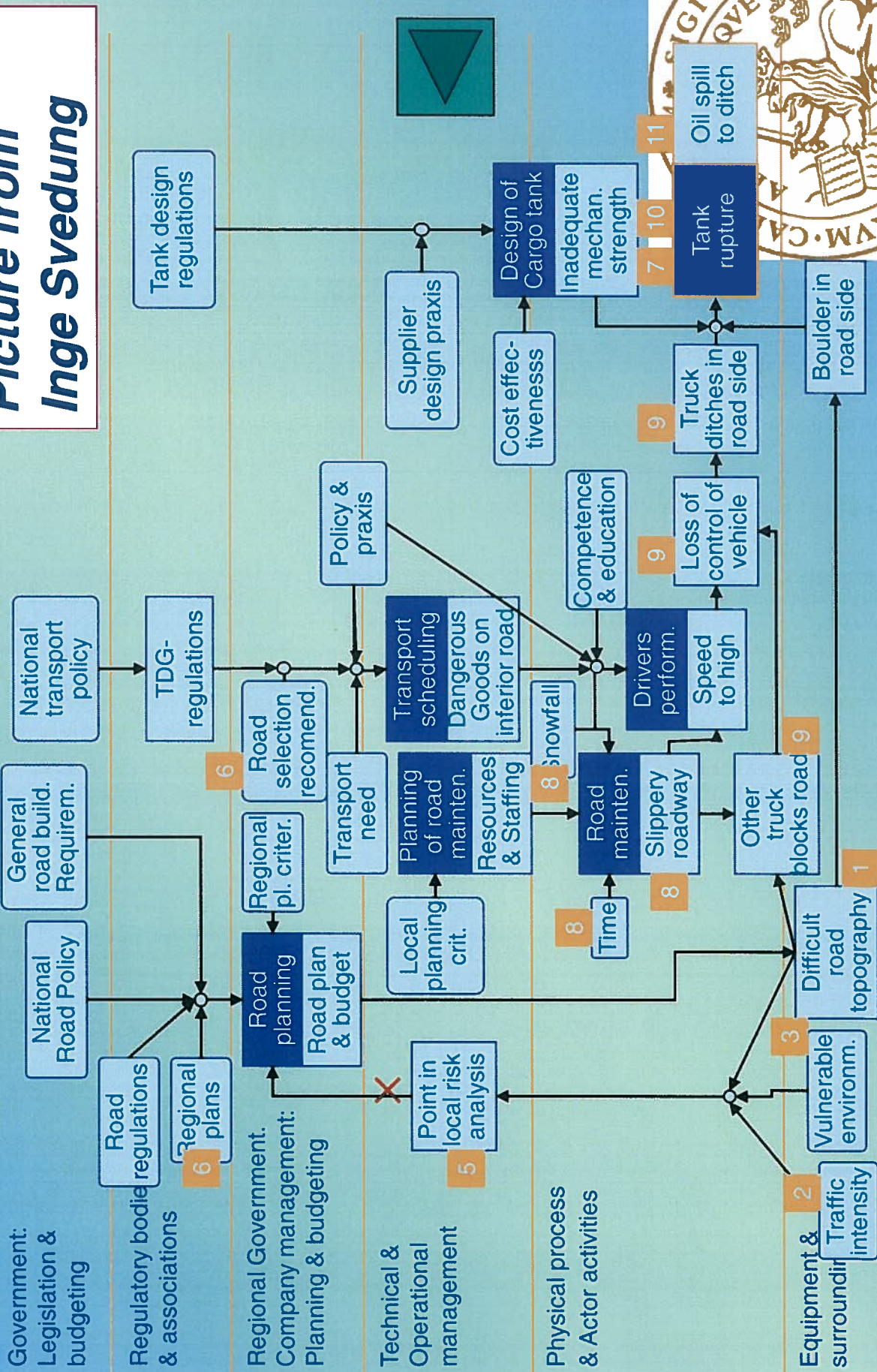
Mapping of Functions and Preconditions

# An "AcciMap"-example

## System: Transport of Dangerous Goods by road

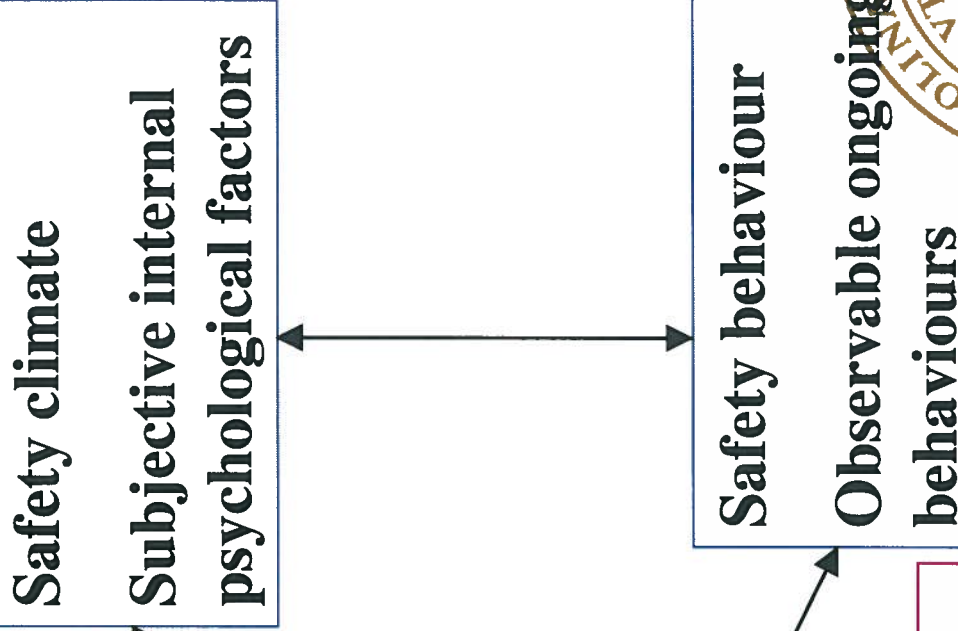
### SYSTEM LEVEL

Picture from  
Inge Svedung



## 5. Safety Culture

The way we work here



A reciprocal model. Cooper and Phillips, 1995. Cooper, 1996, 1997, 2000



# Learning

## Important sources for learning:

1. Unsafe acts
2. Unsafe situations
3. Near accidents
4. Accidents
5. 1- 4 in other organisations
6. Risk analyses
7. Internal audits

8. External audits
9. Education
10. Training
11. Expert involvement
12. Participation in relevant research and development

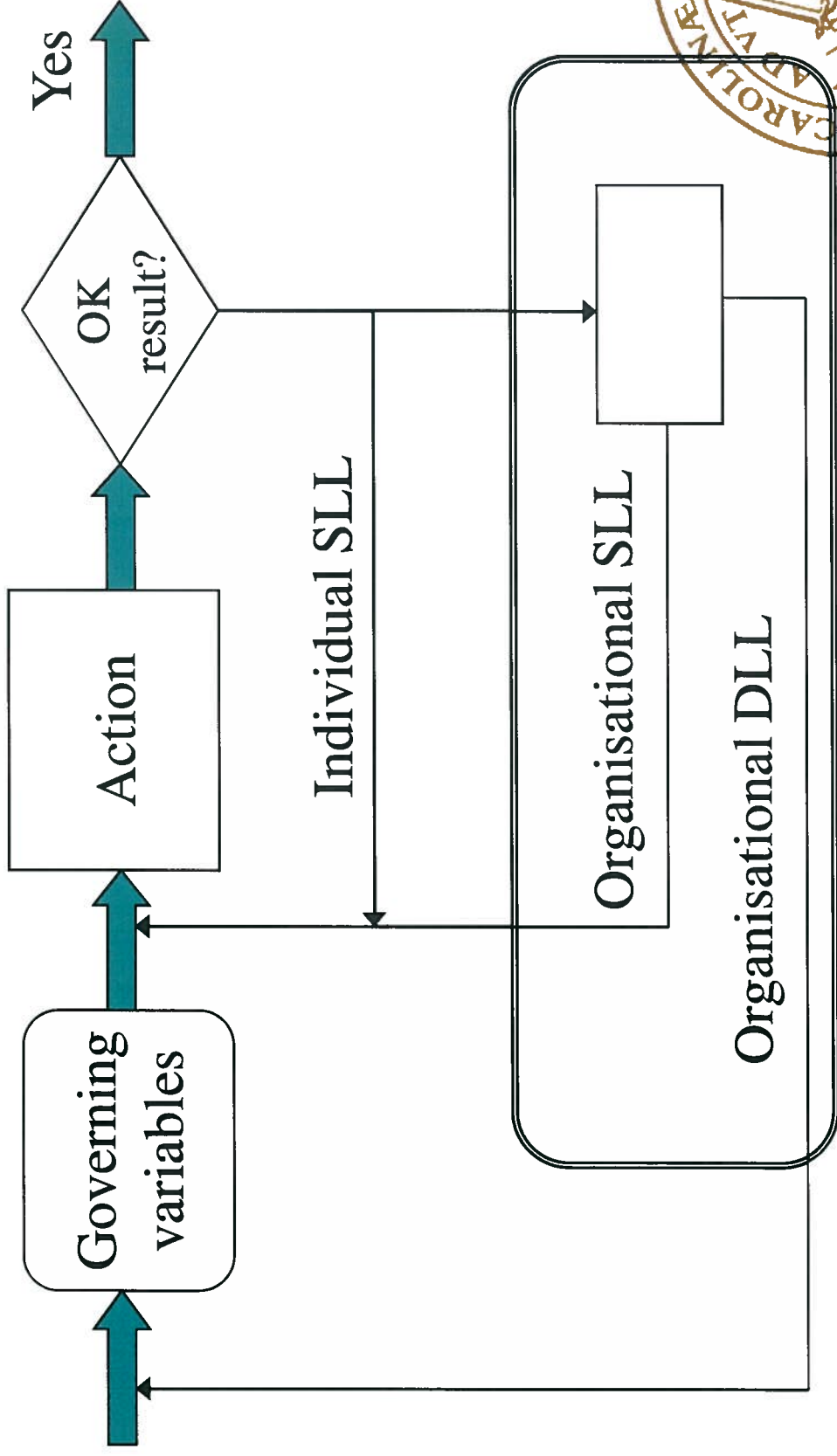




# 'Single- and double loop learning'

## SLL and DLL

After Koornneef



# HOFRIM projects

- **Safety Culture** (Åsa Ek, RA)
- **HUFA. HF in aviation** (Åsa Ek, Markus Arvidsson, Sven Ternov, Curt R Johansson, RA, LFB)
- **RAMP. Safety at ground handling** (Åsa Ek, Mattias Hallberg, Sven Ternov, RA) (pilot project)
- **MARSAF. Maritime safety** (Åsa Ek, Max Mejia, BE Stenmark, Göran Jense, RA)
- **OSHANA. Learning from near-accidents in SMEs** (Johan Jönsson, Curt R Johansson, Per Odenrick, RA, Group in Austria)
- **Safety in Drug Handling** (AnnSofie Fyhr, RA)
- **Safety in Medical Care** (Sven Ternov, RA)
- **[VERDI – Integration of HF in Design** (Lars Hanson, Mikael Blomé, Per Odenrick, RA, PhD-students and researchers from Chalmers and NIWL, Saab)]



# HOFRIM projects – new

- **Pilot training and stress** (Nicklas Dahlström, School of Aviation, Lund University)
- **Safety and downsizing** (Anders Jakobsson, Fire Safety Engineering & LUCRAM)
- **CBT - Centre for Decision Making** (Campus Helsingborg, Community of Helsingborg, Scandlines, C-ITS, LUCRAM, etc.)
- **Integration of management systems for SHE** (Lidia Kovatcheva, Kristianstad University, LUCRAM)
- **Safety in test running of new cars** (2 master students, SAAB)
- **Organisational factors and safety in SMEs** (2 master students, Trygg-Hansa)



# Ground handling characteristics

e.g.

- **Various organisations sharing a work environment**
- **Working in a limited space**
- **Severe temporal pressure**
- **Serious hazards on the ramp**
- **Accidents with serious human and economic consequences**
- **Importance for security**



# Safety for

- **Passengers**
- **Personnel**
- **Aircraft**
- **Luggage**
- **Airport Equipment**

# Security



# Goal

## Promoting Safety in Ground Handling

**The long-term goal is to develop a program for promoting safety in ground handling at airports.**

**The goal of the current pilot project is to plan such a project by e.g. testing a couple of tools in such a program. Also we want to find out what could be used from other efforts in the world?**



# Methods

## Promoting Safety in Ground Handling

- **Literature review**
- **A pilot study of Safety Culture in part of the ground handling in one airport**
- **A pilot study of system weaknesses in part of the ground handling in one airport**
- **Inference from other projects**



## Some good interesting work

- **SCARF** – Safety Courses for Airport Ramp Functions (Trinity College Dublin; Loughborough Univ of Techn; Univ of Gronningen; Traffic Research Centre (NL); Universidad de la Laguna, Tenerife. Four airlines and three airports.  
E.g. Nicholas McDonald (1996); Isla and Diaz (1997)
- **INDICATE** – Identifying Needed Defences In the Civil Aviation Transport Environment. This is a method to proactively improve airline safety performance  
Edkins (1998)
- **QDHB** – A quality management system developed for municipal airports in Sweden
- **etc**





# **INDICATE** – Identifying Needed Defences In the Civil Aviation Transport Environment. I

## **Six core safety activities**

- 1. Appoint a safety manager**
- 2. Conduct staff focus groups to identify hazards**
- 3. Establish a confidential hazard reporting system**
- 4. Conduct regular safety meetings with management**
- 5. Maintain a safety information database**
- 6. Ensure that safety information is regularly distributed to all staff**



# **INDICATE** – Identifying Needed Defences In the Civil Aviation Transport Environment. II

## **Evaluation criteria**

- **Safety culture**
- **Staff risk perception**
- **Willingness to report safety hazards**
- **Action taken on identified safety hazards**
- **Staff comments about the safety management within the company**



## **QDHB**

- **Web-based quality management system (efficiency, competitiveness, safety)**
- **Network of 28 municipal airports in Sweden**
- **Includes**
  - **Processes and instructions for operation of an airport**
  - **Systems for system safety and environment**
  - **Form for reporting about operation**
  - **Training material etc**

**In Swedish: [www.qdhb.org/qdhb.htm](http://www.qdhb.org/qdhb.htm)**

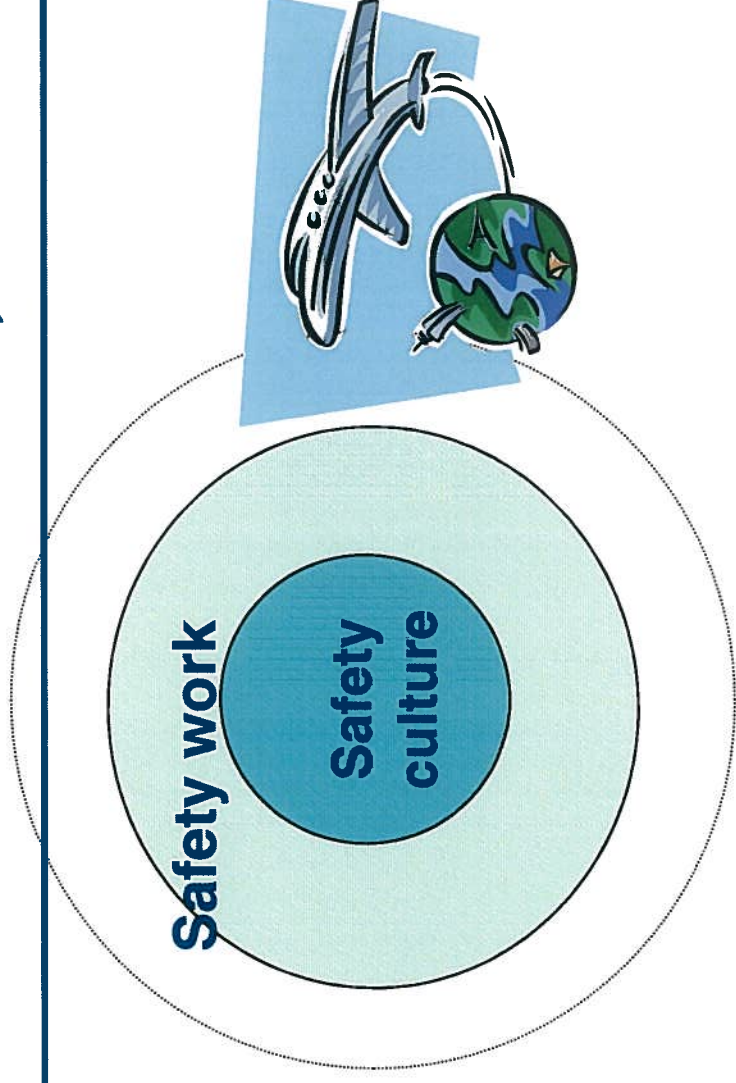


# Part. Safety Culture

## Safe Handling of Aircraft

Åsa Ek, ..

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How successful the safety work will be depends to a great extent on the safety culture.



## **What has been done in the Safety Culture part of the ground handling study?**

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**Observations** – used for ramp workers

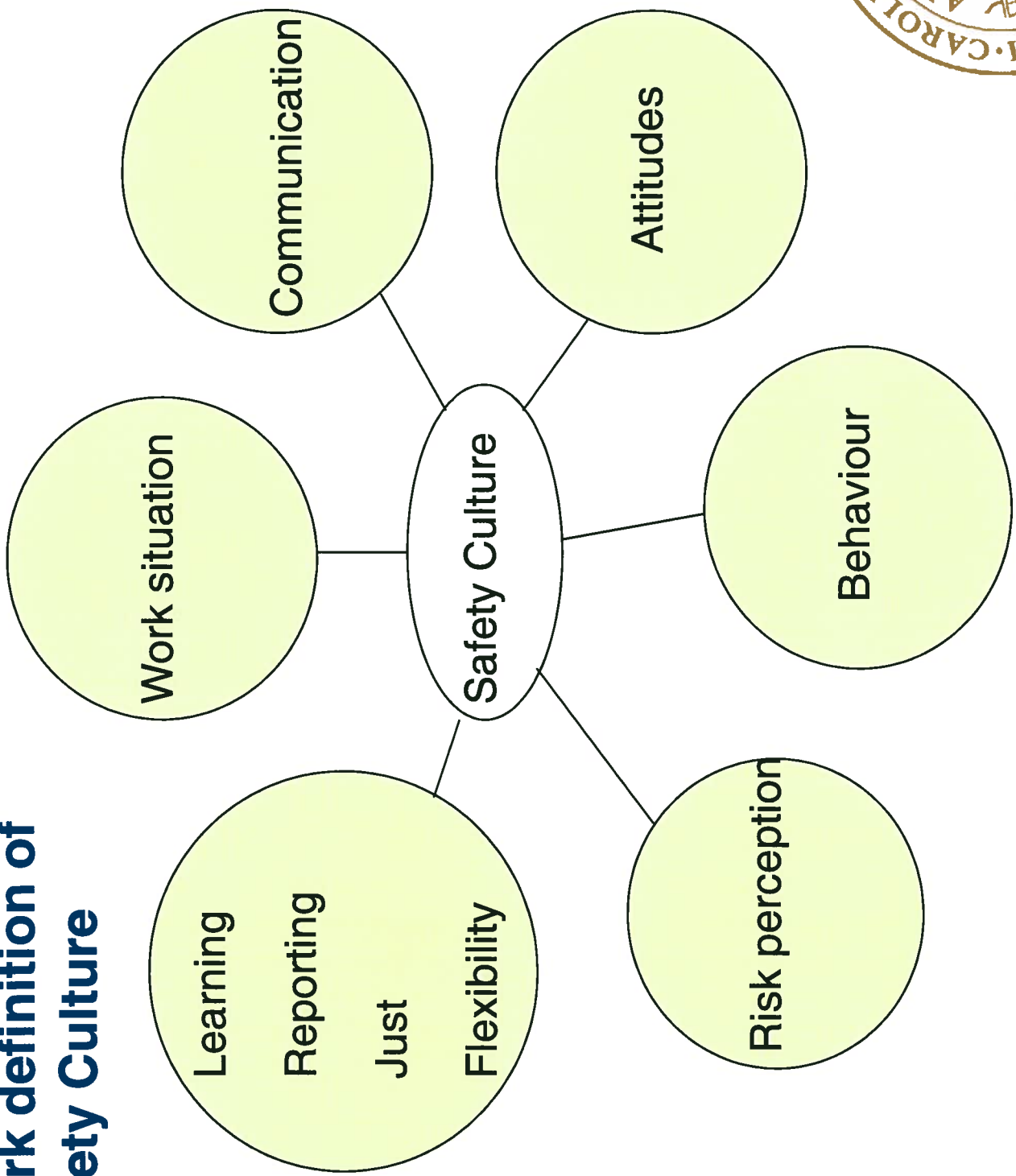
**Questionnaires** – 94 questions,  
response rate = 75%

**Interviews** – 10 persons, in different positions

**Collection of facts**



# Work definition of Safety Culture



# Assessment of Safety Culture by Ground Handling Leaders

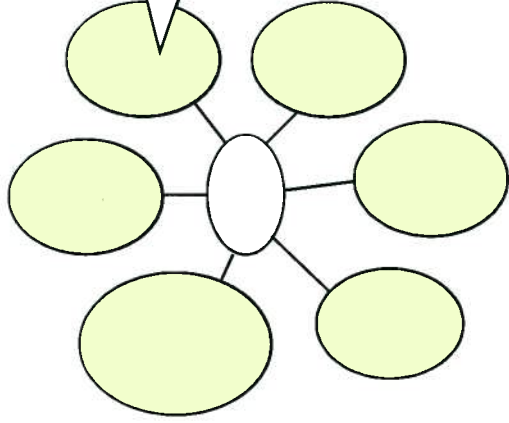
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## Three different assessments:

- 1) What percentage of positive answers from the personnel describes a good Safety Culture today?
- 2) What is a reasonable goal?
- 3) What is the limit for what is acceptable?



# Communication

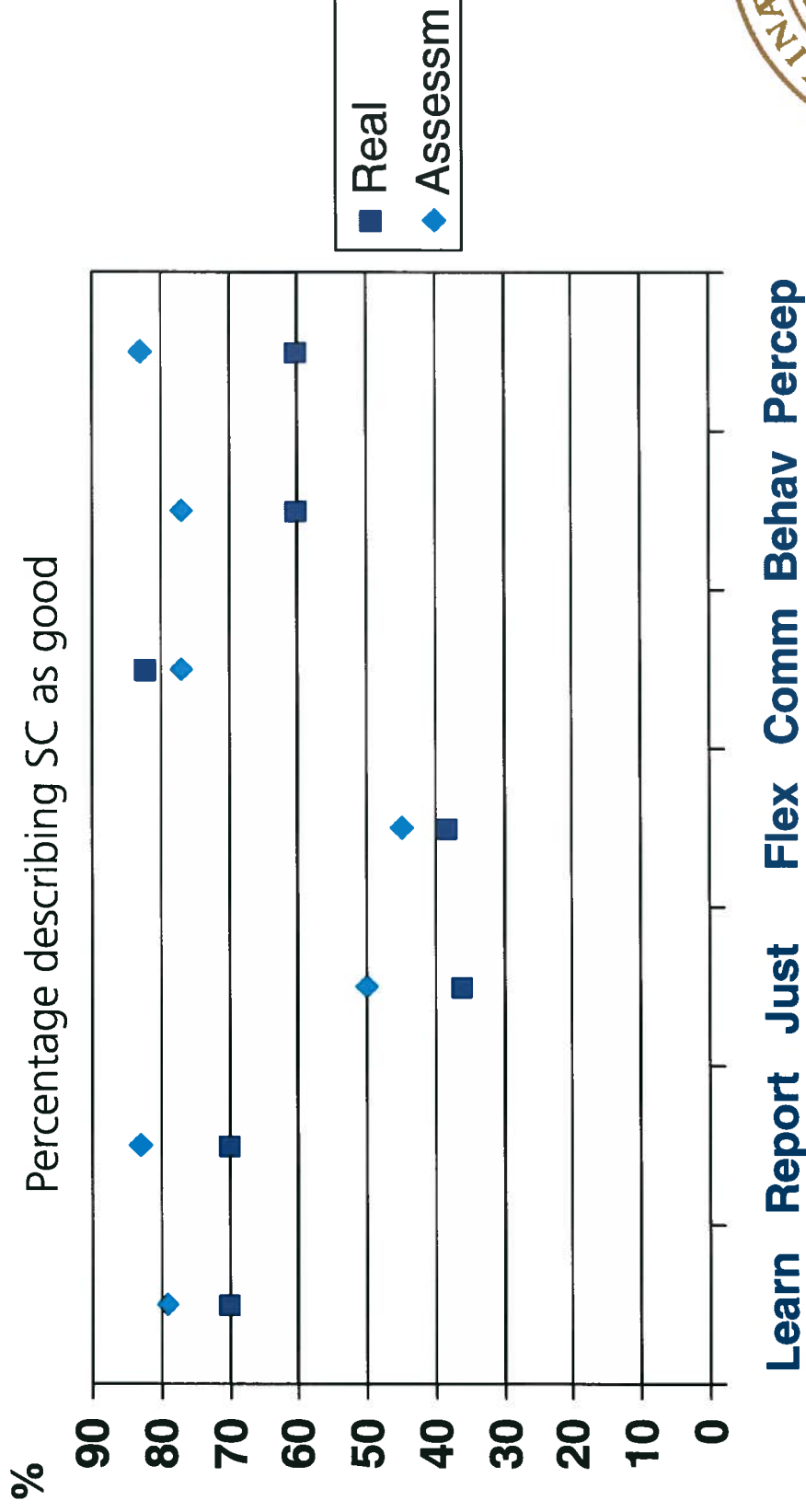


**Do you get the information  
you need for working in a  
safe way?**





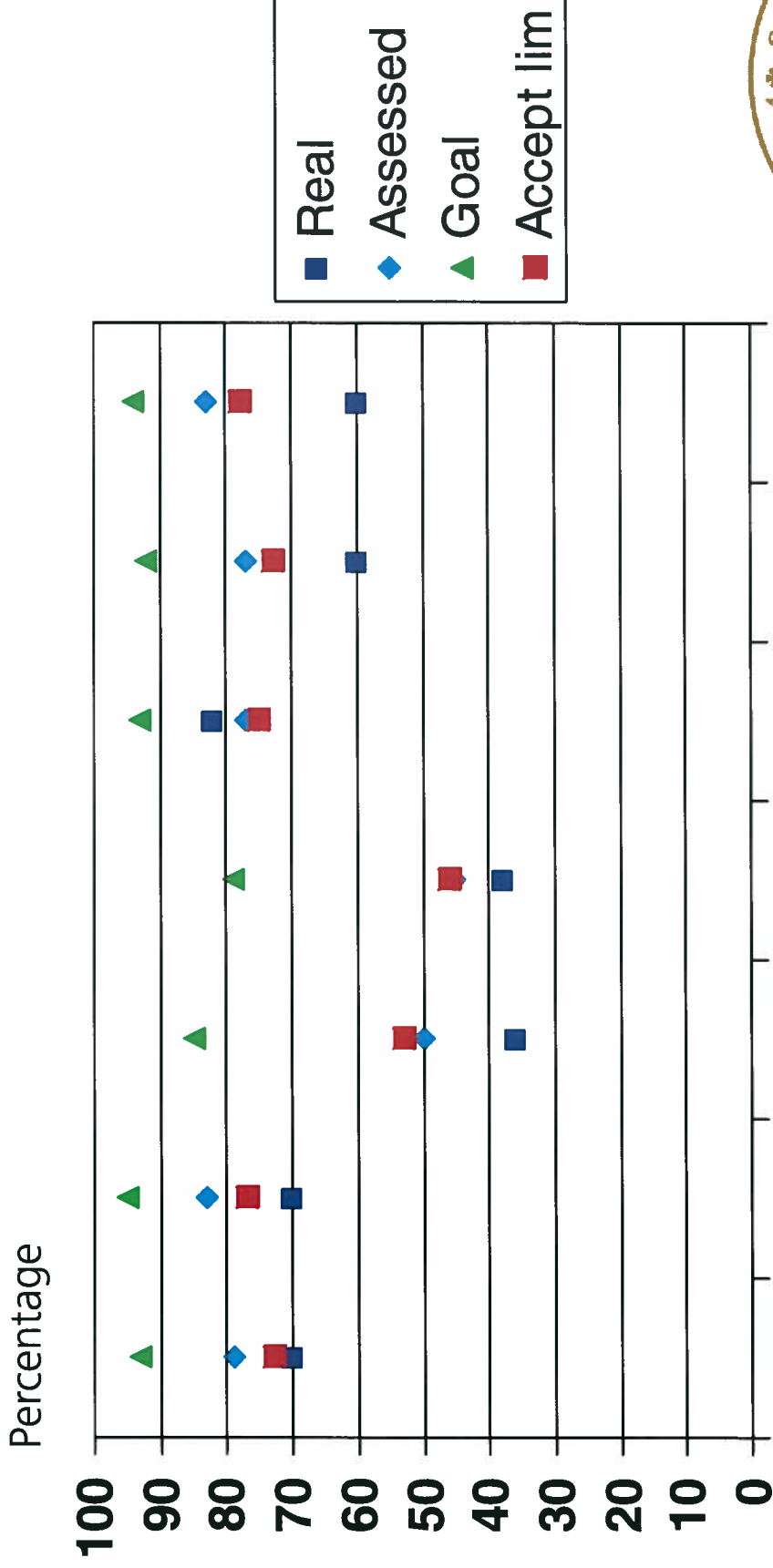
# Assessment of Safety Culture by Ground Handling Leaders



→ Reality often somewhat worse than (not as good as!) assessed.



# Assessment of Safety Culture by Ground Handling Leaders



**Learn Report Just Flex Comm Behav Percep**

→ Reality often worse than assessed limit for what is acceptable.  
Goals are good.



## Result – Work Situation

---

Good marks regarding:

- comfort and well-being
- education in safe work AD
- clarity in work/situations
- cooperation within ground handling



- stress (20)
- staff insufficient (AD 32, I 42)
- education in safe work (I 28)
- physical exhaustion (32)

AD = aircraft damage

I = injuries



## **Result - Flexibility**

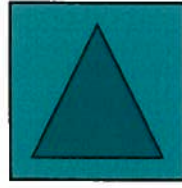
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Good marks regarding:

-doing somebody else's undone work task  
yourself



- no encouragement to give suggestions/ideas for improvements at work (36)
- seldom asked about how to solve a problem that has emerged (30)



## **Result – Communications at work**

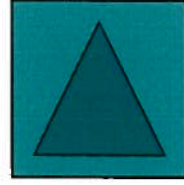
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Good marks regarding:

- gets the information needed for safe work
  - in most cases in time
- clear instructions from supervisor
- communication between units in the ground handling



- gets seldom the information needed for safe work (I 25)
- insufficient training in communication at accidents (42)
- not clear who to contact to discuss safety (AD 20, I 24)



AD = aircraft damage

I = injuries



# **Result - Reporting**

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Good marks regarding:

- information about safety questions
- can say what you think about safety (AD, I)
- management of SH AB listens to the employees about safety questions
- reports if equipment is damaged



- insufficient collection of information about if machines/ technical equipment are functioning (30)
- insufficient collection of information about if work routines are functioning (27)



AD = aircraft damage

I = injuries



## **Result - Just**

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Good marks regarding:

- just assessment if work has gone wrong
- does not hesitate to take one's own initiatives (because of concern if something would go wrong)
- gets often attention if one is not working in a safe way



-you feel operators being worried to get the blame for mistakes  
(32)

-gets seldom acknowledgement for safe work (AD 48, I 49)



AD = aircraft damage

I = injuries



## **Result - Learning**

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Good marks regarding:

- habit to, on one's own accord, look for problems in aircraft safety
- those responsible for ground handling act on info about failing safety (AD, I)
- doing improvements if deficiencies in work are discovered that may affect (AD)



- little encouragement to pay attention to safety deficiencies in the daily work (26)
- measures seldom in reasonable time after reporting (22)
- improvements are, in most cases, not done until something negative has occurred (47)



AD = aircraft damage

I = injuries





## Result - Behaviour

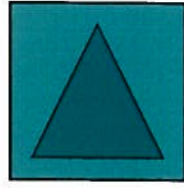
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Good marks regarding:

- colleagues encourage to safe work (AD, I)
- airport men work in a safe way
- ground handling management does not urge anybody to take short cuts at work
- management in SH AB does not urge anybody to take short cuts at work



- can do the work faster if some rules are not followed (46)
- almost no talk about how to improve work for increased safety (AD, I)



AD = aircraft damage  
I = injuries



## **Result – Attitudes towards safety**

---

Good marks regarding:

- SH AB, staff management & FPM are considered working for good safety (AD, I)
- feels it is worth time to talk about near-misses to learn
- feels great personal responsibility for airport safety



- very seldom taken part in the planning for safety (72)
- feeling the management SH AB hardly has any interest in the FPM well-being (20)



AD = aircraft damage

I = injuries



## **Result – Opinion about safety**

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Good marks regarding:

- thinks that work is done in a safe way (AD, I)
- has confidence in the ground handling management regarding safety
- feels that the ground handling work is done with good safety margins regarding the aircraft



- rather big risk to hurt oneself at work (58)

AD = aircraft damage

I = injuries



# **Preliminary summary of results of the SC investigation**

## **What was positive:**

- ◆ Communication in the daily work
- ◆ Behaviour concerning safety
- ◆ Attitude concerning safety
- ◆ Opinion about safety

## **Mixed positive and negative:**

- ◆ Work situation
- ◆ Reporting
- ◆ Flexibility

## **What was negative:**

- ◆ Learning
- ◆ Justness



# Part: Disturbance-Effect-Barrier (DEB) Analysis on the loading and unloading process at an airport

**Mattias Hallberg** (now SYCON), Sven Ternov and Roland Akseleson

Primary goal: Is the DEB method useful for a major investigation of system weaknesses at ground handling as a link in proactive risk management?

Method: The loading and unloading processes were studied with the DEB method at Sturup airport.



## **Disturbance-Effect-Barrier (DEB) I**

Developed by Sven Ternov.

Building on Failure Mode and Effect Analysis (FMEA), on Action Error Analysis (AEA) and on Man, Technology, Organisation (MTO) analysis.

The process is first divided in parts (a task analysis).



# Disturbance-Effect-Barrier (DEB) II

Unloading from luggage wagons to the arrival conveyor band.

Act	19 Towing truck to conveyor belt	20 Parking the truck	21 Unloading on conveyor belt	22 Truck and wagons to suitable place
Comments				
Document				
Possible disturbances				
Effect on the system				
'Probability'				
Latent conditions				
Barriers				



## Disturbance-Effect-Barrier (DEB) III

<b>Act</b>	<b>19 Towing-truck to conveyer belt</b>
<b>Comments</b>	The driver drives the truck with loaded wagons to conveyer 1 or 2
<b>Document</b>	7,8
<b>Possible disturbances</b>	Luggage falls of the wagon. 1) Discovered by the driver. 2) Not discovered by the driver. 3) Raining, snowing.
<b>Effect on the system</b>	1) Loss of time. Damage? 2) Discovered later. Damage? Loss of time. The traveller has to wait. 3) Luggage damaged by moisture.
<b>‘Probability’</b>	1) Occurring
<b>Latent conditions</b>	1,2) Too much loaded wagons (See also col 4&6). Poorly stowed (see also col 15). 3. Poor design of sheltering
<b>Barriers</b>	1,2) Watch backwards (also risk). 3) Good sheltering





**Act: Study of load message (LDM) (col 4)**

**Latent conditions**

- **Not clear who should read LDM**
- **LDM not easy to read**
- **LDM placed in a bad position**



## **And then ..**

- **Disturbance analysis. What happens if ...?**
- **Feedback from the operators (ground handling staff)**
- **Suggest reduction of latent failures and new or improved barriers**



## Results part 2

- **16 system weaknesses were identified**
- **Some improvements were implemented before the report was written**

- **The DEB investigation should be extended**
- **More participation from ground handling staff could save time and improve the quality**



## **How to get a common view ..**

**.. About what is important in an organisation?**

**Sometimes it looks like it is the economic result of the year which is the only important thing.**

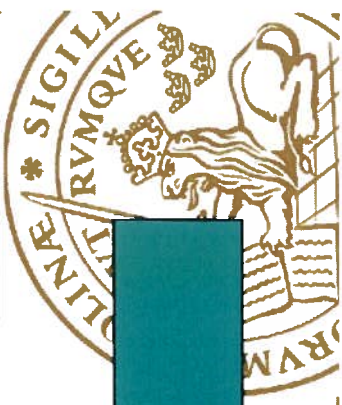
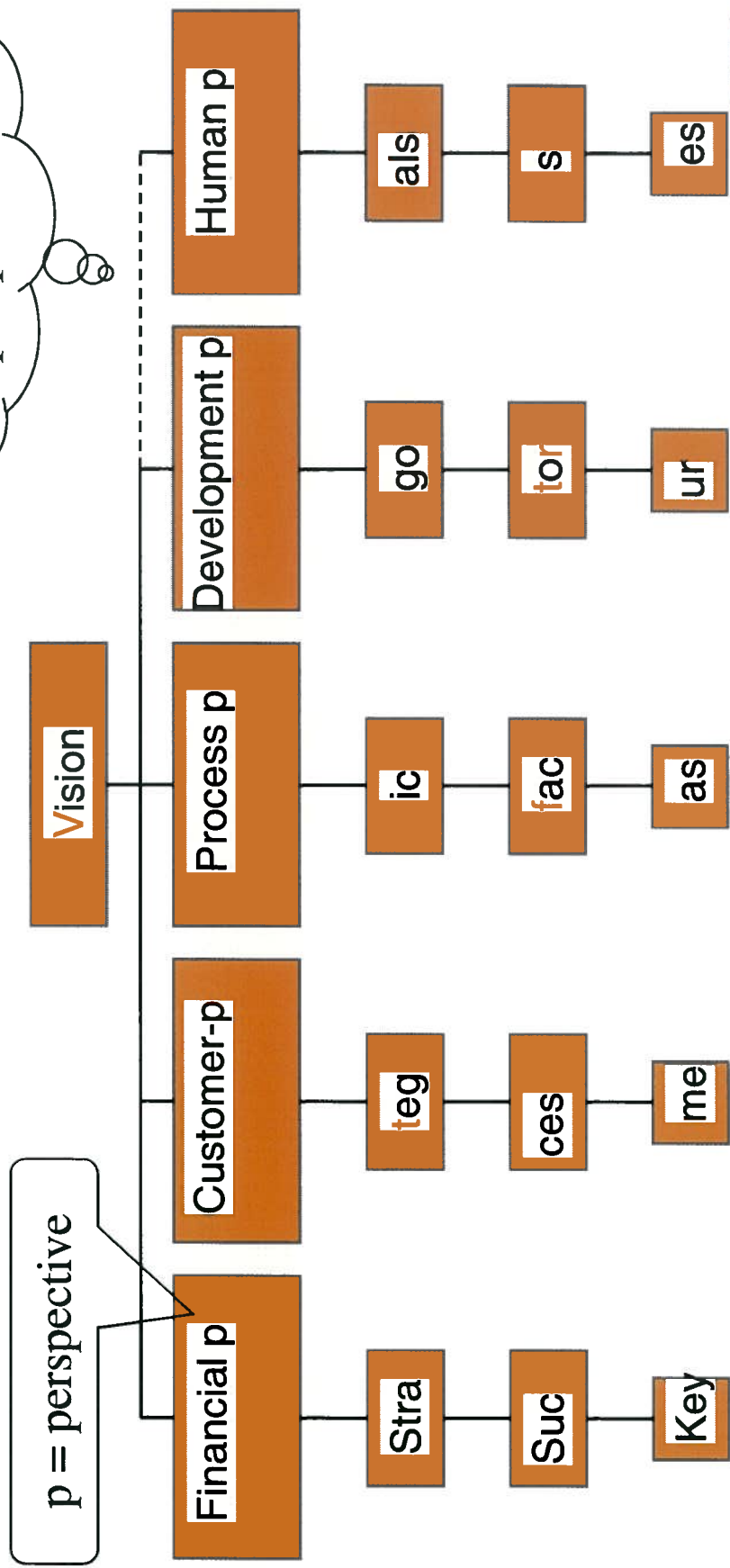
**Balanced ScoreCard or something similar are more and more used to bring out other perspectives as relations to good customers, human resources etc. Sometimes also Safety.**

**By including safety in such a system employees, middle management, top management, customers and other interested parties get the same view.**



# Balanced ScoreCard

Safety could be included as a perspective



Action plan

# Results I

**We hit an organisation with a good safety culture. But that was not the important answer for us. It was instead that the two methods (Safety Culture Evaluation and DEB-analysis) generated results in a form and way that they could be used by the organisation for learning and continuous improvements**

**We also get ideas on how to improve the methods.**



## Further ideas from the pilot project

- A generic AcciMap and an InfoMap should be tested
- Training programmes may be needed (SCARF?)
- Safety as a perspective in Balanced ScoreCard (or equivalent) may be an instrument for disseminating the importance of safety management to all interested parties (e.g. board, management, employees, customers, shareholders)



# Some basic principles for safer ground handling

which we would like to use and further develop

1. **To err is human.  
Design for safety**
2. **A systems approach.  
Involvement by all**
3. **Latent conditions,  
Safety barriers,  
Situational factors**
4. **Proactive risk mgmt**
5. **Safety Culture  
A learning organi-  
sation**
6. **Continuous improvements.  
Change processes.**  
Naturalistic or dynamic distributed decision making.
- 7.
8. **Psychosocial and physical  
work environment**
9. **Comparative studies between different  
trades**





**Thank you for listening -**

**- and coming to Lund**



# Tentative results – hypotheses 1

- **Ground handling needs special concern for safety and security in aviation, especially in an age of stress on and changes of organisations**
- **Safety culture measurements could be an efficient tool supporting continuous improvements of safety and security – i.e. they should be used as a part in the learning and improvement process**
- **DEB-analysis after some adaptation is a powerful method for identification of system weaknesses and for support of improvements**

