RESILIENCE ENGINEERING: THE ROLE OF LEADERSHIP AND LEARNING IN THE CREATION OF SAFETY

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ABSTRACT

The following study describes in detail a comprehensive safety audit that was conducted in a [redacted] company out of the chemical sector in May 2007. The research team consisted of seven persons in total; six of them were present during the actual data collection in the company.

The main goal of this study was to identify if the investigated company features characteristics of highly resilient organizations. In particular, the role of leadership and learning were the two key subjects we basically focused on. We defined these constructs by assigning different dimensions to each of them and listed several indicators how these dimensions could be determined. Thereby we associated highly resilient leadership with dimensions of "top-level commitment" and a "just culture"; to operationalize the concept of learning we used dimensions of "learning culture", "awareness", "preparedness" and "flexibility". Thereafter, we developed questionnaires, based on these indicators, and conducted almost 50 interviews with people from different positions in hierarchy, from operators up to higher management. We also had a two-day period of field observation available as well as other data out of brochures and the company's homepage to derive our findings.

Our analysis was split up in two parts as we decided for an ethnographic approach: The first step was to sum up the answers that were given to the particular questions and to compare the operators' and managers' views. The second step consisted in tracing back these answers to underlying patterns, regularities and circumstances the whole company has to deal with. For this reason we also can say that we followed a systemic approach.

Mainly we experienced that the company in general had a very high commitment to safety and a just culture where an open discussion about safety concerns is encouraged. We also found out that Chemco has already taken some steps to create a learning culture and that there is a high level of awareness – a lot of managers know what is going on in the company; the operators' level of awareness was not as high, though. Most employees felt well prepared for the future, but some of them had concerns about the company's flexibility, for example concerning human resources if shortages appear.

Searching for patterns or regularities we discovered five themes that often appeared in the answers of operators and managers: the existing conflict between safety and production, the doors of managers that were not as open as we first thought, the normalization of daily risk, specific vulnerabilities of the company that come along with the company evolving and an organization that aims at developing new products, and closing the loop of learning, because we think the company hasn't reached a level where learning from failure is certain.

Based on these patterns and also the findings we derived in the first step of our analysis we lastly delivered recommendations for measures that could be appropriate to enhance safety at Chemco.

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PREFACE

This report shows the results of the investigation we have done at Chemco, a Chemical company. Chemco is an established company, founded in [redacted].
The company [redacted] invited us to investigate their safety climate and to provide them with recommendations how the safety could be improved.

[redacted]

In these days the company has to deal with more production pressure than years ago [redacted].

On first sight Chemco seemed to be in a good state with their safety system. There is a yearly safety day, a department dealing with safety and there seems to be a high awareness of the importance of safety. That is the reason why our focus in this report will be more to optimalize this organisation. Chemco is an organization where the safety level is very high yet; therefore our aim is to still increase this already high safety level and to provide new insights from a external perspective.
To perform this investigation we went up to the company and did two days of field research in the different plants, with a team of six people. During this field research we experienced the processes in the plants and conducted interviews with the operators at hand. Afterwards we did interviews with different people from different management levels, laboratory and other staff.

Hereby we want to thank all the participants who contributed to this research; all of them were very open the whole time and shared their opinions with us straightforwardly. We also want to thank the management of Chemco for letting us conduct this investigation, for being also this open and for providing us with great help and support during the research wherever it was possible.

SCIENTIFIC FRAMEWORK

The base of the whole investigation is built by two research questions that were formulated during the first talk to the safety manager. These two questions were:

- What is the role of leadership in the creation of safety?
- What is the role of learning in the creation of safety?

To conduct the investigation the two research questions had to be operationalized. Based on the existing literature we found for each of the two research questions different dimensions that seemed to be appropriate to operationalize the constructs of leadership and learning. The dimensions that will be used to operationalize the research questions are claimed to be the main themes in highly resilient organizations (Wreathall, 2006, p. 279) and can therefore be seen as the success factors of resilient organizations. As a consequence for the analysis later we can say that if we find these dimensions at the investigated company we could also say that this company seems to be a highly resilient organization.

For research question 1 that deals with the role of leadership in the creation of safety we used the two dimensions "top-level commitment" and "just culture" to operationalize the concept of leadership.

By top-level commitment we mean that "top management recognizes human performance concerns and tries to address them" (Wreathall, 2006, p.279), that management shows a sense of significance of human performance and appreciates it (Wreathall, 2006). In general one can say that the human work is valued by the management.
Furthermore we understand by the term top-level commitment that management makes "sacrificing decisions", i.e. that the management knows when to relax production pressure and efficiency goals and to put safety first (Dekker, 2006, p. 83; Dekker, 2007, p. 2). Flin (2006) e.g. reports a survey on safety climate conducted in the North Sea oil industry where a major topic was to find out if "there is sometimes a pressure to put production before safety" (Flin, 2006 after Flin et. al., 1996). Another important indicator for the top-level commitment to safety is if the management encourages people to "speak up when they are concerned about safety" (Flin, 2006, p.229) and if management "encourages people to halt, or slow down production if there are unforeseen safety concerns" (Dekker, 2007, p. 2). In general this could be called appreciation of "safety-first-behaviour".
This level of the managers' commitment to safety is considered to be "the essential ingredient of the organisation's safety culture" (Flin, 2006, p. 229).

The second dimension of leadership, the just culture, can be operationalized as the "degree to which the reporting of safety concerns and problems is open and encouraged" (Wreathall, 2006, p. 285). This includes "that the boss can hear such [bad] news" (Dekker, 2006, p. 78) and that reports of problems are rewarded by the management (Dekker, 2007, p. 2) - people should be "empowered to help intervene, change and improve the organization" (Dekker, 2007, p. 2).

The second research question about the role of learning in the creation of safety can be defined by using four different dimensions: learning culture, awareness & opacity, preparedness and flexibility & adaptive capacity.

A learning culture deals with the question if an organization responds "to events with denial versus repair or true reform" (Wreathall, 2006, p.280). How does the organization deal with incidents or accidents? Is the organization able to rebound also under enormous pressure (Dekker, 2006, p. 78)? Furthermore it is important that the organization doesn't rest on its laurels and that past success is not taken as a guarantee for future success (Dekker, 2007, p. 2). Learning should capture a major significance in the whole organization, "lessons from incidents and other events should be handled seriously" (Dekker, 2007, p. 2) and feedback should be provided throughout the whole organization (Dekker, 2007, p. 2).

Awareness can be defined as the knowledge of "what is going on" in the organization (Wreathall, 2006, p. 280) and opacity means being aware of the system's boundaries and knowing how close it is to "the edge" of it's design envelope (Wreathall, 2006, p. 280). The organization has to gather data of the current state the organization is in and monitor it – beliefs about the organization, safety and brittleness have to be updated regularly (Dekker, 2006, p. 79) and have to be contrasted with e.g. historical ideals (Dekker, 2006, p. 89). Especially the relation of work as imagined and work as actually done has to be investigated thoroughly (Dekker, 2006, p. 86). Often work drifts away from the given procedures without management recognizing that. Therefore management has to continually test whether their ideas about work and risk still match reality (Dekker, 2006, p. 92). To keep the organization aware of "what is going on" safety concerns "have to be widely distributed through the organization at all levels" (Wreathall, 2006, p. 284).

Preparedness is the third dimension to operationalize the concept of learning. Preparedness means to "foresee and avoid" (Westrum, 2006, p. 59) potential events that could harm the organization and its people. This includes being ahead of the problems of human performance and actively anticipating problems and preparing for them (Wreathall, 2006, p. 280; Diamond 2005), e.g. through regular safety group meetings, quality circles or scenario workshops. Diamond (2005) considers the ability to anticipate a problem before it has arrived as on of the major qualities a system needs to be resilient. The ability to predict upcoming treats, which is important not only for designers but also for the operating people, is called "requisite imagination" by Adamski & Westrum (2003). It is a kind of foresight that has to pay particular attention to "faint signals" (Westrum, 2006, p. 59) – an intuitive feeling of something being wrong ("gut feeling") or an intelligent speculation of suspected trends (Westrum, 2006, p. 59). Especially when we keep in mind that the chemical industry can be allocated in the area of ultra-safe systems, which means that their accident probability is 10-6 or better (Amalberti, 2006, p. 262), we have to consider that usually "the next accident has never been seen before. Its decomposition may invoke a series of already seen micro incidents, although most have been deemed inconsequential for safety" (Amalberti, 2006, p. 270). For this reason it is indispensable to take every faint signal and gut feeling for very serious.

The last dimension we have to consider regarding the role of learning is the concept of flexibility and adaptive capacity, which can be defined as follows: "The stiffness of the decision-making in the organization, and its failures to respond in a timely manner to an increasing need for revising its response to the pressures of production to allow increased protection" (Wreathall, 2006, p. 284). People at the working level sometimes have to make quick decisions where they can't wait for management instructions (Wreathall, 2006, p. 280). This degree of freedom can also be seen as an indicator for the adaptive capacity of the system, i.e. "how well the system adapts and to what range or sources of variation" (Woods & Cook, 2006, p. 69) if it is pushed to the boundaries. Woods & Cook (2006) regard this aspect as what resilience is particularly concerned about. Further on the installation and use of "slack resources", e.g. material, design-oriented resources or additional times for people to react (Wreathall, 2006, p. 281) can display another indicator for a flexible organization that can cope with unforeseen trouble (Westrum, 2006, p. 61). In that way organizations can quickly respond to disturbances and can absorb sudden challenges (Wreathhall, 2006, p. 281) when surprising disruptions occur.

Based on these dimensions and indicators, we developed a structered questionnaire for our interviews. Hereby we ensured that each of the dimensions and derived indicators was covered with questions sufficiently, but at least one. We added some general questions about the employees function and daily work and e.g. their workload and personal experience with accidents. We also included a lot of open questions, because we wanted the interviewees to talk and to describe their own feelings about the safety culture at Chemco. Therefore we asked questions with a high emotional level as well; for example "What are you most afraid of?".

We conducted the same interviews for operators and managers most of the time. This way we could compare the answers of the managers with the answers of the operators. For example when we asked the managers "How do your show your subordinates that you appreciate what they are doing?" we asked the operators "Do you think your boss values your work? How can you see that?". This approach provided us with a multi-perspective picture of the actual situation at Chemco and allowed us to directly contrast different views on the same topic. The interview questionnaires can be found in the appendix.

DATA ANALYSIS – GENERAL REMARKS

We chose an ethnographic approach to collect and analyse the data. By ethnographic is meant that we study the "members of a culture-sharing group or individuals representative of the group" (Creswell, 1998, p. 112). We have tried to do that by selecting a wide spread of different operators and managers of the investigated company. Typically "participant observation, interviews, artefacts, and documents" (Creswell, 1998, p. 113) are used to collect and record information. We realized that by conducting dozens of interviews, writing down field notes and using official information that we got from the safety department or from the official website. Analyzing the data we tried to "show different perspectives through the views of informants" (Creswell, 1998, p. 152), especially in our first step of the analysis, where we used quotes very often, and we also attempted to provide the reader with a "rich enough database […] to frame alternatives, to disagree with authorial certainty, to see things different" (Bosk, 2003, p. 216). In the second step of the analysis we "search[ed] for pattern regularities" (Creswell, 1998, p. 152) and interpreted the data from our own perspective:

> "Making an ethnographic interpretation of the culture-sharing group is a data transformation step as well. Here the researcher goes beyond the database and probes 'what is to be made of them' (Wolcott, 1994b, p.36). The researcher speculates outrages, comparative interpretations that raise doubts or questions for the reader. The researcher draws inferences form the data or turns the theory to provide structure for his or her interpretations. The researcher also personalizes the interpretation: 'This is what I make of it' or 'This is how the research experience affected me' (p.44). Finally, the investigator forges an interpretation through expressions such as poetry, fiction, or performance." (Creswell, 1998, p.153)

Analysing the data we chose, as mentioned before, a two-step approach, that we want to describe here in more detail.

Firstly, we will describe and sum up the answers given to our interview questions from both sides – the operators' and the managers'. We will try to do that without interpretation. Whenever we feel that we have to give our own opinions and speculations about the answers of our interviewees we will highlight that with words like "we feel", "we think" etc. In this chapter we will follow the structure of our interview form for the description of the results, presenting the questions and the summaries of the particular answers one by one. Whenever we feel that some questions result in almost the same answers or cover the same topic we will consolidate the answers, though.

As "data never speaks for itself" (Bosk, 2003, p. 241) we will conduct the analytical lift of our interview and observation data in the next step. In this step we will present the patterns and regularities we found and will come up with some higher-order categories for our findings. This chapter will be supported by literature and comprises our own ideas and interpretations about the company we investigated. It shall provide a version of reality that is "good to think with" (Bosk, 2003, p. 216 after Levi-Strauss).

For the whole analysis the interview data will be used as main source for findings. Our field observation notes will be used as background material and will be filled in when we think that our interview data is not sufficient to illustrate the themes ample enough.

To safeguard the company and protect our interviewees we decided to name the company "Chemco" (the chemical company), which is a fictive name of course. All operators and managers obtained codenames, which start for the manager group with MA01 and for the operator group with OP01. The numbers are given in a random order so that no manager or operator can be identified by e.g. interview date, etc.

1ST STEP – DESCRIPTION: FROM SINGLE ANSWERS TO SUMMARIES

For the first step of the analysis we will sum up the answers that were given within the operator group and the answers given within the manager group, so that we can compare the statements of the both groups. In this part we will stay close to the interview data and we will merely describe and sum up what we have heard.
Therefore we divided this chapter into different parts, the different dimensions we mentioned in the first chapter that are crucial for a resilient organisation. In this chapter there are several paragraphs according to the different topics of each dimension. So each dimension consists of several topics. In the final part of our research all these topics will lead to one final thought about the different dimensions. Interpretations or speculations are not intended in this section, but will be presented in the next chapter about the second step of our analysis.
Whenever we speak of the operator group in total we will call them "operators". By operators we mean the persons that have to deal with the production process in direct contact – persons who "monitor processes, have to deal with raw materials, do all processes of chemistry, have to mix materials and pack out products" (OP15).

We will name the manager group in total "managers". In the manager group all plant supervisors, process engineers and lower-, middle- and higher-level managers are included.
In our data sheets we classified the different groups with abbreviations like SV for supervisors, PE for process engineers and MA for all levels of management. That way we can also separate the opinions of the different functions within the manager group.

Plant supervisors are "responsible for personal and plant equipment" (MA02), are in close contact with their operators on the plant and are in charge of the production lines.
Process engineers "cooperate a lot with the plant supervisors" (MA08). They can be "responsible for the development of new products" (MA09) or in charge of "decisions for processes, equipment, how to run the processes (different parts of production), plant upgrade, building new things in plants" (MA09). Process engineers on call can be phoned by the operators, e.g. during the night, if a machine breaks down or safety is at risk during production (OP15).
Managers have different tasks within the company. Production managers e.g. "have to ensure that production runs smoothly" and that "they produce in the right time, the right quality" (MA16), other managers are in charge of other functions like sales & marketing, purchase & logistics, R&D etc.

Whenever we feel that the overall opinion of the manager group is varying a lot we will give a more specific answer taking the three different subgroups (supervisors, process engineers, lower-, middle-, upper management) into account. If we feel that most members of the manager group speak with "one voice" we will not divide the answers into subgroups, though. Although we separated the manager group in these three different subgroups the coding was uniform: the managerial code (MA) and a random number for each person.

General part

In the general questions part we decided to skip the questions that asked for the job, the task and the decisions the person is responsible for, as we felt that the answers within the operators' group and the answers given within the managers' group are very similar, very general and without additional (explanatory) value. Therefore we focussed on the questions that initially dealt with basic safety issues like own experiences with accidents, estimation of workload, greatest fear and the perception of the safety culture at Chemco.

Workload

This paragraph sums up the answers to this question:

- How would you estimate your workload or your production pressure? Would you like to reduce it? How?

Operators
Seeing through the operators' answers we found out that the answers given varied a lot. More than one third of the operators that answered the question felt that their workload is too high and "it would not hurt to reduce it" (OP28). Noticeable is that a couple of people reported a rise of the workload and pressure during the years:

- "There is much faster tempo today than in previous years" (OP19),
- "The workload increases every year and so does pressure" (OP08),
- "The workload is getting bigger as years go by, this increases pressure and stress" (OP05).

Some of these operators experienced a too high workload all the time, others mentioned that the workload is not that high all the time, but that "small periods of time are intense" (OP14) or that "if you have deadlines of course then you have stress" (OP26). A lot of the interviewed operators reported on large variations concerning their workload.

Less than one third of the operators answering the question estimated their workload as too low. They pointed out that it is

- "relaxed", that they have "plenty of time" (OP14),
- that "sometimes the work is too easy" and that "I don't feel any pressure or a too heavy workload" (OP09)

Only three of the 24 operators who expressed their opinion estimated their workload as adequate and said that "it is fine" (OP06) or it is "not too little and not too much" (OP10).

A few operators commented also on the question "Would you like to reduce your workload? How?" and pointed out that they "would like to reduce it" (OP22) and that a reduction of workload "will help a lot" (OP08). Only one operator made a suggestion how workload could be decreased and suggested "hiring more people" (OP05).

Managers
Almost the very same tendencies that we experienced in the operators' group can be found in the managers' group. More than two third of the managers who answered the question bespeak a high workload that is sometimes "too much to handle" (MA20) and "incredibly heavy and stressful" (MA04). Some of the managers also report on an increase of workload and pressure during the years – "the past years the workload increased" (MA01) and there is "more pressure now than before" (MA19).

Half of the managers that felt that the workload is too high stated that for some phases it is too low as well:

- "Stress goes with ups and downs" (MA02),
- "There are periods with intense workloads but other times with no" (MA03),
- "It varies a lot. Some days it is very quiet. Some days it is very busy and stressful" (MA08).

However, there are still one third of the managers who answered and claimed that their workload is constantly very high. Only a few managers highlighted that there is "not a lot of time pressure" (MA17) or that they experience an adequate level of workload.

When asking for the desire to reduce the workload, we received sparsely the answer "Yes, I would like to reduce it" (MA15). More managers thought that they "don't want to reduce it" (MA14) or that a reduction is not necessary (MA21). Two managers relativized their workload by referring to the company itself or other employees: "I have not as much pressure as the company itself" (MA21), "from time to time I have stressful periods, but I think this is the same for all employees" (MA01). Other managers felt a personal satisfaction when doing a lot of work: "I can deal with the stress and I prefer a variety in the stress-level" (MA20), "I like to work a lot, so I want to do more work" (MA04).

Talking about how the workload could be decreased, two managers proposed to hire more personnel and another manager suggested to split work better.

In general one can say that most managers and operators both reported a high amount of basic workload and often an alternation between phases of high and low workload. Both groups experienced an increase of workload during the years and only a few employees feel that their level of workload suits well.

Experience of accidents

This paragraph includes the following questions:

- What do you consider failure? Do you have any examples?
- Have you once experienced an incident or accident?
- How often do accidents occur (per year)?

Operators

Basically, operators did not define what they thought to be failure, but they gave a lot of different examples that will be listed hereafter. Operators think of diverse shapes that the term "failure" can take. Mainly, these points can be categorised by these classes, which are certainly not distinct from each other:

- Technical equipment (break of machines, technical problems)
- Production (not met production goals, fail of production)
- Procedures (not following the rules, pushing the wrong button, opening wrong valve, things boiling over)
- Logistics & supply (delay of materials, not delivering on time)
- Quality & quantity (making inappropriate quantity or quality, inability to produce the proper amount)
- Injuries (injury by chemicals, acid in the eyes)

Managers

Looking at the managers' answers they mentioned the same points as the operators, but three of the classes were stressed by them in particular and were stated very often:

- Quality (product doesn't fulfil quality specifications, quality is not good enough, quality deviations)
- Logistics & Supply (delay of raw materials, delivering the wrong quality or quantity to the customer, delay in delivery)
- Injuries (people getting hurt, injuries of people)

A few of the managers stated opinions about failure that have not been given before, e.g. failure as "not finding a compromise on a meeting" (MA16), "operators that do things contrary to how they should do it" (MA16) or "making the wrong decisions on a project" (MA06).

Operators

Regarding the following question that contained personal experience with an incident or an accident 18 of the 23 operators that answered the question stated that they had a least once experienced an incident or accident at their workplace. Mostly these incidents or accidents dealt with themes of opening wrong valves, mixing wrong substances, spills, splashes, solvents or acids that get in touch with people's skin, burnings, e.g. from hot steam, and explosions. Only five of the operators reported none incident or accident at all.

Managers

15 of the 21 managers answered this question. Most of them admitted that they had at least once experienced an incident or accident. A few of them could merely refer to incidents or accidents their operators experienced, e.g. "rash for employees" (MA15) or "the operator got blisters from an acid" (MA16), but most of them had previous experience as operators or process engineers and told us about events they personally experienced. The managers reported on the same incident and accidents that are listed in the previous paragraph.

Operators
The operators answered the question "How often do accidents occur (per year)?" very different. Of the operators who answered the question, which were 18 in total, six persons estimated that accidents happen zero to two times a year. Four persons explained that accidents happen two to five times a year and one person said that 120 accidents happen per year in the whole company. The rest was "not sure" about it. It could be said that the interviewed operators basically agree that accidents in their own plants happen zero to five times a year (if we omit the one operator who talked about the whole company).

Managers
16 managers answered the same question. Most of them distinguished between incidents/ "smaller accidents, where we have to use the first-aid-kit" (MA17) and big accidents, where "people have to go to hospital" (MA17), "sick leave is required" (MA04) or the environment is affected (MA07). Concerning the big accidents the managers also agreed upon having between zero to five big accidents, most of them estimated zero to two big accidents a year. Looking at the incident or smaller accidents the answers differed a lot: two managers talked about zero to five incidents a year, two others stated there are 10 to 20 incidents and again three other managers pointed out that there are more than 20 incidents a year.

One of the latter even said that "incidents occur all the time at least 100 this year" (MA05). Eye-catching and also alarming is here that also a couple of operators pointed out that "small things happen all the time, e.g. ladders slipping away" (OP16), that "minor things always occur such as trembling when pouring substances" (OP05) or that "burning at hot steam or hot water are typical incidents that happen often" (OP01). Combined with the statement of one operator who declared that - if only small things happen, no report is usually written - this could result in an inaccurate management perception of the actual number of incidents or accidents that happen at the operators' level.

To sum up this paragraph there are a lot of different classes the term "failure" can comprise –from technical equipment to quality to logistics and so on. Almost every operator and also every manager have at least once experienced an incident or accident personally. Regarding the number of big accidents that happen per year operators and manager draw the same conclusion – big accidents happen zero to five times a year. Looking at the smaller accidents or incidents the operators did not put numbers on it, but felt that small things happen all the time. The manager group was rather dissonant – their statements varied from zero to more than 100 incidents a year.

Greatest fear

This paragraph sums up the answers to this question:

- What are you most afraid of?

7 managers and 5 operators did not answer the question. We will present the answers of the rest in a table where multiple answers are permitted. The answers have not been categorized - they are one-to-one extracted from the particular answers.

Operators
The perception of fear is different for the operator and the manager group. Operators describe as their biggest fears:

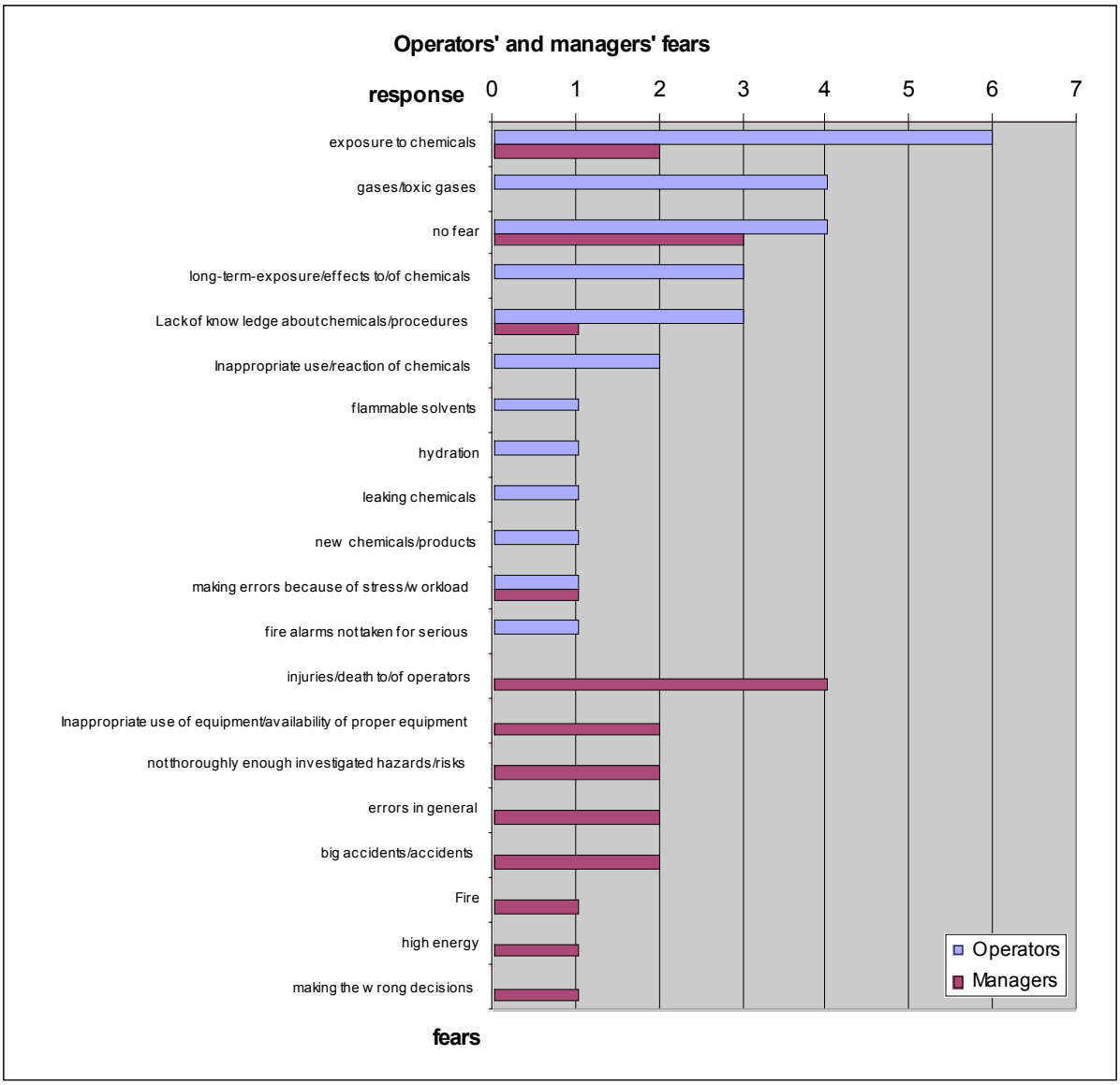
- exposure to chemicals,
- toxic gases/gases,
- long-term-exposure/effects to/of chemicals,
- a lack of knowledge about chemicals or procedures and
- inappropriate use/reaction of chemicals.

Managers
Whereas managers talk about fear as:

- injuries or death of operators,
- inappropriate use of equipment/availability of proper equipment,
- not thoroughly enough investigated hazards/risks,

- errors in general,
- big accidents/accidents and
- exposure to chemicals.

There are also some operators and managers who have no fear at all. They "have confidence in the safety standards" (MA19) or "feel safe" (OP09). However, the major part of both groups is afraid of one or more hazards.



In general operators' fears concern the direct handling and exposure to chemicals ("some chemicals are not safe at all" (OP15)), the long-term-effects this handling entails ("If a new product is produced you do not know what long-term consequences it has to deal with the product, e.g. if you are not getting kids, etc" (OP14)) and their missing knowledge of what they deal with – "are the new chemicals really safe?" (OP01).

The managers' fears are mainly residing on a higher level and don't refer to the daily interaction with "nasty chemicals". They fear that operators are injured, that equipment is used inappropriate ("using equipment in new ways where we haven't it tested for" (MA17)), that risk analysis isn't done sufficiently ("I'm afraid of if they are doing the risk analysis as they are supposed to do it" (MA01)) or that errors or big accidents occur in general. Just as the operators they fear the exposure to chemicals in general.

Description of company (safety) culture at Chemco

This paragraph displays the answers to the question:

- How would you describe the company culture?

As we left it completely open what we meant by company culture the answers on the question "How would you describe the company culture" varied. Most people referred to the safety culture of the company when answering the question.

Operators

Most operators described Chemco as a "company that takes care of you" (OP14) and where "they are focussing more and more on safety" (OP16). A lot of them said that "safety works good" (OP26) that Chemco is a "safe company" (OP02) or that "the safety culture is well addressed" (OP23). A couple of operators stressed also the "very open communication" (OP07) and a climate where "you can talk to anyone, even the vice president has an open door policy" (OP20).

However, there were also critical voices – some of these stemmed from the same persons that stressed the high importance of safety before: Some operators felt that "safety is important when you do not have much hurry. But if there is production pressure, safety is not important – production is put first" (OP16). Another operator explained that he "has seen better and worse. The profit is more important – machines are running 100% of the time although they weren't built to do so" (OP22). We also heard of operators complaining of one and the same problem again and again, but "there wasn't anything done" (OP15) until an accident occurred. And another operator stated that "procedures work well on paper but I am not sure if they work in all the factories the way they are supposed to" (OP21).

Managers

Looking at the managers' answers almost every manager stated that safety comes before production – "it is our slogan, but also reality" (MA09) – and that "safety comes first no matter what" (MA04). A lot of managers highlighted that "safety awareness is high in general" (MA08), that "there is generally a high safety focus here" (MA16) and that the management team is committed to safety – "you feel that the highest manager is dedicated to safety" (MA16). Several managers also felt that there is a great amount of openness in the company, that the whole organization is flat and the communication good.

Nevertheless there were almost as many critical voices as in the operator group – and a lot of the critical voices derived from people who estimated Chemco to be a safe company before: A couple of managers considered the time and production pressure as the main reasons that safety is not always put first. One manager pointed out that "there are also moments when you have to do things the direct, fast way, e.g. if you are very focussed on delivery safety is No. 2" (MA17). "Safety first – say the high people, but just under them production and money is most important" (MA19) explained another one. Other managers felt that "there is too much pressure at the moment" (MA07) and that there are "a lot of SOPs, but some are side stepped to get money faster (at a company level)" (MA18). One manager even conceded that Chemco has a "high standard of safety commitment […], but I do believe we have problems to get it down to the operators" (MA15).

Recapitulatory one can say that operators as well as managers feel that there is a high commitment to safety from the management, that safety is well addressed and that an open communication is possible. Nonetheless, some of the same operators and managers stated that safety is not always put first, especially when time and production pressures appear.

Top-level commitment

Appreciation of work

This paragraph sums up the answers to following question, which was phrased a bit different for the operators and the managers:

- Do you think your boss values/appreciates your work? How can you see that? (OP)
- How do you show your subordinates that you appreciate what they are doing? Do you think your boss values/appreciates your work? How can you see that? (MA)

Operators

The question "How do you show your subordinates that you appreciate what they are doing? Do you think your boss values/appreciates your work? How can you see that?" was answered by 27 of the 28 operators. 20 of them stated clearly that they thought their boss appreciated their work. The remaining seven operators weren't sure if this is the case; some of them merely said "I hope so" (OP06) or "I'm not sure, what my boss thinks" (OP15). One of the operators even answered with "no" (OP22).

Appreciation is mostly shown in direct communication with the operators through statements like "you are doing a good job" by the executives. Some of the operators also reported "the boss shows gratitude" (OP21), "the boss is in good mood" (OP21) or is "nice to me" (OP10). Two operators referred to the yearly evaluation (point system) and the feedback talk that takes place and mentioned that they are "happy with the evaluation" (OP14) or that "in the feedback talk my boss tells me that my work is valued" (OP16).

Managers

The major part of the 17 managers that answered the question stressed the importance of communication and explained that they tell their subordinates "that they did good" (MA16) or that they say other "positive things" (MA15). Some of the managers try to show their appreciation by their behaviour and have an "open door" (MA14), "show importance and provide support" (MA21) or "if they have problems I will help them out" (MA02). One of the managers even mentioned that he "sometimes buys them a cake or something" (MA02). A few managers brought the raise of salaries up (MA15). However, two managers were uncertain if they showed their valuation and stated that "I try to hear what they say" (MA17) or "I hope I show it" (MA15).

Being asked about the appreciation of their superiors ten managers provided their answers. All except for one, who "hope[d] so" (MA16), confirmed clearly "yes, my boss values my work" (MA17). The managers mentioned that this valuation is basically shown in direct communication on a regular basis (feedback talk), but also in an informal way. Some manager pointed out that their superiors show their appreciation through their behaviour: The boss "shows gratitude" (MA19), "trusts my decisions" (MA18), "made my responsibilities grow over the time […] and I got also a salary raise" (MA15).

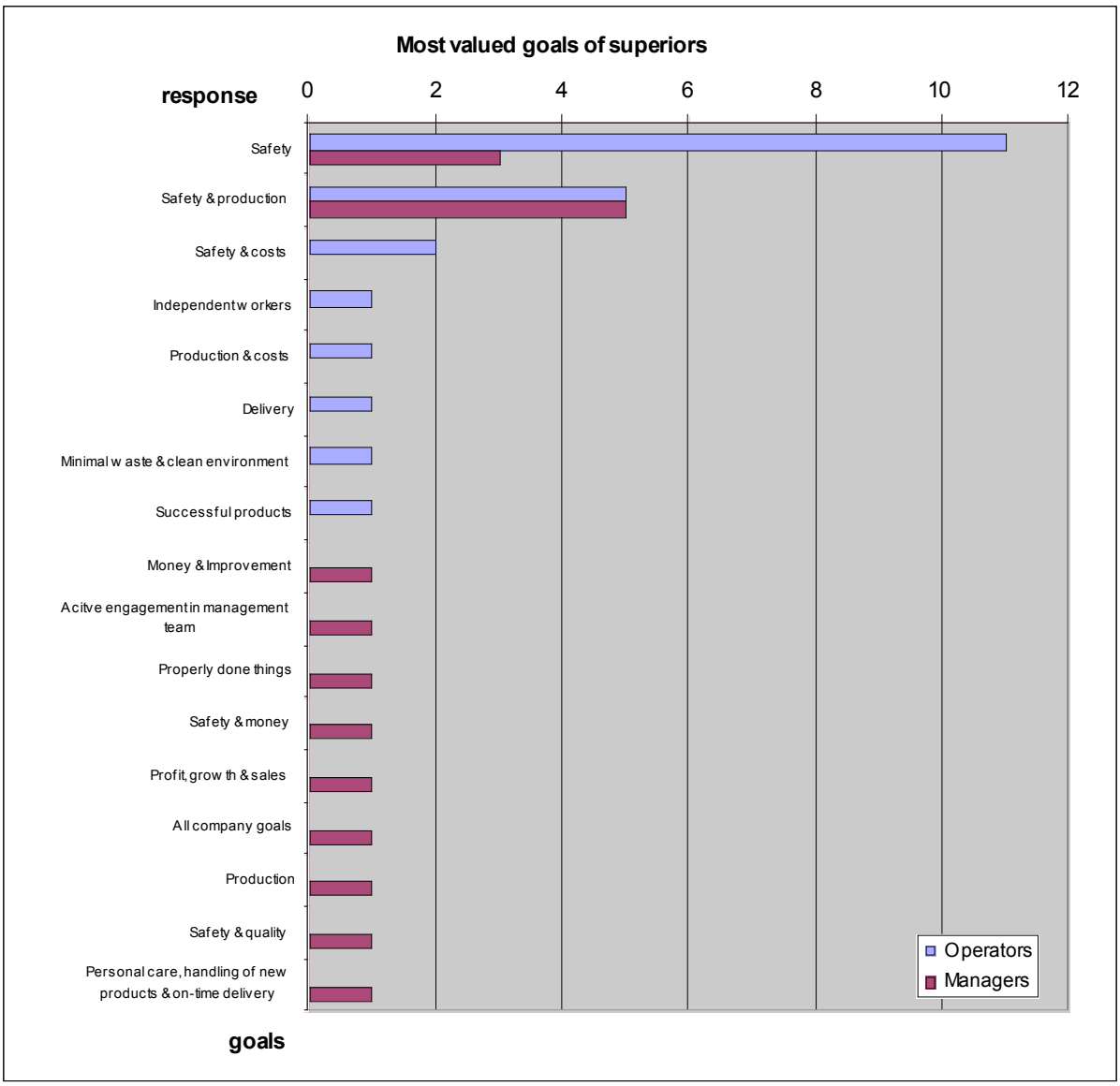
In total more managers than operators had the impression that their work is appreciated by their superiors. Some operators were very uncertain about their boss' opinion. For both parties the main medium to express this valuation is direct communication.

Goals of superiors

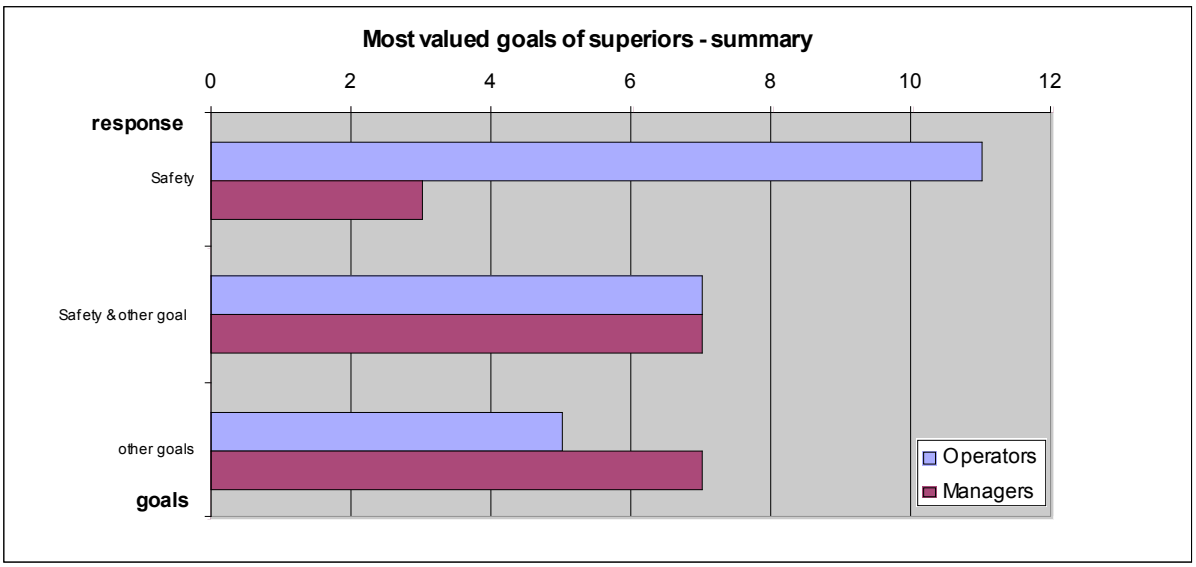
This paragraph lights up the answers to the following question:

- What goal does your boss value most?

The following table illustrates the results:



A lot of different answers were given to this question. To sum them up we divided the answers of operators and managers in three categories: answers that clearly stated that safety is first, other answers that pointed out that safety plus another goal is first and the remaining answers where safety was excluded from the answer. Thus, the following table emerged:



Operators
A huge number of operators explained that their boss values safety most. Combined with the ones that stated that safety is at least one of the two most important goals 18 of the 23 operators that answered the question felt that safety is in one way or the other an important goal to their superiors. Only five operators pointed out that other goals, like costs or delivery, are the most valued goals of their superiors.

Managers
For the managers a different picture unfolded: Only three of the 17 managers felt that their superiors put safety first. Seven managers felt that safety plus another goal is most valued by their bosses and the same number of managers experienced other goals to be first for their superiors.

The feeling that safety is not always put first was explained in more detail by some of the operators and managers that claimed other goals to be first, but also by a small amount of operators and managers who stated that their superiors put safety always first. All of them told of uncertainty about the credibility of superiors, the conflict between production and safety and some even addressed the stakeholder orientation of the company:

- "The management says that they emphasize safety, but you never now if they mean it the way they say it" (OP14)
- "The boss says that safety is first, but I don't feel that the boss believes in it to 100%" (OP19)
- "Safety is first – and maximum production" (OP05)
- "I'm not sure – sometimes safety and production conflicts. Things that are not safe are done anyway and you can tell your supervisor later" (OP15)
- "Safety is the most important, but money is always an issue" (MA05)
- "Safety is first, but they overlook minor safety procedures to reach production goals" (OP23)
- "I'm pressured to get the product in time, but safety is always first" (MA03)
- "Money is of course No. 1, to make the reports for the market and the steering committee" (MA16)

In general there are more operators than managers who think that their boss values mere safety the most. Only 3 of the 17 managers, but 11 of the 23 operators stated that safety is exclusively the most important goal for their superiors.

Stopping production because safety is at risk
This paragraph deals with the answers to the following questions:

- Have you ever made a decision where you had to stop production because safety is at risk? (OP)
- Do you feel you have the ability to stop production if safety is at risk? (MA)

- Does your boss encourage you to stop production if safety is at risk? (OP)
- Do you encourage your employees to stop production if safety is at risk? How? (MA)

Operators
Looking at the operators' answers there were just as many operators who stated that they have never taken the decision to stop production as operators who said that they once did. A couple of them explained that they would anyway "stop the process and call my boss" (OP16) or "stop the machine and call the engineer on duty" (OP15).

Managers
All managers who answered the question pointed out that they definitely have the ability to stop production if safety is at risk. Some furthermore replied that they feel "that is my role" (MA15) or "it is my responsibility" (MA07) to do so. "Even if it takes longer I prefer that things get done properly" (MA11).

Operators
20 of 23 operators who answered the question "Does your boss encourage you to stop production if safety is at risk? How?" stated that their boss encourages them to stop production if safety is at risk. This high amount of positive answers seems to be an indicator for a high supportive and encouraging culture, but could be due to the partly leading wording of the question as well. It is noticeable that a few operators restricted their answers and explained that "it depends on how serious a risk is" (OP20) or "it depends what happens – small things are fixed right away, bigger things take time, but if possible production continues around the problem" (OP07). One operator mentioned also that "sometimes you feel a bit afraid to call your boss if only minor things happen" (OP14).

Managers
Again, all managers, who were asked the question, expressed that they would encourage their employees to stop production if safety is at risk. The instruments to do so are: mainly "talking about it" (MA16) or giving "constant reminders" (MA19). It is remarkable that one of the managers also showed self-criticism and said "[I tell them] but I haven't expressed that so thoroughly" (MA15) and that another one mentioned that "I don't need to say that – that is clear" (MA09).

In general most of the managers and operators feel they have the ability to stop production if safety is at risk. All the managers encourage the operators to stop production if safety is at risk and most operators said they feel encouraged.

Just culture

Subordinates' active role in creating safety
This paragraph sums up the answers to the following questions:
- Have you ever consulted your boss when you had concerns about your work, safety, etc.? Has this happened yet? (OP)
- Do your employees consult you if they have concerns about their work, safety, etc.? Has this happened yet? (MA)
- Do you think your boss empowers you to change, intervene and help the organization to improve? (OP)
- Do you empower your people to change, intervene and help the organization to improve? How? (MA)
- In what way can you influence your boss' decisions? How does decision making take place? (OP/MA)

Operators
All except for one operator have at least once consulted their boss when they had concerns about their work or safety. Some of them even explained that they have done it "many times" (OP22), "all the time" (OP03) and that "my boss is very nice – I can talk to him about every issue" (OP09).

Managers
The same perception was made clear by the managers. All of them stated that their subordinates consult them or their direct supervisors if they have concerns about their work or safety. A huge number also pointed out that this has happened yet and that they "get input all the time […] – nobody is afraid to say something" (MA07). Only one manager doubted "if they do it all the time" (MA16).

We also want to show a negative example here: Some operators told us about a problem concerning their work environment, where they asked their superior for help – but actually nothing has happened so far. We think it is as noteworthy as all the positive opinions of operators about their superiors mentioned earlier:

> "I have to lift 40 kg sacks with material by myself without support of a machine. I have no idea how to improve the situation and I have consulted my boss. My boss had also concerns about the damage to the workers' back. But there is only a little space down there, so there is no solution so far. They could use a vacuum lifter, but it costs a lot of money and these lifts have to be done not so often. But it is no fun to do those lifts – if you are unlucky you have to lift these sacks on every shift you get."

Operators
Asking the operators if they think that their bosses empower them to change, intervene and help the organization to improve 22 of 25 operators that answered the question agreed that their superiors do so. Only three operators denied it or explained that they were not sure about it. Some operators also mentioned critically that "even when my boss thinks the concerns are reasonable the boss above him finally decides" (OP17). Two others again referred to the trade-off between safety and costs, as touched on in the tale above:

- "If there is a problem they will try to find a solution to make working conditions better if it is not too expensive" (OP13)
- "I'm empowered to tell the boss the good ideas. My boss does something with this if the ideas are good. But the costs are also very important" (OP27)

Managers
The answers of the managers are congruent with the operators' statements. The major part of them claimed that they empower their people to change, intervene and help the organization to improve. The managers offered different possibilities to do so: "by coaching them" (MA16), by "working together on […] goals" (MA15) or by "systemizing work together" (MA17), by "involving people in improvement projects, like six sigma" (MA14) or simply by "talking to them" (MA03).

Operators
Presenting the question "in what way can you influence your boss' decisions?" the few operators who answered the question agreed mainly that this is directly possible, by e.g. "just talking to him, he listens to you" (OP14) or having an "open discussion, e.g. at the weekly meetings" (OP20). Also the indirect way is mentioned, e.g. "when reports and logs are made [because they] influence the boss' decisions" (OP04). Three of the 16 operators did not agree and pointed out that "it is very difficult" (OP22) to influence the superior's decisions and that "it is possible, but difficult. It needs to go bad before he will see my side of the situation" (OP23) – "decisions usually come from above" (OP21). Another operator mentioned that he is simply "not sure" (OP15) about it.

Managers
All managers felt that they could influence their superiors' decisions in one way or the other, mainly through discussions, in formal meetings (e.g. management team meeting) or informal talks. The different ways were stated as "showing my boss the consequences of different options" (MA16), "talking about my

opinions" (MA17) or "showing him all the facts" (MA01). "Complaints and suggestions are always heard at these [meetings] and taken into consideration" (MA04).

To sum this up one can say that almost every operator has at least once consulted his or her boss when concerned about work or safety. The managers confirmed these descriptions. Almost all operators felt that their superiors empower them helping the organization to improve, which is congruent with the answers of the managers. Most operators also agreed that they could exert influence on their superiors' decisions in one way or the other; this was confirmed by all managers who felt the same way with their superiors. A few operators disagreed on that point. However, trade-offs between safety and money have emerged more than once when answering these questions.

Superiors' imperturbability to hear bad news

This paragraph refers to the questions:

- Do you feel comfortable reporting safety issues/problems to your boss? (OP)
- Do you feel comfortable reporting safety issues/problems to your boss? Do you think your employees feel comfortable coming to you to report safety issues? (MA)

Often to these questions was added: "Can your boss hear bad news?"

Operators

All operators who were asked the question confirmed that they feel comfortable reporting safety issues to their boss and that their boss can hear bad news. Some of them even stated that

- "my boss is like one of the workers, I can talk to him about anything" (OP14)
- "he can hear bad news, he is used to hear bad news, because we had a lot of trouble with the machines/production" (OP15)
- "reporting is very easy and [I have a] comfortable feeling. Concerns are mostly taken care of immediately" (OP05)

Managers

The managers also expressed that they feel comfortable reporting safety issues to their own bosses. They highlighted that

- "it is better to report on too many things than on too little" (MA15)
- "I'm never afraid to report problems" (MA21).

Regarding their perception if their subordinates feel comfortable reporting safety issues to them, too, all managers felt pretty confident that they do so: "It is an open atmosphere here – you can say I did wrong without being punished" (MA16), "I can hear bad news – we in the x department only hear bad news, we never hear good news" (MA17).

Two interviewees limited their feeling of confidence: One manager told that the "boss can hear bad news, he would be a little sad, but that is no problem" (MA07) and an operator stated that he once made an error and reported it to his boss and "my boss wasn't happy. There were no direct consequences, but my boss keeps an eye on me" (OP15).

To draw a conclusion one could say that almost every one – be it operator or manager – feels comfortable reporting safety problems to their superiors.

Rewards for reporting

This paragraph integrates the answers to the questions:

- Are you rewarded if you report your ideas or concerns, e.g. about safety? (OP)
- Are you rewarded if you report your ideas or concerns, e.g. about safety? Do you reward your employees if they report a safety issue? (MA)

Operators

Although all operators felt comfortable reporting safety issues to their superiors (see 0) and although they were empowered to contribute to the organizations improvement (see 0) two third of the operators who

were asked this question negated that they got a reward for their reports. Some pointed out that "the management had a reward system before, […] but they stopped it, because sometimes workers handed in the ideas of other workers. So there are no longer rewards today" (OP14). Others felt that "my boss is not good at praising people. I don't get so much commendation" (OP16), that "it is expected" (OP21) to report ideas or even that "it is pointless to report anything" (OP22). It is remarkable that most people felt that they got no reward at all.
However, a couple of people confirmed that they were rewarded for reporting their ideas: "My boss says then: yes, it was good to write it down" (OP15), "I can see that on the behaviour of my boss" (OP10) or "when a good idea is implemented my boss tells who's idea it was" (OP27).

In our first meeting with the managers of Chemco was stated that the SHE (Safety, Health, Environment)-Index, which is an indicator for the company's safety level, contributes to the bonus compensation of all employees. This result could show that the influence of the individual contribution to enhance safety is not – in the operators' perspective – connected to any form of appreciating these efforts, like a rise in the SHE-Index and finally in the bonus payouts for all employees. At least this connection was never mentioned by any operator.

Managers
It is alarming that, again, almost two third of the asked managers felt that they don't get a reward at all for reporting their ideas. One of them pointed out that "no, there is no reward system" (MA15) and another one that "my boss doesn't reward it. […] People have to do it [report ideas] to make it better for themselves" (MA01). Again, the former reward system was mentioned – "there used to be a form for ideas to improve production and people were paid for those ideas" (MA20). A couple of managers affirmed that they are rewarded for reporting their ideas, though. Some said that they are rewarded "by comments" (MA02) and "not by money, only a pat on the back" (MA09). It is noticeable that at least two managers mentioned the connection to the SHE-index and highlighted that "we have a bonus system. And in the long run everyone should profit from sharing ideas e.g. by raised salary" (MA14) and that there are "positive points for reporting incidents within the index" (MA21).

In general only a few people felt that it is somehow valued and rewarded when they report their ideas – this is the same result for operators and managers. The connection between the daily safety improvement ideas and the new established SHE-index seems to be not well-known. A culture of natural commendation seems to be not established, too.

Learning culture

Consequences of system-failure
This paragraph includes the following question:

- What are the consequences if the system fails? (accidents)

Operators
The operators said the consequence of a system failure could be very huge like fire, explosion or chemicals leaking over them. People could be injured or a fatal accident like the one in 1992 could happen. In some plants the consequences are not that big. The consequence could also be delay or broken equipment. According to one operator, "the only consequence is that the company will lose money. There is an automatic safety mechanism build into the system (security valves) so that when there is too much pressure the valves will open and the process will shut down itself" (OP11).
Most operators said there are no consequences for them if the system fails: "Nothing will happen to me, there are no consequences" (OP14). Another operator said "when I conduct an error: I have to explain myself, talk to the boss and discuss, why I did wrong and how" (OP15).
Two operators told that they have to stop the production if the system fails. One operator mentioned the standard for reporting, "first report to your boss he will report HSE and then is reported online" (OP28).
Managers

A lot of the managers said, the consequences of a failure can be very huge. A factory can blow up if something goes wrong. A failure could be fatal. "Some processes are very dangerous. These processes can cause big accidents, e.g. buildings that blow up" (MA09). One manager refers to the explosion in 1992, where one person was killed and four were injured.

Depending on the size of the system failure the managers know what they should do. First of all the production has to be stopped, a few managers said. At the same time they try to contact for help and protect other people in the area if the risk is still there. There is a plan how to handle personnel, media, community and the fire brigade. None is sent home. The supervisor, boss, safety representative and if it is necessary the government representative will have a meeting. The production could only be started if there has been an investigation to find the cause of the accident. A person from the HSE department has to agree to start the production again, the manager said. When a big accident happens also the law comes in. And another manager said: "We will have to inform Chemco USA within 24 hours" (MA07).

Afterwards they have to write a report. One manager told us that "we encourage them to report small incidents as well" (MA16). Another manager said that "if an incident report is filled in, an investigation is started every time" (MA17).
There is a separation between failure caused by the boss and failure caused by operators.
"If an insufficient guideline is the cause of a system failure, the boss will be in charge of the failure. Sometimes is it a personal failure" (MA08), one manager said. "It's not the operator, who will be pointed out, it is me or my boss, because we are responsible for safety. Only if operators are sabotaging they will be pinpointed. If there are only small incidents"(MA16). Another manager said, before the operator can start his work again the management has to find out if the person suits to do the job or if there are some other factors. "It is often more than one mistake - like a chain reaction. We seldom pinpoint at someone" (MA15).
The consequence of a system failure for the managers could be they get in trouble with their customers. One manager said, "The consequence could be an upset customer if the process is not completed on time; I have been held responsible if it should have been foreseen" (MA18).

In general the managers and operators said the consequence of a system failure could be very diverse. The operators do not feel a system failure has consequences for them. According to the managers there is a system how to handle failures.

Information from failures

This paragraph includes the following questions:

- What do you do with the information you have from failures?
- How do you learn from failures?

Operators

A lot of operators said they are well informed about accidents. Information about accidents is put on intranet and an email is sent out. A few operators pointed out that they have to report anything. They have specials files where they fill in their report. They can look in those files if something happens, if it happened before and what the causes were. One employee said something about a weekly plan report: "If something happens at your plant a report is generated once a week. Every problem is described in this weekly plant-report (what, why)" (OP15). Another possibility is the morning talk one operator mentioned. If something went wrong the production will be stopped and look the cause of the problem will be investigated. "The management will say what to do to start over again" (OP24). About injuries one employee said: "When a person is injured, a report has to be sent to Chemco USA. Also when it could have been an accident. But it depends on how serious it was. When it is a very small accident and there is no time, then it won't be reported" (OP28).
There are a few problems workers see. "Reports about accidents are published once a month in the intranet, but they are not very substantial. They just contain what happened, not why", an operator said (OP15). The same operator also said "I don't hear about errors in other factories/on other plants" (OP15).

Managers

Most of the managers said they have a good system to report system failures. One manager was not sure; he said "If something happens in one factory, then the procedures are changed in this particular factory. I'm not sure if there is a system to ensure that this accident will not happen in another plant" (MA16). It depends on the size of the accident what next step should be taken. With a big accident an email is send to everyone in the company. There is a system where all the accident reports are filed. One manager said about this system that "the system could be improved to ensure people take action" (MA21). Another manager said about it: "Accidents are well reported if it relates to this part of the company-all major incidents are reported online" (MA18). "The one who is involved writes down the accident/incident. We put it in the database system that can be used for statistics. The statistic evaluation gets to the supervisor of each plant one time in a quarter" (MA15), a manager said, "once a year a total summary is written by the director and placed on the intranet" (MA15).
"There are meetings between supervisors once a month and in this meeting they talk about safety. When the HSE agency thinks an accident could also happen in another plant they will talk to the supervisors of this plant. The intranet is used as well to show information about safety" (MA15). One manager said, "there is always action taken that it does not happen again" (MA17).
Workers will talk to their direct boss. This boss will inform the management. Several people are involved in solving the problem such as plant supervisor and HSE agency. One manager said "once a quarter there is a plant meeting on safety concerns". There is also a safety committee meeting once a quarter. According to a manager "there is a standard agenda: mention the 3 most prior safety issues, economic issues, hazardous environmental issues, hazardous behaviour issues" (MA07).
"Afterwards an accident it really depends on the situation" one manager said. "If there are big incidents we talk about it in groups" and "one other thing we do with information is rewrite the manual. But to continuously do this is difficult" (MA01). Remarkable is that another manager said about accidents in the company "I will not talk to the operators because they will hear it from some other operator in the factory" (MA02).

Operators
The operators try to keep in mind what went wrong and avoid this the next time, most operators said. "But sometimes it is bad luck. For example big pieces of acid that fall in the liquid and cause a failure" (OP10), one operator said. Most operators use intranet or information from the boss to be aware of failures next time. A few operators also try to make things better, "change of methods, better instructions in the lab" (OP28), one operator said. Another operator suggested to "rebuild equipment, rewrite protocols and tell others about it by e-mail" (OP27). One operator told, "Experienced colleague knows all the tricks and tips (if small things happen)" (OP14).

Managers
The way most managers learn from failure is the natural way to learn something, the managers said: Keep in mind what happened and try to avoid it next time. But a few managers see some problems. "There are a lot of things we are unknown of. An example is because we are often working with new chemicals" (MA01).
After a failure they are looking for how to improve the system. "I have to think about questions: what to do to solve the problem right now. And how to prevent an accident like this" (MA24), one manager said, "I have to write down the points for improvement for next campaign"(MA24). "After an incident or accident a group, local safety committee, safety representative plant, HSE representative, supervisor and boss, comes together to talk to each other how they have to deal with new rules" (MA25). One manager pointed out that before starting a process there is always a risk analysis done and "I have to sign a paper for every major change, so I'm aware of what is going on. Also, if a new product is produced, you go through the processes, procedures, materials with workers" (MA16).

Overall the operators and managers are satisfied with the way information is reported. Operators and managers use the –what they described as– normal way of learning: Keep in mind what happened and try to avoid it next time.

The discussion about risk

This paragraph includes the following question:

- Do you feel the discussion about risk is kept alive in your company or workplace?

Operators

Most operators pointed out the discussion about risk is kept alive. There are several arguments why the discussion is kept alive:

- A lot of operators said the safety day is very important to keep the discussion about risk alive.
- A lot of operators pointed out that they get education to keep the discussion alive.
- A few operators said they talk about risk on conferences and in discussions.
- One operator said before he can do anything he has to do a risk assessment.

A few operators did not think the discussion is kept alive. They saw some room for improvement as well. One operator said, "The management does not inform you about long-term exposure. Sometimes the management lacks information about that" (OP15); he also said, "the people in that part of the building know what they are dealing with, but the people next door don't know about the chemicals here. If they go cross our area they don't know what the gases are here/what stinks here" (OP15).
One other operator told, "I do not feel the discussion is kept alive on operator level, maybe on management level" (OP16) and another colleague stated: "Not that often. We have safety days 3-4 times a year. It could be done a bit more often" (OP17).
One operator thought there has to be more education and another one said that they do not talk about risk that much because they are not a very dangerous department. "The discussion seems to be more alive when things happen" (OP26), another operator said.

Managers

All the managers are confident the risk is kept alive. The managers mentioned a lot of common arguments, for example:

- A risk analysis has to be made before updating or changing processes. "Do a risk assessment. If you do a small change or a huge change. A new process must have a different checklist" (MA12), one manager said. In the lab all employees have to do a risk assignment before they begin.
- The managers have a lot of discussions about risk. "Daily small risk discussions" (MA21), a manager said. Another manager told, "There are meetings several times a week where they are talking about safety" (MA13). At the same time another manager said, "There could be better discussions but it is talked about" (MA20).
- A lot of managers mentioned the safety day to keep the discussion about risk alive. The safety day is held one time a year and all plants are closed that day. The whole day is spent to talk about safety. "There is a joint programme 0.5 day. SV and operators 0.5 day to practise situations like fire, escape routes, safety equipment" (MA07).
- Another aspect to keep the discussion about risk alive is intranet, a few operators said. "Intranet is used to keep the discussion alive" (MA05).

There were a few remarkable comments of some managers. One manager said, "handling with safety is quite natural for the experienced employees" (MA01). A few managers said about the safety day: "Sometimes it is not interesting. I get the most information from experienced supervisors by informal meetings" (MA02) and another one said the "Safety day sometimes [is] a little bit boring, you know what to do, but you have to know it" (MA07).

To sum up there is a small contrast between operators and managers according to if they feel the discussion about risk is kept alive. Overall they think the discussion is kept alive. But there are some operators with another opinion. Remarkable is that some managers have a lot of trust in experienced people.

Feedback

This paragraph includes the following questions:

- How do you ensure that the feedback or revisions made when accidents happen are distributed through the whole organisation? (MA)
- Are you informed with feedback or revisions made when accidents occur? (OP)

Operators

The operators were asked if they are informed with feedback or revisions made when accidents happen. There are different ways to distribute information, the operators mentioned:

- Shift change, it is written in shift report and told by colleagues.
- Database, where you can find information how to handle things.
- Intranet, "everyone in the organisation has access to a computer" (OP26)
- Through newsletter (OP05)

Most of the operators are well informed, they said. "If something changes they go through the procedures with the operators" (OP14)

Managers

The managers reported there are different information flows in the organization. Just a few managers said something about how they ensure that information is distributed trough the whole organization. Most of the time the managers that answered this question found it hard to deal with it. First we will discuss the different ways of informing operators about revisions and feedback:

- A lot of managers said email is very important to distribute information. "The team leaders send an email to the organisation or a part of the organisation this depends what kind of incident/accident"(MA01)
- Once a month there is a report, a few managers mentioned. In this report the different company goals are presented. One manager said, "There is a report on Intranet every month. This report influences the bonus. Safety can vary from 0% till 100%. This moment it is a goal to reach the 88%"(MA08).
- Smaller accidents are distributed by hardcopy in each department; the hardcopies circulate in each department for about a month.
- Incidents are reported in a system on the intranet. One manager said about this: "Not everyone sees this because you have to search for this information so perhaps there can be an easier way that everyone can see these reports" (MA04).
- Once a month in the management meeting the managers can discuss their problems and dispute about safety.

About distributing revisions different managers said: If there is a change in the standard operational procedures everyone is send an email. One manager said, "if local instruction is updated the supervisors inform and train operators. If it's relevant for the whole company: all staff is trained" (MA15). Another manager pointed out that "it is the job of the process safety engineer to inform everyone. This person puts all the information together and distributes it" (MA09).
However there were a few concerns about distributing information. One manager was not sure if the information reaches everyone (MA20). Other managers said it was someone else's responsibility that the information is distributed through the whole organization. For example, "I do not check if the feedback is distributed. The team leaders send an email to the organisation or a part of the organisation" (MA01). Another manager said "it is always difficult to pass information down. Hopefully union helps and supervisors are passing information" (MA12).

A lot of managers that answered the question about how they ensure the feedback is distributed found it hard to deal with that problem. However, the operators said they are well informed. We think we have to consider that two different phenomena could lead to this last finding: The operators could be really well informed or the operators could feel well informed about the things they get to know. In other words, this answer of the operators does not ensure that every operator gets to know all the information he should get.

Training

This paragraph includes the following questions:

- What kind of training procedures does exist?
- How often does retraining occur?
- What do you think of the quality of the training?
- Do you think you get sufficient training lessons to conduct your work appropriate and safe?

Operators

There is a big contrast between the amount of training the operators said they get. There are operators thinking they have a lot of training and operators thinking they get too little training. One operator spoke about "an endless amount of training" (OP14). In contrast another one said "not much. Less than more" (OP16). A lot of the operators said they see the safety day as training day. Most of the operators stated that they would get the most training when they were new. The general trainings, that a lot of operators pointed out are: fire training, information about chemicals and first aid. Only a few operators mentioned that when something changes they get retraining. One operator explained that "new people follow along with another operator. Each factory has lectures for retraining every once in a while. Most training occurs when you are new" (MA21). Another operator talked of two different type of trainings, "selfstudies (you have to read things like updated manuals and sign a paper); self-studies under supervision (sometimes supervisor has to sign that you did/read it)" (OP15).

There is a big different between the answers about retraining. A lot of operators are not sure about retraining. A few operators said something about the safety day again. Other operator stated that it depends on what kind of training. In some plants they are doing different processes. In some plants there is retraining every week or every two weeks, because different processes are done there. "We have retraining before every chemical step, because every step is different. One step is about 0.5 - 2 weeks, but depends on how much of the product the customer wants" (OP27), one operator said. A few remarkable answers some operators gave us are written down below.

- "Process operators have so much experience that the company only get retrained when the company receive new high tech equipment or switch plants" (OP11)
- "The operator said they should do some training every year but that does not happen. If there is something updated they receive training as well" (OP25)
- "You go and learn with experienced men, you do not get any retraining" (OP02)

Most of the operators are satisfied with the quality of the training. Some of them pointed out some suggestions for improvement:

- "Management is mostly doing the training but there have to be more new ideas, maybe it is better to listen to someone else outside the company" (OP24); on the other hand one operator said "it is good that the training is given by insiders this people know how it works over here" (OP25).
- "Basically you can read the most information on internet, often the training is given by inside people, if they are good I do not have any problems" (OP26).
- "intense in time; you have to practice" (OP28)
- A few operators think the information is repetitive, "sometimes it's a waste of time because they are not giving in new relevant info" (OP23). "For the most part the information is repetitive" (OP22).
- "They just talk about what should be done in an emergency, when we have an emergency training. But we don't practise the procedures in real live. Training should be done more actively." (OP16)
- "just reading instructions and updates is not a guarantee that you do things correctly" (OP15)
- "In some manners- I would feel better with new more updated training (are the new chemicals really safe?)" (OP23)

The most operators said the training they get is sufficient. Sometimes they have a few remarks related to the earlier suggestions for improvement. One operator said, the one week sight by sight training in new plant is not enough. Another one pointed out the training could always be better, but he is not sure how to improve the training.

Managers

According to most of the managers there is a common training when you start working at Chemco. In this training you get basic information about the company, environment and quality. In this training you also get to know the standard operating procedures. For every employee there is some retraining and some training if the employee has to increase his or her competences. There is a need for different competences each plant. One manager said, "for the special tasks the operators have local descriptions and the batch protocols, the general rules are on the intranet" (MA16). This manager also said "a lot of training is based on GMP (good manufacturing practice) - that is our bible". In some positions employees have to have a license for the use of special equipment, another manager said. Operators have to sign production documents. A lot of managers see the safety day as training as well. For the managers there are also different seminars. "If I think I do not have sufficient knowledge I will ask for more education. Very often they allow this" (MA02).

Depending on the factory there can be a new training when starting a new process. If people switch from one assignment to another assignment they will have to do a training as well. A manager said about this, "Move between plant must be trained. Sometimes there is a risk because of time constraints" (MA16).

There is a big difference concerning the answers about retraining in the manager group. One manager said there is every 3 months a training for managers and every year for operators. "Every year I check if the workers are trained enough for their particular tasks to ensure that they get sufficient training" (MA16). If there are any changes in equipment, updated procedures or other important changes, everyone will be retrained. Most managers said there is retraining every two years. But this is of course dependent on plant, kind of training and function.

The managers do not have the same idea about the quality of training. A lot of managers think trainings do in general have a good quality; however, there are also a lot of managers with requests for improvements. For example:

- "Sometimes you learn because you have to learn"(MA02)
- "Sometimes a little bit boring" (MA08)
- "There should be more time for the person being educated" (MA18) and another manager said, "Could be better with more time" (MA20)
- "More training should be conducted/ more self chosen courses" (MA06)
- "We focus too much on what is written in the instructions - you have to sign a lot of papers to show you read it. But it is seldom checked if the way of work is really changed" (MA17)
- "The retraining sometimes needs more structure - at the moment supervisors have to decide on their own, which training the operators need" (MA15)

The courses are often given by an experienced person. Two managers think this is a good status. One manager said that "you have to be aware of changes in behaviour, because experienced people can become lazy" (MA21).

The most managers also think they get sufficient training. There are just a few negative arguments:

- "Operators don't feel that training is a part of their job at all. They prefer real work" (MA16).
- "We have a training program but this program is not so good. I feel pressure to get products out of the plant. There are more checklist, and I am not sure to what degree workers are following them. I need to sit down face-to-face with my operators and encourage safety." (MA12)
- "There are some things that can be discussed more and the introduction program can be simpler" (MA03).
- "Maybe a little bit too fast, but in general sufficient" (MA07)

Learning from failure

This paragraph includes the following questions:

- Do you think the past success the organisation experienced is taken as a guarantee for future success? Or do you feel the company actively tries to create a learning culture?
- If you could change the way learning from failure is organised what would you do?

Operators

In contrast to the managers almost all operators think the past success is not taken as a guarantee for future success. Just one operator said, "Yes, past success is taken as guarantee. And yes they do a lot, like getting new employees" (OP14).
All the rest of them pointed out they are really satisfied with the way the organisation tries to create a learning culture. "They try to improve safety since the last big accident happened in 1992" (OP15) and "the organisation actively tries to create a learning culture by educating more and learn from failures" (OP10).
The operators also see some improvements, though. One operator said: "I think it is safer now than it was. But they should work more on safety. They should focus on safety culture. I need more safety input. We have discussions about safety in spring and autumn, but that should happen more often" (OP16). Another one stated that "the company has no real means of acquiring information from operators except word of mouth (no surveys or anything to get their opinions)" (OP21).

Almost half of the operators who answered the second question, "If you could change the way learning from failure is organised what would you do?", did not know what to change or they thought everything was perfect concerning the learning culture. The comments from the operators that answered the question were mostly concerned about the way information is distributed. "Sometimes you want more information of what other workers experience in other plants" (OP15). Another operator said "management just states that accident occurred. Management never says what they will do to ensure that it will not happen again" and "You hardly get the information what is getting on here and which accidents have occurred. Only one person of each shift (who belongs to the MIA-group) has the information about work problems, but all workers should have this info" (OP16). Another operator mentioned almost the same: "Keep people more informed on how they handle other accidents and how to avoid it" (OP21).
One operator mentioned something different, namely that "it is not easy to find the writings you have written down" (OP25) and another one suggested "maybe more meetings with every operator in the plant where we can change manuals" (OP24).

Managers
The majority of manager said they do not think the organisation takes past success as guarantee for future success. However, some managers said the past success has been taken for future success. "You feel more and more confident if nothing happens" and "as long as nothing happens you get more and more confident that nothing will happen again"(MA16). Another manager said, "by the time people will slack in risk automatically" (MA12). "It is mostly if it worked before it will work again" (MA02). However more managers said they thought Chemco is trying to create a learning culture. "Past success is caused by learning and improvements for safety" (MA09) – "The organisation can't lay back, but has to learn always. We have to learn how to deal with the new dangerous products. Company has competition now, so safety has to be improved" (MA07). "The company is focused on constantly improving (lean-6 sigma)" (MA18), a manager pointed out.
There is still some room for improvement, the managers said. One manager explained that "there are too little Supervisors at this moment" and "there is not a 100% guarantee that everybody reads everything" (MA07). "We are on the right path, but we need more focus to get everyone thinking safety" (MA20).

The second question we asked the managers was: "If you could change the way learning from failure is organised what would you do?" This question delivered us a lot of different answers. However, a few answers were basically the same.

- Database problems. "The database for incident reports should be open to everyone, every manager should check it, e.g. every two month to see what happened" (MA16). Another manager said about the database: "If you work in a specific area you don't have much influence on other failures, it is not an easy problem to solve, change the data base on reporting failures so it is easier to see" (MA06). "Find another way to document and find information" (MA03), one manager suggested and another one proposed a "better monitoring of failures. For example: Same kind of accidents pop up when an employee search for a certain accident" (MA07).
- The visibility of failures. One manger said "we should make failures more visible, i.e. we have a lot of reports, but we should have more operator-talks; at the moment the chain goes from the operator->writes report->supervisor(s) see et->other supervisors form other plants get to know it->they talk to their operators. On that way you loose the feeling that the accident could happen

to you, too" (MA15). "Better communication for reporting past accidents to operators so that everybody knows it" (MA09), a manager said.
- "A safety engineer has to be more in the plants" (MA21).
- "Work more with past experiences. Find better ways to prevent them [failures] from happening"(MA20)
- It is "difficult to make sure that everybody is learning from failures" (MA09). Another manager stated that "the monthly reports are good, but must more affect the active behaviour of employees. Employees have to do something with this information. Problem is communication. E.g. report only for the plant where the accident/problem happened/occurred. But sometimes also other plants can learn from mistakes/accidents in plants" (MA08).

Almost all operators think past success is not taken as guarantee for future success. While at the same time a few manager said something that matches the expression "past success is taken for future success". Operators find it hard to answer the second question about what they would improve. The managers have some ideas e.g. solving database problems and making failures more visible.

Processes, procedures, manuals

This paragraph includes the following question:
- If you could change the processes, procedures or manuals what would you change and how?

Operators

Most of the operators said they would do something about procedures and manuals. But there is a big contrast between the opinions of different operators. One operator said "the procedures are very well written; they understand everything. People who write the manuals are on the worker's level" (OP14). Another operator told us, "company has two people that come by and asked them how they would change the manual and those people are responsible for retyping" (OP11). In contrast to this one operator said: "The colleagues should rewrite the instruction of the boss" (OP04).
A different opinion is stated by another operator who said: "I would like to have more minimalistic instructions (shorter, concreter) - sometimes it's a lot to read, but not much substance" (OP15). And again another operator pointed out "the procedures are out of order because it does not make sense. For example the batch reports/checklists are old and out of date" (OP22). "The way things are said in the manuals is wrong, for example shut down pump-allow liquid to flow into water treatment facility. But valve closes so pump must be on for the water to flow" (OP23), an operator mentioned. "Sometimes the manual prescribes the process too difficult and this can be done more easily" (OP09). Operators were further on complaining about the difficulty of manuals (OP03) and about the large amount of manuals (OP25).
Other answers the operators gave us on this question were:
- "There is to much a focus on paperwork. You can deliver a bad result as long as the paperwork is fine", one laboratory operator said (OP26).
- "I would like a little bit more time to learn new operators, The production speed has to be slowed down" (OP24).

Managers

Not many managers answered this question. However, the most managers said they have a lack of time:
- "Get more time - the bottom of the chain always gets pressured because the top takes long" (MA03)
- "The time to prepare for new production line is too short. There is not enough time to work out all the kinks so the process is significantly slower the first couple of weeks" (MA19)
- "It would be nice to be not on the market (as a company) to get rid of the quarterly and end of year reports. (because of the high stress that goes with the reports, more incidents and mistakes are bound to happen); Each factory screams for there stuff while this building has to try and make everyone happy" (MA18).
- "I am a little behind with changing procedures in some plants, because I have to little time to change the procedures" (MA07)

There were also a few not time related comments the managers mentioned:

- "we have to evaluate if the updated manuals/instructions really affect work" (MA17)
- "focus is on behaviour, not on procedures" (MA21)
- "System for working instructions must be easier" (MA02)

On operators level they want the procedures and manuals to be enhanced. There is a huge contrast in operators' opinions about the manuals. Managers said they have to deal with a lack of time and they would like to solve this.

Awareness

Multiple goals

This paragraph includes the following questions:

- Do you feel the company expects you to perform multiple goals simultaneously? (safety, costs, production)
- Do these goals conflict?

There is a lot of variation in the answers of these questions, both for the operators and the managers. Almost all employees thought that they have to handle more goals at the same time. However, more operators than managers felt no pressure on them by handling these multiple goals. Operators as well as managers spoke about goals as production and safety. A lot of managers stated that they have to deal with issues like these, but also operators mentioned the (conflicting) goals of their operational work.

Operators

Sometimes the operators regard it as impossible to manage all their tasks at the same time. "You sometimes have to work three different batches parallel." Some operators feel that they decrease their level of safety when a faster production is required, for example because "chemistry goes too often too quick into the plant. There is the real danger" (OP25). A faster production can lead to stress for the operators. One operator said the that "there are always a lot of things required to do at the same time and this always causes stress" (OP05). But operators also thought that the lack of enough personnel can also lead to stressed operators and unsafe situations, as this statement illustrates: "High workload, little number of personnel has to be at 3 or 4 places at one time, this increases risk" (OP23).

Managers

The conflicting goals for the managers are partly the same. The managers also mentioned the conflicting goals of production and safety, but beside this they mentioned costs as an important goal. The managers are asked "the fast way to improve every working process and at the same be cost-efficient and at the same time produce and work safely" (MA17). "It becomes more and more economic" (MA19). Another issue for the managers was the conflict between personnel and produce on time. Some managers mentioned that sometimes there are too little operators available in the plant to finish the production on time. This delay can then of course cause a lower customer satisfaction.

The main conflicting goals for operators as well as managers are safety and production. Managers mentioned other goals beside safety and production, for example cost efficiency.

Safety and budget

This paragraph displays the answers of the following questions:

- Is the quality of safety affected by the budget?
- In what manner does this concern you?

Operators

Most of the operators felt that safety is not affected by the budget. Though, some operators do not have this feeling. These operators think that safety is affected by the budget, or at least partly. One operator said the following: "For personal equipment, the budget is not affected. But small technical issues are overlooked when budget is low" (OP23). And some operators were unsure. "Management said: Safety goes before budget, but sometimes I feel like the budget comes first." (OP18)

Managers

The managers felt partly the same. Some thought that safety is not affected, some thought it is. But some managers pointed out that you can always do more about safety if you have enough money, "there are always restrictions of course" (MA21). "But there is a minimum safety that is never affected by budget and it is always attained" (MA06). Different managers talked about the old plants. There is no budget to improve the plant, "only to run the plant" (MA02).

The "safety affected by the budget" issue did not concern most of the operators. Only a few operators had concerns about this, because of their daily work or because they thought that the managers "could be more dedicated to the issue of improvement" (OP21). Most of the managers did not have concerns either. But there were some worries about the feeling of safety on the operators' side: "If people feel that safety is not valuable (not first) then this concerns me" (MA15) and there were also concerns about the long exposure to chemicals for the operators in the labs (MA09).

In general there are operators and managers that think safety is affected by the budget, but most employees think money is not affecting safety. The former concerns some employees.

Understanding of tasks and procedures

This paragraph sums up the following questions:

- Do you think you have a full understanding of what your manager has told you? (OP)
- Do you think you subordinates have developed a full understanding of what you have told them? (MA)
- Can you tell me something about the safety procedures you use?

Operators

All the operators gave an affirmative answer on the question if they have a full understanding of what their manager told them and "otherwise they ask it" (OP25). Only one operator added that the information that is told "could be more exact" (OP22).

Managers

Most managers were positive about the understanding of tasks of their subordinates. But "some are better than others" (MA15). One manager thought that it is "not always understood; sometimes it is easy to be misunderstood" (MA20). Others explained that subordinates "call when there is a concern or question" (MA04) and one of the managers underlined that he/she "tries to push the employees due asking questions if he/she is not sure they understand him/her"(MA01).

All the operators and managers said that they work with procedures and manuals. One manager told that they "have about 400 procedures and 10-30 local procedures in every plant - some are in good, others are in bad shape" (MA15); an example of a procedure is wearing the protection clothes. "We have oxygen and masks against dust and they have other clothes to take over their normal clothes" (OP01) like "gas masks, gloves, safety shoes, goggles" (OP20), "hearing protection" (OP19) and "climbing equipment to go down in reactor" (OP04). Operators and managers both talked about the meeting for new products. "Before

producing a new product we have a chemical meeting and a risk analysis and go through the batch protocol with the workers and we also have a data sheet for the new chemicals"(MA16) and there are also "direct procedures for specific operations" (MA09) and "checklists for safety issues" (MA07); examples for the last one are weekly "safety rounds" (MA19) in the plant.

Overall the operators have a good understanding about what there boss told them to do. Most of the managers also think their subordinates know what they mean. There are a lot of different safety procedures.

Use of manuals

This paragraph includes the following questions:

- Do you use manuals?
- Are you able to understand and follow the manuals?
- Are the manuals strictly followed or are they used as guidelines?

All the employees use a lot of manuals. There are a lot of different manuals; "for example local operator manuals and company manuals (general manuals about safety)" (OP10) or "SOPs (how general things should be done)" (MA09). But not all the manuals are written down in a book. Some are more like "working instructions for some tasks and protocols for special things" (OP27).

Operators

All the operators are able to understand the manuals, "otherwise I ask a colleague" (OP16). Sometimes there is a little difficulty with the manual because the operator is "working with very specialized chemicals and then the operator has to look it up somewhere else. But that is once in a year or something" (OP26). Only one operator who answered the question thought that the "instructions are written complicated" (OP03).

About half of the operators who answered the question said they strictly follow the manual. "The manuals are used very strictly because small deviance can cause big consequences" (OP09) and "because safety is involved and there are strict rules about filling out the protocols" (OP12). The other half of the operators use it as guidelines, although it depends on the situation. It is "depending on experience, if the operator gets stuck than he/she will use the manual. Of course is there a safety risk in using it as guidelines" (OP26). Another operator said the following about this: "In the beginning: they are strictly followed. Afterwards: they are mostly used as guidelines or as a check-up later" (OP16) or it depends on the manuals: "The recipes are strictly followed. But the manuals for wearing safety clothes/protection are not strictly followed. Because it takes time to put it on and off and it is so hot under these clothes" (OP18).

Managers

The managers told us that they use manuals, too. They also mentioned the SOPs. Almost every manager was able to follow the manuals. But "instructions do not cover all issues; sometimes they are very general and sometimes they are too detailed and you can't follow them" (MA17). One manager said the following: "Mostly manuals are used, not always. Sometimes you have to make a discussion if some procedures affect the safety. Sometimes we consider the production over the safety."

On the question if the manuals are strictly followed or used as guidelines a lot of managers answered that this depends. They mentioned: "SOPs are more guidelines. But more specialized documents (local) are strictly followed" (MA08) or it is "a little of both. Some are more written as guidelines. And some have to be followed strictly because that is too dangerous to use as guidelines" (MA09); it "depends on how important it is" (MA21) and it "depends on how you clean the factory is" (MA19). One manager said: "If operators think that the protocol or the procedures don't fit any more I would like them to report that, so we can change them" (MA16). Another one talked about human errors at the plants due to less awareness. "But things have occurred due to human error - humans have to interact with the system and have to take the appropriate action. If you have done things for many years your awareness gets decreased. But I think that humans are not lazy by nature - just after some years your awareness gets down" (MA14).

There are a lot of different levels, operators and managers mentioned. In general it depends on the situation if the manuals are used as guideline or strictly, the managers said. Half of the operators use the manuals as guidelines. Overall almost everyone could understand the manual.

Problems in the company

This paragraph sums up the answers for the following questions:

- Do you feel there are any problems in the company? If yes, what kind of problems? Does your boss know about these problems?

Operators

Most of the operators do not know about the problems the company faces. "Certainly there are problems, but I do not know them, I am only on operator level!" (OP16). One operator thinks that the company has to deal with "environmental problems" (OP19), but some others think that "the organization is very healthy" (OP10).

The operators think that "more problems exist in the plants" (OP28); examples that were mentioned are: "Heavy lift for personnel, smell in the factory, bad ventilation" (OP24), "Time: recommendations from operators are not considered top priority" (OP21), and fixing things takes too long. "People say something will be done but it takes a while for action to take place" (OP20). Concerning the question if the boss knows about these problems the operators answered differently. One operator said: "It is unsure if the boss really knows what is going on beside what is logged" (OP08), but another one was much more positive: "The boss has his office downstairs so he is around and knows what is going on" (OP06).

Managers

The managers have more ideas about the problems in the company. However, not every manager was asked this question and not every manager had an idea of the problems.

We will sum up the problems the managers have mentioned:

- "One problem is that the company can not meet budget by the end of year." (MA16)
- "Quality (to fulfil the quality requirements) versus production" (MA15)
- "There are quality issues but not safety" (MA06)
- "It is a bureaucracy so it is difficult to "row the bat". There is a lot of effort to make changes because every step of the way is something new" (MA04)
- "Age of machinery and equipment. (built with a different goal in mind)" (MA21)
- "The increase in risk because of new hazardous materials" (MA21)
- "Increase in production demand" (MA21)
- "Production quality. (quality index, might impact on safety)" (MA21)
- "Increase in personnel pressure" (MA21)
- "Increase in production, there should be a decrease in environmental impact" (MA21)
- "More people, but that is always and everywhere a problem." (MA09)
- "Yes, lack of time, a lot of processes are not fully investigated. We see a lot of troubles and often it is just lab work." (MA02)

The managers mostly did not answer the question if their boss knows about these questions, but some spoke about a "very open company so everyone is aware of what is going on" (MA18).

To sum up most of the operators told us about problems inside the plants e.g. bad ventilation and bad smell in the factory. They are not all sure if their boss knows these problems. The managers mentioned some superior problems. The answers were very different.

Safety measures

This paragraph is about a question that we only asked the managers:

- How often are safety measures updated?

Managers

The managers came up with different answers. Four of ten of the managers who answered the question said that the safety measures are updated on Intranet monthly. "Guideline says update safety measures for production once in 2 years. But this doesn't happen always. For products that are produced the whole time: once in 4-5 years. For new products: every time the production will start again"(MA09). Two other managers said that the safety measurement is updated with every new product (MA19, MA20) and "a

safety committee goes around in the plants quarterly" (MA18). Two managers are a little negative and told that it "depends on what safety measures. They should be updated but could be updated more often; this is something that could be better" (MA01). Another manager said updating occurs "too seldom, there are too much things I have to do so I do not have the time for it."

Knowledge of activities in the company

We asked the operators and the managers a different question about the knowledge of the activities in the company. This paragraph sums up the answers of the following questions:

- Do you think your manager knows what's going on in the company? Do you think he know what you daily hazards are? (OP)
- Do you think what's going on in the company? How do you collect data about what's going on? (MA)

Operators

It seems that most of the operators answered this question for their boss' knowledge of their plant, not for the knowledge about the company itself. They are very positive about the knowledge of the managers about what is going on in the plants. 18 of the 24 operators that have answered this question had the opinion that their manager knows what's going on in the plant. A reason for this was that the managers had "hands-on" experience in the plant: "He/she used to work in a plant, too. So he/she knows the "smell", the steps" (OP14). Another reason that the managers know what is going on is because "the manager is mostly in the factory" (OP01), "because of the Wednesday-meetings with him/her" (OP17) and "because you can discuss every item" (OP09). Two operators told us that they don't think that their manager knows about the daily hazards in the plant, because "he/she's never around" (OP08) and because "the boss is new" (OP16). One operator thought that it depends on the size of the plant: "In small plants they now exactly what is going on in big plants they do not"(OP24).

Managers

The managers answered the question for their knowledge about the company in total and some about their own area. Overall the managers told us that they think they have a solid knowledge about what's going on in the company. Most of the managers talked about the weekly and monthly meetings with their boss(es) and the use of Intranet. "Every month there is a chief meeting and they are weekly talking to operators. They also get information from other plants. The manager does not write on intranet but checks it daily" (MA02). But not all managers thought that they were just as well informed about the whole company: "I think I now what's going on in my own area of responsibility. Don't know what is going on in other area." (MA16), or about every level in the company: "I believe I know it on a high level. But I go to the operators too seldom; I would like to do it more often. I focus on my organization and I'm too little time out in the plant" (MA15). Only one manager talked about other locations and told us that he/she "does not know very much about sister company in Italy and The States" (MA11).

Most of the operators pointed out that they think their boss knows what is going on. They especially refer to items on the work floor. Overall the managers have the feeling they know what is going on in the company.

Major safety concerns

This paragraph is about the major safety concerns the company faces and displays the answers of the following questions we asked the operators and the managers:

- Do you know what the major safety concerns are the company has to deal with?
- Do you think all employees know about these safety concerns

Operators

Of the 20 operators who answered the first question, 15 operators said that they think they know about the major safety concerns. Some answered that they think they know about the major safety concern but did not tell us their ideas. Others told us about their ideas. Underneath their answers are listed:

- Safety versus production (OP15)

- Long-term exposure (OP15)
- Explosions (OP20, OP25)
- Environmental issues (OP20)
- Waste water effects the environment (OP23)
- Dust (OP02)
- Every year different team (OP03)
- Fire hazards (OP26)
- (Pressurized) chemicals (OP01, OP04, OP26)
- Poisons (OP26)

15 of the 20 operators also answered the question if they think that every employee knows about these concerns. 11 of them thought that other employees know about these concerns too, three of them thought they don't know and one hoped that everybody knows it. The reason of the operators who said that everyone knows about these concerns is "because of the safety day and the developing of safety in the plants" (OP10) and "because the managers report the safety concerns on Intranet" (OP09).

Managers
Only one of the 15 managers who answered this question thought that he/she did not know about the major safety concerns. All the others had their thoughts about these concerns and they were almost similar to the concerns the operators mentioned.
Again, the answers of the managers are listed as follows:

- Handling solvents and solvents fires (MA16, MA21)
- Chemicals (danger with unknown chemicals/handling chemicals/exposure to chemicals/spillage of chemicals) (MA16, MA01, MA02, MA15, MA05, MA03, MA09, MA21)
- Production pressure (MA15)
- Time pressure (MA15)
- High energy projects (MA14, MA01)
- Hazardous materials (MA14)
- Handling explosives (MA03, MA05)
- Toxic environment (MA03, MA05)
- Runaway reaction (MA21)
- Environmental safety (MA19)
- Protecting goggles (MA09)
- Waste of water (MA01)
- Safety versus production (MA08)
- Use of new equipment (MA01)

One manager was not sure about the major safety concerns because "there is always different chemistry involved so it is always different".
The managers gave different answers on the question if they think that everyone knows about these concerns. From the 14 managers who answered this question six managers said that they think that everyone knows it. Two managers said that everyone should know it, three thought that most of the people know it, two said that they think the people don't know this and one was unsure about it. The reasons that were given by the managers who said that everyone knows the major safety concerns, were because of the "safety day and also each plant has its own day that they discuss issues within the plant" (MA04) and "there is a lot information on the Intranet". (MA01). These are exactly the same reasons the operators have given.

Mainly the most managers as well as the operators said they know what the major safety concerns are. They pointed out a lot of different safety concerns. About two third of the operators think other employees know about these concerns. At management level there is a distinction between, they know it, they should know it, most people know and not everyone knows.

Awareness of superiors
This paragraph describes the answers of these following questions:

- What do you want your boss to be aware of, that he does not know yet? What would you like him to know about "what is going on here"/your daily work?

Operators
Most of the operators think that their bosses are well informed about what is going on in the plant. But that is the same as we found out in the paragraph about the knowledge of activities in the company. This is "because the boss has hands-on-experience" (OP15), one of the reasons we also identified in the mentioned paragraph.
From the 19 answers on this question, 16 operators told us that they think that the boss knows what is going on, but some had ideas what bosses can be more aware of. Examples are: "I wish that my boss had more time for the operators and had more contact with them" (OP15), "boss stays well informed because of his openness" (OP19), "He/she has too little time and it rushing around. Boss could have more time for operators" (OP27). Three operators think that their bosses do not know what is going on or want their bosses to be aware of some things. The answers they gave were: "My boss should know more about my daily work. Boss doesn't see how the different shifts are functioning" (OP16), "I feel the boss doesn't know what is really going on in this particular factory because of his lack of knowledge. And the boss is not very open of my particular opinions" (OP22) and "that the operators works so much" (OP28).

Managers
Also most of the managers thought that their boss knows the most of what is going on. 13 of the 14 managers who answered this question thought that the boss is aware of things, but some had remarks for what the boss should know better. The one who said that the boss is not aware of everything what is going on said that "it is not possible" (MA21). The remarks of other managers were: "He should know that a change of company/safety culture takes a lot of time - he wants the change from today to tomorrow. I would like him to understand that it is a process that takes its time" (MA15), "maybe he should better follow my work and he should know how I make success in my tasks. He knows what my group does, but he doesn't know much about how I lead the group and how the group gets the results" (MA17), "things take time" (MA01) and "many other things are not good but accepted; an example is the handling of waste: it is not good but accepted" (MA02).

In general most managers and operators thought their boss knows what is going on. However there are some things the operators want their boss to be more aware of. For example the boss should spend more time talking to the operators. The managers want their boss to be aware of the factor that actions take time, to better follow the work of others and to understand that acceptation is not a guarantee for quality.

Preparedness

Preparation for future problems
This paragraph includes the following questions:
- Do you think that your safety culture and safety procedures are prepared for the future?
- Do you feel ahead of upcoming problems?

Operators
The most operators said they are satisfied with the safety culture and the safety procedures, and they think that the safety culture and procedures are prepared for the future. According to a few operators the management is working hard on the safety culture. One operator said "if there is a better product like safety protection on the market, the management will substitute the old things (OP14)". Another operator pointed out that not everything is fixed, "there are still a lot of things to fix in the factory" (OP15). Just one operator said he was really not satisfied with the safety culture, "they prepare and work on everything that saves time"(O16). There are a lot of operators that pointed out that it depends on several issues like new technologies, regulations and company vision. One operator said "we have to be aware we do not become to confident according safety" (OP25).

Managers

The overall opinion of the management group on this question is that almost everyone felt prepared for the future. Most managers think that the safety culture and safety procedures are prepared for the future, especially the near future, about two to three years. However a few managers said that there has to be a continuous development of safety procedures and safety culture. At the moment this is done by doing a risk based approach and by looking to other companies. The reasons for this approach are e.g. new chemistry, unknown chemicals and new products. A few managers stated positive that the company always wants to improve. One manager said that "the structure is good but the company is getting bigger, that is why there must be more minds together" (MA03). Another manager explained that the company has to be aware for safety reasons: "Sometimes we cannot handle because of safety reasons" (MA 01). This manager thought using modern technology and modern equipment can solve this problem. Just one manager was negative, he or she said "the company was not moving up while it should" (MA12).

Operators
Most operators said they feel ahead of upcoming problems. Just one operator was really negative. This operator declared: "I am not feeling ahead I do not have an overview what is going on, only my boss has an overview (OP27). Another operator said about this topic, "the management tells the workers in the last step because they do not want the workers to be afraid for anything" (OP14). Another operator said "the management is building new things without mentioning the old one" (OP03).

Managers
Most managers said they feel ahead for upcoming problems as well. Some managers pointed out tat the biggest risk comes from chemicals. However there is a lot of knowledge about chemicals inside the company. One manager said "the main risk are the chemicals and the tricky reactions, but we have a lot of knowledge about that" (MA15). Other problems, like equipment failure are hard to predict, explained one of the managers. Most managers try to see problems in an early stage and try to imagine what could go wrong; sometimes this happens with help from the operators. A few managers said before handling a new product they will keep a good discussion.

To sum up the most managers and operators are satisfied with the safety culture and procedures and they think they are prepared for the future. They feel ahead of upcoming problems as well. Just one operator was negative because he did not have an overview about what is going on.

Active anticipation of future problems

This paragraph includes the following questions:

- Do you actively prepare to anticipate future problems, e.g. by conducting safety group meetings or workshops?
- Do talk with your colleagues about your concerns about safety?

Operators
Most of the operators said they are not involved to anticipate future problems. One operator said they had a workshop about the 20 major safety hazards, but he/she did not know what they did with the results. Another operator pointed out that he thinks the management does not listen to the operators. "Management never listens, we are only stupid operators" (OP16), he said and another operator mentioned that "operators think the management does not care about safety and the management does not know this of the employees" (OP24).

Managers
The answers of the managers differed largely. There are managers that are involved in such workshops or meetings but there are also managers that are not involved at all. A few managers reported on the safety day. Once a year on safety day all employees talk about future problems. There are also four safety meetings a year for the managers to discuss different safety problems. Beside this there are the normal inspections of the plant and a lot of managers said they are having a constant dialogue with the operators.

Operators
Most of the operators said they talk about safety with other operators. A few operators said they talk about safety all the time; the most said they in general talk about safety or they sometimes talk about safety. Just one operator did not talk about safety, only if he or she really has to do it, otherwise "it is as good as it is" (OP27). One reason to loosing sight of talking about safety is experience, "everything is clear, and after six years nothing happened", one operator said (OP09). A few operators in particular mentioned the safety day as day where they talk about safety. "Especially at changing shifts it is very important to talk to new colleagues what is going on", an operator said (OP11)

Managers
Most of the managers said they talk about safety with other managers. Just one manager said he did not talk about safety with colleagues (MA20). One manager said "we have good cross links in the company" as explanation in what manner he or she talks with colleagues (MA01). "There are both formal and informal meetings about safety", one manager said (MA02). The HSE team plans what to do next year about safety and herein are the ideas of the supervisors as well. "Gut feelings are mostly discussed in the plant with the supervisor", one manager said (MA15).

Overall most of the operators said they are not really involved in anticipating future problems. Some mentioned "the management does not listen to us, we are just stupid operators". There are managers actively involved in preparing for future problems, but there are also managers not involved at all. Most of the managers and operators talk about safety; operators often do that with other operators and managers often with other managers.

Gut feelings, faint signals or intuitive feeling

This paragraph includes the following question:

- Do you feel your boss pays attention to you if you have gut feelings, faint signals or intuitive feelings about trends or future hazards?

Operators
The most operators said their boss would pay attention to them when having some gut feelings. Most of them would then go to their manager, they said. They do not feel scared to go to the managers, the operators said. A few operators pointed out that they will first talk to colleagues before they go to their boss. One employee stated "it depends which plant it is, my supervisor does not have solid knowledge base for all the plants he supervises" (OP23).

Managers
This idea is almost the same with the managers. They would always listen to operators, the managers said. None of the managers would not listen to operators with gut feelings. "There is always space for improvement and their ideas can be part of a solution for problems", a manager said (MA09).

Unlimited budget

This paragraph includes the following question:

- If I gave you an unlimited budget, what would you do to improve safety and prepare for future problems?

Operators
The operators gave very different answers on the question what they would do with an unlimited budget. The improvements of the operators are more related to their work than the managerial improvements. A few operators said they do not know what to improve anything. Other operators also said everything is fine and one operator said they always discuss about that in weekly meetings.
However there were a few common improvements operators suggested. They proposed improvements concerning lifting of materials, ventilation in the plants and the lab, replacing old machines and building a new factory:
A few operators said they would do something about the lifting of materials if they had an unlimited budget. "I would buy a lifter and would fix other ergonomic issues that often involve lifting stuff (you

have to lift sometimes sacks of 25 kg to refill a machine)" (OP15), the operator said. A few other operators would spend their unlimited budget on better ventilation, "improve ventilation" (OP28), another operator said and focus on "fresh air from air system while cleaning the dryer. Boss didn't do anything with this so far, because he had too little time. He has no time to think of this" (OP27). Other operators would like to improve or change the old machines or build a whole new factory. "In F16 there are very old machines. I would throw them out and would buy new ones" (OP17), one operator said. Another operator stated, "I would like to change some old machines because they are not very safe" (OP01). "I would build new factory to improve safety" (OP03), the operator said.

Some operators mentioned some other improvements:

- "Try to engage people what it is about, how do you behave on your lab. It is hard to improve technical stuff to change behaviour, I am thinking on a bonus system." (OP26)
- "Air treatment of chemicals. There are too many leaks of gases and fumes." (OP23)
- "Something about the noise" (OP04)

Managers

There are a lot of different topics the managers mentioned that could be improved with an unlimited budget. The topics can assigned to different categories: plant related, equipment, people, chemicals, precautions and research. The order the answers are listed here is from most mentioned till least mentioned. So the most stated topic is to do something about plants and the least mentioned is precautions and research.

Most problems with plants are caused due to hazardous chemicals. They are not appropriate any longer to handle chemicals there; for example:

- "With an unlimited budget I would build a new lab with a good ventilation system. Everything must be modern and flexible" (MA01).
- "I would build a new warehouse, where chemicals can be handled in right way and were hazardous materials are in a different rooms" (MA14).
- "multipurpose plants are old so would get new ones" (MA04)
- "Build a plant to handle high risk hazard chemicals"(MA11)
- "rebuild pilot plants" (MA21)

After plant related topics the managers mentioned equipment second most. The equipment should be changed or there should be new equipment according to the managers. For example:

- "I would invest: in new equipment for the factories, e.g. tanks to make products, dryers, centrifuges, reactors" (MA16)
- "Invest in better equipment to invest in projects that the company is unable to handle because of outdated equipment" (MA10)
- "Improve to monitor chemicals and change old equipment" (MA12)
- "Change all the equipment and have it remotely controlled so there is no contact" (MA06)
- "Fix loading equipment to load solvents in reactor, has to be more easy" (MA02)

People related topics are often about hiring more people. The managers said they feel vulnerable without having buffers, so they want to do more about that topic and especially need more people. For example:

- "more people working on the same shift in some plants to not be so vulnerable if someone is sick - some people have to work overtime, like 12-16 hours" (MA16)
- "Hire more personnel for my department"(MA15)
- "more people/good system in place ahead, time is such a factor because there aren't enough people" (MA05)

Another topic the managers mentioned was related to chemicals .The managers want to improve the safety in handling chemicals. For example:

- "I would also buy a containment closure system, that should be established that no one has to deal with nasty chemicals" (MA15)
- "solvents in the air; dust problems" (MA20)
- "more training in chemical handling & process engineering for operators" (MA16)

Just a few persons said something about precautions for safety like more sprinklers and fire alarms. Just one manager said something about research and that there is a need for "more education and training and more investigation about what factors influence the operators' behaviour" (MA15).

Biggest problem

This paragraph includes the following question:

- What do you think is the biggest future problem concerning safety that your company faces?

Operators

The operators had a lot of different opinions about future problems the company faces. Several operators said they saw problems in the processes as the biggest problems, for example:

- "You never know e.g. if an acid is leaking, how a boiling acid reacts or when a valve is going to break" (OP14).
- "Safety in chemicals perhaps. Pumping out of cans has not been modernized for years (very old processes). Management does nothing about it! There are a lot of reports written about that problem and there are also a lot of accidents - but they don't do a thing!" (OP17)
- "There are so many occasions where you can hurt yourself, like lose ladders. But there are a lot of other procedures that are unsafe, especially in old plants - you have to be extra-careful there" (OP15).

Other operators said the biggest problem concerning safety is dealing with chemicals. The operators are often not sure if they know everything about the chemicals they handle:

- "We don't know how chemicals moving" (OP24).
- "There are allergy problems giving asthma to workers" (OP21)
- "New unknown chemical compounds where operators might not know a lot about"(OP21)
- "Handling of chemicals and long-term-exposure" (OP15)

Other remarkable topics that were mentioned are time, behaviour and environment.
One operator said time is safety-critical issue for the future: "Sometimes I want more time to conduct my work safely, sometimes more machines to help me do my work" (OP 18).
Three of his colleagues mentioned future problems come up with the behaviour of people. They said "everybody has his own level of acceptance for products this is not good. Optimalize!" (OP26) and the other said "sometimes behaviour is a big problem" (OP26). The third operator thought future problems could go along with "human mistakes and failures with machines. But as long as there will be people, there will happen (small) accidents" (OP10).
Two other operators said the environment and waste are the biggest problems (OP19/28).

Managers

Almost 50 percent of the managers, that answered this question, said the biggest future problem is about chemicals. But there is a contrast between the different problems with chemicals the managers pointed out. For example the use of new chemicals and the use of new chemicals in old plants is a problem, the managers said. "Every year the projects get "nastier" and the chemicals become more toxic so this is an issue" (MA04). Another manager talked about the knowledge of new chemicals. "I don't know what to do if the chemicals react and an accident occurs. You don't know much about new things - you work with an unknown level of hazards" (MA17).
A few managers pointed out something about organisational aspects. They see future problems in the growth of the organisation. "We are growing as a company and there are more and more demands so it is difficult to maintain the organizations' needs and communications that are present right now" (MA05), the manager said. Two other managers mentioned some problems with experience: "Make a job more attractive to keep people in position. There is a gap between the old engineers with a lot of knowledge and experience and the new ones."(MA11).
Two managers manager told us they are worried about environmental problems. "Environmental factors- everyone is trying hard to fix it" (MA19), the manager said. Another one talked about waste as future problem. "Waste is a big future problem, but the director would like to talk about challenge" (MA01).

A few remarkable problems the managers pointed out were:

- "People must think that safety goes before production. Some people just don't listen" (MA20)
- "Conflict between profit and safety. Managers have to deal with this. Tight production schedule" (MA08)
- "In this building it is getting to crowded with people and equipment making it more prone to accidents" (MA18)

To sum up there is a very huge contrast between all the answers from the managers as well as from the operators. Operators saw problems in the processes and problems relating to handling the chemicals as the biggest problems. Almost 50 percent of the managers saw problems according to dealing with chemicals.

Flexibility

Slack and scarce resources

This paragraph sums up the answers to the following questions:

- Do you have any slack resources available to cope with sudden accidents? (material resources, time, buffers, etc.)
- What kind of scarce resources would you like to have more of?

The questions were difficult to answer for managers and operators. Many times we had to explain what we meant by slack resource and scarce resource. A slack resource could be simplified explained as a back-up resource. A scarce resource is a resource of which you only have a few available.

Operators

The operators gave very different answers to the first question. Some thought about materials, others about machines, things or persons. But the answers did not always have something to do with sudden accidents. A few operators thought that there were no slack resources at all. The fire-brigade was an answer that was mentioned several times. Other slack resources operators mentioned are listed below:

- "We have bags to suck up chemicals; we have a lot of material for the batches, but we only can use the material specified in the protocols. Base materials like salt are always in stock, but odd materials are ordered for every customer, so there are no slack resources of it." (OP14)
- "Sometimes they have time buffers; usually you can't stop production, because otherwise product gets wasted."(OP15)
- "Sprinklers water from the roof." (OP13)
- "We have alarms if temperature/pressure gets too high. Then try to fix it before it gets to that point." (OP13)
- "There is always an abundant supply of materials" (OP06)
- "We don't like to restart therefore more equipment." (OP08)
- "No, not really. There is a "back up" person during nights and evenings in case of a accident will happen. Every week this is another person." (OP09)
- "Air pressure" (OP04)
- "Dieselgenerator" (OP04)
- "Computer back up systems." (OP25)
- "Some machines have a back up, if the van is out it is not permit to work." (OP26)
- "Water waste plant safety basins" (OP24)

Managers

The managers partly gave the same answers as the operators. E.g. they mentioned the fire brigade, too, but they also gave other answers:

- "If there is an accident the pilot lab would reorganize to make sure it does not happen again" (MA10)
- "Talk with the supervisors to come up with a solution to resolve the problem" (MA04)
- "Generators for factories that require it" (MA 21)
- "Process stops/sprinklers for fires provides time buffer for people to get out." (MA20)

- "Emergency stops for gas but no back ups. Only analysis will be ruined with a loss of power" (MA18)
- "Yes, HSE group and boss" (MA07)
- "Always resources available for accidents. Industrial fire brigade always on call." (MA09)

But not every manager thought that they he or she would have any slack resources available.

- "We don't have that, e.g. there are no extra human resources available. We have talked about extra human resources for one plant; the supervisors always want to have more human resources." (MA16)
- "No buffers. I work a lot with contractors, with a lot of external sources (mechanical workshops, programming, designers), we rely much on external services. We have enough maintenance staff to fulfil our daily work, but no staff for improvement." (MA17)
- "No the plant is a bunker" (MA19)
- "Not really we have to repair anything, no extra vans, no slack resources." (MA01)

Operators

We also asked the employees if they have an idea about scarce resources - if they want to have more of some resources. Six of the 18 operators who answered these questions thought that their situation was ok. They did not want more of something. The other 12 operators had some ideas about the resources they want to have more of. Underneath an enumeration of their thoughts is given:

- "More updated (up-to-date, modern) equipment; a lot of the equipment (machines, vessels, etc.) is old" (OP15). That was also confirmed by other operators (OP22, OP23).
- More equipment (OP06, OP23)
- "More time to conduct the work safely" (OP18). That was also stated by OP05.
- "More machines to help the operator to do his/her work, like automatic lifts" (OP18)
- "Shorter workdays" (OP11) (the resources this operator wants to have more of is probably employees)
- More people (OP05)
- More powder (OP08)
- "Some machines are smaller and require multiple loads/ many floors-a lot of running around." (OP21)
- More ventilation (OP25)
- A secretary (OP28)

Managers

The managers mentioned four groups of resources they want to have more of:

- People (15x)
- Equipment (4x)
- Time (3x)
- Space. (1x)

To start with the first category, people, the managers want to have more maintenance personnel (2x mentioned), safety personnel (4x mentioned), chemists (1x mentioned), operators (5x mentioned), process engineers (2x mentioned) and more experienced people (1x mentioned). The managers also wanted more and better equipment. Examples of these equipments are a storage of machines parts (MA16), better clothes to protect operators from exposure to chemicals (MA09), vans (MA01) and better courses (a simpler way to understand instructions for new things) (MA03). Three managers mentioned that they want to have more time (MA03, MA19, MA02) and one person asked for more space (MA18).
Only two managers said that they do not need any extra resources. One came up with another remark, though: "To improve safety I think it is not necessary to have more resources, it is more about procedures and how the people behave" (MA14).

To sum up, the definition of slack and scarce resources was not clear all the time. The managers and operators told about a lot of different slack and scarce resources they have. Partly, the answers were

overlapping each other. The scarce resources managers want to have more of could be divided into four different: groups, people, equipment, time and space.

Actions and decisions regarding system failure

This paragraph displays the answers on the following questions:

- What do you do if the system (the part of the organization where you are responsible for) fails suddenly?
- Do you have to wait for your boss to make a decision (e.g. to stop production) or can you decide on your own?

Operators

About half of the operators said that they have to call their boss or the person on call if something happened. Operators can handle the problem by themselves if it is only a little thing that happened: "If it is just a power blip you can reset the machine by your own" (OP14). For major things the operators have to stop the process and call somebody, "e.g. if gas is leaking somewhere, the operator has to call the person on call. Person comes in and the boss makes the decision. But first we as operators stop, then we call" (OP18) or "many times you stop on your own the process and call your boss. Decision if to go on is up to the boss" (OP15).

Some operators gave an impression of the situation and the important things to do in their plant. Their answers are listed below:

- "Sounds a general alarm for the immediate area/factory and then calls the guard for further instructions" (OP20)
- "Try to save as much as possible" (OP21)
- "Shut it down without accidents (oxidation facility can be extremely hazardous and must be taken care of immediately)." (OP23)
- "When electricity supply stops, there is electricity available on diesel. Most important thing is to cool everything down." (OP10)
- "Depends on what is happening. In risk assessment is said what to do. For critical situations: operator knows what to do, in other situations, operator can look it up." (OP27)

20 of the 24 operators who answered the question if they were allowed to take decisions by their own, for example to stop production, said that it depends, but in dangerous situations they are always allowed to do that. The other four operators have to wait for their boss when they want to shut down the production. "I feel I need to contact my supervisor" (OP19). Another reason why an operator doesn't shut down the production is because "over here it is not so important as in the plants. We do not feel hazardous" (OP25) and the other two mentioned: "The operator can make decisions but if he wants to shut down the production he has to call his boss" (OP01). All the other operators told us something like: "It depends. If I is really dangerous I can make decision, but if it is not, then have to consult with supervisor" (OP13).

Managers

The actions of the managers differed a lot, because we interviewed managers from different levels of the organization. Below an overview of their answers is given.

- "Contact process engineers of the system and ask what to do." (MA02)
- The manager "expresses to everyone 'no heros-just let it burn'" (MA19)
- The manager "restarts the system if there is a power outage to try and prevent the emergency cooling from destroying the product." (MA20)
- The manager calls "the fire brigade for reaction to any incident requiring it" (MA21)
- The manager "talks with the bosses to come up with a solution to resolve the problem." (MA04)
- "Hopefully it can be seen when it begins to fail. There are plenty opportunities to watch and see if failure occurs." (MA05)
- "Only way to be separated is if you by-pass the safety mechanism." (MA12)
- "Close down work, so that no person is hurt, call for help, protect other people in the area, if the risk is still there. If an incident report is filled in, an investigation is started every time."(MA17)

The managers' answers to the question if they can decide on their own or if they have to ask their boss to take a decision are very similar. Every manager is able to take decisions on his/her own. If there are decisions about certain issues like money, then they have to ask their boss first: "Depends on what it is. If it is cost affected then it goes to higher" (MA10) level. Almost all of them said that they have to inform their boss about their decisions. "But I always have a discussion with my boss about it" (MA08).

In general the operators said it depends on the situation if they could take decisions on their own. In dangerous settings they are always allowed to do that, the operators said. Four operators pointed out that they have to wait for the boss.
Every manager is able to take decisions on his/her own. Sometimes managers have to ask their bosses, but there is also a contrast between the managers of the different hierarchy levels.

2ND STEP – INTERPRETATION: FROM SINGLE ANSWERS AND SUMMARIES TO HIGHER ORDER FINDINGS

As told before, this chapter will deal with the patterns and regularities we found and will come up with some higher-order categories for our findings. This chapter will be supported by literature and comprises our own ideas and interpretations about the company we investigated.

Answers that did not match the particular questionnaire questions are presented in this chapter as well as interesting, fascinating and sometimes appalling stories and episodes the operators and managers told us. We also interpret the findings of the first step of the analysis and look for reasons how and why the answers were given the way they were given.

We try to answer the question how the picture that unfolded here could have developed – how e.g. a conflict between production and safety, that some employees experienced, could have merged or why workload or training issues sometimes have been seen so different.

How could these phenomena have been generated? What underlying principles do we see looking at the findings? Which common principles do these results refer to? What tells us the literature about the patterns we found and about the dynamics behind?

When comparing and speaking about the results of the first part of our analysis we felt that there are five basic principles almost all answers refer to; we named them "we choose safety over production – except when we don't", "Limits of the open door", "The normalization of daily risk", "Specific vulnerabilities of development" and "Closing the loop of learning". In the following section we will present these principles one-by-one. The main base for our arguments will be the summaries of the first part of the analysis as well as direct quotes of the interviewees and literature.

"We choose safety over production – except when we don't"

"You feel that the highest manager is dedicated to safety" (MA16)

The conflict between safety and production is a subject that has been discussed for years; not only in companies that have to deal with that issue, but also in scientific literature. In the following paragraphs we will provide some suggestions of the underlying principles of the behaviour and answers of people we have interviewed. What we experienced could be conceptualized by terms like: a general faith in the company's safety efforts, the little daily trade-offs between safety and production, level-inverted perceived and self-announced commitment to safety, management double standards, the internalization of external pressure and the macro-micro-level connection. We will explain these concepts now in more detail.

A general faith in the company's safety efforts

Most operators and most managers felt in general pretty safe in their company. It was stated that the management focuses more and more on safety and that they are committed to improve safety at Chemco (see 0). Furthermore almost all people were confident that they had the ability to stop production when safety is at risk. The operators explained that they would stop the process and call their boss or the engineer on duty; they also claimed that their bosses encourage them to do so. All managers agreed that they definitely had the ability to stop production if safety is at risk and that they stress the importance of stopping production when talking to their employees (see chapter "Stopping production when safety is at risk"). Most operators and managers stated that the quality of safety is not affected by budget.

Altogether from that perspective one could assume that the company is doing very well - Chemco seems to have a good safety record. Almost all employees are very confident in the high safety efforts the company makes to improve safety over and over again.

The little daily trade-offs between safety and production

However, there are too many critical voices concerning safety to hide from the daily trade-offs concerning safety and production that are made at Chemco. "Safety is important when you do not have much hurry. But if there is production pressure, safety is not important, production is put first" (OP16). Daily trade-offs between safety and production are made by operators and managers at Chemco and, of course, by a lot of other companies as well. It is not always easy to put safety first - or as Dekker (2002, p. 89) put it: "Although 'safety' is almost always cited as an organization's overriding goal, it is never the only goal (and in practice not even a measurable overriding goal), or the organization would have no reason to exist." To enhance safety on such a high level – and Chemco has already reached a level where big accidents occur very seldom – it makes more sense to look at the small accidents or incidents than at the big ones, because almost every operator told us that "if big things happen you can always call them [managers, engineers]" (OP15). But the devil is in the details here: Little daily trade-offs are made between production and safety, e.g. operators who do not put on their safety protection, because this would "waste" some minutes in the production process. These daily trade-offs happen not only, but very often at the very sharp end, the operators' workplace:

> "[…] the actual managing of goal conflicts under uncertainty gets pushed down into local operating units – control rooms, cockpits, and the like. There the conflicts are to be negotiated and resolved in the form of thousands of little and larger daily decisions and trade offs. There are no longer decisions and trade-offs made by the organization, but by individual operators and crews." (Dekker, 2005, p.146)

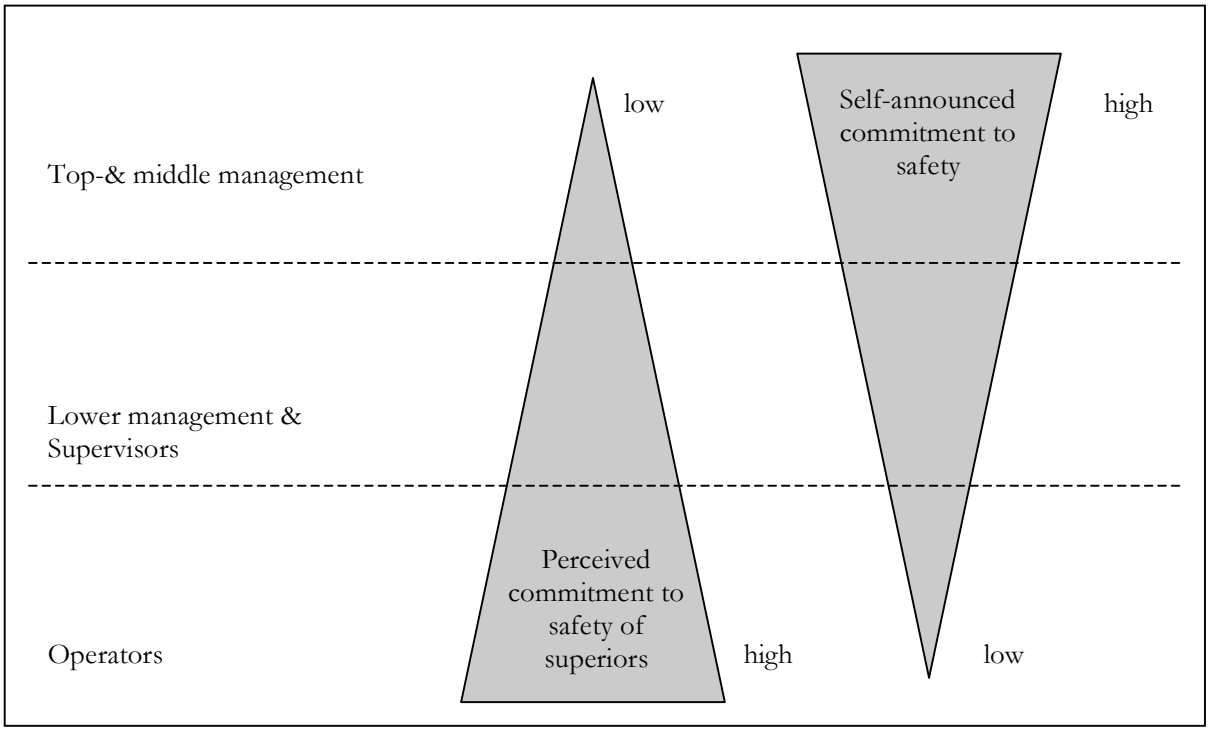
Hollnagel (2004) formed the expression "ETTO" for these types of situations: ETTOs are efficiency-thoroughness-trade-offs, where people have to decide to go for safety/thoroughness or production/efficiency. "On the one hand people genuinely try to meet their (internalized) goals, i.e., they try to do what they are supposed to do – or at least what they believe is reasonable to do – and to be as thorough as they find it necessary. On the other hand they try to do this as efficiently as possible which means without spending any unnecessary effort or time to do it" (Hollnagel, 2004, p.147f).

But as one can imagine it is not possible to be safe and efficient to the same great extent without being limited by time (Hollnagel & Woods, 2006) or as Hollnagel put it: "if anything is unreasonable, it is the requirement to be efficient and thorough at the same time" (Hollnagel, 2004, p.159). And then ETTOs appear: "It depends what happens – small things are fixed right away, bigger things take time, but if possible production continues around the problem" (OP07). To avoid ETTOs sacrificing decisions have to be made to deal with these problems; that are situations where safety is put first and the pressure on throughput and efficiency goals is relaxed (Dekker, 2006, p.83).

The management plays a major role in creating these daily trade-offs and taking sacrificing decisions. While all managers told us that safety plays an important role at Chemco, interesting findings came to the surface when asking for the most valued goals of superiors: only a few managers stated that safety is really put first by their superiors. Most of them felt that other goals like production, costs or delivery are put first, though. The operators were more confident here; however, it is still only the half of the operators who felt that their superiors put safety first.

Level-inverted perceived and self-announced commitment to safety

It is remarkable that concerning the levels in hierarchy, the picture of the perceived commitment to safety and the self-announced commitment to safety seems to be reciprocal. A lot of operators pointed out that safety is at least one of several important goals for their superiors; this assessment made by subordinates about their superiors can be called "perceived commitment to safety of superiors". Only a few managers stated that as well. Regarding the self-announced commitment to safety most managers expressed their high commitment to safety, whereas most workers reported daily trade-offs between safety and production that are made by them.



One possible explanation for this phenomenon could be the sometimes doubted credibility of the superiors. If operators think that their bosses do not believe in what they say or that "the management says that they emphasize safety, but you never know if they mean it the way they say it" (OP14), then this picture could emerge. This credibility-approach will be presented in the chapter "the limits of the open door" in more detail.

Management double standards

Another factor that could play a role here are "management double standards. This is a situation where people are pushed to make efficiency-thoroughness trade-offs because of an […] management policy that clashes with the official one. Typically, the official policy puts safety first, but in practice people know that efficiency is more important" (Hollnagel, 2004, p. 156). If the management states – even with an official policy – to put safety first and then this obligation for safety is negotiated in the daily activities, then operators get conflicting signals of what is really first. They experience a "double-bind", or as Dörner (1989) put it, a "doublespeak". This is a situation where conflicting signals or messages are sent and the recipient has no chance to behave in the "right way" (Watzlawick, 2000, p.196). The situation gets tricky: Either you put safety unconditionally first, but then the consequence is that "you feel a bit afraid to call your boss if only minor things happen" (OP14), or you decide for that "things that are not safe are done anyway [and] you can tell your supervisor afterwards" (OP15). To be more explicit here – we think that the operators do not really explicitly decide for or against safety. But they are bound in the multiple everyday goals they have to fulfil.

Conflicting signals are also sent when the management states the importance of safety but no one feels rewarded if safety improvements are handed in or incident reports are filled out. Several operators do not get a grateful or friendly word when telling their concerns about safety, the incident report form is too complicated for most people, so that it is burdensome to fill out a report, and the direct connection between reporting an incident (with the incident form) and a final raise of the SHE-index seems to be unknown. If most people feel that they do not get a reward at all – why should they report safety concerns? If they feel that handing in reports is more valued than simply talking to other people or their superiors about safety – how can you keep the *discussion* about risk alive? We heard a lot of people telling of their superiors who encourage them to fill out paper reports. Is that the solution – a bureaucratic reporting system- that –by the way– is not used too much, because of a complex reporting form?

The internalization of external pressure

"Improve every working process and at the same time be cost-efficient and at the same time produce and work safely." (MA17)

Safety versus production is a challenge a lot of companies face and together with them all their employees, be it operators or managers: "Safety is never the only goal in systems that people operate. Multiple interacting pressures and goals are always at work. There are economic pressures; pressure that have to do with schedules, competition, customer service, public image" (Dekker, 2002, p. 62). A lot of operators have internalized these multiple goals and try to fulfil all of them simultaneously with their best efforts, like this little story shows:

> "Usually you have to […] monitor every 15 min. If you do it only after 16 min., you have to fill a report and the "paper error" goes down to the office. To avoid that this happens, you usually write down that you checked it in time, but sometimes you have to work for two production lines at the same time and then it's not possible to perform the checks in time. So you look afterwards what the temperature was some minutes before (in minute 15) and you write it down (e.g. 5 min. too late). Because you have to do things simultaneously and you have to do things right - these are two goals that sometimes conflict." (OP15)

One of the managers told us that "the higher in hierarchy the more goals you have! You have fewer goals if you go done the hierarchy, you act more local" (MA15) – but actually the opposite is the case. One manager stated that he/she has to "improve every working process and at the same be cost-efficient and at the same time produce and work safely" (MA17). Exactly the same pressure can be found at the operator's side, though, because "institutional pressures are reproduced, or perhaps really manifested, in what individual people do" (Dekker, 2005, p.147), but this will be described in more detail in the next paragraph. It is no difference on what hierarchy level you are: "Safety is first – and maximum production" (OP05). If we remember the multiple goals that subordinates pointed out when asked for the most valued goal of their superiors it is not astonishing that these subordinates internalize these often conflicting goals and make them their own goals. They just orientate themselves on what they hear from their supervisors and do the best they can.

The macro-micro-level connection

"How is it that global pressures of production and scarcity find their way into local decision niches, and how is it that they there exercise their often invisible but powerful influence on what people think and prefer; what people then and there see as rational and unremarkable?" (Dekker, 2005, p. 43)

Operators try to keep pace with the increasing demands. Even when "the workload is getting bigger as years go by" and "this increases pressure and stress" (OP05), people give their best to fulfil their tasks, to get the job done – quick and safely. "We have a lot of good knowledge, procedures, all that technical stuff. If you put together time limits and the good technical stuff you drive yourself harder every time. People put a lot of pressure on themselves, an internal pressure to perform better every time. (MA15)". But even if you drive yourself harder, you have to cut back on something. Vaughan (1996) describes an illustrating example of a "culture of production" that has to deal with safety issues concerning the Challenger Launch. It is also a good example how company goals can become internalized by the operator at "the sharp end":

> "Marshall's Wear commented on the workload, describing how production pressure became institutionalized and taken-for-granted: 'The program is set up, there is a plan to launch, twelve this year and fourteen next year and sixteen the next year. That is in the cards. In order to do that, you have to do certain things on Monday, something else on Tuesday, and something else on Wednesday, just to make the machine work. So, you can call it pressure: I call it work. That says I've got to get ready to fly the next flight quicker than I did the one before that, because you can't go from six a year to fourteen a year without either expanding the work day or working faster. It's as simple as that." (Vaughan, 1996, p.232)

This phenomenon is also known as the macro-micro-level connection: Company goals that are set up on high hierarchy levels are reflected in the thinking and behaviour of operators. But Chemco itself is

embedded in higher systems and reproduces the principles of these: there is e.g. the "competitive environment (competition, scarce resources, and norms), which generates pressure on organizations to violate laws and rules in order to attain goals" (Vaughan, 1996, p. 458). There is also a "wider cultural belief system […] of society: capitalism and competition are "the" economic way; concerns with cost, production goals, and efficiency dominate industries" (Vaughan, 1996, p.237). When employees complain that "it would be nice to be not on the market (as a company) to get rid of the quarterly and end of year reports - because of the high stress that goes with the reports, more incidents and mistakes are bound to happen" (MA18) or that "money is of course No. 1, to make the reports for the market and the steering committee", then one can clearly experience how company goals are passed down to managers and operators, who then internalize these company goals – "I'm pressured to get the product in time, but safety is always first" (MA03).

Limits of the open door

"I feel that everyone is on the same level and because of this I can talk to anyone, even the vice president has an open door policy (the vice has expressed the fact that he worked his way up from being an operator so is more than willing to meet with any and all who have concerns)" (OP20)

"The management says that they emphasize safety, but you never know if they mean it the way they say it" (OP14)

One operator felt comfortable to report problems to his/her boss; "always and for everything." But the boss "has too little time and is rushing around, […] boss could have more time for operators." (OP27)

The last two quotes from above illustrate that there are limits of the "open doors" of the managers, like the first quote suggests. A lot of employees talked about the open door of their bosses, they told us it is "easy to communicate" (OP08) or they said there is a "very open communication" (OP07) in the company. The "organisation is an open and flat organisation. For that reason it is not difficult to talk with bosses."(MA07) And for a lot of managers this is reality. But for some of the people there are limits of open doors though, and in this paragraph we want to speculate about the reasons for the limits of the open doors or in other words: what problems could exist and why?

High workload

As stated before the doors are not always as open as it is said by most of the employees. One reason for this could be the high workload. About one third of the managers said that their workload is constantly very high. And half of the managers told that their workload varies a lot and that it can be very high for a short period: "There are periods with a intense workload but other times with no" (MA03). Another supervisors said: "Now there is just one supervisor instead of three and I have no help of a process engineer. There is some high workload at this moment, especially in one plant" (MA07). This supervisor also told us he/she has too much pressure at this moment because there is a problem with finding new supervisors.

A cause of the managerial unawareness of the high workload of operators is that the managers do not have enough time in the plant to spend together with the operators. "I go to the operators too seldom, I would like to do it more often. I focus on my organization and I'm too little time out in the plant." (MA15) Therefore the operators could get the feeling that managers do not want to get in contact with them or that they get the impression that "management never listens. We are only stupid operators" (OP16).

Stress

Another consequence of a high workload could be stress. "Psychologists still debate whether stress is a feature of a situation, the mental result of a situation, or a physiological and psychological coping strategy that allows us to deal with a demanding situation." (Dekker, 2002, p.123).

Stress could e.g. be caused by a mismatch between demands and resources, in particular by small mismatches. If big mismatches occur that people can not handle they usually go and ask for help or more resources. In a situation with only small mismatches it is possible for the employees to get the work barely

done, in spite of having additional resources that would be appropriate to cope with the situation. (Dekker, 2002)

According to literature, two consequences of stress and a too heavy workload are tunnelling and regression (Dekker, 2002). Tunnelling describes "the tendency to see an increasingly narrow portion of one's operating environment". Regression is "the tendency to revert earlier learned routines even if not entirely appropriate to the current situation." Tunnelling and regression could cause unsafe situations because employees do not pay attention to all the threads (tunnelling) and employees do not use check the appropriateness of a method in every situation (regression).

Unawareness

Furthermore the unawareness of some managers can lead to a less open door because of a lack of interest and knowledge from the manager's side.
Although we heard a lot of positive stories about the knowledge of the managers about the activities in the plants, some operators had different opinions. They told us "the management does not see everything. I got a new boss in spring 2006, so he/she knows something. But I do not now how much he/she really knows" (OP16). And others were not sure if their boss knows what is going on in their plant: "I do not think he knows what is going on because he is never around" (OP08) and "they should know what is going on! Not so certain right now" (OP22).
These examples show that the door of the supervisors is not always as open as it is said, because some supervisor are mostly away from the plant or simply because a supervisor is new and has not sufficient knowledge yet.
One operator suggests something about the size of the plant and the knowledge of the supervisors: "In small plants they now exactly what is going on in big plants they do not"(OP24). It is possible that the "door is more open" for operators of small plants than for operators of bigger plants because the contact to their supervisors is closer, but this is speculation.

Also the managers themselves said that they are not aware of everything what is going on in the company. One manager said that he/she knows "what is going on in his/her own area of responsibility, but does not know what is going on in other areas." (MA16). And another one told us: "I believe I know what is going on at a high level. But I go to the operators too seldom, I would like to do it more often. I focus on my organization and I am too little time out in the plant" (MA15). Something similar is said by another manager: "I do meetings all the time. I have to ensure that production runs smoothly, that production has to run safe; that they produce in the right time, the right quality; that the supervisors in plant have all the skills to do their job. I go to the plant once a week; but this is too seldom; I would like to talk to the operators more often; but I can not do that because there are a lot of meetings and it is hard to prioritize to which meetings I should go and not" (MA16). These quotes make clear that the communication between plants and between higher management and operators is not conducted on a regular basis and that the managers themselves have the feeling that their contact with the operators is too spare. The limits of the open door are in this case set up by the managers themselves, e.g. by favouring other obligations over direct contact with operators or by focussing too strong on their own area of responsibility.

Inactive attitude

Almost all of the operators said that they are able to participate to improve the organisation. And all managers also said that they stimulate operators to help the organisation to improve. In some cases the door was not as open as described above. Problems with lifting heavy stuff were told to a superior several times, but he/she did nothing about this problem. Here is another example that was told of a situation where the superior heard about the complaints of the operators, but did nothing with this information: The operator suggested a solution for cleaning the dryer in the lab, but the "boss did not do anything with this so far, because he had too little time. He has no time to think of this."
For this reason we can conclude that the problem last mentioned could be also caused by a workload problem. Other reasons why the superiors did nothing with solutions from the operators could be that these solutions are too expensive. "I'm empowered to tell the boss the good ideas. My boss does something with this if the ideas are good. But the costs are also very important" (OP27). It is clear that there is no company with an unlimited budget and that some solutions are expensive, but it is pitiable if

the operators risk their health because of some problems in the plants and become ill because of a lack of money to solve their problem.

Level of communication

As said in the first lines of this chapter, the communication is very open and subordinates and superiors do not have problems to inform each other about issues in the company. Strange enough is that not all the subordinates know if their superiors value their work. Some operators said the following: "I hope so" (OP06) and "I'm not sure, what my boss thinks" (OP15). The fact that they do not know suggests that the door to their boss is not as open as stated in the beginning, because otherwise they would know what there boss thinks of them.

Stagnated cross communication

A different reason why open doors sometimes are less open is because of stagnated cross communication. With cross-communication we mean the communication between different departments and different plants.
The doors are not as open as they have to be sometimes, because there is not enough communication between the different parts of the company. The following quote illustrates this: "Monthly reports are good, but must more affect an active behaviour of employees. Employees have to do something with this information. The problem here is communication. E.g. report only for the plant where the accident/problem happened/occurred. But sometimes plants can also learn from mistakes/accidents in other plants" (MA08). And another example for the fact that not everybody knows what is going on in the plant next to them: But they also do not know what is going on in other plants. "Yes, I know what is going on with the chemical until it leaves the pilot lab, after that he/she does not know what is happening when it is in the plants." (MA10)

In general it could be concluded that the door of managers is not always as open as is said because of a too high workload, unawareness of the managers concerning for example the workload of their operators, the level of communication and sometimes the lack of cross-communication in the company.

The normalization of daily risk

"If the fire alarm goes off nothing happens. No one runs out of the factory, because we are so used to it. The fire alarm goes off ca. one time per month because of steam getting out (e.g. out of some pipelines) and then the fire detector reacts." (OP17)

"There are so many occasions where you can hurt yourself, like lose ladders. But there are a lot of other procedures that are unsafe, especially in old plants - you have to be extra-careful there" (OP15).

These examples show that situations in the plants can be very dangerous. Not all employees are all the time aware of these dangerous situations. They feel safe or think they work safely. In this paragraph we will try to find reasons why these unsafe situations exist and how they look like.

Small accidents are normal

Almost every employee had once experienced an accident or incident. On average the employees thought that big accidents happen zero till five times a year. But small accidents happen all the time they said.
It is interesting that most operators call acid in the eyes or a burned skin only a little accident. They are used to that this happens more often. Here is one example of an operator's answer: "I have just experienced some small incidents. Burning at hot steam or hot water are typical incidents that happen often. I was involved in a burning incident." (OP01) Another operator said about small accidents the following: "Small incidents like burns from steam - mostly not reported." (OP21)
It seems that the operators do not consider these daily experiences as accidents and that these experiences are not compulsory associated with normal work. The boundaries of what is meant to be an accident are redefined because of the mere frequency of accidents; small accidents are normalized.

Procedures and manuals as guidelines

Besides the normalization of all the small accidents, the use of manuals and procedures is interesting for this section, too: "One marker of resilience […] is the distance between operations as management imagines they go on and how they actually go on. A large distance indicates that organizational leadership may be ill-calibrated to the challenges and risks encountered in real operations" (Dekker, 2006, p.86). The employees told us that they use a lot of manuals. Only one person gave us an indication: we "have about 400 procedures and 10-30 local procedures in every plant - some are in good, others are in bad shape" (MA15). Almost every employee has to deal with a lot of procedures and manuals. We found out that not every employee uses the procedures and manuals - some use them as mere guidelines. Experience and the kind of manuals and procedures were the most common reasons for this. Experienced operators think they know what is dangerous and what is not and some of the procedures and manuals are written as guidelines, they said. "Actual work immediately drifts away from protocol and procedure, and workers defer to people with experience and resource access rather than to formal hierarchy" (Dekker, 2006, p.87). When operators use the procedures and manuals as guidelines they directly violate their work instructions, because it is strictly required to adhere to them. But why do they change them? An answer for this could be found in the next paragraph.

The process of normalization

We do not know the cause of all these small accidents, but we will provide some possible reasons how these could occur.

Sometimes small changes in the procedures are made by the operators, be it conscious or unconscious. Moreover, "there is always a risk between a written rule and an actual task. This distance needs to be bridged; the gap must be closed, and the only thing that can close it is human interpretation and application" (Dekker, 2005, page 136). These shifts from the initial procedure to the unwritten changed procedure can cause unsafe situations, but this is not necessarily the case: Through this shift, applied practise becomes the pragmatic imperative; it settles into a system as normative. Deviance (from the original rules) becomes normalized; nonconformity becomes routine (Vaughan, 1996). It is possible that the new situation, that became normal, turns out to be an unsafe situation. This could be one reason why small accidents happen, but there is another possibility:

"When rules are violated, are these bad people ignoring the rules? Or are these bad rules, ill matched to the demands of real work? To be sure, procedures, with the aim of standardization, can play an important role in shaping safety practise", "but there is a deeper, more complex dynamic where real practise is continually adrift from official written guidance, settling at times, unsettled and shifting at others" (Dekker, 2005, page 133). The employees mentioned some complaints about the procedures. The managers said that they have not enough time to fix these problems. One of them said: "I am a little behind with changing procedures in some plants, because I have too little time to change the procedures" (MA07). One operator confirmed this as well. This "lagging behind" could be another reason why there is a gap between the procedure and the practise of the operators that may result in necessary shortcuts with accidental ending.

Another reason could be the following: "There is too much a focus on paperwork. You can deliver a bad result as long as the paperwork is fine", one laboratory operator said (OP26). There is no focus on how well the operator does his job, but on the forms he produces. We also heard about wrong contents in procedures and procedures that did not make sense.

Finally another reason why the normalization of the daily risk could occur is because the operators always work with the same colleague in the same plant. The work could become monotone. If you always work together with the same person there could be a danger that operators do not correct each other as well as when they started working there. As a result their awareness for danger could be less than in the start. An advantage for the fact that they work in the same factory all the time is that they become very experienced, but a disadvantage is that they also could become easy-going and that could cause unsafe situations. It is dangerous when operators think that have already seen everything due to their wide experience in one field.

We could find arguments as mentioned above or in earlier sections in literature that illustrate this point: "The literature had identified important ingredients in the normalization of deviance, which can help organizations understand the nature of the gap between procedures and practise" (Dekker, 2005, p.150):

- Rules that are overdesigned do not match actual work most of the time (e.g. about 400 procedures and 10-30 local procedures in every plant)
- Emphasis on local efficiency of cost effectiveness pushes operational people to achieve or prioritize one goal or a limited set of goals. (e.g. there is too much a focus on paperwork. You can deliver a bad result as long as the paperwork is fine)
- Departures from routine become routine (the examples that operators change the original procedures for themselves and work in the way they think is right)
- Past success is taken as a guarantee for future safety

About the last topic we have already said something in earlier chapters. Most employees agreed that Chemco actively tries to create a learning culture and does not take past success as guarantee for future safety. But some did not agree and said that "by the time people will slack in risk automatically" (MA12) – but another chapter in this report has dealt with that topic more comprehensive.

We assume that this drift from work as imagined and work as actually done could happen easily. "The challenge then, is to make the gap visible and provide a basis for learning and adaption where necessary" (Dekker, 2006, p.89). When operators change the procedures or manuals and nothing happens, then they presume the situation is safe. By the time the procedures have changed little by little the situation could become unsafe and a small or big accident could happen "For progress on safety, organizations must monitor and understand the reasons behind the gap between procedures and practice. Additionally, organisations must develop ways that support people's skill at judging when and how to adapt" (Dekker, 2005, p.139).

Specific vulnerabilities of development

In this chapter we will discuss the vulnerabilities of development we recognised at Chemco. We tried to define the vulnerabilities in different categories; changing workloads, lack of knowledge, ergonomics, personal constraints, the growing company and conflicting procedures. These topics are named vulnerabilities of development because of two reasons: on the one hand these themes are specifics for a company based on development; for example a lack of knowledge is a feature connected to a company that strongly has to focus on research, development and launching new products. On the other hand a lot of these issues come along with companies that evolve over time; especially ergonomic issues are often associated with plants that become obsolete.
Some of these topics are meant for the whole organisation. Other subjects are more related to multipurpose plants.

Lack of knowledge

"If a new product is produced you do not know what long-term consequences it has to deal with the product, it could be you are not getting kids" (OP14)

In the interviews we had, we asked the employees what they were most afraid of. Number one theme for the operators was exposure to chemicals. A lot of operators and managers referred to the lack of knowledge they have about chemicals. Especially the new chemicals and the long term exposure of chemicals worried them. It seems the company tries to give all the information they have about this chemicals, but often the effects of long term exposure of chemicals is unknown.
Better research could solve this problem partly. However, some researchers at the research department said us they are often in a hurry. The different project teams have very tight deadlines and they often have situations with high workload. One operator from the lab pointed out his concerns about the investigation from chemicals: He said that research in the laboratory is often done not properly, because of time constraints. According to this operator the hazards move from the laboratory to the plants. One major reason behind the time pressure in the research department could be the high amount of money the company gets for each day they are finished earlier with the investigation.

Another area, where a lack of knowledge was mentioned by many operators and managers, was the unknown processes or materials other plants deal with. A lot of employees do not know what chemicals they are using in other plants and what the hazards of these chemicals are. One operator said "people in this building know what they are dealing with, but people next door do not know anything about the chemicals over here" (OP15). This missing knowledge affects e.g. the decision of wearing protection or not and could therefore influence the safety level in a negative way.

Changing workloads

"There are periods with intense workloads but other times with no" (MA03),

In this paragraph we will discuss the fluctuation of the workload. A lot of operators and managers felt they have periods with high workloads and periods with less workload. We consider this as a vulnerability of development because it often is not possible to do a continuous production in the development process.
Deadlines, the introduction of new products and the start of a new campaign, problems in the production line, promises management made to the customer and paperwork cause stressful periods. Most of the causes do only exist at the multipurpose plants and laboratory, were the products change every certain amount of time. These departments need more attention according to safety in stressful periods. It seems to be that the supervisors of these plants need more time to prepare the new process. A few of them said it really depends on when they receive the production planning. There seem to be some problems in the beginning of a new process, because managers have to deal with different processes in one plant and that is why the whole process is very slow then. A better preparation could be a solution for this problem.

One proposal could be to switch operators to other factories when the work pressure is low and get operators from other factories when the work pressure is high, but this will be discussed later in more detail.

Ergonomics

"The main cause for things going wrong: Using equipment for things that it is not made for" (MA17)

In this paragraph we will describe some of the ergonomic problems that came out of our analysis. This includes problems with equipment (not up to date, not available) and problems with housing.
When we asked the mangers "What are you most afraid of?" a lot of them said they were afraid of injured operators. One reason for injuries they gave us is the use of equipment. The equipment is used for ways it is not tested for, not built for or it is not up to date any more and need to be replaced. Reasons for this are mainly budget problems: There are not enough budgets to replace or buy equipment. We found a lot of examples were it is clear the management does not listen to complaints or can not do anything about it e.g. lifting problems, where workers have to lift 40kg humanly or about the splashing of acid out of a centrifuge (MA16). There are also a lot of indications the problems with equipment are solved ad hoc; when something is broken down it is replaced.
However it is not just the equipment that is outdated. Also the buildings are often not up to date and not build for the use of chemicals inside. It is not surprisingly that the answers following on the question "What would you do with an unlimited budget?" are often related to building a new factory. Especially the use of hazardous chemicals in the old factories appears to cause problems. In many plants they handle several hazardous chemicals simultaneously and in the same area with other chemicals as well.

Personal constraints

"Some plants have extra operators to fill gaps, but often people work overtime and do extra shifts" (MA15)

In this paragraph we will discuss the personal constraints that exist inside Chemco. There is a lack of people in different levels of the company. On supervisor level, workers level, staff level and maintenance level there seem to be not enough employees. The most gaps that arose could not be filled with other people. Operators themselves have to fill this lack of resources. During our fieldwork we talked to one operator who had to work for 16 hours that day and the next day as well. Her colleague, who is in the same shift, worked a few days before 16 hours doing physical work in a not very healthy environment.

The lack of people could be one reason why a lot of people complained about a heavy workload.
We also see some risk in the two shift plants. While talking to different operators in this plant they explained the case if they stop production. Because they are not running a continuously process people sometimes have to work over time if production is stopped. The risk of this situation is that people do not stop the production because otherwise they would have to stay longer.
Another risk in the two shift plants is caused by the opposite as described before. One employee told us "when we want to be home earlier we increase the speed of the process. But I do not think this affects safety". We think increasing the production speed takes larger safety risks along, though.

Conflicting procedures

"Instructions do not cover all issues - sometimes they are very general, sometimes they are too detailed and you can't follow them" (MA17)

Development goes along with changing processes. There are a lot of different factors influencing the processes, for example changing equipment, changing use of equipment, changing products and changing personnel. Often the procedures conflict with the job the worker has to do or the worker does not know how to do this and he does it his own way. During our investigation we talked with an operator who has to run three production lines at the same time. It was impossible for him to follow the procedures as prewritten in the manuals.

Growing company

"We are growing as a company and there are more and more demands so it is difficult to maintain the organizations needs and communications that are present right now" (MA05)

In times of prosperity it is necessary to keep the structure of the company healthy. In the last couple of years Chemco became bigger and bigger. This came along with an increase of workload and contracting many new people for the company.
When we asked the question "What are you most afraid of?" some people answered the company getting bigger. As a company that has to deal with business competition on the market company it is Chemco's target to grow, but a lot of employees are worried about that or they see changes when the company is getting bigger: Team leaders in the laboratory have more researchers, communication is getting more difficult and the familiar sight is hard to keep. There might come a point where the company has to do some more changes about for example the communication structure and the organizational structure than what is done right now.

The way people behave

"The level of safety is not in investment it is in personnel to act right with chemicals transporting to be careful" (MA10)

In this paragraph we will discuss the misunderstanding that exists that you can make a company safer when you just challenge your employees to be more careful. People are not coming to their work to do a bad job. "Human error is not a cause of failure. Human error is the effect, or symptom, of deeper trouble" (Dekker, 2002, p.61) inside a system. This is why it is important for all the employees to know this. Yes, operators have to be careful, but it is not the only thing to do and least of all *the* reason why accidents or incidents occur. The sentence in the beginning "The level of safety is not in investment it is in personnel to act right with chemicals transporting to be careful" is not the way we see it. It is often the easiest way to pinpointing to motivational factors of single operators when looking for the causes of failures and a way to improve safety easily, but it covers not in the least what we think to be the contributing factors to accidents or incidents. Without taking systemic factors into account one disregards that failures and also "adjustment can occur at different levels, for example, an operational group, the organisational system, groups of organisations […]. In principle all of these levels of analysis are relevant to resilience and are interdependent, as if each wider layer of the onion sets the context for how the layer inside can operate" (McDonald, 2006, p. 158). All of these levels within the organization are interwoven and should be similarly examined when investigation causes of failure. The macro-micro-level connection that was described in chapter 0 illustrates this phenomenon by the same token.

Closing the loop of learning

In this chapter we will discuss the way the organisation's learning culture is organised. The chapter is named "Closing the loop of learning" because our opinion is that there could be done some improvements to create a better learning culture. During our investigation we found out Chemco actively tries to create a learning culture, as this investigation proves, but there are some gaps in the way it is structured right now. In this chapter we define different categories for describing the process of learning; training, reporting information, learning from failure, discussion about risk and feedback.

Training

"We focus too much on what is written in the instructions - you have to sign a lot of papers to show you read it. But it is seldom checked if the way of work is really changed" (MA17).

It is obvious that training and retraining are very import for a resilient organisation. In our interviews we spend different questions on training, retraining and the quality of training. In this paragraph we will discuss the higher level findings of this interview questions based on the training topic.
Within the employees of Chemco there seems to be a very ambiguous meaning of training and retraining; especially at operators' level. As we spoke to the different operators they pointed out a lot of different associations with training. One operator stated they have two types of training; self study and self study under supervision. In contrast another operator stated they have a meeting with the boss and he tells them if something is changed.

There can be several reasons for this ambiguity. One of the reasons could be that not every operator gets the same training as other operators, even if they work in the same plant. Another reason could be that the operators are using different terms for training and retraining. For example some operators consider the safety day as training and others do not. The last reason seems to be the most likely for Chemco. The meaning of training is often different for everyone, but there are also a lot of communalities. However, we think it is not just about defining training.
At managerial level they are all satisfied with the training they receive. On this level the different answers look definitely like a definition problem.

However, at operators' level it is hardly assumable that it is just a definition problem. In general the training and retraining schedule works very well, but according to the answers we have to say other issues appear to be disregarded. Firstly, there is a very big contrast between the different definitions of the operators. Secondly, a few operators, in contrast to the managers, seem to be not very happy with the amount of training they get. Some operators said they get a lot of training and other operators mentioned they get too little training. Thirdly, there are some important remarks of a few operators like "we should do some training every year but that does not happen. If there is something updated we receive training as well" (OP25) and "process operators have so much experience that the company only get retrained when the company receives new high tech equipment or switch plants" (OP11). It seems to be that there is quite a big difference between plants.
One of the managers said that supervisors have to decide by themselves what kind of training their operators need. This could be a reason why differences between plants exist.

There are a few other topics we found: A few managers and operators complaint about too little time to conduct the training. Of course, there will be always people complaining about lack of time, but in this case these people where spread over several levels.
Operators also often do not know in which periodic intervals they are regularly retrained. Even if we left the contrasting answers out there were a lot of operators that did not know when or if the next retraining is scheduled. If the operators knew when they are regularly retrained they could also stimulate their supervisor to schedule training for them.

Reporting information

"I don't hear about errors in other factories/on other plants" (OP15).

It looks like the information from failures inside the plants is mostly known by all operators of that particular plant. As some operators pointed out, they wanted to be better informed about failures that happen in other plants. This statement is not surprising, because most data and information Chemco employees receive are only put on the intranet. In this paragraph we will discuss the different opinions about reporting information.

There seems to be no trigger to get information from the intranet to the supervisors and operators. They have to search for information; information about accidents or incidents is not presented for example by the supervisor or in a weekly paper or something. This could lead for supervisors and managers to a lack of improvement and for operators to a lack of knowledge about failures in other factories. Supervisors appear to be well informed by meetings and information given by the safety department, though.

We think a big problem is the distribution of information to operators. As our investigation showed, operators desperately want to know what is going on in other factories.

> "Weick et al. (1990) refers to 'collective mindfulness' as a characteristic of highly reliable organizations: collective mindfulness includes that fact that safety issues and concerns are widely distributed throughout the organization at all levels." (Wreathall, 2006, p.284)

But, without having the intranet there is no structure to tell operators about other plants – the chance to create such a collective mindfulness relies on the intranet as single source. And the system for reporting failures on the intranet is not good as well: First of all, as we said before, people have to search for information and this search for information is difficult according to the employees. This could be one extra barricade in the process of informing yourself. Another problem we heard is that employees want to know more about a failure than is reported; today people are only informed by intranet that e.g. an accident *has* happened - but the cause of a failure and what the management did to prevent the company for a similar accident is not reported there. To solve this lack of knowledge about failures in other plants Chemco could improve the way information is reported to the operators by giving more comprehensive information about accidents and by presenting them in a different way.
A lot of employees said that when a big accident occurs, in other plants, an email is send. We would like to say, there is *just* an email send. Our opinion is that sending an email and putting information on the intranet is not enough to involve people and sharpen their awareness that this particular accident could happen to them as well. It is a very formal and indirect way to get people to know about failures – and a simple and time-saving way as well.

Learning from failure

"It is mostly if it worked before it will work again" (MA02).

The majority of the employees of Chemco said the company is actively trying to create a learning culture. Although a few managers mentioned past success is taken for future success. It is important that on each level everyone knows that past success does not immediately mean future success. The operators, the supervisors, the middle management and the top management they all have to know what they are doing. There has to be awareness for continually improving of work.

We almost identified the same situation in the way employees speak about their experienced colleagues: As earlier stated past success sometimes seems to lead to future success and now in this situation experience leads to safety. We think this "good trust" in experienced people is even a bigger problem inside Chemco. On different levels we recognised this situation: "Handling with safety is quite natural for experienced people" (MA01) and "process operators have so much experience that they only get retrained when the company receive high tech equipment or when they have to switch plants" (OP11). People should be aware experience does not immediately lead to safe production. Small incremental steps away from the norm, from experienced employees who "know" how to work, could cause a big incident.

During the interviews we asked the operators and the managers "How do you learn from failures?". There seems to be no kind of an active learning culture, especially for operators. Managers said they often try to improve things after a failure happened. Most of the operators told us, they keep in mind and try to use their knowledge if they get in the same situation again. A lot of managers mentioned this as well. But leaving the responsibility for corporate learning to single individuals who "try to remember" is not a sufficient way to create a structured, global learning culture, where people are given room to share their best practises and their knowledge. Chemco should more provide a corporate structure for learning from failures here. Monthly discussions about what managers experienced or expect to go wrong, how some failures happened, if there is a possibility these failures could happen again in their or other factories and how to prevent the company from these failures could be a starting point to solve this problem.

Discussion about risk

"The discussion seems to be more alive when things happen" (OP26).

Keeping the discussion about risk alive is very important to get people alert every time they are doing their job, because "the extent to which the organization succeeds in keeping discussions of risk alive even when everything looks safe" (Dekker, 2006, p.78) is a broad indicator of resilience. Most of the managers thought the discussion is kept alive. A lot of operators said the same but there were a few operators with the feeling that the situation could be better. Of course there could always be more discussion about risk and the trade offs have to be made, but a few remarks from operators showed the mismatch between managements' and operators' opinions: One operator said "Some employees think the management does not care about safety and the management does not know that of employees" (OP28). This is exactly what the company should be aware of - try to involve every employee in safety discussions and making clear that caring for safety is not a task just on managerial level.

Feedback

"It is always difficult to pass information down. Hopefully union helps and supervisors are passing information" (MA12).

In this paragraph we will discuss the way Chemco is trying to distribute feedback through the whole organisation. We asked the managers how they ensure feedback is distributed and we asked the operators if they think feedback is distributed through the whole organisation. Most of the operators are satisfied with the way feedback is spread. However, we also identified a trend in the management answers on this question: Some managers point a finger to other persons in the company, e.g. "the team leaders send an email to the organisation of a part of the organisation" (MA01) and "representatives have to distribute this to the other groups" (MA07). Not every manager takes his own responsibility to ensure his information is spread out to the whole company.

RECOMMENDATIONS

Before coming up with recommendations how to improve the safety culture of Chemco we want to point out first that a lot of efforts have been undertaken already to enhance safety over and over again. The general commitment to safety is very high and the yearly safety day, where production is stopped throughout the whole company to discuss about safety issues, is a clear statement how important safety is considered at Chemco.

The recommendations we formulated will provide some ideas for further improvement on safety. Some of them only focus on small things that could be enhanced; others are related to bigger issues. We can not deliver solutions for all the findings we discovered, especially referring to the second part of our analysis; but we want to provide at least some inspirations or suggestion for what we thought to be the bigger issues in this company.

All recommendations directly refer to the particular chapters of our 2nd step analysis – it is easier to compare our findings with the suggestions that way.

"We chose safety over production – except when we don't"

We would like to make five proposals how the phenomena we described in the chapter "we chose safety over production – except when we don't" could be improved; our suggestions are creating a new form for reporting, enhancing the transparency of the SHE-Index, making more sacrificing decisions, prioritizing safety verbally and conducting more direct talks.

Creating a new form for reporting

People who are not rewarded for filling out a complex accident reporting form will early loose interest in doing so. The first thing that could be improved here is the design of the form – at the moment it is very long and complicated: A new accident reporting form could be developed that can be filled out easily without needing too much time and further instructions to do so – a lot of people reported that it is complicated to fill out the form and that they need guidance to do so. The current form could be taken as background to create the new one, though.

Enhancing transparency concerning the SHE-Index

Employees who report their concerns or ideas about safety should be rewarded in one way or another. At the moment it seems as if not all supervisors or managers are good at praising people or at giving them a friendly pat on their shoulders. Without such words or gestures employees feel that their ideas and their engagement to enhance safety is not valued and they will not show such a behaviour like telling own ideas again. Another important instrument to reinforce such behaviour is to clearly demonstrate how the SHE-Index is influenced by e.g. handing in accident reports. Today the connection between filling out reporting forms and the pay-out that is dependent on the SHE-Index seems to be widely unknown. The management could work on the transparency of this system, could inform all employees how it works and in that way help to understand the interplay between reports, safety and a higher pay-out for all employees.

Making sacrificing decisions

Sacrificing decisions are hard to take. They imply that production is stopped because safety is at risk. If a company, like Chemco, sets up a policy where it is stated that safety is always first, then it is not tolerable when small things happen and "production continues around the problem". Supervisors and managers have to make these sacrificing decisions, even if only small safety concerns occur. It is clear that one considers twice if production has to stopped, e.g. if the production is already delayed and the customer is waiting for the product. But it is exactly in these situations, where multiple goals conflict and pressure is present, where supervisors and managers have to show their clear and unquestioning commitment to safety. If the whole company speaks with one voice then there will be no situation where the decision for

safety of an employee is challenged by his superior a level higher up in hierarchy. To unconditionally prioritize safety also implies that a little part of the external pressure that employees usually internalize can be taken off them. In that way employees are unburdened from their weight to do things efficiently and thoroughly at the same time, because they know that –if they feel it is necessary- they can take more time as usual to thoroughly investigate or perform a safety-critical step without them, their colleagues or their superior getting into trouble.

Verbally prioritizing safety

Sending conflicting messages confuses subordinates so that they do not know what is right or wrong any more, e.g. stating that safety *and* maximum production is first. Clear messages are required from management and direct supervisors to precisely show how they want the work to be done. If safety shall be prioritized then a clear message has to be sent; often sentences contain a lot of "but", "however" and so on, but that is not beneficial for a better understanding. Behaviour that should be avoided in any case is for example:

- Supervisors or managers who state that they want to be called if safety is at risk and who are then grumpy when being called, for example during the night.
- Supervisors or managers who point out that safety is always first and who then let production continue around safety problems or who tell their employees that they have to work faster.
- Supervisors or managers who want their people to fill in accident reports and who then do not provide them with a positive feedback if they do so.

A need for more direct talks

Some operators simply do not know if their bosses really mean what they say, if their behaviour is valued from their bosses or if it makes any sense to report safety problems. Some are not taken for serious if they "only" talk to their supervisors without filling out an accident form. Simply talking seems to have often not the desired effects: things that operators complain about are not fixed until an accident happens and/or an accident form is filled out. Sometimes operators complain about things, e.g. ergonomic issues, a dozen times, but nothing really happens, e.g. because of a lack of money. It seems as if attention is only paid when things are reported formally, bureaucratic and direct communication is of little value. But the direct communication with operators is the best source for information concerning safety, because they know, where safety is really at risk in daily work. A lot of managers complained about having no time to go to the operators – but it is worth the time to regularly go and speak to them. If managers have an open ear for operators, even if they are not their direct reports, then they will get to know all the daily trade-offs, the places that are really hazardous and the safety concerns operators have, sometimes for years. Nothing can substitute these direct talks and they should be given a regular entry in every manager's schedule.

Limits of the open door

For us it seems that the main reason for the limits of the open door is that managers do not have enough time for their subordinates; in particular the middle managers for their operators. Another reason for the limits of the open door is stagnated cross communication. We will start with the recommendations for the communication between managers and operators and afterwards the recommendations for the communication between different parts of the company.

Stress and workload

A lot of employees thought that their basic workload is (very) high; however a reduction of workload is not always possible. In some cases an effective method to reduce workload would be to hire new employees. But there is always a trade-off between money and the amount of personnel. We understand that it is not realistic to hire a lot of employees when having not the required amount of money. But it could be useful to be more aware of the consequences from this heavy workload: tunnelling and regression (as described in the analysis section "Limits of the open door"). When employees have the knowledge about tunnelling and regression, they could be trained to be more aware of these phenomena.

This does not reduce their workload, but maybe it could make it easier for the employees to handle this heavy workload in a better way.
Besides, most of the employees did not have a problem with their high workload and did not want to reduce it. However, sometimes there is no time for certain activities because of the high workload. An example about such an activity is that an operator has to monitor a process every 15 minutes, but he/she was not possible to do this every 15 minutes because of other activities (see the chapter about multiple goals as well). In this case the operator can not do his job sufficiently according to the manuals. It is necessary to search for these "impossible" tasks in the company and look if the situation could be improved for example by reducing workload or changing manuals. Otherwise it is just like waiting until something happens.

Operator talks

Another consequence of the high workload is the fact that managers do not have enough time for their operators. The limits of the open door are in this case set up by the managers themselves, e.g. by favouring other obligations over direct contact with operators or by focussing too strong on the own area of responsibility (see the analysis section Limits of the open door as well). It is useful for managers to be more aware of the trade-off between contact with the operators and their other obligations. Besides the weekly meetings between operators and supervisor, maybe more and/or more effective meetings could be planned between managers (from different levels in the company) and operators to reduce the limits of the open door; for example once in two weeks or once a month. In this way meetings could become an obligation for the managers and they are able to have contact with the operators on a regular basis. On the other side, we have to keep in mind that more meetings between manager and operators might increase the workload of the managers.

Cross communication

The communication between different parts of the company could be improved. In the recommendations of the section "Specific vulnerabilities of development" a more comprehensive answer is given to this topic. Nevertheless, one idea shall be illustrated here.
A lot of employees do not know what is going on in other plants or parts of the company. The monthly reports on the Intranet show information about what is going on in the company. These reports are very clear, according to the employees, but the managers are not sure that everybody reads them and tries to actively work with the information. To ensure that the information of the reports is widely distributed, the monthly report could be discussed once a month during the weekly meetings between operators and manager.
Not all information, for example about accidents, is useful for every part of the company. To make sure that everybody reads the relevant information, it might be possible to spread information about for example accidents to plants -where this information is relevant for- by mail, like in the current situation. This information could be also on the agenda of the weekly meetings. Thereby the manager gets a bigger role for informing employees. For the manager it is a trigger as well, to work with the information. A disadvantage is that it will take a longer time to decide which plants need the information and which plants do not; but this approach could ensure that people get only relevant information. Another disadvantage is that it will take some time for the manager to extract the relevant information, but as the manager should always read the information anyway, this does not seem to be a big thing.

The normalization of daily risk

The main point that could be concluded from the analysis of the section "Normalization of daily risk" is that there is a gap between the procedures and the actual work. This gap could cause dangerous situations in the daily work of the employees at Chemco. Reasons for this gap and other causes of the normalization of the daily risk can be found in this chapter. Some measures to reduce this gap and to prevent the normalization of the daily risk will be given hereafter.

Awareness of the gap

One of the measures to reduce the gap between the written procedures and the work method used by the operators is to make sure that operators are aware of this gap.

Dekker (2005) proposed the following to organizations (including regulators) who wish to make progress on safety with procedures need to:

- monitor the gap between procedure and practise and try to understand why it exists (and resist trying to close it simply telling people to comply)
- Help people develop skills to judge when and how to adapt (and resist only telling people they should follow procedures) (p. 143)

From this we could conclude that it is useful to make employees aware of this gap and teach them how to deal with these gaps in their daily work. This could be done by training for example. The safety day is a good opportunity for this, because all employees participate in the safety day. Another option would be that this awareness could be taught in smaller groups during the year, per plant for example.

Focus

"There is too much a focus on paperwork. You can deliver a bad result as long as the paperwork is fine", one laboratory operator said (OP26). There is no focus on how well the operator does his job, but on the forms he produces. We also heard about wrong contents of procedures and procedures that did not make sense (see the analysis section Normalization of the daily risk).
Because of this operators could deviate from their normal working method and work in a different way, maybe a more unsafe way, to deal with a deadline or to get a good result, for example. It seems that the result is what counts and not the way to get there. It is important to be ahead of problems like this. The management has to make clear that not only the result is important, but also the way of working.

Procedures

In the section normalization of the daily risk is spoken about the procedures the employees of Chemco have to use. There were some complaints about the procedures and one employee told us that there are more than 400 procedures for each plant. In this section it is also talked about over designed rules that do not match with the actual situation anymore. This could also be the case at Chemco. It might be useful to check the length and appropriateness of the procedures used and to reduce or modify them to achieve an applicable clear, lean and concise amount of procedures. This will take a lot of time, but it will be a benefit in the long run. Procedures also have to be updated more often. Managers pointed out the procedures have to be updated every certain amount of time but sometimes this does not work. As we said, also during updating phases there has to be more focus on making procedures clear and appropriate. Talking more with the operators about procedures could help.

Colleagues and plants

During our interviews we found out that all employees normally work with the same colleague in the same plant all the time. There are a few disadvantages of working with the same colleagues. Firstly, other colleagues will earlier identify gaps in the handling of the chemicals, because they are not professionally blinkered. The same colleagues could after a while adapt each others' way of working and there will be no critical voice to prevent this from happening. There is a chance operators will make the same shortcuts after a while. Secondly, people could get bored after a certain amount of time. If people get bored and have to do monotone work they are not that alert anymore. A third reason could be the other operators have other experiences to talk about and other suggestions about safety.
This situation will only happen if there is an open culture in the plant. People could say to each other if someone is doing something wrong. A learning culture has to be established or even enhanced and people have to be open for feedback.
It could be dangerous that the employees are not as experienced as nowadays, but there is less danger that the work bores the employees and influences their awareness of danger.
We recommend changing colleagues once in a while. This period has to be not too long to avoid that people adapt each others behaviours, but it also has to be not too short to frustrate that the advantages of experienced colleagues will slip away. We think about a yearly job-rotation.

Specific vulnerabilities of development and closing the loop of learning

Earlier we said something about the "specific vulnerabilities of development". Several times these vulnerabilities go along with a lack of money. Of course we know the budget at Chemco is not unlimited. The management has to make trade offs, every time. Most of the problems we described in the analysis chapter "Specific vulnerabilities of development" are typically based on trade offs. If you had the time and money to research everything you will not get a lack of knowledge; if you had enough money you could solve all the ergonomic issues.
While formulating the recommend we tried not to use the typical trade off problems. However Chemco still has to consider if they could free some more money to deal with certain problems we described in our analysis sections. In general, it is very important that a plan will be established with problems to be solved in the near future. Nowadays problem solving is often working ad hoc, when a problem becomes a real problem because for example production can not be run any longer.

Lack of knowledge

A lot of employees declared they have a lack of knowledge about certain issues, mainly chemical issues. For a chemical company it is often not possible to have all the information because there is often no information. In the recommendations about learning culture we will talk about an information letter. This is one possibility to give the employees new information about chemicals.
As one chemist said, he is afraid chemistry goes too early to the plants because of time pressures. There has to be a standardisation form for information about chemicals. In this form all basic specifics of a chemical can be put into, before it goes to the plants. Just when all the information for this form is gathered the chemical should be made ready for use in the plants.

Changing workloads

On the multipurpose plants there seems to be a big difference in the amount of workload over and over again. There are times with high workload and times with low workload and there are often not enough budgets to hire more operators for these plants. One solution for this problem could be a multipurpose operator pool, where operators can fill in for someone or if workload is high on short notice. These operators must of course have working experience in the different plants. Depending on the workload in the different plants and possible shortages there they can rapidly switch plants. So, if there is a plant with high workload operators from the pool can work in this plant temporary. For this reason it is necessary to adjust the different production plans of the multipurpose plants to ensure they do not have a huge amount of workload simultaneously. In this suggestion, every plant has standard operators and for the multipurpose plants there are some extra operators for heavy workload phases available.
This idea could be combined with the recommendation of the section "Normalization of the daily risk" that employees could work with other colleagues and in different plants to make sure that operators do not suffer under monotone work and remain aware of dangerous situations all the time.

Closing the loop of learning

In the second section of this report we said something about the way the company's learning culture is organised. In this chapter we will recommend some changes in the structure.

Information letter

The company is using intranet to put on information about for example accidents. But we think just intranet is not enough, even with such a big amount of users a day. During our investigation we experienced some gaps in information distribution. Operators want to know more about certain things, for example what's going on in other plants. One way to solve this is to put more information on intranet, but we are not sure this works out well. There is already a lot of information on the intranet available and people find it hard to search and look for the right information. In our understanding a better way to present the information could be in the form of a weekly or monthly newsletter. This information is closer to the workers; workers do not have to search for information as they get it presented and it is less formal than putting it on intranet.

In this newsletter Chemco could publish information about other plants e.g. what they are producing, what is new in the factory, if an accident occurred in the last month or what kind of accident occurred. This could be done by doing interviews with operators from different plants and the laboratory could insert information about new chemicals. Every newsletter could be placed on the intranet but also spread out as print-outs in the factories so operators can read them during lunch or when they have time off. There are several reasons to do it this way: We earlier mentioned that this is a more informal way to present information; people are able to find information earlier because they do not have to search for information. There are some other reasons why we think this kind of presenting information works more effectively. Firstly, employees read stories from other operators instead of hearing it from supervisors. This reduces the chain of command and people will be more involved and experience incidents or accidents more directly without a mediator. Secondly, it is possible that operators themselves are interviewed or a colleague from the same plant is interviewed as well. This demonstrates that their concerns and opinions are taken for serious. Thirdly, there is a possibility that the operators who read the newsletters know the interviewed people from the company. The reasons mentioned above increase the involvement of employees; their awareness of incidents or accidents is sustained in this way as well.

During our investigation we found out that there is a lack of knowledge such as information about other plants and information about chemicals. These topics could be covered by using the above mentioned newsletter and due to interviews with operators from different plants the knowledge about what is going on in other plants will increase.

Some employees said they were afraid about the growth of the company. For example they said it is hard to keep communication the way it is right now. Chemco seems to be a very familiar company. Such a newsletter will keep the communication short and will attribute to the familiarity of the company. And, although we did not see big problems on this subject, it will keep the discussion about risk more alive. This newsletter could also create a more open communication culture if people are talking about accidents happening in other factories.

Training

In this paragraph we try to give some recommendations to improve the training and the training structure. The recommendations are given in order to the problems we identified in the second part of our analysis.

Our first suggestion is to establish a better structure for training. There has to be a person in the company that coordinates the different types of training according to the job the employees have. This person could dispute with managers, but is not the manager that has to decide if the operators need training or not. A lot of managers have to deal with heavy workloads and we are afraid this affects the way the training is organised. If Chemco centralizes the training there will be some scale benefits, too: This training person knows a lot about different kinds of training. At this moment every manager has to choose the training for their operators out of a large amount of training, while they just need some specific courses. Different training schedules could be better combined when there is one person, or one department in charge of training. Another benefit could be that this person can prepare a better training because of his experience.

The employees of the company have to be aware what kind of training they get and how often. Some employees are not very happy with the amount of training they get yet. Maybe there are some employees that do not consider specific training measures as training or maybe they forget what kind of training they got. Pinpointing at the training schedule and making clear how many training employees got could satisfy them more. Another reason for making people aware of their regular training is that they can check themselves if they have already got their required training for a year or if there is still something missing. It could also attribute to the "collective mindfulness" as described in the chapter "Closing the loop of learning". Creating training awareness could be very simple, for example just by a sheet of paper in the employee's lunchroom.

It seems that managers can influence the kind and the amount of training they get. If this applies to the operators as well they will certainly show more commitment to do the training. Also their opinion about the training will probably be more positive. Asking the different employees twice a year weather they

consider having a lack of knowledge could be one option here. This way Chemco can provide appropriate training based on the answers of the operators or the company can modify the training according to the needs of operators; it could also be useful to do a questionnaire after the trainings. In this questionnaire Chemco could evaluate the conducted trainings e.g. by asking the employees if they like or dislike their training, what exactly they like or dislike and if they think the training increased their knowledge and affected their behaviour. That way Chemco can constantly improve the quality of the trainings.

During our investigation we found out that there are a lot of different opinions about the way the training is given. It is always hard to find a good balance between persons from inside who know what is going on in the company and external persons who have a different view to give these trainings. Using this questionnaire as stated before Chemco could try to find out if the balance is right. We found out that there are some advantages and disadvantages if a person from inside the company will conducts the training, but we also found some advantages and disadvantages if an external person will held the training. That is why we think that it is the best solution to have a combination of internal and external people who conduct the trainings.

Reporting information on big accidents

We earlier said something about the way information from other plants could be distributed through the whole organisation. In this paragraph we will state some improvements about the way big accidents could be reported.
It seems that sending an email is the only way Chemco reports major incidents and accidents in other plants. We are wondering whether this is enough or not and we think it is better when the management more actively tries to tell operators what has happened in other plants so people become more involved. We recommend telling every employee in person what happened in another factory. Preferable is face to face, e.g. by a short "crisis meeting" arranged by the particular supervisors, but if this is not possible then by giving people a call. Afterwards an email could be send with the consequences of these accidents; the different steps the management will take to prevent the company from these accidents the next time should be included there as well.

Improving the intranet system

During our first meeting at Chemco the management already told us that employees and management use intranet a lot to search for news and to look for information. During our investigation we identified some problems about using the report system on the intranet.
There are problems with searching information and the interest of information, as we have already mentioned several chapters earlier. Searching information is difficult according to some employees. Another problem employees pointed out is that they want to know more e.g. the causes of an accident and in what way the management handled this accident.
Looking on the intranet system of other companies could help Cambrex improve their system for searching. For information it could be easy to have a basic template first; what and where something happens. And a second template with more information about the cause and what the management did to solve the problem.

Creating a real learning culture

A lot of operators said that they try to keep in mind when and why things went wrong and that they try to avoid these failures from happening again. But to create an active learning culture this seems to be not sufficient. In this paragraph we discuss different recommendations to enhance the safety learning climate.
Firstly, there could be added some questions to the report forms e.g. what could you do to prevent the accident or incident from happening again? How do you ensure it will not happen to your colleagues? These questions trigger employees to think about the way they could learn from this accident.
Secondly, it is important to trigger supervisors to actively work with the information from the intranet. One possible trigger could be that the supervisor monthly discusses all the accidents and incidents that he thinks could happen in his own factory, too, with his operators.

CONCLUSION

Our conclusion is based on the two research questions that we stated in the first chapter:

- What is the role of leadership in the creation of safety?
- What is the role of learning the creation of safety?

The answers to these questions shed light on the question if Chemco can be considered as a highly resilient organization based on the comments we made in the first chapters.

What is the role of leadership in the creation of safety?

We will first give a conclusion to each of the dimensions top level commitment and just culture and will then present our overall opinion what the role of leadership in the creation of safety is and if we feel that this role is sufficiently adopted by the managers at Chemco.

Top level commitment

We operationalized top level commitment by different questions; for example appreciating human performance in general, prioritizing safety over production and taking sacrificing decisions, i.e. stopping production when safety is at risk. Concerning the general valuation of human work more managers than operators stated that their work is appreciated; some operators were not sure at all about it. Asking for the most valued goals of superiors more operators than managers stated that safety is first. Actually, only a few managers pointed out that safety is unconditionally prioritized. This confirms our observations of a lot of little trade-offs that are made concerning safety. However, when it came to the question if production can be stopped if safety is at risk all employees felt that they had the ability to do so.

Just culture

A just culture can be determined when a company actively encourages their employees to report on safety problems and to help the organization to constantly improve. There also should be a reward system to value such behaviours.

Almost all employees feel encouraged to report safety concerns and have at least once consulted their superiors in this matter. Almost everyone feels comfortable reporting safety problems to his superior and confirmed that their superiors "can hear bad news" as well. However, rewards for reporting safety concerns exist sparsely and the connection between filling individual reports and the SHE-index seems to be widely unknown.

Overall

Leadership plays an important role in creating safety. Leaders can encourage people through their behaviour to help the organization to improve; they can reward their subordinates for telling their concerns about safety and they can create a climate where an open discussion about safety problems is feasible. By adopting a "non-blame" policy they can also show their strong commitment to safety and function as role models for their subordinates. Leaders guide their subordinates' behaviour and show them through their feedback what is right or wrong. For these reasons leaders play a major role in maintaining and enhancing safety that should not be underestimated.

In our opinion Chemco shows a high top level commitment to safety – there is a great effort and willingness to put safety unconditionally first. Sometimes these intentions collapse through daily trade-offs that are made in favour of other goals like production or costs, though. Nevertheless, the so called just culture seems to be established in most parts of the company, in particular regarding the case that subordinates feel comfortable reporting safety issues to their superiors. Most of them also experienced at least once that their boss listened to them. However, there are huge differences in the rewards people are given for reporting their ideas about safety.

What is the role of learning in the creation of safety?

To answer this question we have looked at the four dimensions we identified in the first chapter: learning culture, awareness & opacity, preparedness and flexibility & adaptive capacity.

Learning culture

The topic learning culture deals with the question if the organization responds "to events with denial versus repair or true reform" (Wreathall, 2006, p.280). How does the organization deal with incidents or accidents? Is the organization able to rebound also under enormous pressure (Dekker, 2006, p. 78)?
For an organisation, especially an organisation handling chemicals, it is very important to have a learning culture. All organisations that have to deal with safety-critical issues want to prevent accidents from happening again and want to ensure that small incidents or accidents do not lead to a bigger accident.
We think Chemco tries to create a learning culture; for example most of the managers and operators stated past success is not taken for future success; the company put a lot of information on the company's intranet, they are improving training facilities; there is a yearly safety day and a lot of operators think the discussion about risk is kept alive. However, there is still room for improvement, and there are gaps that need to be filled to enhance the current learning culture.
We will now handle the major improvements. Firstly, the discussion about risk should be more alive on operator level. Secondly, there is still a big lack of knowledge, e.g. concerning new chemicals, that needs to be covered. Thirdly, managers should be pointed out their responsibility to give feedback. Fourthly, Chemco has to create a more active learning culture where people not just keep in mind what happened, but also actively work with the information they got from failure. On the other hand our investigation showed that operators want to be informed better and that the way information is spread out seems to be not appropriate. There are several problems with the presentation of information on the intranet. A last topic that could be improved is people's awareness of training issues. For example operators mentioned they did not know when they are retrained or they did not receive retraining at all.
After all, we would say that Chemco is definitely trying to create a learning culture and has already taken some steps in the right direction. However, the current learning culture seems to leave some room for improvement.

Awareness

We defined awareness as the knowledge of "what is going on" in the organization (Wreathall, 2006, p. 280).
The awareness of the company has different aspects. On the one hand most of the supervisors know what is going on in their plants. More general, most of the managers know what is going on in the company; they know about the problems, they know about the major safety issues, although their opinions about problems and safety concerns were very divers. The operators do not know much of the problems in the company, but they have some thoughts about the safety concerns. On the other hand we noticed some problems with regard to awareness. Firstly, the knowledge about other parts of the company does partly not exist. A lot of employees do not know what is going on in other parts of the company, although they work with very dangerous chemicals in some plant. There could be a higher awareness of the effects of these dangerous chemicals. Secondly, some safety measures are not up to date and this could cause unsafe situations. And thirdly, operators gave some examples from situations where their managers could be more aware of the daily work of the operators; for example managers who do not have enough time for their operators or who do not show the duly respect by regarding them as individuals but rather look at them as a group producing something.
Overall we think that the company already has achieved a good awareness; most employees know what is going on in the company, but there could be made some improvement at some points.

Preparedness

Preparedness means to "foresee and avoid" (Westrum, 2006, p. 59) potential events that could harm the organization and its people.
The preparedness with regard to the future is very good, according to the operators and managers. At all levels of the company they talk about safety, most of the employees see no problems for the future situation of the company. The biggest problems in the company are the processes in the plants, the chemicals, time, the behaviour of employees, environmental issues and the growth of the organisation,

according to the employees. Most of the operators are not involved to anticipate in future problems, for example safety problems, but managers are more involved in safety issues. If the operators have gut feelings, they are not afraid to go to their managers and managers confirmed this by stating that they are always listening to operators with gut feelings. We also asked the employees about improvements they would tackle if they had an unlimited budget. Operators and managers gave different answers. We found out that managers would like to rebuild the plants, buy new and better equipment, hire more employees, improve the handling of chemicals and improve the precautions to be better prepared for dangerous situations. For operators we found out that they would like to rebuild new plants, buy new and better equipment and improve the facilities in the plants.
The employees of Chemco felt well prepared for the future; although they identified some problems for the future, e.g. concerning equipment, plants or human ressources. According to us, a good awareness of these challenges is a first step to create a safe environment and be well prepared for the future.

Flexibility & adaptive capacity
As mentioned in the first chapters these constructs deal with "the stiffness of the decision-making in the organization, and its failures to respond in a timely manner to an increasing need for revising its response to the pressures of production to allow increased protection" (Wreathall, 2006, p. 284)
To get an impression of the flexibility of the company we asked the employees questions about slack and scarce resources. We found out that the definition about scarce and slack resources was not clear all the time and we got a lot of different answers from the operators as well as from the managers. The operators and managers had similar ideas of scarce resources; they mentioned things like more and better equipment in the plants, more facilities in the plants, more employees, more time and more space.
If we talk about flexibility concerning taking decisions it depends on the situation. All the managers and most of the operators can take decisions on their own in dangerous situations. But in some cases operators and managers have to talk to their boss first and can not take decisions on their own. Although, for managers it depends on the level in the company they are.
In general, there is flexibility in dangerous situations, but in "normal" situations the employees have to ask for approval of their managers. Only managers on higher level could take decisions on their own.

Overall
In this section we will answer the question "What is the role of learning in the creation of satefy?".

The creation of safety could be divided into three phases. In all the phases learning captures a big role. First of all it is very important that the employees of Chemco are aware of what is going on in the company. For example they have to know what processes they are dealing with, what kind of safety concerns the company faces and what kind of accidents happens in the company. The problems that are inside and outside the company need to be monitored.
A second step is the question for what the company does with this information they have. How do they handle the information they have from failures? And how do they deal with their major safety concerns? It is important that Chemco has an active learning culture. It is not just identifying risk, as company you have to handle the risk. In the second step money is an important issue. It is often depending on the budget if the suggested improvements that are made in the second phase can be finally implemented.
A third step is the communication. When you have a problem and also the solution it needs, it is important that there is a good communication between people from different levels, but also between people from the same level. Learning is very important here as well.

Overall we could say that learning plays an important part to improve the safety climate at Chemco and the company actively tries to create a safe environment. Chemco tries to be aware of dangerous situations at this moment and in the future. Moreover, the company also tries to learn from the information about failures and tries to let the employees learn from failures. And finally the company tries to communicate about safety by meetings, intranet etcetera.
But every phase could be improved. There are some points for improvement concerning awareness. Learning from failure is a part of the company, but not all accidents and incidents are reported, so there is a need for improvement on this topic. And finally, the communication about safety issues could be improved, for example by encouraging the communication between different parts of the company and between operators and managers.

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Appendix

Interview questions for managers

Question # and descriptions

General questions

1. What do you do? What is your role in the company?
2. What decisions are you responsible for? Can you tell me about the processes you manage?
3. Did you have "hands-on" experience coming to this position?
4. How would you estimate your workload or your production pressure? Would you like to reduce it? How?
5. What do you consider failure? Do you have any examples?
6. Have you once experienced an incident or accident?
7. How often do accidents occur (per year)?
8. What are you most afraid of?
9. How would you describe the company culture? (safety, procedures, chain-of-command (organization), environment)

Top-level commitment

10. **How do you show your subordinates that you appreciate what they are doing? Do you think your boss values/appreciates your work? How can you see that?**
11. What goal does your boss value the most? (production, costs, safety)
12. **Do you feel you have the ability to stop production if safety is at risk?**
13. **Do you encourage your employees to stop production if safety is at risk? How?**

Just culture

14. Do your employees consult you if they have concerns about their work, safety, etc.? Has this happened yet?
15. **Do you feel comfortable reporting safety issues/problems to your boss? Do you think your employees feel comfortable coming to you to report safety issues? (Can your boss hear bad news?)**
16. **Do you empower your people to change, intervene, and help the organization to improve? How?**
17. Are you rewarded if you report your ideas or concerns, e.g. about safety? Do you reward your employees if they report a safety issue?
18. In what way can you influence your boss' decisions? How does decision making take place? (upward/downward/lateral)

Learning culture

19. What are the consequences if the system fails? (accidents)
20. What do you do with the information you have from failures (within and out of company)?
21. How do you learn from failures?
22. **Do you feel the discussion about risk is kept alive in your company or workplace?**
23. **How do you ensure that the feedback or revisions made when accidents happen are distributed through the whole organization? (changed manuals, policies)**
25. Do you think that the past success the organization experienced is taken as a guarantee for future success? Or do you feel that your organization actively tries to create a learning culture?
26. What kind of training procedures exists?

appropriate and safely?

30. *If you could change the way in which learning from failure is organized what would you do?*
31. *If you could change the procedures, processes or manuals what would you want to change and how?*

29. **Do you think you get sufficient training lessons to conduct your work appropriate and safely?**

Awareness & Opacity

31. **Do you feel the company expects you to perform multiple goals simultaneously? (safety, costs, production)**
32. Do these goals conflict?
33. **Is the quality of safety affected by the budget?**
34. In what manner does this concern you?

Awareness & Opacity

31. **Do you feel the company expects you to perform multiple goals simultaneously? (safety, costs, production)**
32. Do these goals conflict?
33. **Is the quality of safety affected by the budget?**
34. In what manner does this concern you?

Interview questions for operators

Question # and descriptions

General

1. What do you do? What is your role in the company?
2. What decisions are you responsible for? Can you tell me about the processes you are responsible for?
3. Do you have any prior experiences in the same field?
4. How would you estimate your workload or your production pressure? Would you like to reduce it? How?
5. What do you consider failure? Do you have any examples?
6. Have you once experienced an incident or accident?
7. How often do accidents occur (per year)?
8. What are you most afraid of?
9. How would you describe the company culture? (safety, procedures, chain-of-command (organization), environment)

Top Level Commitment

10. **Do you think your boss values/appreciates your work? How can you see that?**
11. What goal does your boss value the most? (production, costs, safety)
12. Have you ever made a decision where you had to stop production because safety is at risk?
13. **Does your boss encourage you to stop production if safety is at risk?**

Just Culture

14. Have you ever consulted your boss when you had concerns about your work, safety, etc.? Has this happened yet?
15. **Do you feel comfortable reporting safety issues/problems to your boss? (Can your boss hear bad news?)**
16. **Do you think your boss empowers you to change, intervene, and help the organization to improve?**
17. Are you rewarded if you report your ideas or concerns, e.g. about safety?
18. In what way can you influence your boss' decisions? How does decision making take place? (upward/downward/lateral)

Learning Culture

19. What are the consequences if the system fails? (accidents)
20. What do you do with the information you have from failures (within and out of company)?
21. How do you learn from failures?
22. **Do you feel the discussion about risk is kept alive in your company or workplace?**
23. **Are you informed with feedback or revisions made when accidents occur? (changed manuals, policies) And are the changes being reported?**
24. Do you think this feedback/information is distributed through the whole organization?
25. Do you think that the past success the organization experienced is taken as a guarantee for future success? Or do you feel that your organization actively tries to create a learning culture?
26. What kind of training procedures exists?
27. How often does retraining occur?
28. Do you think the quality of training is appropriate?
29. **Do you think you get sufficient training lessons to conduct your work appropriate and safely?**
30. *If you could change the way learning from failure is organized, what would you do?*
31. *If you could change the procedures, processes or manuals what would you want to change and how?*

Awareness and Opacity

32. **Do you feel the company expects you to perform multiple goals simultaneously? (safety, costs, production)**
33. Do these goals conflict?
34. **Is the quality of safety affected by the budget?**
35. In what manner does this concern you?
36. Do you think you have a full understanding of what your manager has told you?
37. Can you tell me something about the safety procedures you use? Do you use manuals?
38. Are you able to understand and follow the manuals?
39. **Are the manuals strictly followed or are they used as guidelines?**
40. Do you feel there are any problems in the company? If yes, what kind of problems? Does your boss know about these problems?
42. **Do you think your manager knows what is going on in the company? Do you think he know what your daily hazards are?**
43. Do you know what the major safety concerns are the company has to deal with?
44. Do you think all employees know about these safety concerns?
45. *What do you want your boss to be aware of, that he doesn`t know yet? What would you like him to know about "what is going on here"/your daily work?*

Preparedness
46. Do you think that your safety culture and safety procedures are prepared for the future? **47. Do you feel ahead of upcoming problems?** 48. Are you actively engaged to anticipate future problems, e.g. by participating in safety group meetings or workshops? 49. Do you talk to your co-workers about your concerns about safety? **50. Do you feel your boss pays attention to you if you have some gut feelings, faint signals or an intuitive feeling about future trends or hazards?** *51. If I gave you an unlimited budget, what would you do to improve safety and prepare for future problems?* *52. What do you think is the biggest future problem concerning safety that your company faces?*
Flexibility
53. Do you have any slack resources available to cope with sudden accidents? (material resources, time, buffers, etc.) **54.** What do you do if the system (the part of the organization where you are responsible for) fails suddenly? (production vs. safety) **55. Do you have to wait for your boss to make a decision (e.g. to stop production) or can you decide on your own?** *56. What kind of scarce resources would you like to have more of?*