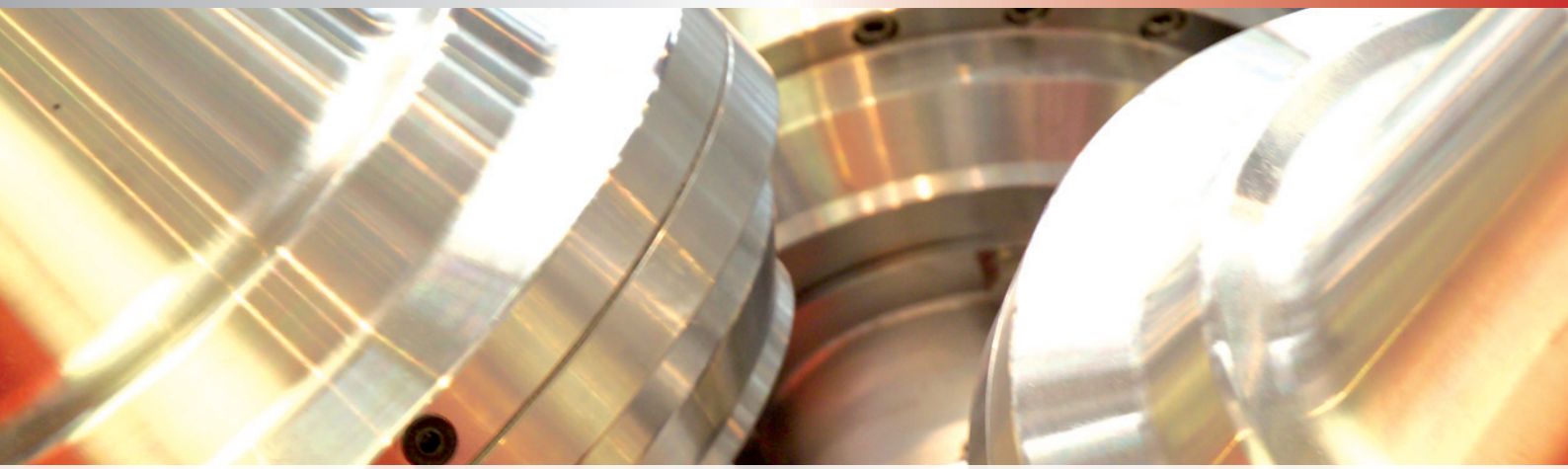

Process Safety Competence –

European Strength degrading to Weakness?

Booklet on the ECCE 8's special session on process and plant safety

EFCE

PROCESSNET
EINE INITIATIVE VON DECHEMA UND VDI-GVC

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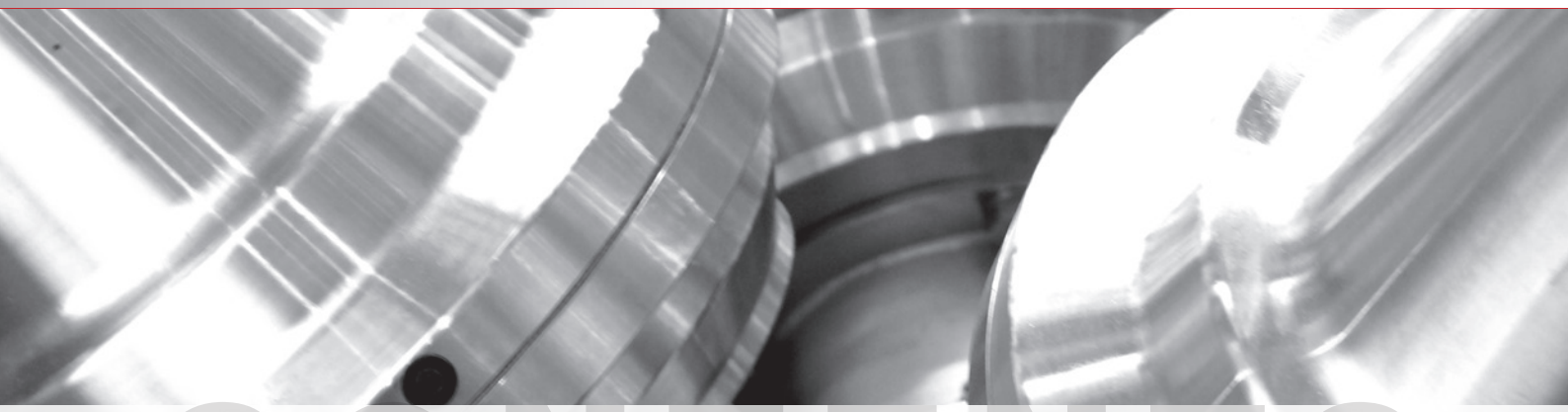

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Booklet on the ECCE 8's special session on process and plant safety "Process Safety Competence – European Strength degrading to Weakness?"

Two days of lectures and discussions on something which all stakeholders in all areas of chemical and petrochemical industry doubtlessly strive for: a high level of competence in process and plant safety. Representatives from industry, associations, universities, non-governmental organisations and authorities have exchanged their respective opinions and experiences for one of Europe's most important economic sectors. Was such an effort really necessary? The answer at the end of the two days: Yes, it was!

The idea of a special session on process and plant safety (PPS) competence within the 8th European Congress of Chemical Engineering (ECCE 8) from 25th to 29th September 2011 at the ICC Berlin was born six years after having started a respective German initiative (Maintaining and improving competence in safety engineering, Position Paper of the DECHEMA/GVC Research Committee „Safety Engineering in Chemical Plants", March 2004). In 2009 a corresponding Dutch initiative followed (Strategic Approach for Safe Chemical and Energy Industries – Knowledge Infrastructure for Safety and Hazardous Substances for the Netherlands of 2020, Hazardous substances Council). Questions arose like

- Is it assured that the appropriate level of competence in process and plant safety is maintained in Europe for the future?
- Do we have indications for a trend (degradation, standstill or further strengthening of PPS competence) in Europe?
- What can different stakeholders do to maintain or further develop the high level of process and plant safety competence?

More than 50 congress participants joined the special session titled "Process safety competence – European strength degrading to weakness?" on average. What are the major results? In the view of the members of the session's organization committee the generally accepted views – also reflected in the concluding panel discussion – are:

- Most incidents or accidents happen because necessary knowledge or competence was not available at the right time in the right place. Increased automation and its improved reliability would not necessarily support the presence of PPS competence, especially when it is needed in abnormal situations.
- Todays level of safety benefits from extensive basic research in the past decades and from continuous learning from incidents and near misses. Currently the development of process safety relies to a far extend on the initiatives by a very few remaining academic or research institutions, on industry funded expert organizations, relevant associations and on a few leading companies.
- Process and plant safety competence requires specific knowledge and skills beyond what can be expected of graduates having successfully passed a standard curriculum in chemistry or chemical engineering. However – a sound basic knowledge in process and plant safety has to come with every relevant bachelor or master degree. Obviously this is only rarely the case. Furthermore, to achieve student´s necessary awareness of safety needs as a first step from knowledge to competence, academic teaching must be complemented by industrial traineeships.
- Therefore, both universities and the individual professors need to be encouraged – or even urged – and enabled to ensure this necessary basic knowledge. A better European or even worldwide understanding on what this knowledge for the relevant bachelor and master degrees comprises would help.
- Industry and industry sponsored associations have practice proven concepts how to develop and maintain the new hired or existing coworkers to/at the required level of PPS competence. This for all levels of responsibility in a company – from operation to board members. As in the past industry continues to offer opportunities to gain practical experiences for students also.

- Another way to keep process and plant safety in the focus of academic education would be to use the steering effect of public research funding programs. Process and plant safety has to keep up with other developments in science and engineering. Since years, research funding programs primarily support topical research areas like climate change, life sciences or security. Other areas like safety remain neglected. One consequence is that the academic research on process and plant safety continues to decrease more than desirable. And with respect to education, there is no doubt that research rather has a positive than a negative influence on the quality of teaching.

- Last, but not least: ensuring a high level of process and plant safety needs adequate competence at different levels of responsibility, relevant societal areas or bodies as there are industry itself, the educational and scientific system, legislation and inspection, test bodies, consultants, non-governmental organisations and industry associations.

The broad agreement on the statements above encourages the bodies having prepared this session on process and plant safety competence to approach stakeholders at both national and European level. Long lasting solutions have to be found to prevent any degradation in process and plant safety competence in Europe. Chemical and petrochemical products are indispensable for the today's world, not to forget the important economic impact of the respective industrial branches. A high level of safety (health and environment protection included) is intrinsically tied to a sustainable economic success. The necessary process and plant safety competence must be available wherever and whenever needed.

To support this goal it was found necessary to compile and to preserve all the presentations given in the ECCE 8's special session on process and plant safety competence in this booklet. On the basis of what was discussed and concluded in this session all stakeholders in process and plant safety are invited to

- continue and strengthen existing initiatives developing systematic approaches to create and maintain process safety competence for design and operation

- benefit from the currently fair or even better process safety performance in Europe giving stakeholders a good degree of freedom to develop these systematic approaches without external pressure

- support the idea of an European university curriculum on process and plant safety for relevant bachelor and master degrees, best preferably with EFCE taking the lead

The organizing committee of the ECCE 8's session on process and plant safety competence will continue with its own activities, but is also prepared to support other initiatives considered helpful to strengthen process and plant safety competence creation in Europe and elsewhere. Let us start now and jointly!

P. Schmelzer C. Jochum N. Pfeil K. Mitropetros

01. Nov. 2011

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Avoiding accidents – Process safety competence could make the difference

Manuel R. Gomez
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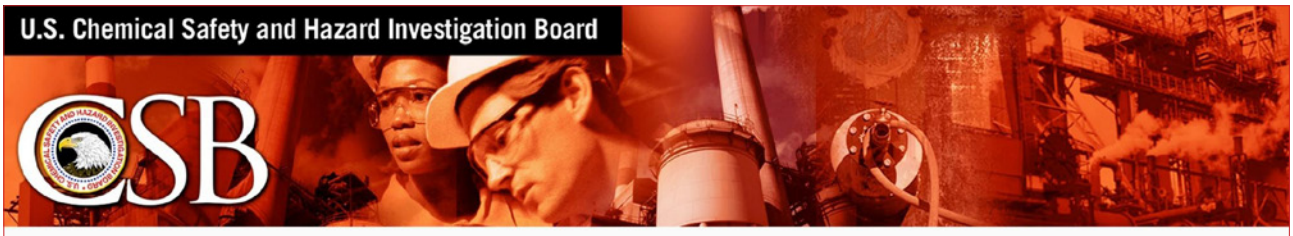
Since its establishment in 1998, the U.S. Chemical Safety Board (CSB) has investigated the root causes of most of the significant chemical-related disasters across the United States. The reports of the CSB contain many striking examples where major accidents resulted from inadequate knowledge and implementation of process safety concepts, standards, and good practices ¬– that is, a lack of process safety competence. Scientists and engineers involved in the design and development of new processes are themselves the product of a university system where systems-level safety thinking is rarely emphasized. CSB investigations reveal many common findings related to competence, including: (a) erosion of corporate knowledge through downsizing, attrition, and the lack of formal reporting and learning mechanisms; (b) lack of knowledge and education on chemical reactivity hazards; (c) inadequate communication of safety information between process developers and production personnel; (d) lack of sufficient design safeguards to protect against foreseeable accident scenarios; (e) inadequate operator understanding of control systems; and (f) unavailability of competent engineering expertise to troubleshoot complex process safety issues. Although the lack of competence is sometimes perceived as a problem of smaller businesses, even the largest corporations can be vulnerable to accidents caused by a lack of knowledge and action to control established hazards. The CSB has thus urged that corporate boards of directors and executives take measures to ensure sustained process safety competence in all their operations.



AVOIDING ACCIDENTS:
PROCESS SAFETY COMPETENCY COULD MAKE THE DIFFERENCE

Manuel R. Gomez, DrPH, MS, CIH
Director of Recommendations, CSB

8tH European Congress of Chemical Engineers (ECCC-8)
Berlin, Germany
September 28, 2011

Disclaimer

This presentation by Manuel R. Gomez of the US Chemical Safety and Hazard Investigation Board (CSB) on 9/28/11 to the 8th European Congress of Chemical Engineers has not been approved by the Board and is given for general informational purposes only. Conclusions or other statements do not represent the official views of the CSB. Any material in the presentation that did not originate in Board-approved reports is solely the responsibility of the author and does not represent an official finding, conclusion, or position of the Board.

Copies of all CSB reports can be found at www.csb.gov

U.S. Chemical Safety and Hazard Investigation Board

Outline

- Primer on US Chemical Safety Board
- CSB Cases and Safety Competence
- Current Cases and Issues
- The Future of the CSB

U.S. Chemical Safety and Hazard Investigation Board

CSB OVERVIEW

- 1990 Federal Clean Air Act Amendments
- Trigger: Bhopal
- Modeled after National Transportation Safety Board (NTSB): Not regulatory
- Law also mandated:
  - Process Safety Management Standard (PSM, 1992) by the Occupational Safety and Health Administration (OSHA)
  - Risk Management Program (RMP) regulations (1996) by the Environmental Protection Administration (EPA)

U.S. Chemical Safety and Hazard Investigation Board

CSB OVERVIEW

Mission

- To ***promote prevention of industrial chemical accidents*** that harm employees, damage the environment and endanger the public.

Activities

- Incident Investigations & Safety Studies
- Find Causes & Issue preventive recommendations
- Data Collection role (not yet in place)

U.S. Chemical Safety and Hazard Investigation Board

CSB OVERVIEW

- Agency straddles occupational & environmental arenas

- PSM nominally a performance-based (management system) standard, but:
  - Relies heavily on *Recognized and Generally Accepted Good Engineering Practices* (RAGAGEP) as enforcement benchmarks, or minimum "specification" performance criteria.

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U.S. Chemical Safety and Hazard Investigation Board

CSB IN CONTEXT

Staffing:

- EPA: 17,000
- OSHA: 1,700
- NTSB: 400
- CSB: 45-50

U.S. Chemical Safety and Hazard Investigation Board

INVESTIGATIONS & STUDIES

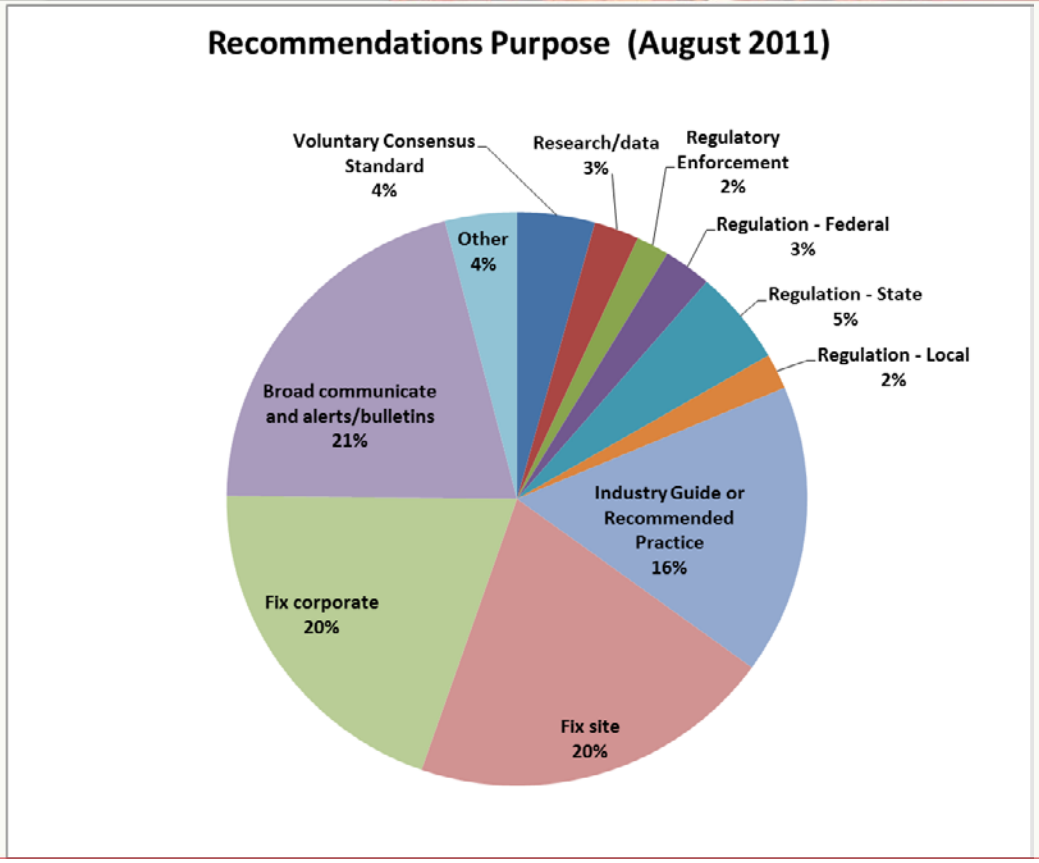
- Independent: No oversight or pre-publication review of reports or conclusions by *anyone.*
- Multidisciplinary teams, multiple visits, interviews, extensive data collection, subpoena powers.
- Investigate regulatory and voluntary standards, industry common and best practices, similar incidents.
- Public meetings & reports (1-2 yrs.)
- Output:
  - 3-6 “major” investigations + 5 “assessments”/yr.
  - Study every 3 years

U.S. Chemical Safety and Hazard Investigation Board

RECOMMENDATIONS

- Agency's Primary Preventive Tool
- To regulatory agencies (OSHA, EPA), industry, trade groups, standards organizations, unions, others.
- Not obligatory, only "moral" authority
- If We Do Them Right: Prevention

U.S. Chemical Safety and Hazard Investigation Board



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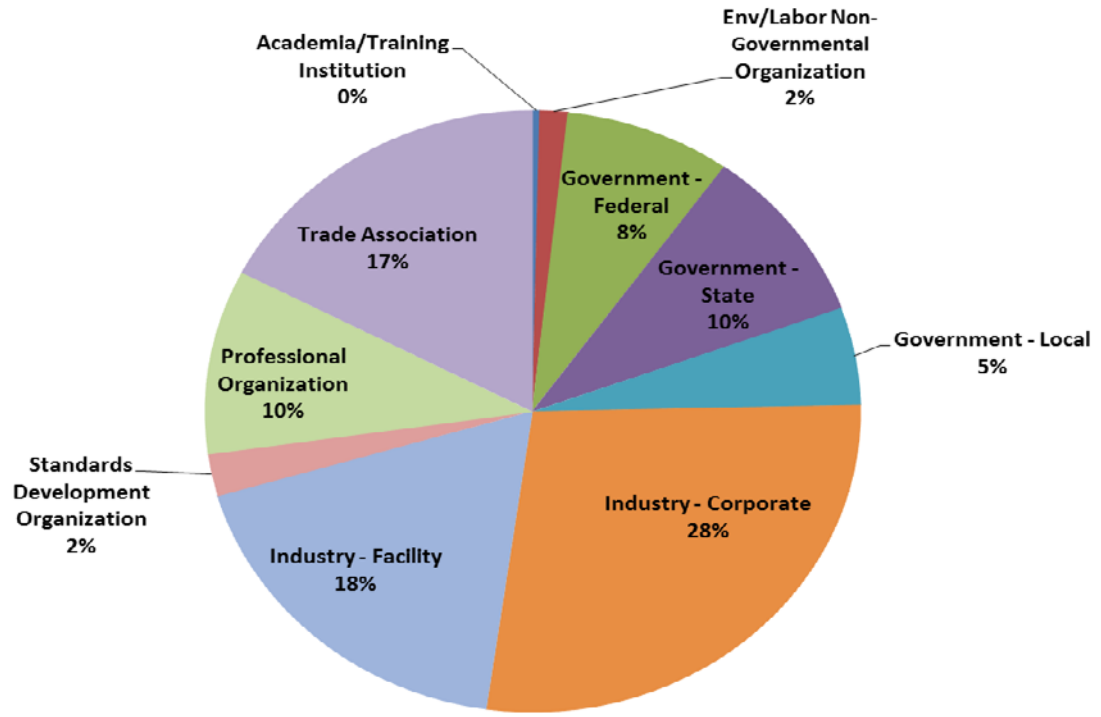
Recommendations Recipient Type (August 2011)



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Safety (In)Competence Where?

- **Societal Factors** (e.g., market forces, legislation)
- **Government/Regulatory System**
- **Company** (e.g., cost cutting, mergers/acquisitions)
- **Organizational** (e.g., management systems, programs)
- **"Front line"** (e.g., equipment failures, faulty procedures, human "errors")

(*Modified from Hopkins, AcciMap of Esso Gas Plant Explosion)

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BP Refinery, Texas

- March 23, 2005
- Largest US refinery
- Start-up of process
- Liquid overfill of tower, gas cloud
- Massive explosion, fire, toxic release

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Summary

- 15 deaths
- >180 injured
- Large property loss

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BP Texas Refinery Disaster
"Front Line" or Direct Causes (Incompetence?)

- Start-up pursued despite knowledge of faulty safety critical equipment (esp. tower level indicator, others).
- Error: Improper closure of a valve led to overfilling tower.
- Tower not equipped with automatic safety devices (SIS).
- Insufficient control board flow display.
- Insufficient skilled staffing during dangerous start-up
- Operators:
  - Fatigued (some with 29 consecutive 12-hour shifts); and,
  - Inadequately trained, especially for abnormal situations.

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BP Texas Refinery Disaster
Site Organizational Causes

- Use of obsolete blowdown drum & atmospheric stack, despite multiple recommendations to replace it with adequately sized flare system.
- Eight previous releases from unit were essentially ignored.
- Temporary trailers with non-essential personnel placed near high-risk start-up.
- "Run to failure" mechanical integrity mentality.
- Routine tolerance of violation of procedures.

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BP Texas Refinery Disaster Corporate Causes

- **Cost-cutting pressures** (continued use of obsolete technology, reduced staffing, poor maintenance,).
- **Improper "measurement" of high risk performance through routine injury rates** (distorted image of "good" performance).
- **Inadequate Board oversight of high-risk programs and safety culture.**

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BP Texas Refinery Disaster Government/Regulatory Causes

- **No requirement for high-risk indicators.**
- **No limits on hours of work = fatigue**
- **No requirements for Board accountability of high-level risks**
- **Regulation lags technical knowledge: Obsolete technology allowed by government *and* industry standards**

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Bayer Cropscience, West Virginia
Runaway and Explosion

- "Sister" plant to Bhopal
- Only facility in US still making, storing and consuming large amounts of methyl isocyanate
- Long-standing community concerns

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Bayer Cropscience, West Virginia
Runaway and Explosion

- GO TO:

http://www.csb.gov/videoroom/detail.aspx?vid=50&F=0&CID=1&pg=1&F_All=y

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CSB U.S. Chemical Safety and Hazard Investigation Board

Bayer Cropscience, West Virginia
Runaway and Explosion

- "Front-line" causes:
  - Rush to start unit
  - "Accepted" violation of procedures;
  - Operator errors
  - New computer-control system not fully operational, and operators not trained to it
- Corporate causes:
  - Proximity of MIC tank not fully evaluated
- Regulatory and Societal causes:
  - Insufficient inspection resources
  - No legal or regulatory requirement for inherently safer technology

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CSB U.S. Chemical Safety and Hazard Investigation Board

T2 Laboratories, Florida
Reactive Chemical Explosion

- GO TO:

http://www.csb.gov/videoroom/detail.aspx?VID=32

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CSB U.S. Chemical Safety and Hazard Investigation Board

T2 Laboratories, Florida
Reactive Chemical Explosion

- "Front-line" cause:
  - Lack of knowledge of reaction & hazards
  - Inadequate hazard analysis; no redundancy in controls (cooling, pressure relief)
  - Little or no management of change (scale-up)
- Corporate causes:
  - No safety oversight by French parent company
  - Multiple warning signals unheeded
- Regulatory and Societal causes:
  - Facility *not* covered by regulations (PSM & RMP)
  - Small, specialty chemical, supply-chain production

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CSB U.S. Chemical Safety and Hazard Investigation Board

CURRENT INVESTIGATIONS & STUDIES

- 18 ongoing investigations, one Deepwater (BP) Gulf explosion
- Some Major Current Issues:
  - Gas safety (purging and "blows")
  - Combustible dust in general industry
  - Petroleum Storage Tanks
  - Academic Laboratories
- Always a Central Issue: OSHA PSM Standard

CSB U.S. Chemical Safety and Hazard Investigation Board

GAS SAFETY

- Two Investigations
  - Conagra Slim Jim (food product) plant
  - Kleen Energy Power Plant (in construction)
- Common Issue: Release of natural gas in work areas under inherently dangerous conditions

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CONAGRA SLIM JIM FACTORY

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Kleen Energy

- 6 Deaths
- Many injuries
- Significant damage to ~ $1 billion facility

CSB U.S. Chemical Safety and Hazard Investigation Board

Gas Safety Recommendations

- Same goal for all: Purge gas to outside, and replace natural gas "blows" with inherently safer alternatives
  - OSHA: Promulgate gas safety standard; not yet accepted or in progress.
  - National Fire Protection Association (NFPA): No indoor purging or gas "blows"; nearly fully implemented.
  - State of Connecticut: Ban gas blows, legislature adopted unanimously earlier this year.
  - Amer. Society Mechanical Engineers: Will likely be silent on pipe cleaning.

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CSB U.S. Chemical Safety and Hazard Investigation Board

Combustible Dust-General Industry

- **Study issued in 2006:**
  - Some 300 dust explosions in general industry (1980-2005); 119 deaths, >700 injuries, property losses
  - OSHA grain dust standard in 1986 was very effective.
- **Major Recommendation: OSHA Standard**
  - In progress, but very slowly;
  - Two CSB investigations since study, 29 deaths
  - Numerous others in same period, no decline is visible
- **Other Recommendations**
  - Improve MSDS under ANSI, HazCom & GHS

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U.S. Chemical Safety and Hazard Investigation Board

OTHER CURRENT ISSUES

- **Petroleum Storage Tanks:**
  - Youth deaths, accidental, need to make them inaccessible
- **Academic Research Laboratories**
  - Unpredictable environment, changing conditions
  - Great autonomy of professors
  - Little specific guidance available
  - PSM "concepts" not adapted to lab environment
  - Little culture of safety

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U.S. Chemical Safety and Hazard Investigation Board

THE FUTURE FOR THE CSB?

- **Inherently Safer Technology:**
  - Not a major thrust of our work so far, but changing
  - Ongoing NAS committee: IST methods to make MIC
  - Replace natural gas blows: IST recommendation
  - Recycled water treatment: Move from Cl to bleach
- **PSM is 20 years old:**
  - **Two major CSB recommendations to OSHA:**
    Reactives & Management of Organizational Change.
  - **Other gaps have been noted:**
    Design, Inherently Safer Technology, Safety Culture
  - **Under Consideration: Symposium in 2012**
    What have we learned? What has worked? Not worked?
    What needs to be changed? How?

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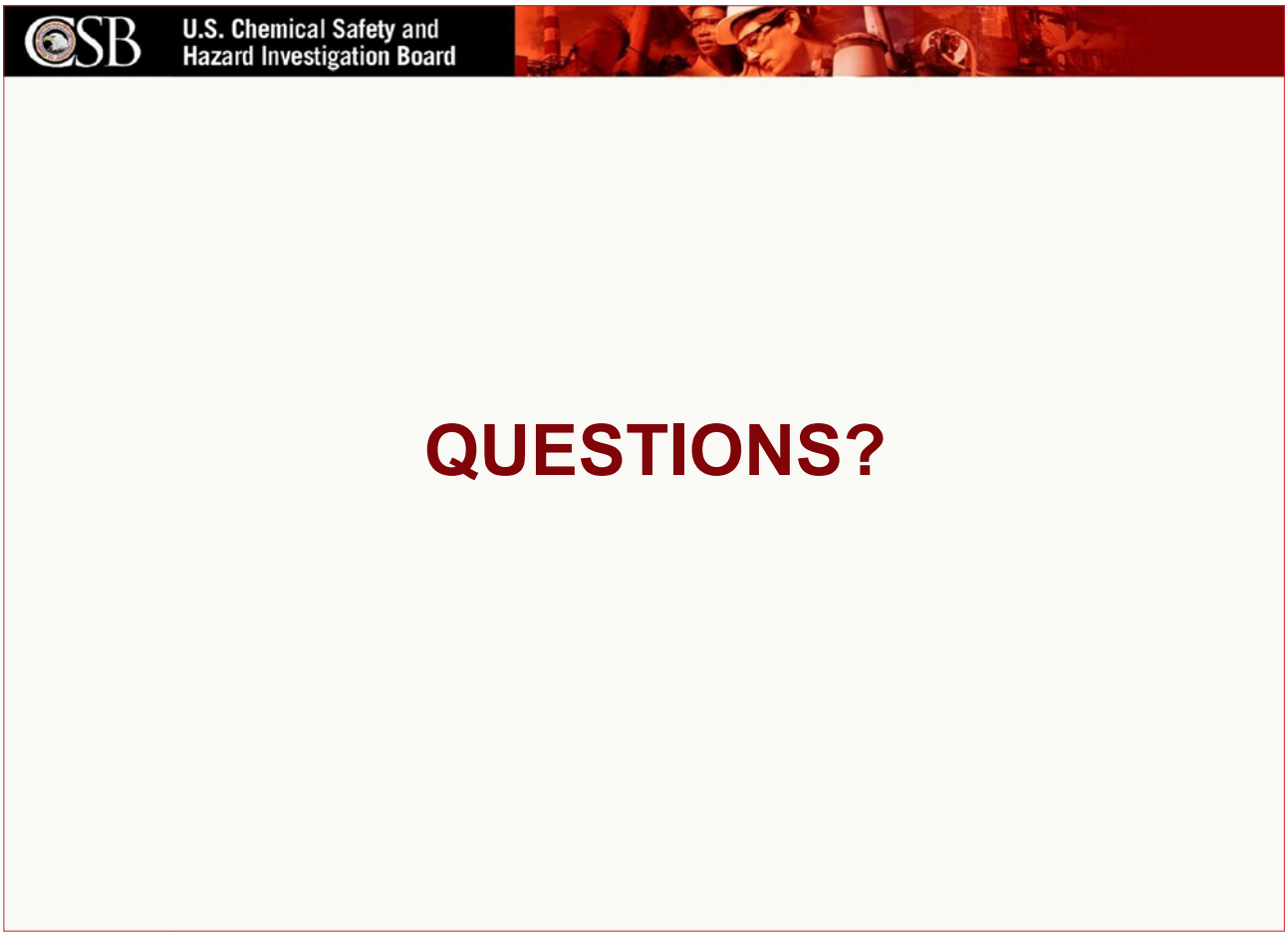

CSB
U.S. Chemical Safety and
Hazard Investigation Board
QUESTIONS?

Competence – conceptual introduction from a pedagogic and scientific point of view

Peter Dehnbostel
Helmut-Schmidt-Universität
Hamburg, Germany

Successful enterprising needs both companies and their individual employees to perform their jobs properly and competence based. Therefore both corporate and individual competences are needed. For the chemical and petrochemical industries process safety competence is indispensible for safety and environmental reasons. When a two days expert meeting is going to discuss what the European state of process safety competence is, it was found worth to spend half an hour in an introduction to the term competence from a pedagogic/scientific point of view.

The lecture answers in brief what competence is and addresses specific types of competences which are specifically needed in the professional area. Competence building processes are exemplified concerning the development of individuals from childhood to working life (general education in schools, vocational education with apprenticeships and further education, and university education) and in the further career (training on the job, gaining experience, training courses etc.). The definition of competence will be combined with the holistic action competence as a unity of technical, social and personal competences. The development of corporate competence will also be reflected and extended to management and controlling concepts in companies.

Introducing into the competence related vocabulary and some generally accepted pedagogic principles could help the session to step successfully into the discussion of the specific situation and needs in process safety competence – maybe not only in Europe.

Competence –

Introduction to the Concept from a Pedagogic and Scientific Point of View

Prof. Dr. Peter Dehnbostel
www.peter-dehnbostel.de
www.hsu-hh.de/debo

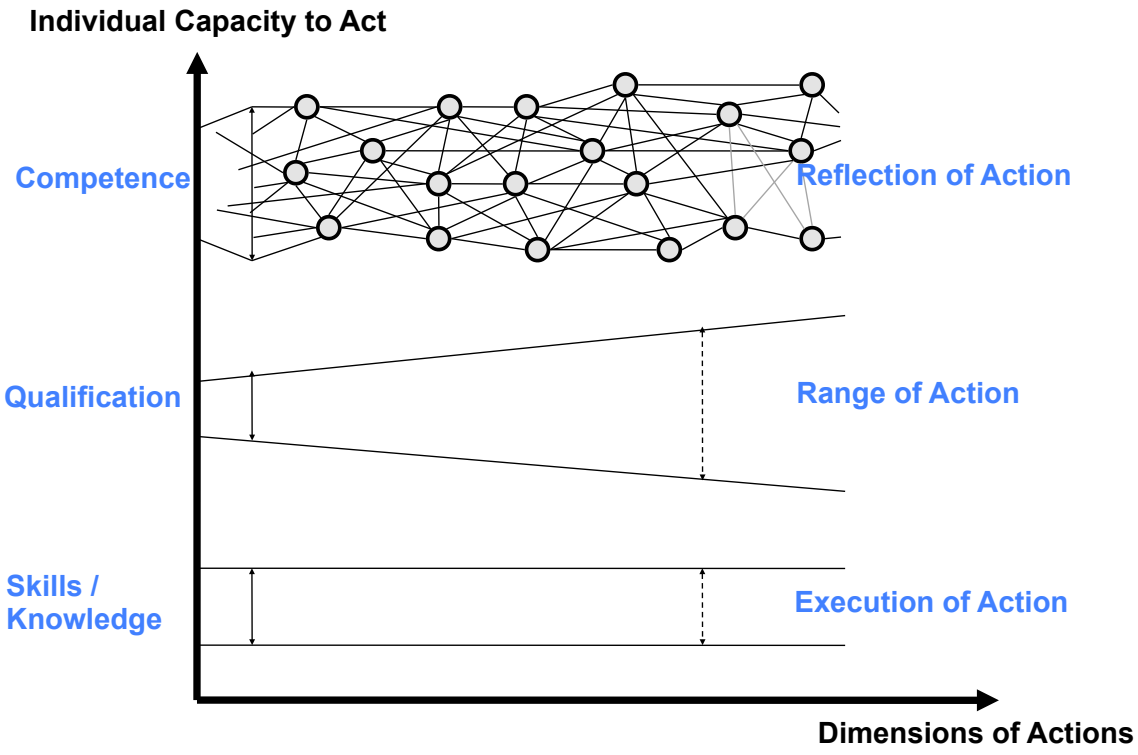
Competence

Introduction to the Concept from a Pedagogic and Scientific Point of View

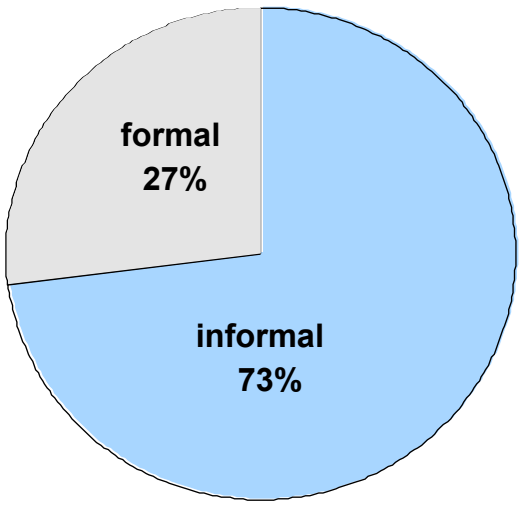
1. Approaches to competences
2. European use in qualifications frameworks
3. Occupational competence

2

From Skills and Knowledge to Competences



Formal and informal competences in work processes



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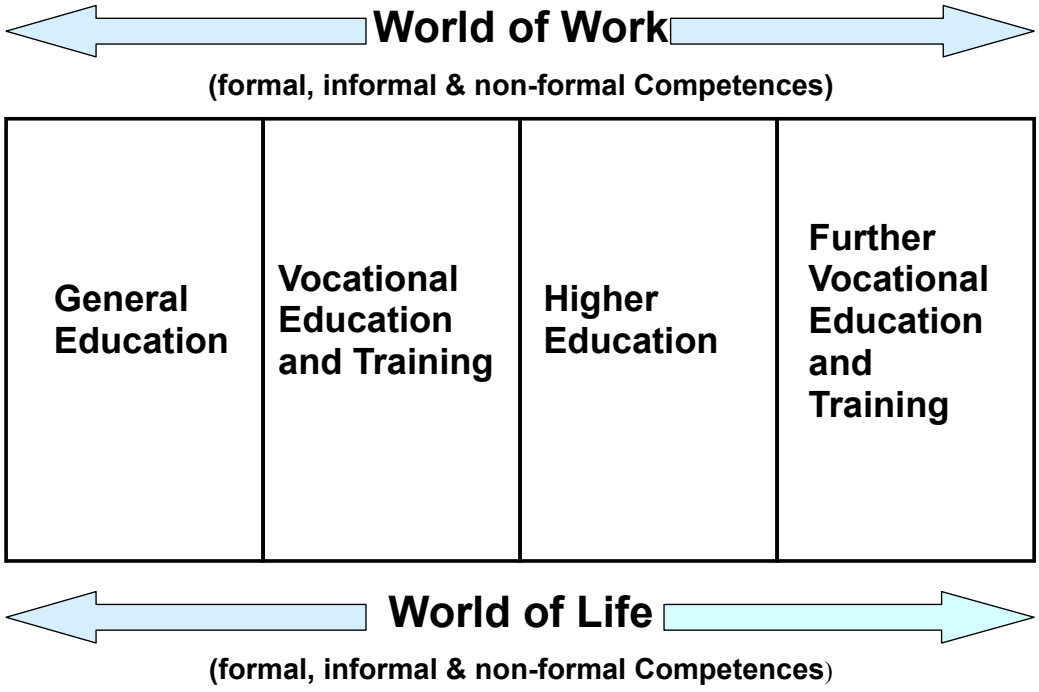
Areas of competence and competence development



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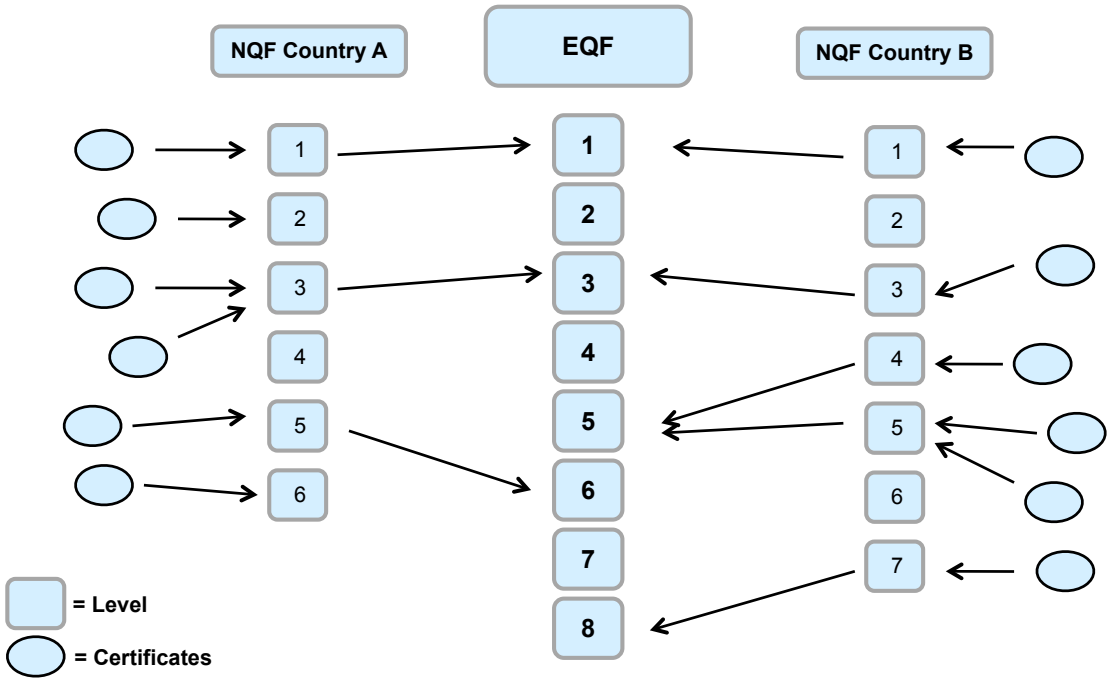
Competence

Introduction to the Concept from a Pedagogic and Scientific Point of View

1. Approaches to competences
2. European use in qualifications frameworks
3. Occupational competence

6

European Qualifications Framework for lifelong learning (EQF)



European and German definitions of competences

- **European Qualifications Framework (EQF)**
  „‘Competence‘ means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development. In the context of the EQF, competence is described in terms of responsibility and autonomy.”
- **German Qualifications Framework (DQR)**
  Competence within the DQR describes the ability and readiness of the individual to use knowledge, skills and personal, social and methodological competences and to behave in a considered, individual and socially responsible manner. Competence is understood in this sense as comprehensive action skills. The DQR presents competence within the dimensions of professional competence and personal competence.

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Competence

Introduction to the Concept from a Pedagogic and Scientific Point of View

1. Approaches to competences
2. European use in qualifications frameworks
3. Occupational competence

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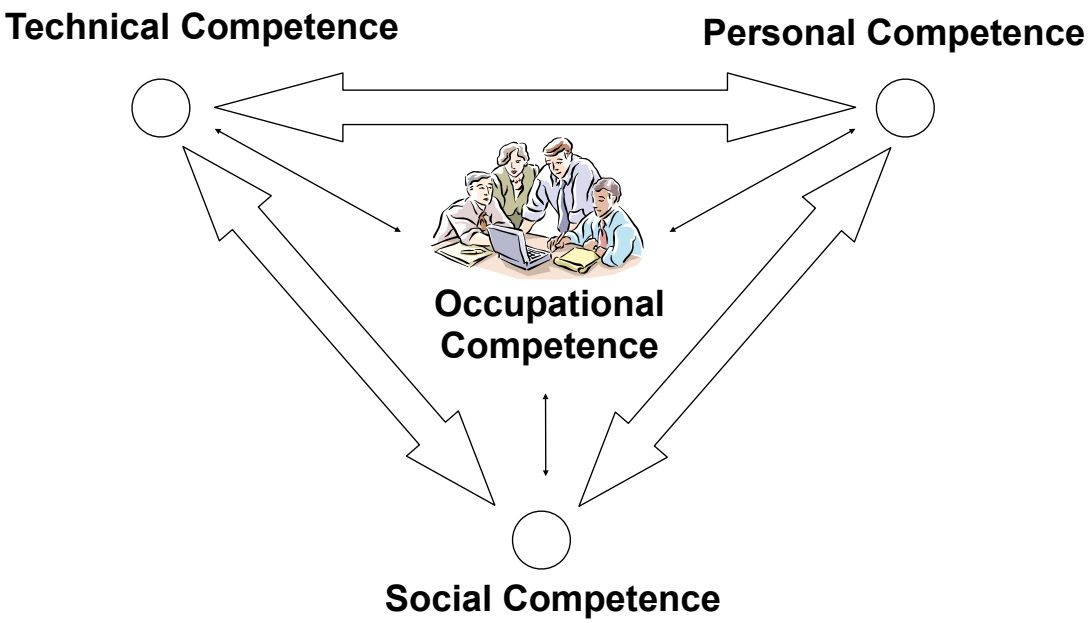
Occupational Competence



Definition of occupational competence

as a basis for individual competence development, team competence, organizational competence and

- **Technical Competence** constitutes a person's ability and readiness to process tasks and problems in an autonomous, professionally appropriate and methodical manner and to evaluate the result.
- **Social Competence** describes a person's ability and readiness to work together with others in a target oriented manner, understand the interests and social situations of others, deal with and communicate with others in a rational und responsible way.
- **Personal Competence** describes a person's ability and readiness to develop further and to shape his or her own life in an autonomous and responsible manner within the respective social, cultural or occupational context.

11

Universities teaching process and plant safety – the European map

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The Map of European teaching of process and safety presented here is based primarily on information available publicly on the web-sites of the universities.

In order to get a feel for how much process and safety teaching there is at European Universities a survey of all universities with public websites have been performed. Time only allows the data relevant to process and safety teaching to be presented here. The survey has been supplemented with a questionnaire e-mailed to selected professors at selected European universities.

Todays presentation will contain 3 parts:

- An overview of where you can obtain a process safety degree from a European university.
- Where you can get the degree, which allows you to study process safety in more detail. In this presentation the focus will be on chemical engineering degrees, but other engineering degrees can also be a ticket to study process safety.
- Finally there will be a discusion of the two different approaches to teaching process safety – either as a separate course or immersed in the chemical engineering curriculum.

Of the almost 1400 European universities surveyed less than 1.5% offer a degree in process safety. However, this does not include offerings of a fire safety degree which is mostly concerned with prevention of fires in buildings.

You are lucky if you live in either the France, Germany, Hungary, Norway, Russia, Scotland, Spain or Sweden because then you can study process safety without travelling to a foreign country.

The relatively large number of Norwegian universities offering a process safety degree is properly a result of the large Norwegian oil industry, and a focus on safety in this nation which for years have faced the dangers of the sea.

I have not found a university which offers a Ph.D. In Process Safety. However, that is not the same as saying you cannont specialize in process during in your Ph.D. Work. Many chemical engineering and other engineering departments offer that possibility.

A number of universities offer either a degree in fire safety, which is aimed at people involved in fire safety from a public perspective, or a degree in safety engineering which a clear focus on occupational safety. These are not counted here.

One of the strange finding is that it is not necessarily the large and respected engineering schools among the universities which offer process safety degrees, and you can see on this and the following two slides.

Ostrava is a city in eastern end of the Czech Republic. Sheffield is abou 100 kilometers east of Manchester. Caen is near the English Channel, Auvergne in the middle of France, and Limoges about 200 kilometers west of Auvergne. Wuppertal is in the Ruhr area of Germany, and Magdeburg is just west of Berlin.

The Norwegian University of Science and Technology is located in Trondheim. Tromsø is a good deal further north, and Stavanger is in western Norway, and Haugesund is a bit north of Stavanger.

Kazan is more than 500 kilometers east of Moscow.

It seems clear that both the Norwegian universities and the Scottish universities offering process safety degrees is a result of the development of the oil industry in these countries during the last quarter century.

But you cannot start studying process safety with your high school diploma. At least not at European universities. You need some degree as a basis for studying process safety.

This basis could be a chemical engineering degree, a petroleum engineering degree or a mechanical engineering degree or any other batchelor degree in the field of engineering.

In the following the survey results as it relates to were a chemical engineering degree may be obtained will be presented.

About 220 European universities offers either a batchelor of chemical engineering or a master of chemical engineering or both. That is about 16% of the European universities.

A little less than half of the universites, which have a chemical engineering or similar department offer a doctoral program in chemical engineering.

Most of the universities in Europe have by now aligned with the Bologna model. However, that are universities offering a 4 year master of engineering degree. Others offer a 4 year batchelor of engineering degree. Both of these can be suplemented with either 2 year or 1 year master degrees.

The survey done have not used the length of the programme to categories the degrees, but rather relied on the information provided by the university.

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The survey done have not used the length of the programme to categories the degrees, but rather relied on the information provided by the university.

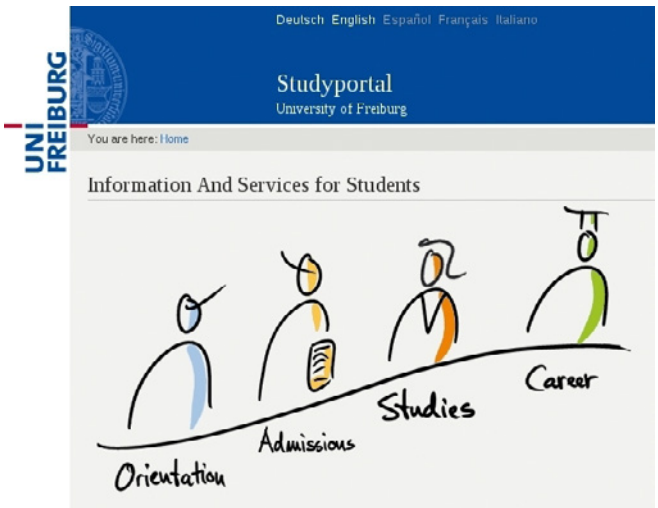
Most university website use a standard layout. It is almost as if you need to be in arts to be creative. At least the creativity of engineering is not expressed through the design of the web-sites of engineering schools.

While many have clear parts aimed at prospective students and already enrolled students. Not many sees companies or parents as a website visitor which they should aim for.

The website shown above is Miguel Hernandez University of Elche http://www.umh.es/. They do offer an engineering degree, but not in any of the tradtional fields.

The globalization of university education means that more and more universities have web-sites in multiple language.

A few attempt to accomplish this using Google Translate. That is definitely not yet a good idea.



English is of course the dominating language. But websites aimed at chinese students are starting to appear. My impression is mostly in southern Europe.

Then I have discovered that there are almost as many ways of specifying the URL of a secondary language site, as there a multiple language university website.

Some web-masters fail to specify the language of the web-site in the HTML code for the main page. That makes Google Translate a bit confused.

My initial idea was to mainly base this presentation on an online survey of selected processors at chemical engineering departments across Europe.

However, due to a limited database of relevant contracts and lag of contracts in many countries this idea was dropped in the middle of the summer.

The survey is still available online, and on the following slides I will highligth some of the questions especially about the outcome of process safety courses. You can take the survey at http://safepark.limequery.org/14514/lang-en .

Since the number of responses is very low no statistical significance should be placed on the results.

The specialization in process safety is normally part of the master degree program.

Not all view the chemical unit operations laboratory as an opportunity to teach process safety.

The picture is from Wikipedia Commons and shows a Poly-Silicon Plant.

The survery shows, that after a process design course at a chemical engineering department not all students are able to

- Use inherently safer design principles to improve the design
- Use CAMD to choose safer solvents for use in extraction
- Use Insurance company separation distances in plant layout
- Use tools to calculate safe distances to neighbors for possible releases

I don't think these are acceptable outcomes from a process design course.

I find it a bit disturbing that all students after taking a process safety course cannot identify the relevant US and EU regulations such as the Seveso II directive in EU, OSHA's PSM and EPA's RMP in US.

I guess we have to be satisfied, that at least they can identify the risk of chemical production, i.e. releases, fires and explosions. They can also create a plant layout respecting safety distances. They know appearantly how to use both the Dow Indices, i.e. the Fire & Explosion Index and the Chemical Exposure Index.

They can also create fault trees and event trees, and contribute to a Seveso II safety report and participate in a HAZOP study.

However, these results tell me, that the process safety course in some places is just another tools course. That I find rather disturbing.

Immersion of the safety teaching into the different parts of the curriculum has in my view the advantage of presenting information in a relevant context.

Some elements such as emergency procedures can be used in several courses to focus of relevance in relation to types of emergencies and amounts of material handled and the conditions of the handling.

A pre-startup safety check becomes much more relevant in the unit operations course – in my view – than in a lecture on checklist in a process safety or risk assessment course.

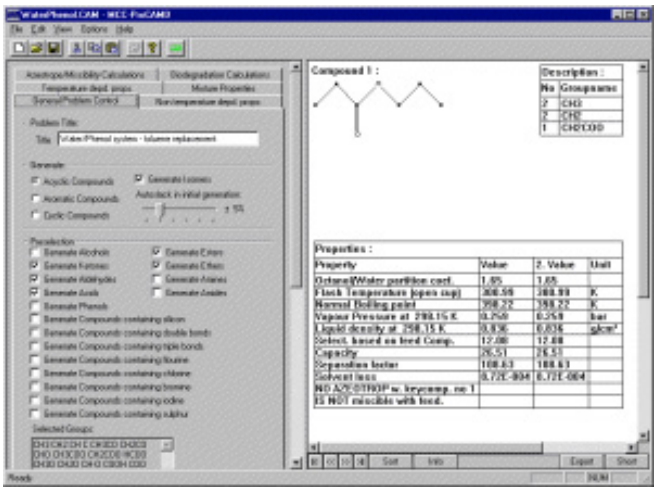
The process design course is another change to emphasize process safety by asking students not just to create the flowsheet and size the major pieces of equipment.

But also to create a layout, which attempts to satisfy all the different access needs – operations, maintenance, emergency.

Or choose extraction processes which use less dangerous chemical.

And have the students choose a location based on the needs for transport of raw materials and products.

The picture is a screen capture from the program ProCAMD developed by students at the CAPEC research group at DTU.



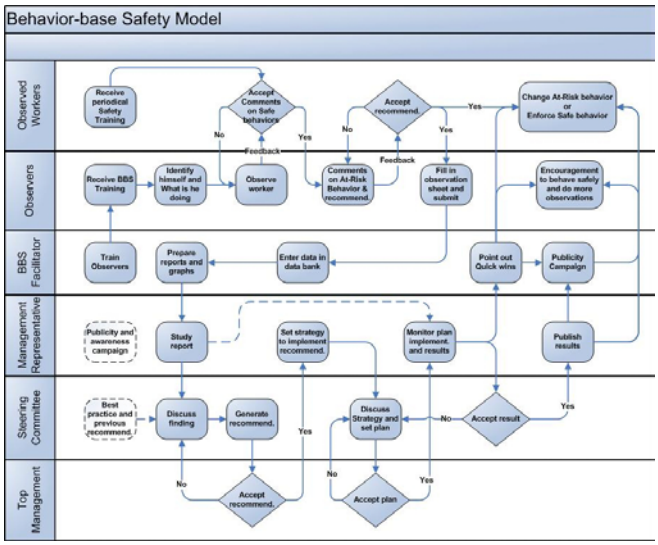
The immersion approach to process safety does precent some difficulties.

Primarily it requires extensive collaboration on curriculum design. Most places just within a single department, but at some universities also among different departments.

Also to be successful in the execution phase of the teaching this approach requires a safety culture among the faculty members.

Maybe these difficulties are the reason that the immersion approach is not seen at many universities. Although some – also in Europe – have started implementing parts of it.

However, it is worht noting, that companies like Dow Chemicals and Imperial Oil (partly owned by ExxonMobil) have been extremely successful with the immersion approach to process safety. Read for example a reasent article by a Dow executive on ChemicalProcessing.com



The reason most universities choose to teach process safety as a separate course is because this is the easy approach to process safety.

As chairman of the department you just have to find a faculty member willing to teach process safety
or in wurst case hire a new faculty member for this job.

Then send the selected person on some training. I can highly recommend the CCPS Workshops for
Professors conducted at different US chemical facilities.

Then all the other faculty members can get back to work on their research and teaching – and forgetabout process safety.

The picture is from the CCPS Workshop at ExxonMobil's Baton Rouge Chemical Plant. I am the second person form the left in the front row.

The conclusion is that,...

- There are high quality process safety education at the master level at a number of European universities
- Teaching process safety immersed in the curriculum is better, but separate course is easier

I will like to acknowledge the extensive use of Wikipedia – especially their list of European universities in the collection of data for this presentation.

Also my language skill are to limited to read most of the native language website of many European universities. There Google Translate – with whatever limitations it currently has – has been another valuable tool.

Finally the use of some pictures and other material from Wikipedia Commons is aknowledged.

The above comments are based on the comments giving orally at the symposium at ECCE-8 in Berlin on Wednesday, September 28th, 2011.

Process and plant safety – ProcessNet´s curriculum recommended to universities

Jürgen Schmidt
BASF, Ludwigshafen
Karlsruhe Institute of Technology (KIT)
Karlsruhe, Germany

Germany's chemical and petrochemical industry is the largest in Europe and one of the largest in the world. Hence high competence in chemical engineering including safety engineering is – amongst others - indispensable for keeping this position. With its activities in process and plant safety ProcessNet and its parent institutions supported the exchange of relevant knowledge and experience since long. 1978 a Research Committee "Safety Engineering in Chemical Plants" was established with a number of specialized working parties, later extended to a German community of interested experts from industry, science and administration.

In accordance with its goals, the Research Committee published already in 1997 a curriculum on process and plant safety usable both for basic academic studies in chemistry or chemical engineering as well as for specializing in safety engineering (Lehrprofil Sicherheitstechnik – Teaching Profile Safety Engineering [1]). Just about that time it began to show that safety engineering shifted out of the focus of many professorships since both national and European research programs in this field expired. The Research Committee was concerned about adverse developments with respect to both teaching and research and started in 2004 a still standing competence initiative [2]. Convincing government, universities and industry that something should be done to avoid a loss of necessary competence in process and plant safety, it was necessary to update the "Teaching profile Safety Engineering" according to the state of the art as well as to the Bologna Process.

The lecture introduces briefly into ProcessNet, its activities in general, and the initiative above, and mainly presents details of ProcessNet's updated process and plant safety curriculum for bachelor and master studies.

[1] Lehrprofil Sicherheitstechnik, DECHEMA e. V., Frankfurt am Main, Februar 1997

[2] Position paper „Maintaining and improving competence in safety engineering", DECHEMA/GVC Research Committee "Safety Engineering in Chemical Plants, March 2004
http://www.processnet.org/processnet_media/Elsen/Maintaining+and+improving+competence+in+safety+engineering.pdf

8th European Congress on Chemical Engineering
Berlin 25th to 29th of September 2011

Session:
Process Safety Competence –
European strength degrading to weakness ?

Process and plant safety – ProcessNet´s curriculum recommended to universities

Jürgen Schmidt,
BASF SE, Ludwigshafen / KIT Karlsruhe

BASF
The Chemical Company

Content

BASF
The Chemical Company

Process Safety -

- European Competence
- Lifecycle
- Competence Initiative
- ProcessNet´s **Curriculum** for Universities
- Industrial Demand on Safety Competences
- Key Aspects for Education of Safety Engineers

Process Safety – European Strength

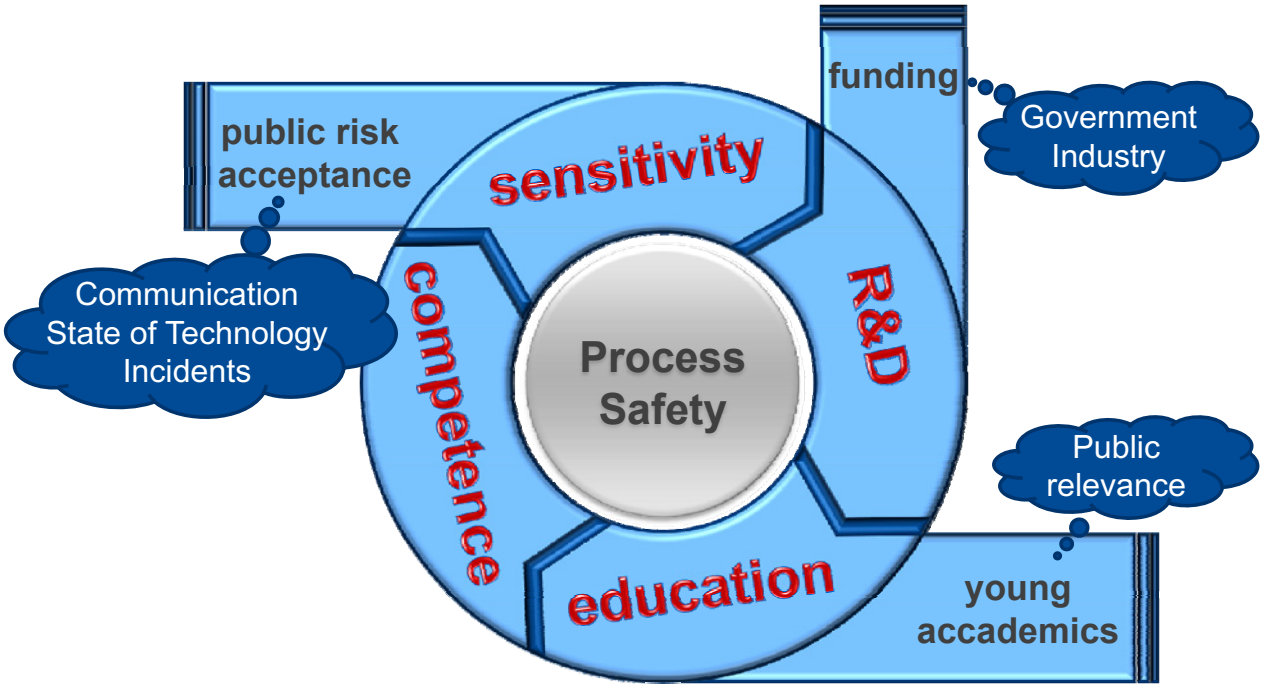
BASF The Chemical Company

- **Process & Plant Safety Performance**
  - Number and severity of incidents continuously decreased
  - National and international knowledge exchange enforced (e.g. Dechema/VDI-GVC safety community / ProcessNet WG´s / EDUG)
  - Industrial safety competence sustainably enlarged

- **Globalization & Trends**
  - Harmonizing of regulations / management processes
  - Decreasing public risk acceptance
  - Outsourcing of process safety divisions / concentration on expert groups
  - Lowering of over-conservatisms due to improved safety methods

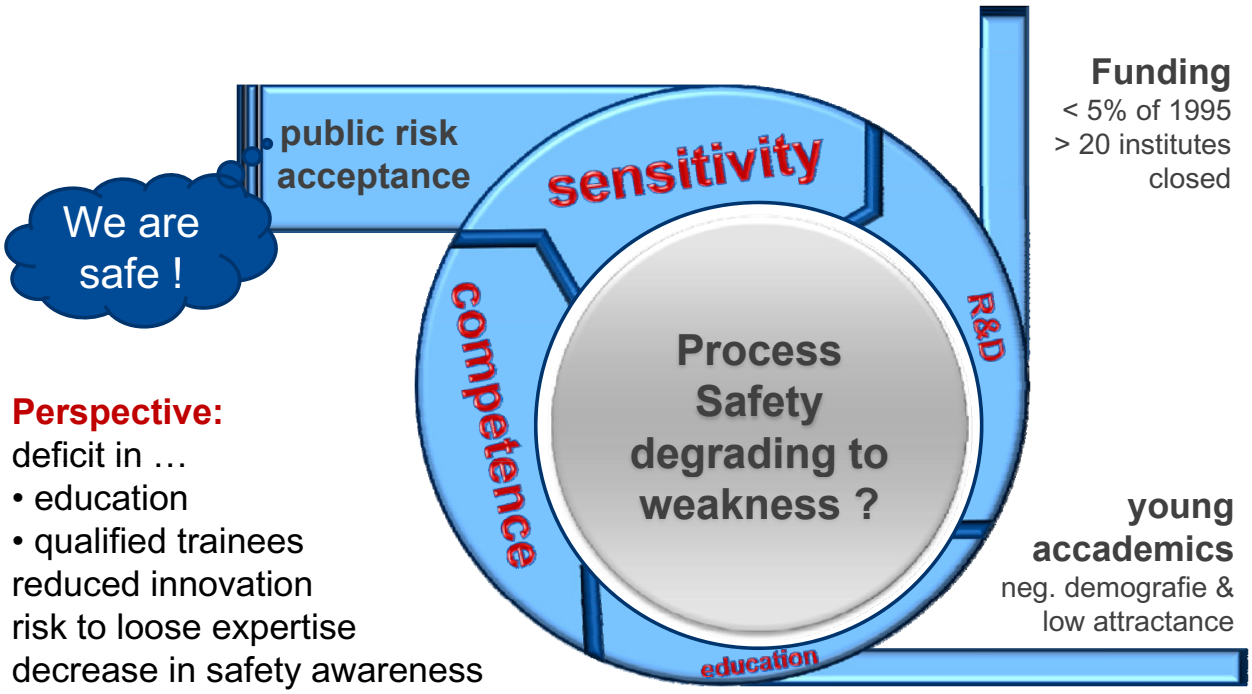
Process Safety Lifecycle

BASF The Chemical Company



Process Safety: current state in Germany

BASF The Chemical Company



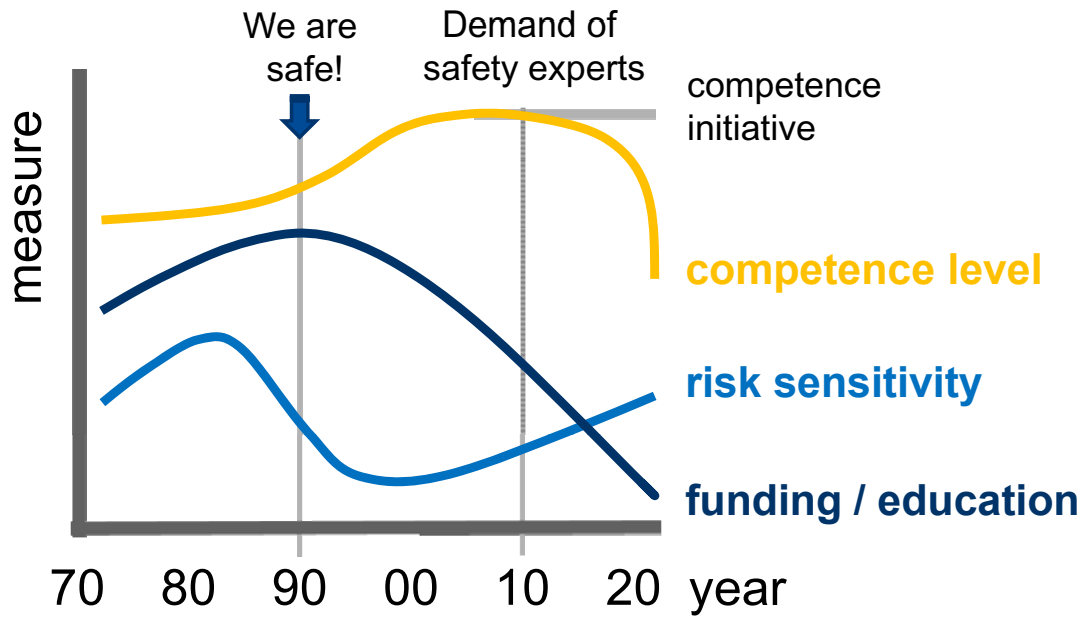
Funding
< 5% of 1995
> 20 institutes closed

Perspective:
deficit in …
• education
• qualified trainees
reduced innovation
risk to loose expertise
decrease in safety awareness

young accademics
neg. demografie & low attractance

Process Safety development

BASF The Chemical Company



Competence Initiatives

BASF The Chemical Company

- 2004: **Dechema/GVC Position Paper**
- 2008: **VCI** supports Dechema/GVC Initiative
- 2011: ECCE Symposium: Workshop Competence Preservation

Objectives (Industrial view): Safety Engineering to …

- … maintain competence transfer sustainably (young acad. / retired experts)
- … provide adequate prevention concepts for latest technologies (R&D)

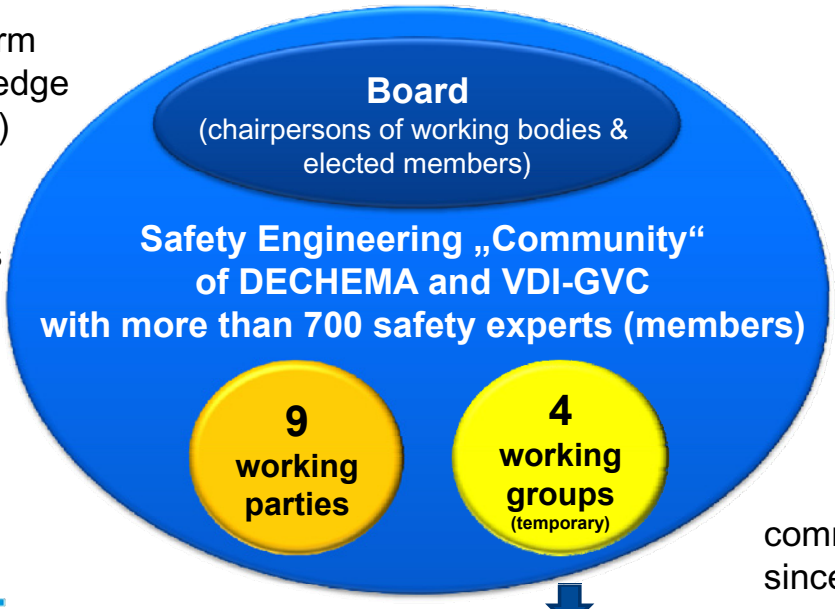
Solution steps

1. **Universities:** Process Safety Education as integral component of chemical and process engineering disciplines → ProcessNet´s curriculum
2. **Industry / third parties:** allied initiative for financing of R&D activities (intensive cooperation of University / Industry)

ProcessNet Section Safety Engineering

BASF The Chemical Company

- Exchange platform for expert knowledge (Working parties)
- Conferences
- Training courses
- Publications
- Property data base



Safety community since 1978

PROCESSNET
EINE INITIATIVE VON DECHEMA UND VDI-GVC

Safety Engineering Curriculum

ProcessNet´s curriculum

BASF The Chemical Company

Process and Plant Safety lectures

- Target group / majors:
  - process engineering / technical chemistry / chemistry → **mandatory**
  - mechanical- / bio- / industrial-engineering → **optional**
- **Bachelor** (~28 h per semester lecture / ECTS: 2-3 credit points)
  - Objective: **Basic training** of all aspects of process safety engineering (safety typical mindset / complete set of basic principles)
- **Consecutive Master** (elective module, major concentration)
  - Objective: (1) project-oriented **intensification** of Bachelor knowledge
    (2) formation of a **technical safety mindset & approach** (cope with uncertain data basis / abnormal conditions)
    (3) prep for safety engineering research (PhD thesis)

ProcessNet´s curriculum (Bachelor module)

BASF The Chemical Company

Lecture topics (time units)

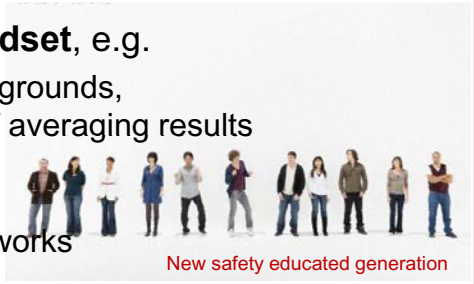
1. Introduction in process and plant safety (1)
2. Safety and risk management (4)
3. Hazard evaluation of substances (3)
4. Hazard evaluation of chemical processes (2)
5. Plant safety concept (2)
6. Protection of equipment (end-of-pipe-technology) (4)
7. Disposal systems (2)
8. PLC safety concepts (4)
9. Dispersion calculations of hazardous substances (4)
10. Fire and explosion protection (3)
11. Electrostatic (1)

Key Competence of Safety Experts Master & PhD candidates

BASF The Chemical Company

Young Safety Professionals …

- … should have a distinct **technical safety mindset**, e.g.
  - try to get the bottom of a problem / find backgrounds,
  - stay with conservative boundaries instead of averaging results
  - question interpolations / assumptions
  - double-check / short-cut complicate results,
  - consolidate safety approaches in expert networks
  - maintain the safety culture



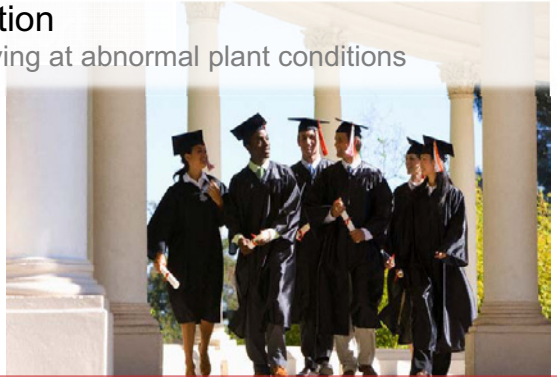
New safety educated generation

- … apply self evident safety methodologies / practices
- … estimate possible consequences of their safety recommendations (application of **risk management principles)**
- … are able to **work interdisciplinary / intercultural** (e.g. HAZOP teams)
- … evaluate new approaches from a safety point of view
- …develops innovative plant safety concepts by improving safety while increasing reliability

Key Aspects of Education Master & PhD candidates

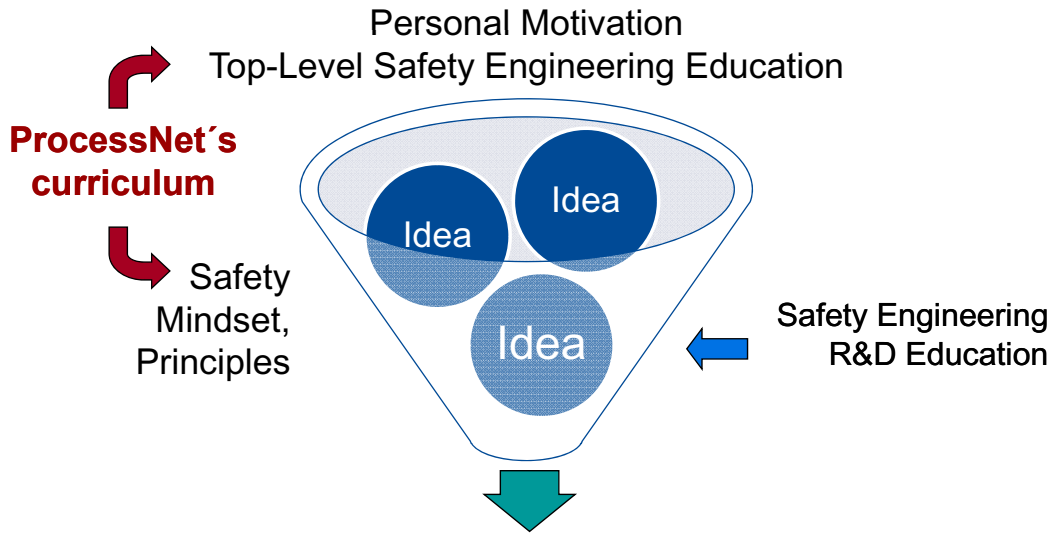
BASF The Chemical Company

- **Focus education on …**
  - safety methodologies / practices based on real industrial projects
  - interdisciplinary training / safety typical networking & communication
    → Basis for innovative safety concepts / maintaining the safety culture
  - physical essentials (Short cut methods)
    → safe&fast double-check of key important results / estimation of consequences
  - fundamental knowledge and experience in numerical modeling
    → e.g. Aspendynamics / gProms / CFD, potential & limitations …
  - experimental training / method validation
    → Valuation of suiteablity of methods for applying at abnormal plant conditions



- **Safety Engineers should…**
  - think lateral
  - examine carefully
  - communicate actively
  - evaluate discipline overlapped
  - act socially responsible and convinced
  - seek economical solutions

Excellence in Safety Engineering



Summary

- European Safety engineering currently on a world class level
- Strong demand on innovations in Safety Engineering to balance the decrease in risk acceptance
- Sustainable transfer of competences and innovative follow up of safety concepts to new technologies are major challenges for the near future
- ProcessNet´s Section Safety Engineering suggests: a curriculum for education in Safety Engineering
  - mandatory for Bachelor engineers and
  - as elective module and R&D platform for Master engineers
- Adequate R&D Funding in Safety Engineering will make the difference between future strength or weakness (SafEE´s Initiative)

Working Group „ProcessNet Curriculum“

Temporary working group of ProcessNet´s Section Safety Engineering:

- Prof. Dr. Schönbucher, University Duisburg-Essen
- Prof. Dr. Hauptmanns, University Magdeburg
- Prof. Dr. Brenig, Fachhochschule Köln
- Prof. Dr. Moritz, University Hamburg
- Dr. Klais, Bad Soden
- Dr. Mitropetros, Dechema, Frankfurt
- Prof. Dr. Schmidt, Karlsruher Institut of Technology, Karlsruhe

Acknowledgement

- Prof. Dr. Norbert Pfeil, BAM
  (Chairman of the Board of ProcessNet´s Safety Engineering Section)
- Dr. Peter Schmelzer, Bayer Healthcare AG
- Dr. Rainer Kohlen, Evonik Industries AG
- Dr. Sebastian Muschelknautz, Linde AG
- Dr. Kai Ehrhardt, BASF SE

Safety competence – key insights from a study on the Dutch situation

Hans J. Pasman
Member Council on Hazardous Substances
The Hague, NL

With the growth of process industry and the development of technology together with the growing awareness in the 70s and 80s that safety must be assured and risks controlled, special concepts, approaches, methods and tools were developed and people trained to apply these. Over the years safety knowledge grew into a discipline of its own to be applied in all stages of design and engineering, construction and operation of process plant and in handling and transport in which hazardous substances are involved. In the 80s and 90s various levels of education in personal and process safety became institutionalized, also at university level. Research in subjects as protective and safe technology, risk analysis methods, management systems, human behavior and safety culture started to flourish since for adequate prevention there was – and still is - a need for investigating mechanisms, further development of methods and new approaches.

The efforts had success and accident rates declined. With more recent economic pressures and the feel an adequate safety level has been achieved the urge to educate and invest in safety faded away and seemed to be suppressed by more direct potential gains in work on material and process innovation. This seemed to be true most prominently at university level. Since university should be the nursery for future 'teachers of teachers' and feeling that on the longer run decline would lead to problems the Council on Hazardous Substances in the Netherlands decided to perform a more systematic study. It consisted of mapping the global production of process safety papers over a period of ten years in a broad sense and trying to understand trends, and to interview various groups being part of the knowledge infrastructure: research institutes, industry, university and government, to survey their stand on future perspective. A number of university professors some in process engineering, others in safety were consulted for guidance of the effort. The findings of the study were discussed in a platform with broad representation of stakeholders from industry, government and other organizations. As a result an advice was issued to the Cabinet how the knowledge infrastructure can be maintained, elementary safety concepts can be part of education of future engineer generations, how young graduates can be attracted to specialize in safety and what funding will be needed to be able to participate internationally and to stay abreast of developments. The paper will present details of the study, conclusions and recommended actions.

Adviesraad Gevaarlijke Stoffen

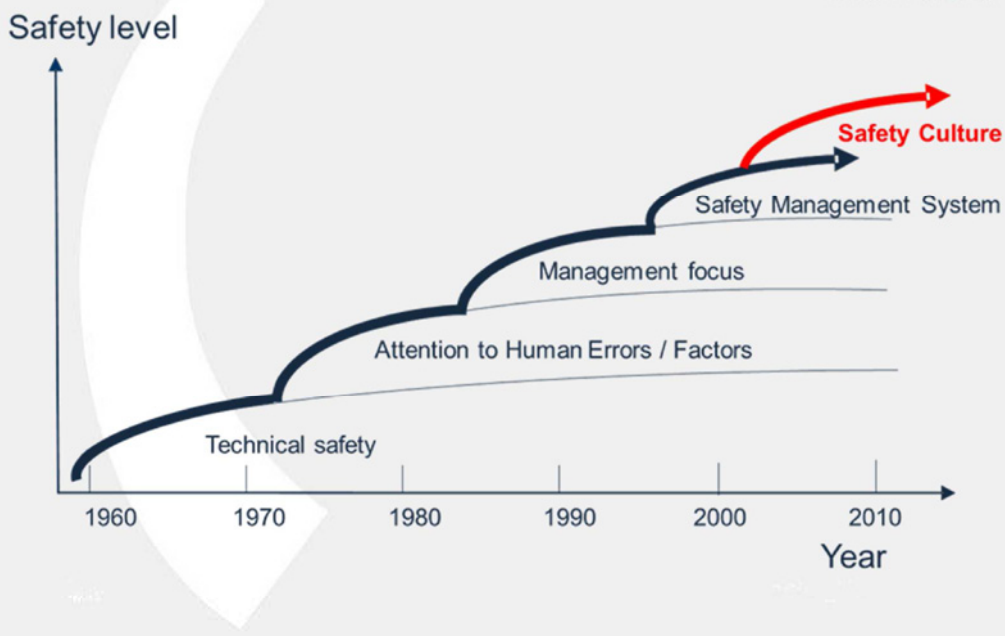
8th ECCE, Berlin, 28-29 Sep 2011

"Safety competence - Key insights from a study on the Dutch situation"

Hans Pasman

Mary Kay O'Connor Process Safety Center, Texas A&M University
Previously, chairman AGS Knowledge Infrastructure Committee
Emeritus TU Delft, retired TNO

History in brief



History in brief (2)

- 70-90s: With development of process industry university chairs established on process safety/loss prevention; Ph.D. studies funded; (sub-)discipline developed. Competence = product of interaction practical experience - knowledge - research
- TU Delft 1978 first general safety curriculum: behavioral safety/risk management; later specialist chair process industry in Faculty ChemTech; much later Toptech Master for policy makers in public safety.
- Abundance of courses on applied levels and special topics: e.g. gas and dust expl.
- 90s and later: Governmental support diminished, beta-education lost popularity, less interest for chemical engineering, knowledge level students broadened but not deepened.
- At the same time industrial competition strengthened; cost cutting, less positions.
- Market paradigm in funding research ; rush on the 'pots with gold'; 'safety = softie'.
- Process safety chairs at TU Delft, TU Eindhoven and UTwente silently vanished.

AGS advices on competence to Dutch government:
2004 Expert Ctr, 2006 KIS, 2009 Strategy
2009 Advice: How bad is it? What can be done?

Deliberations with:

- **Chemical industry association (VNCI): Do they see need?**
- **University professors to discuss knowledge domain.**
- **Ministry representatives: Education, Economy, Infrastructure.**
- **Funding agency NWO: Vision?**
- **Knowledge institutes, industrial research labs.**

Assignments to:

- **Institute for Scientific and Technology Studies, CWTS, Leiden : *mapping articles process safety, 10 years worldwide; trends?***
- **Technopolis, Amsterdam: Interviewing people in R&D; *what are their relationships; what perspectives do they see?***

Process safety as a discipline

to be distinguished from personal safety

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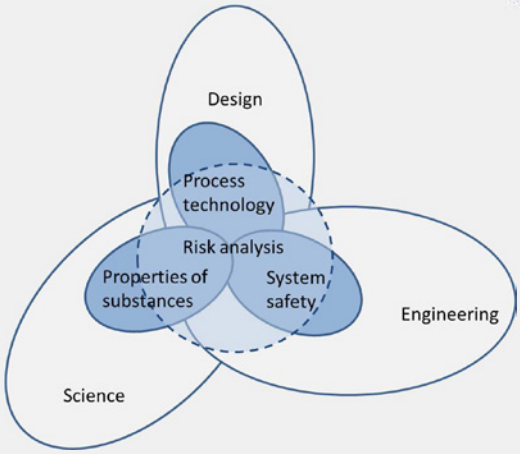

Typical areas:

- Properties: Combustion, thermal stability, deflagration, detonation, toxicity – test methods, criteria, classification, regulation.
- System safety: Safe design principles, FTA, reliability engineering, IEC 61508.
- Process technology, engineering, operation and organization: Inherent safer, SMS.
- Risk analysis: LOPA, Consequence analysis, QRA, Decision analysis, Criteria.

Institute for Scientific and Technology Studies, CWTS, Leiden :

Web of science – 8300 articles process safety – 1997-2006

data mining, combinations of nouns, frequency grouped

position circles = degree of association, size = fraction of world; number = %

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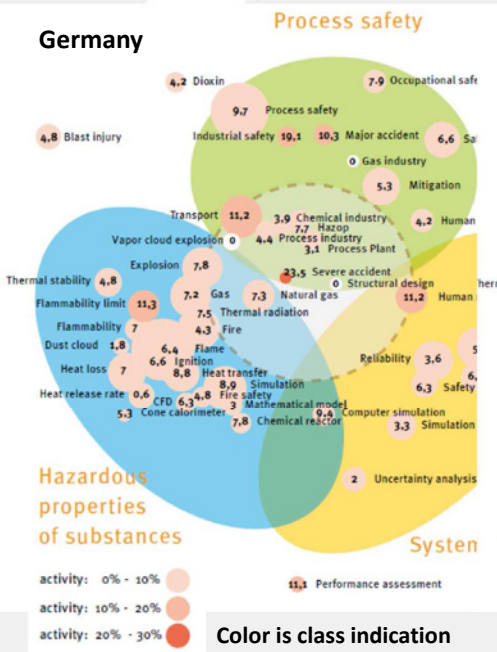
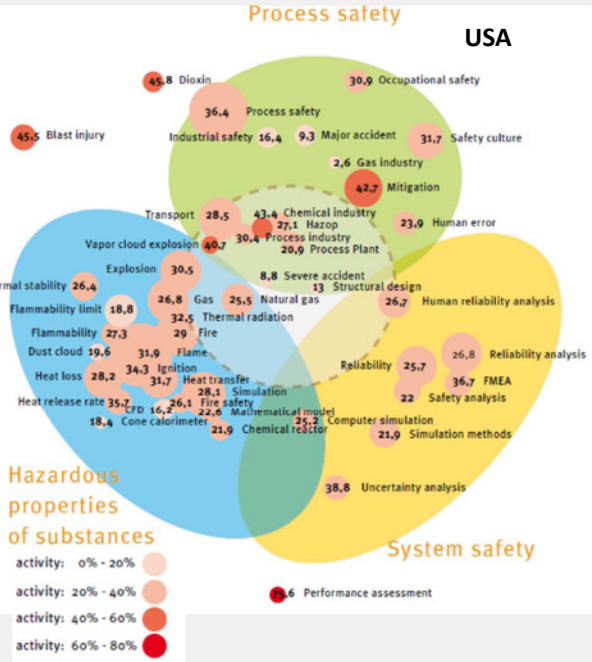
Germany



USA



Color is class indication

Further results:

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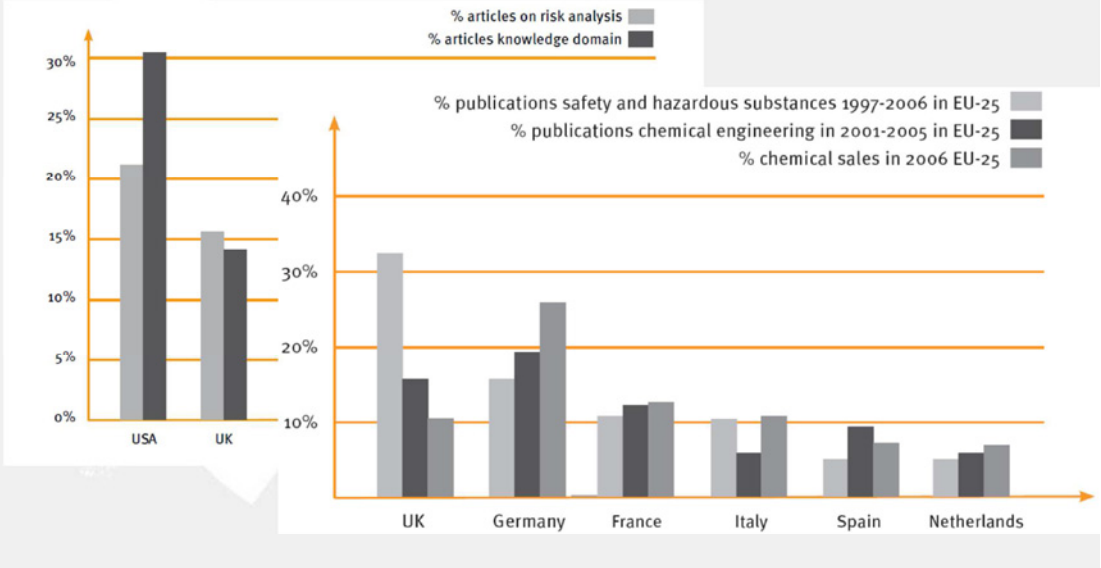
The Netherlands: some emphasis on risk analysis
U.K.: emphasis on culture, HF, thermal; France: on properties



Interview results Technopolis, Amsterdam:

Adviesraad Gevaarlijke Stoffen

- **Many bilateral relationships exist between industry - knowledge institutes – universities.**
- **Research is rather fragmented, narrow areas – lack of overview.**
- **Research still lives on successes in the 70-80s.**
- **Work declines slowly; areas disappear; groups are below critical mass.**
- **Funding is for projects with immediate pay-off.**
- **No budgets for longer term strategic work.**
- **Researchers themselves see little future perspective.**
- **There is a need for a plan, roadmap, platform and leadership.**

Conclusions AGS study:

Adviesraad Gevaarlijke Stoffen

1. **In general, Dutch process safety research at university is below critical mass. Level of education is tied to level of thinking, hence research.**
2. **There is international exchange of knowledge: ETPIS, EPSC, IGUS, Loss Prevention, but if no contribution, no gain because there is no or little connection.**
3. **If no expertise build-up at academic level, in the long run knowledge institutes will suffer as well.**
4. **If no deep knowledge available then scope of training courses will become narrow or too superficial.**
5. **In a few years remaining expertise may have disappeared. People will assume safety is an obvious matter. Only after an accident, one would exclaim : "How is it possible?"**
6. **Recommendation: Install a chair, increase R&D 3X + platform**

Actions after delivery advice?

Yes, some!

Adviesraad Gevaarlijke Stoffen

- October 2010: Reaction of Cabinet of Ministers on Advice (of March 2009)
  - Thanks for all the work; we also talked with all stakeholders
  - At universities possibilities are very limited (program full)
  - NL cannot be excellent in all fields
  - Industrial thematic area Chemistry will take care: PPP funding
- 'Strategic Knowledge Platform' founded by Ministry (Public Safety)
  - First meeting October 2008; second meeting January 2011
  - Active participants knowledge institutes; presence of industry
  - Short-middle term research (hence not strategic)
  - Meanwhile financial crisis; new cabinet; R&D funding is now problem

In the mean time developments in industry and in the country:

Adviesraad Gevaarlijke Stoffen

1. 2007 Business plan chemical industry: growth! Now one of top-sectors.
2. Transportation chemicals in NL: growth!
3. VNCI-NWO: research projects 10% for safety aspects.
4. Need for academic position recognized ('teacher of teachers'), however action failed – TU's budget cuts.
5. Globally gap academic knowledge level - industry is growing. (Industry people have no time – academic people not much industrial experience)
6. General safety (safety management) at TU Delft seems barely to survive *(but no properties substances/chemical technology).*
7. AGS will be reduced from 10 members to 1. That member part of a general council for the 'Living environment and Infrastructure'.
8. Letter VNO-NCW (Conf. industry and employers) to minister, 13 September 2011, proposes to discuss university education

Situation in other European countries and USA:

Adviesraad Gevaarlijke Stoffen

1. ***Situation in Be, Cz, Dk, Fi, It, No, Po, Sl, Sw, Sp may be less dramatic.*** **(Niels Jensen's presentation)**
2. ***Is effort in Fr, Ge and UK decreasing?***
3. **USA : TeXas A&M, North-Eastern, Michigan-Tech; SAChE (Safety in Chem.Engrg Education) of CCPS/AIChE; *ABET* (Accreditation Board for Engrg&Tech) : *all chem. engrg faculties in U.S. shall teach principles of process safety*.**
   (Safety in nulear engineering and aeronautics/aerospace)

   N.B. At MKOPSC ,TX A&M, director Dr Mannan organizes in October a workshop to develop a process safety research agenda for next decade.

After-burners:

Adviesraad Gevaarlijke Stoffen

1. **It will be great if WPLP EFCE supported by EPSC (incl. IChemE) establishes a kind of SAChE in Europe!**
   (Is EFCE Working Party on Education still active?)
2. **Can companies create career perspectives in process safety?**
   (In fact, board members should have a notion of basic concepts of process safety and quality)
3. **Is public-private partnership for funding of university chairs an option?**

How to achieve high quality teaching in higher education? General approaches applied to the field of process and plant safety.

Jörg Steinbach
Technische Universität Berlin
Germany

Since Wilhelm von Humboldt's concept of a university in unity of research and teaching a common interpretation was that high quality academic teaching can only exist in conjunction with high quality research. Although such a conclusion is simply wrong it is worth to elaborate accepted and possible correlations between research and teaching as the two cornerstones of the university.

The lecture starts with a brief introduction on the main academic teaching methods, their areas of application and educational objectives. Using examples from the area of process and plant safety it will then be worked out how the research background of an academic teacher can positively improve content and transfer of knowledge. Inversely, possible adverse impacts on the quality of academic teaching will be shown for the case that teaching staff is completely cut off from own research activities. Building on that, the situation in teaching process and plant safety at German universities will be assessed and proposals for improvement be given.

Leading from the top in making process safety competence a reality

Lee Allford
MIChemE CEng
EPSC Operations Manager
IChemE

Increasingly it is recognised that across Europe many organisations have a role to play in promoting competence in process safety within the chemical and allied industries. The compe-tence and expertise that practitioners in process safety need is clearly different to that required by specialists in occupational safety and in other industry sectors such as transport, construc-tion etc. IChemE has many years experience already in training process and chemical engi-neers in process safety and with the formation of IChemE Safety Centre (ISC) in 2009 has taken the initial steps together with other UK bodies of defining formal accreditation criteria for process safety training.

The presentation will describe a multi stakeholder competence project that the IChemE has recently led in

- compiling information on existing process safety training provision & guidance
- drafting a skills matrix against various job levels using a high level process safety framework
- developing a simple benchmarking tool using word models to describe desired behav-iours at various levels for each element of competence.

Assuring competence in process safety

Lee Allford
IChemE

ECCE-8
Berlin 2011

Chemical engineers and process safety

"Process Safety refers to the prevention of unintentional releases of chemicals, energy, or other potentially dangerous materials that can have a serious effect to the plant and environment"

www.icheme.org

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Chemical engineers and process safety

Safety Culture + Safety Knowledge

www.icheme.org

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Chemical engineers and process safety

Safety is CORE!

www.icheme.org

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Why it matters?!!

Huge Consequences

www.icheme.org

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Why it matters?!!

1984: Hundreds die in Bhopal chemical accident - BBC News

2005: A global oil company has been ordered to pay more than £1m for breaching health and safety regulations after an explosion at its Humber refinery.

2011: Pembroke Chevron refinery blast: Inquiry after four die

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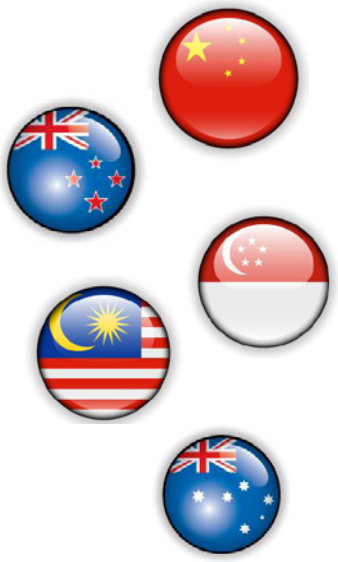
IChemE & Safety

- Qualifying for Chartered status
- Degree accreditation
- Conferences and events
  - Hazards, Hazards AP
- Training and master classes
- Publications
  - academic, Loss Prevention Bulletin, ***tce***
- Special interest group
- Collaboration across the profession
- Advocacy



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heart of the process

Safety Challenges

- Introducing the IChemE Safety Centre
  - Review and reset the strategic direction of safety within IChemE
  - Align with and deliver on IChemE's Technical Roadmap
  - Build on inherent strength of expertise and range of activities
  - Enhance further the relationships with and among major employers

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IChemE
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IChemE Safety Centre

- Brings together a comprehensive range of activities and services
- New model for company participation
- Initial launch – Australia 2012

Process Safety Management

"Ensure that the process industries, and particularly the operators of high hazard sites, have access to comprehensive fit-for-purpose safety-related training, offered by duly accredited training providers and delivered by competent and knowledgeable presenters"

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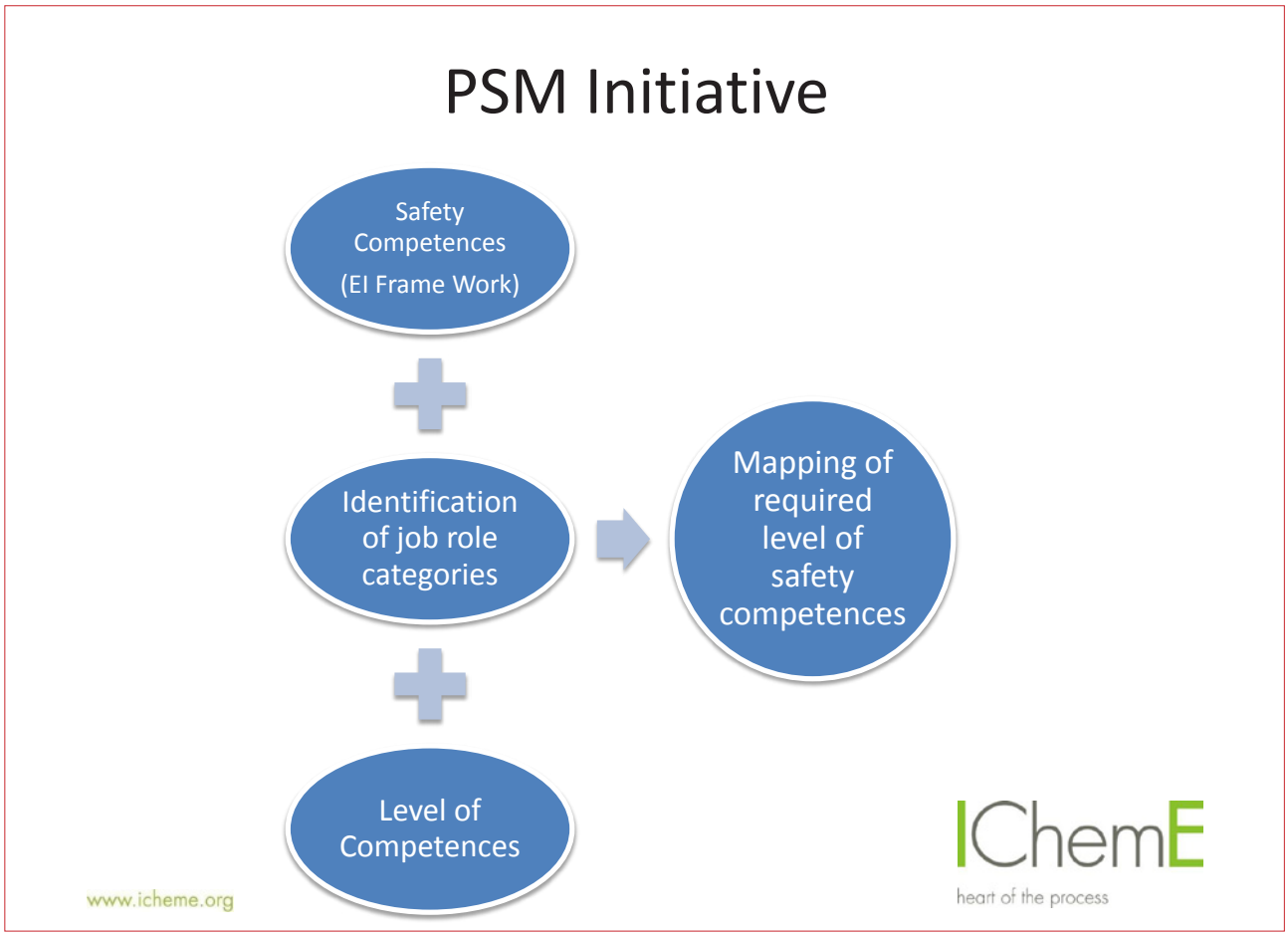
PSM Initiative
Safety Competences (EI Frame Work)
Identification of job role categories
Level of Competences
Mapping of required level of safety competences
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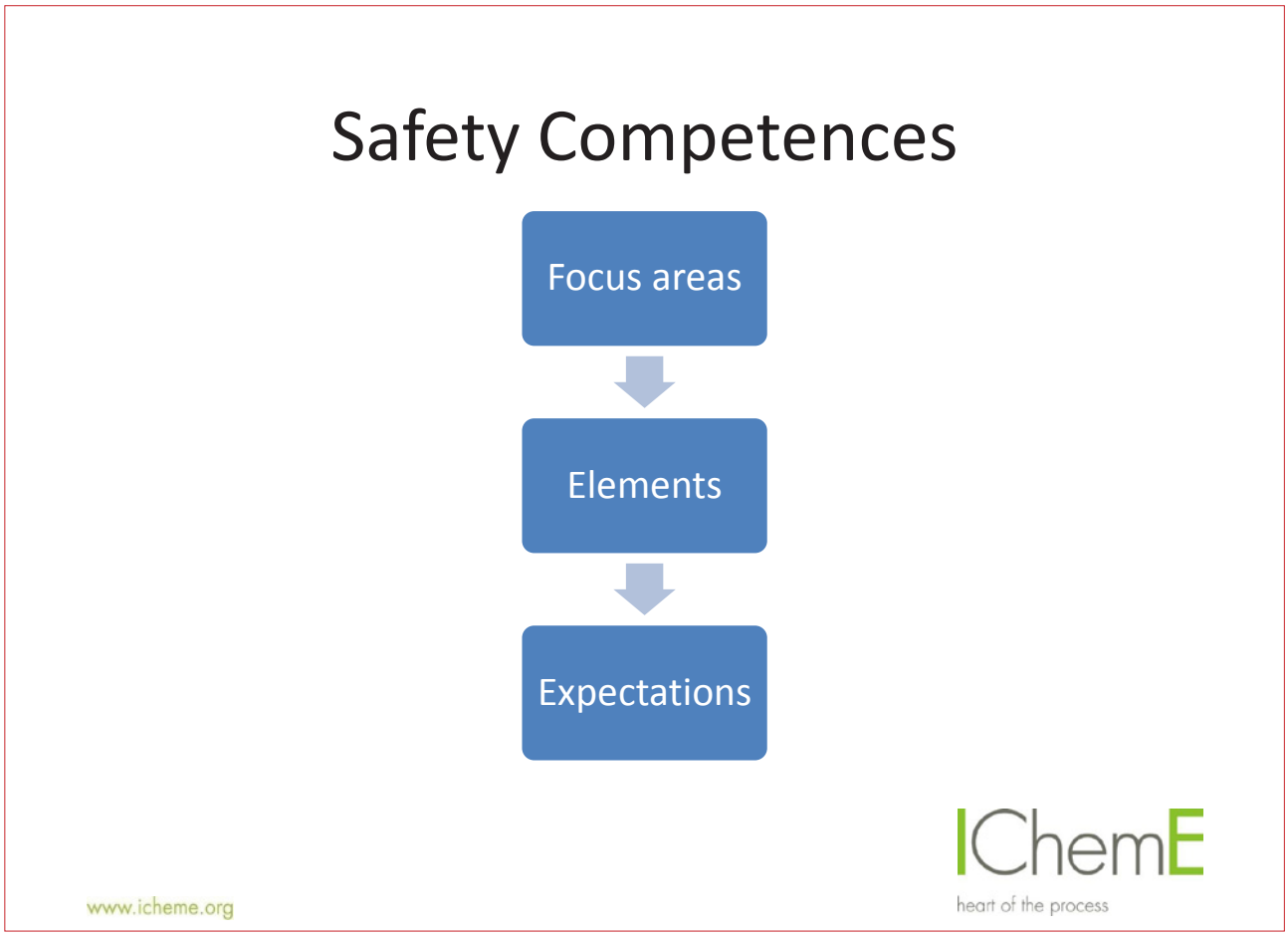
Safety Competences
Focus areas
Elements
Expectations
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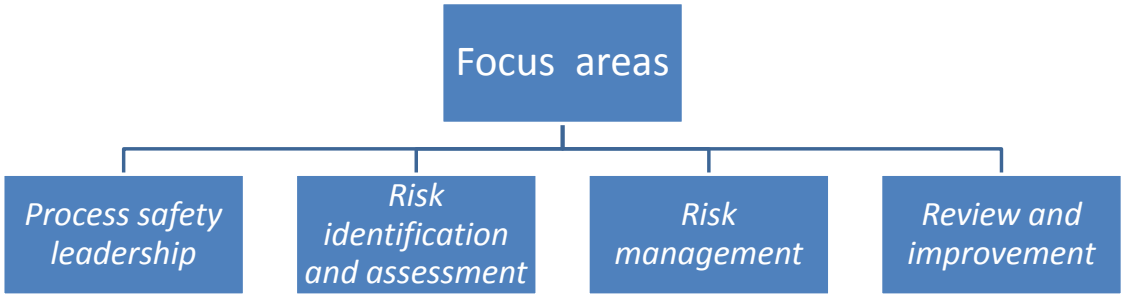
Safety Competences



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Job Role Categories

Role Category	*Job titles*
Above-site Senior Executives	Board level directors Chief executives Business manager Supply chain manager Manufacturing VP
Site Leadership	Site manager Production/plant manager Technical assurance managers (process, engineering)
Technical Specialists	Engineers (process, mechanical, power & control, inspection, etc) Process safety assessors Design engineers (plant & process)
Front-line supervisors	Production team leaders Shift managers Production supervisors Maintenance planners
Front-line staff	Process operators Maintenance technicians Contractors

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Level of Competences

Level	*Required Competence*
3	Company/site expert
2	Professionally able
1	General awareness
0	Not necessary

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Training

Very little training available at the board and operator level!!

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Training Standards

Mapping of safety competences → Development of training standards

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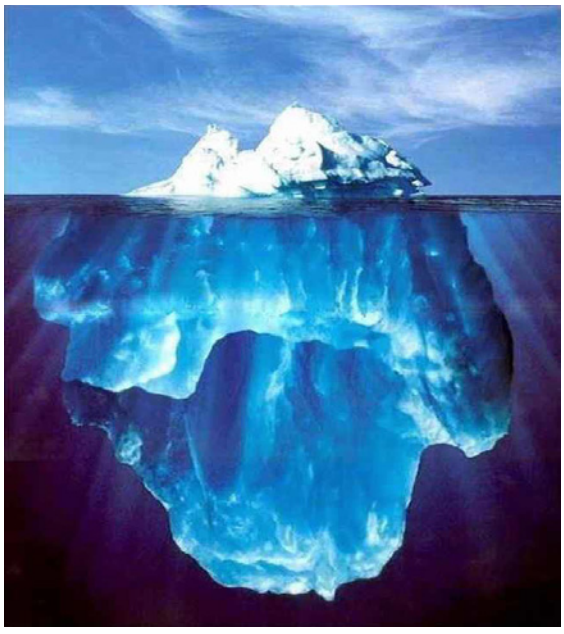
Training Standards



Start at Top
- Company Leadership

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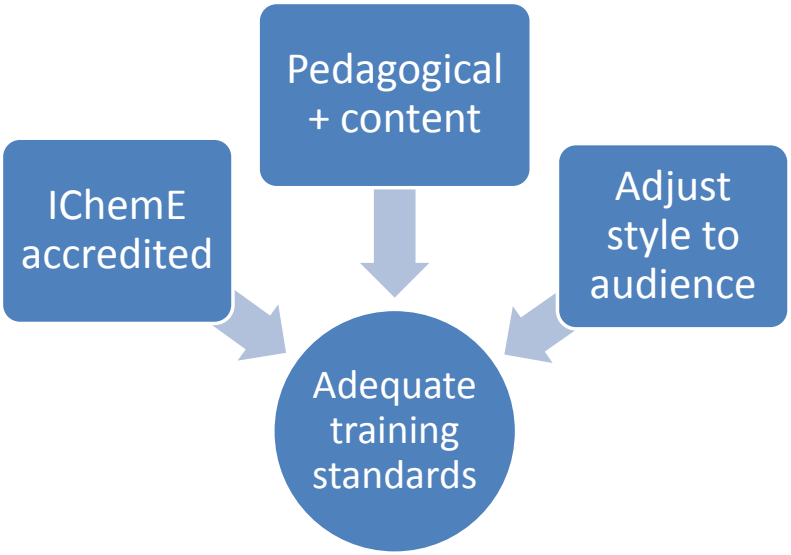
Training Standards



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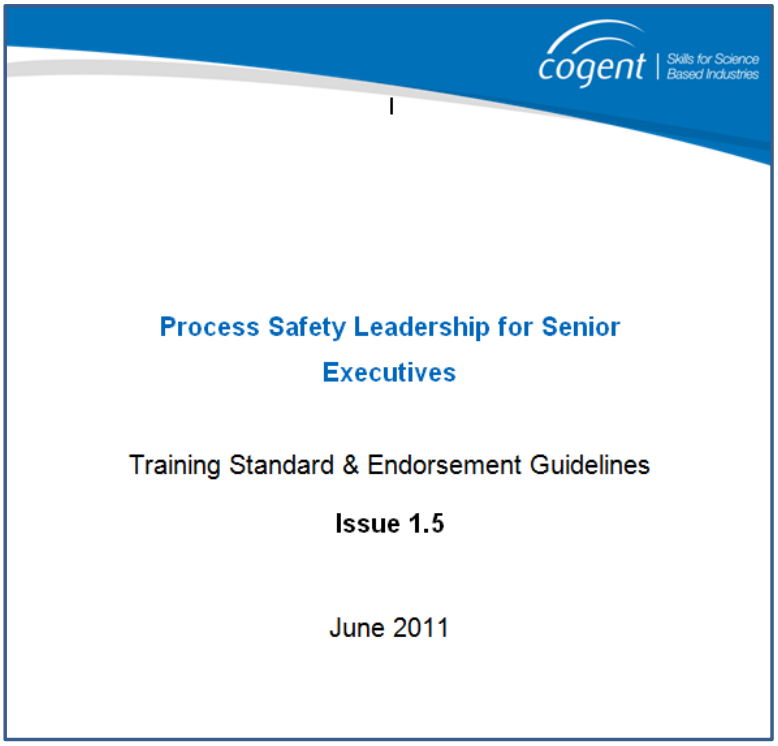
cogent | Skills for Science Based Industries

Process Safety Leadership for Senior Executives

Training Standard & Endorsement Guidelines

Issue 1.5

June 2011

Rolling out the standard

- Top tier hazardous sites
- Good response so far at Leadership level
  - Pilot stage in progress
- Work through a series of training standards
- Encourage course development to fill gaps
  - But not “reinvent the wheel”

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Future plans

- Message cascaded from the top
- Forthcoming standards
- Join IChemE Safety Centre to take part

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Process Safety Competence Management

Paul Delanoy
Dow Chemical Co. Ltd

In response to requests from members and other interested parties, the European Process Safety Centre (EPSC) set up a Working Group project to examine Process Safety competence. The Work Group comprises people from industry or industry support ensuring a "hands on", practical approach to the topic. The objective of the project is to develop a Management System for Process Safety competence. This work should complement the works of others who are defining Process Safety skill sets and developing Process Safety assessment tools.

As a management system the concepts of the process developed could be applied to most fields where competence is required, however, the detail of this work is tailored to specific groups in the chemical process industry. The aim is to target the people who have a direct influence on the chemical process such as: Process Operators and Supervisors, Maintenance staff, Production and Process Engineers, Plant and Site Managers and Process Safety Specialists.

The management system establishes a framework of requirements to ensure that the people with direct influence on chemical process operations achieve and maintain the necessary Process Safety competence:

- Selection and recruitment of personnel
- Individual competence needs analysis
- Facility minimum competence requirements
- Training and development
- Communicating individual expectations
- Relationship of competence and supervision
- Competence assessment
- Maintaining competence
- Competence reassessment
- Managing competence gaps
- Special competence requirements for emergency situations
- Monitoring trends in competence

None of the elements above represent new ideas but this project provides guidance for their application to the Chemical Process Industry. It advises a holistic approach whereby the competence requirements for the overall safe operation of the facility are examined as well as those of the individuals who contribute to this. The project also addresses some of the specific challenges of the Chemical Process Industry such as training people to deal with situations they are unlikely to ever encounter, dealing with stress in emergencies and ensuring people have knowledge beyond that required for their normal work such that they can make the correct decisions when unplanned events occur.

Process Safety Competence Management

Framework for an EPSC Report

8th European Congress of Chemical Engineering

Paul Delanoy

Dow Chemical Company

The EPSC Working Group

In response to requests from members and other interested parties, the European Process Safety Centre (EPSC) set up a Working Group project to examine Process Safety competence

The Work Group comprises people from industry or industry support ensuring a “hands on”, practical approach to the topic

Gerry Brennan	ABB	Norbert Baron	ExxonMobil
Herman van Lochem	AkzoNobel	Martin de Zeeuw	LyondellBasell
Hans Schwarz	BASF	Iain Clough	Marsh
Peter Schmelzer	Bayer	Carlos Videla Ivanissevich	Repsol
David Sullivan	TataSteel Europe	Elena Marin	Repsol
Paul Delanoy	Dow Chemical Co.	Friedrich Stoll	Tuev Sued
Christian Jochum	EPSC	Linda Bellamy	White Queen BV
Albert Walrave	DuPont	Matthias Burkhardt	DSM
Klaus-Juergen Niemitz	Clariant	Urbain Bruyere	BP
Robert Robinson	Marsh		

2

Current Competence Issues

The competence of the Operator and Engineering staff in petrochemical plants is being reduced by:

- Increasing automation
- Improved reliability
- The trend towards centralization of Process Engineering, Design and Software Development functions
- The loss to retirement of the people who retain an in depth knowledge of the plant from the time of largely manual operation

3

The EPSC Competence Initiative

- Most Chemical Companies have programmes in place to address competence
- These programmes vary greatly in scope and quality but it is likely that every element required for a competence system already exists
- What is often lacking is a structured approach
- The EPSC Competence Working Group concluded that the most beneficial product it could work on was a framework to ensure:
  - All essential elements to ensure Competence are in place
  - The Competence process is integrated into the other work processes
  - The function of the Competence process is periodically verified
  - The Competence process is practical and workable

In short a **Process Safety Competence Management System**

4

The EPSC Project Scope

- The EPSC Project is intended to cover all the elements necessary for a Process Safety Competence Management System
- To keep the size manageable it is focused on the people expected to have a direct influence on the process operations:
  - Process Operators
  - Supervisors
  - Maintenance staff
  - Production and Process Engineers
  - Plant and Site Managers
  - Process Safety Specialists
- Adding other groups to the Process Safety Competence Management System should be relatively easy

5

The EPSC Project Objective

The most important objective is to produce something which is **helpful**:

- Process description kept at a high level minimising text

  A 300 page document which nobody reads has little value!

- As far as possible the content of the appendices will provide the detail for the project.
- The appendices will provide the working documents and are intended to turn the Competence Management System theory into reality:
  - Templates
  - Tools *(e.g. Excel)*
  - Audit and/or review checklists
  - Process Safety Competence Standards *(some "Thou shalt" statements of the sort often provided by regulators, pointing out the key points)*

6

The Report Structure

Section 1: Introduction

1.1 Preface

1.2 How to use this guidance

1.3 What is Process Safety Competence (PSC) in the context of this report?

1.4 Why is PSC Important?

1.5 Challenges

1.6 How a PSC Management System can help

7

The Report Structure (continued)

Section 2: Guidance on Creating a PSC Management System

2.1 The need for a holistic approach

2.2 The elements of a PSC Management System

2.3.1 – 2.3.12 (1-2 pages per element)

2.3 How to implement and maintain a PSC Management system

2.4 Definition of success

Section 3: Appendices

8

Elements of the PSC Management System

Section 2.3 The elements of a PSC Management System:

1. Facility minimum PSC requirements
2. Selection and recruitment of personnel
3. Individual competence needs analysis
4. Training and development
5. Communicating individual expectations
6. Relationship of competence and supervision
7. Competence assessment
8. Maintaining competence
9. Competence reassessment
10. Managing competence gaps
11. Special competence requirements for emergency situations
12. Monitoring trends in competence

- Objective
- Key elements
- Features of a mature system
- Audit and review
- Templates and Tools
- Records

9

Use of the Report

The report is intended as an aid to enable people to create a Process Safety Competence Management System

Section 1

The aim of the introduction is to demonstrate why such as system is necessary

Section 2

The guidance section provides an easy to read overview of the process and highlights the essential elements and objectives

Section 3

The appendices are the heart of the process allowing people to turn the process described above into a working system

10

Differentiation from other Work

- Specific to Process Safety in the (Petro-) Chemical Industry
- Concise, easy to read and absorb guidance
- Written using industry terms and language
- Guidance linked to appendices which lead users through the implementation process
    - Implementation flow chart
    - Tools and templates
    - Audit/Review documentation provides a ‘checklist’ for the entire process
- Possible links to other sources of information e.g. DNV or IChemE

11

Project Timeline

- First meeting of the Working Group was in January 2011
- Section 1 of the report is largely complete
- Section 2 exists in an early draft form but still requires work
- Section 3 will use existing processes where possible and these are being sought from member companies
- The completed report will require an extensive pilot programme before it can be shared
- The target completion date for the project is the end of 2012

12

Promoting Process Safety Competency – Work of the Center for Chemical Process Safety (CCPS)

Louisa Nara
Technical Director (Presenter)
Scott Berger
Executive Director

Center for Chemical Process Safety of the American Institute of Chemical Engineers

Contact: louna@aiche.org +1.646.495.1371

The Center for Chemical Process Safety (CCPS) was established in 1985 following the Bhopal toxic gas disaster to lead the global chemical engineering profession's effort to prevent future process safety incidents. CCPS' goals include developing process safety technology and management practices, making these practices available to support competency development, promoting education to develop competency, and promoting process safety as a key business value. Over the past 26 years, CCPS has produced and presented globally hundreds of books, courses, training modules, conferences, university lecture modules, and monthly electronic newsletters, all aimed at promoting process safety competency around the world.

In recent years, CCPS has come to recognize a need to define more precisely the types of competencies according to job function and across all levels of the organization, including front line chemical operators, mechanics and instrument technicians through senior management, including financial and business executives. This recognition led to a current project to develop such a comprehensive framework for competencies and the training and education needed at all levels to build those competencies. The CCPS framework will reference materials through which to gain this knowledge, building on CCPS's extensive library of materials.

The project would develop a comprehensive matrix, vertically and diagonally, covering all roles within a corporation, for all relevant aspects of Process Safety Management knowledge. For example, what makes one competent to conduct a QRA, what does the CEO need to know about QRA, what does the DCS operator need to know about QRA….each of those cells referencing where one might go to seek that level of knowledge on the topic, etc. The final product will also include a gap analysis tool and will be flexible to tailor to companies' specific requirements and needs.

Coupled with CCPS' longstanding Safety in Chemical Engineering Education (SAChE) initiative, the competency project will create a comprehensive roadmap to career-long learning in process safety.

Promoting Process Safety Competency

Work of the Center for Chemical Process Safety

Presented at the
European Congress of Chemical Engineers
ECCE- 8 - Process Safety Competence
September 28, 2011

Louisa A. Nara, CCEP
Technical Director
Center for Chemical Process Safety (CCPS)
New York – Mumbai - Qingdao

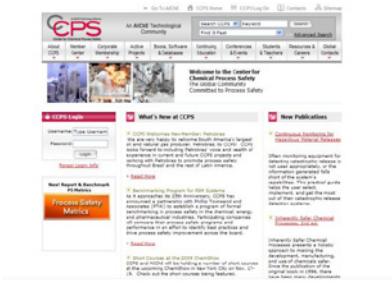
Mission

Established in 1985, to eliminate catastrophic process incidents by:

- ADVANCING state-of-the-art process safety technology and management practices.
- SERVING as the premier resource for information on process safety.
- FOSTERING knowledge of PS by engineers, students, and the public.
- PROMOTING process safety as a key industry value.

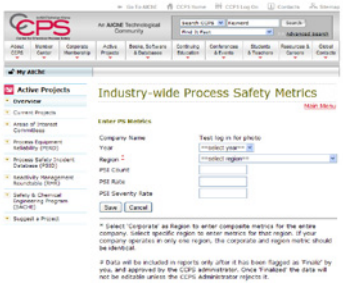
26 Years Leading Process Safety

Sharing Best Practices



Creating Books and Publications

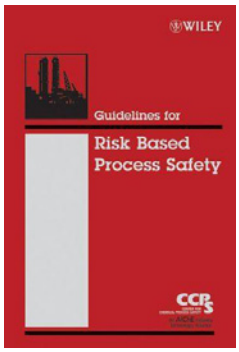
Creating Industry-wide Tools, Programs and Guidelines



Process Safety Beacon

Conducting Global Conferences and Training

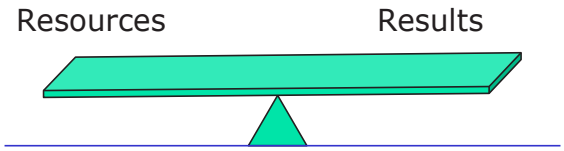
Risk Based Process Safety



http://www.wiley.com/WileyCDA/WileyTitle/productCd-0470471978152.html

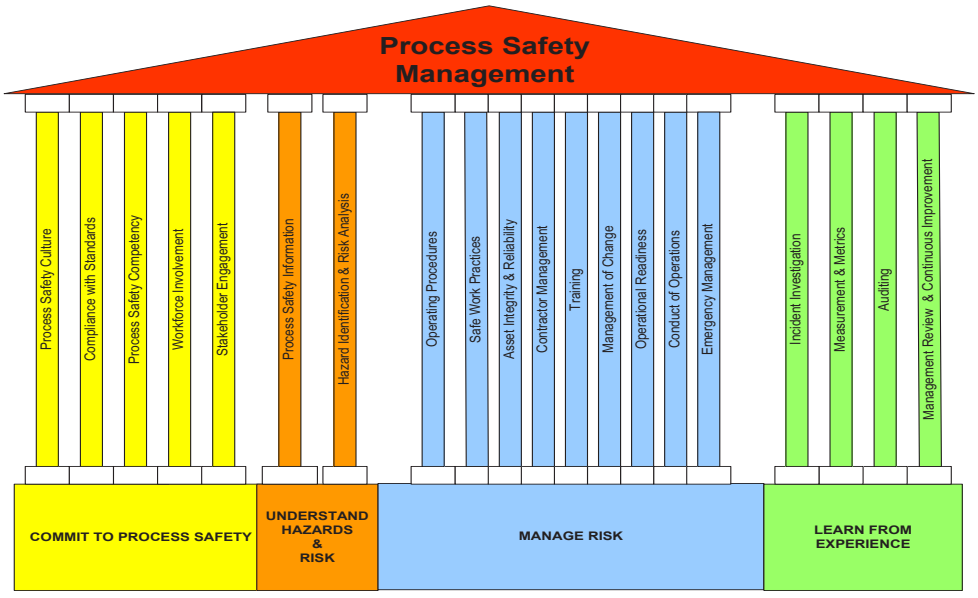
- Published in 2007
- Over 4,600 international users and counting
- Adopted by companies worldwide
- 20 Elements
  - Commitment to Process Safety
  - Understanding Hazards and Risks
  - Managing Risks
  - Learning from Experience
- Not regulatory driven

Trying to Balance Between Resources and Results

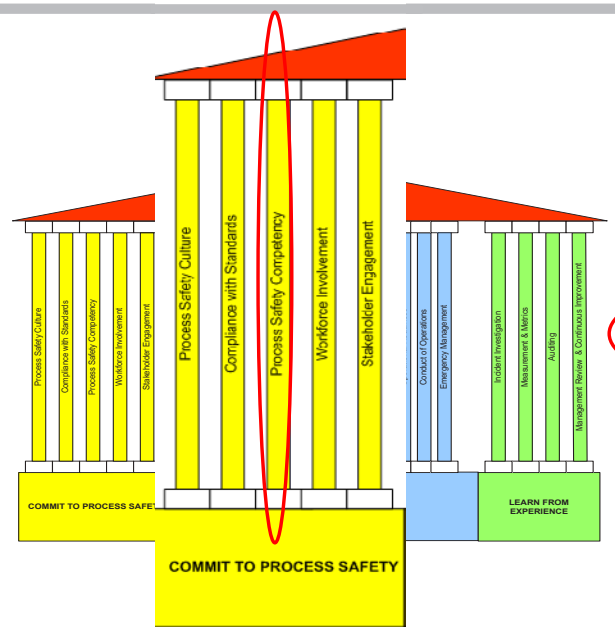


Leads to a Risk Based Process Safety Approach to stabilize the system and provide the best results with limited resources.

Elements of Risk Based Process Safety



Commit to Process Safety



- Process Safety Culture
- Compliance with Standards
- Process Safety Competency
- Workforce Involvement
- Stakeholder Engagement

Driver for Change in the United States

- US Chemical Safety Board Recommends Improvements in Process Safety Competencies
  - Recommendation #3 - Baker Panel Report

- Develop and implement a system to ensure that its executive management, its refining line management above the refinery level, all US refining personnel, including managers, supervisors, workers and contractors possess an appropriate level of process safety knowledge and expertise.

Competency

What is it?

- Knowledge
- Skill
- Behavior



Why is it important?


Process Safety Competency

Developing Process Safety Competencies encompasses three interrelated actions

- Continuously improving knowledge and competency
- Ensuring that appropriate information is available to the people who need it
- Consistently applying what has been learned

Your Book of Process Safety Knowledge

Best Practices

- What does this include?
- Who should know this?
- When should they know it?
- How do they identify hazards?

New Supervisor Review Process

EXAMPLES

- Chemicals used in this operation (and their hazards)
- Operating set points and limits
- Production rates
- Upstream and downstream requirements
- Regulatory requirements
- Maximum and operating capacities
- Operating procedures
  - Startup, Normal, Abnormal, Emergency, Shutdown

Competency Inputs and Outputs (examples)

RBPS Element	Inputs to Competency Element	Outputs from the Competency Element
Culture and *Involvement*	• The *competency* element must be supported by a culture and management system that encourages learning and facilitates sharing of information, both internally and externally	• A continual supply of ideas for enhancing culture and involvement that have proven successful elsewhere
Standards	• New technical information (e.g., previously undiscovered or undocumented failure modes, new equipment inspection practices) • External requirements such as regulations, codes, and standards, including changes to these requirements	• Participation in efforts to develop, revise, or update codes, standards, recommended practices, and industry guidelines
Risk	• Requests for technical and other process safety, hazard identification, or risk information from outside sources, either directly from teams charged with performing hazard or risk analysis activities or via the *knowledge* element	• Responses to requests, either based on formal initiatives such as technical committees, or informal networks
Training	• Knowledge and performance gaps in knowledge (identified by difficulties encountered during training of personnel) • New hazards identified while training personnel	• Topics that need to be covered (or emphasized) in initial or refresher training • Newly identified hazards or other critical information for inclusion in training programs

Developing Tools for Process Safety Competencies

- Committee representing 15+ international companies

- Developing comprehensive matrices covering all roles within an organization

- Gap analysis can be developed to identify targeted training

Competency Matrix

(used by permission of Flint Hills Resources)

SAFE WORK PRACTICES EXPECTATIONS

Minimum Knowledge Level Expectations

Level IA:	**Expert knowledge of SWP; Able to trouble-shoot complex scenarios, facilitate Cold-eyes, Understands how to interpret SWP issues**
Level IB:	**Expert user of SWP; Able to field-execute procedure w/o help, Understands how to interpret SWP issues**
Level II:	**Regular user of SWP; Knowledgeable on critical steps of the procedure; Able to execute or understand procedure w/o help, Understands issues requiring an interpretation of SWP**
Level III:	**Occasional User of SWP; Needs paper reference and possible refresher training prior to use to follow all steps correctly**

	Permitting	*Confined Space*	*Hot Work*	*Blinding*	*Energy Control*
Equipment Operators	II	III	III	III	III
Equipment Garage	III	III	III	III	II
RTG- Fixed	III	II	III	III	III
RTG-Rotating	III	II	III	III	III
RTG-Instrument	III	II	III	III	III
RTG-Inspection	II	II	II	II	II
Safety SWP CSO	IA/IB	IA/IB	IA/IB	IA/IB	IA/IB
Safety	IA	IA	IA	IA	IA
Mechanics	II	II	II	II	II
Maint. Engineers	III	III	III	III	III
LDAR	II	II	II	II	II
Warehouse	III	III	III	III	III
Run-It Day Support	III	II	III	III	III
Lab QC	II	II	II	II	II
Lab Tech	III	III	III	III	III

Safety and Chemical Engineering Education

- Enhance the value of Process Safety in Undergraduate Education
- Student Handbook on Process Safety
- Outreach to 160 Colleges and Universities Internationally
- Scale-up Program provides corporate support of University Programs

Final Thoughts

- Where do we go from here?
  - Continually improve ways to strengthen process safety competencies
  - Improve interactive training programs
  - Document successes
  - Sharing lessons learned and best practices

Thank You!

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www.ccpsonline.org

The DECHEMA approach to Process and Plant Safety knowledge transfer

Andreas Förster
DECHEMA e.V.
Frankfurt am Main, Germany

Safety expertise is a key competence for the process industries. Maintaining and further strengthening this competence is necessary from an environmental, economic and societal point of view. Therefore, mechanisms of keeping the know-how in the companies and the scientific community have to been ensured.

In the last decade the question of adequate mechanisms for knowledge transfer – or rather the growing lack of such mechanisms – has become a dominant aspect in the discussion on safety competence.
DECHEMA as a scientific society with a non-profit status commits significant own resources to improve knowledge transfer in the safety community. DECHEMA's main approach is to be a reliable, dynamic link between science, industry, politics and the general public, thus enabling significant multifold synergies. These synergies demonstrate themselves in particular through activities such as:

- a growing number of continuing training and education -courses for students and professionals, the organization of national and international scientific events, e.g. workshops, colloquia, annual meetings
- prominent addressing Industrial Safety in scientific program of ACHEMA, the worldwide largest exhibition for the process industries
- the DECHEMA-Databases for Industrial Safety, e.g. „CHEMSAFE", „Safety Incidents" (Initiation, coordination or execution of) research projects
- a close cooperation with relevant national and international organization, like: BG-RCI, NAMUR, VCI, VDI, VDE, ISSA Section Chemistry, EPSC

In addition, a significant role for extending and promulgating knowledge of safety engineering is played by ProcessNet, a neutral multidisciplinary platform provided by DECHEMA and VDI-GVC. ProcessNet provides a unique platform for

- public and confidential discussions within the community
- regulatory processes: information, influence, participation
- political research initiatives, compilation of position papers on cutting-edge safety themes
- supporting the modernization / maintenance of norms and technical guidelines
- offering scientific advisory support to research projects
- the compilation of safety books

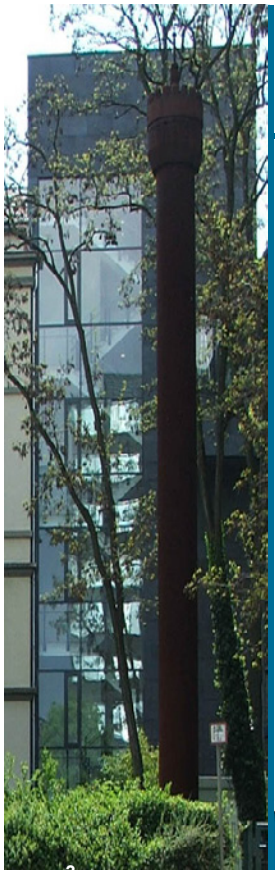
ProcessNet unites today more than 5,000 experts from all process industry related disciplines. Its section "Safety Engineering" has since 1978 a wide range of successful activities

The DECHEMA approach to Process and Plant Safety knowledge transfer

Andreas Förster

Plant Safety within DECHEMA / ProcessNet

1. **DECHEMA**
   Your professional network
2. **Plant safety @ DECHEMA**
   Multifold active contributions since 1978
3. **A short introduction to ProcessNet**
   A joined initiative of DECHEMA and VDI
4. **...and of the ProcessNet-Section „Safety Engineering“**



DECHEMA

- Your professional network

a scientific society for Chemical Engineering and Biotechnology

- non-profit organisation, founded in 1926
- mission: to support the interdisciplinary co-operation between scientists and engineers
- today:

  > 5,500 members from science and industry
- headquarters in Frankfurt am Main
- approx. 200 co-workers

DECHEMA

…supports Plant Safety since 1978

Main focus:

Safe design and safe operation of processes

Areas of activities (examples):

- Risk assessment
- Process safety management
- Inherently safe processes
- Safety characteristics
- Safety devices
- Competence transfer
- …

DECHEMA

…supports Plant Safety since 1978

Activities in the field of Plant Safety

- ▶DECHEMA-Databases
  - e.g. „CHEMSAFE“, „Safety Incidents“
- ▶ Reseach projects
- ▶ Nine continuing education courses for students and professionals
- ▶ Safety always an important part of the scientific programme of ACHEMAs
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  (e.g. BG RCI, NAMUR, VCI, VDI, VDE, ISSA Section Chemistry, EPSC)

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“lessons learned” by non-notifiable incidents relevant to safety
>130 reports so far
free online access: http://www.processnet.org/incidentdb

contents: ProcessNet working party „Lessons from Process Safety Incidents“

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Activities in the field of Plant Safety

Since 1985: Database chemsafe

The database Chemsafe contains **assessed safety parameters and properties** for more than **3,000 flammable liquids, gases and dusts**.

- **The Problem: Reliable Data**
- **The Solution: CHEMSAFE**
- **The Sources: BAM and PTB**
- **The Data: Safety Parameters and more**

Rated safety parameters like:
-flash points, autoignition temperatures, explosion limits, minimum ignition energy, max. explosion pressure, ...

Besides the rated safety parameters:
- substance identification data, thermophysical data, labelling and classification according to national and international regulations, maximum working place concentration (MAK), ...

Currently **> 79 000 data sets** are available!

http://www.dechema.de/chemsafe.html

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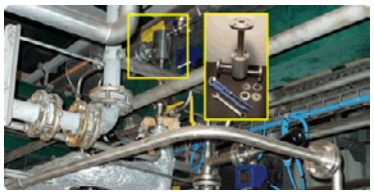
BMBF-research project „µVT-Guide“

The research project µVTGUIDE aims at the compilation of a compendium for the industrial use of micro process engineering. Based on industrial experience with micro process engineering this guideline is particularly dedicated to small and medium sized enterprises, and shall enable such companies to subject own processes and products to a first analysis with respect to the technologically and economically advantageous application of micro process engineering.

Chapters
1. Introduction
2. Economical aspects
3. **Safety aspects**
4. Industrial experience with microreactors
5. Current research on microreactors



Microreactor from Microinnova with an output of 3 t / h

Förderung des Projektes im Rahmenprogramm Mikrosysteme (2004-2009):
Bundesministerium für Bildung und Forschung

Projektpartner:
- DECHEMA e.V., Frankfurt/Main

Förderkennzeichen:
16SV2183

(K. Mitropetros and A. Bazzanella; 130 pages, 2010, ISBN 978-3-89746-114-7)

DECHEMA

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IGF-research projects

(application oriented research for SMEs)

Examples:

2009: Project 14782 BG, „Entwicklung eines inhärent sicheren, kostengünstigen und flexiblen Verfahrens zur Herstellung von Wasserstoffperoxidlösungen durch Direktsynthese mittels katalytisch beschichteter Membranen“, DECHEMA e.V., Karl-Winnacker-Institut; Hermsdorfer Institut für Technische Keramik e.V.

2008: Project 14261 BG, „Beurteilung und Verhinderung von Selbstentzündung und Brandgasemission bei der Lagerung von Massenschüttgütern und Deponiestoffen“, Universität Halle-Wittenberg; BAM Berlin

2007: Project 14264 N, „Ausblassichere Dichtungen für Flanschverbindungen mit emaillierten und glasfaserverstärkten Kunststoffflanschen in der chemischen Industrie“, Universität Stuttgart

2004: Project 13238 N, „Explosionsauswirkungen bei der thermischen Selbstzündung von verdichtetem Ethen“, TU Darmstadt

Detailed information: www.dechema.de

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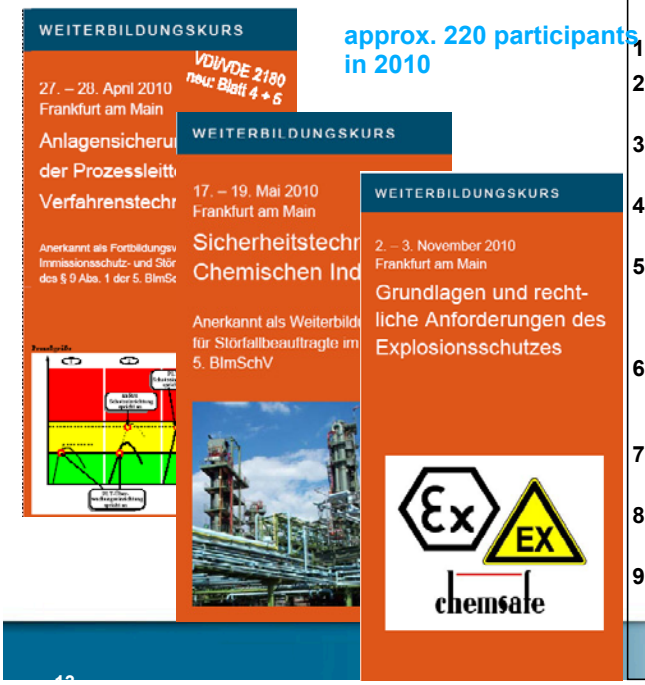

approx. 220 participants in 2010

Courses 2011

1. Sicherheit chemischer Reaktionen
2. Sicherheitstechnik in der Chemischen Industrie
3. Druckentlastung und Rückhaltung von gefährlichen Stoffen
4. Grundlagen und rechtliche Anforderungen des Explosionsschutzes
5. Anlagensicherung mit Mitteln der Prozessleittechnik in der Verfahrenstechnik
6. Probabilistik bei PLT-Schutzeinrichtungen / Pragmatische Wege zur quantitativen Sicherheitsbetrachtung (SIL)
7. Störungsbedingte Stoff- und Energiefreisetzungen in Chemieanlagen
8. Der SIL-Tag: Spezialthemen zu PLT-Schutzeinrichtungen
9. Zündgefahren infolge elektrostatischer Aufladungen

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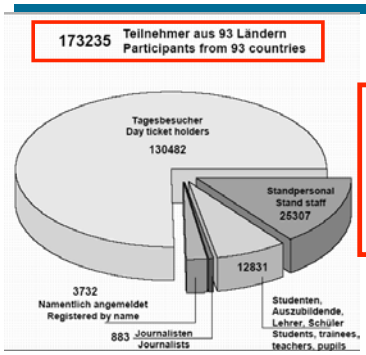

ACHEMA 2009
Scientific programme „Plant Safety“

- 10 Sessions (= 53 oral presentations)
- 10 expert round tables (= about 10 hours)
- ISSA workshop „explosion safety“ (2 days)

Aussteller pro Ausstellungsgruppe / Exhibitors per Exhibition group

Forschung und Innovation Research and Innovation	164	Pharma-, Verpackungs- und Lagertechnik Pharmaceutical, Packaging ans Storage Techniques	318
Literatur, Information, Lern- und Lehrmittel Literature, Information, Learning and Teaching Aids	71	Sicherheitstechnik und Arbeitsschutz Industrial and Labour Safety	37
Labor- und Analysentechnik Laboratory and Analytical Techniques	659	Mess-, Regel- und Prozessleittechnik Instrumentation, Control and Automation Techniques	304
Anlagenbau Engineering	343	Werkstofftechnik und Materialprüfung Materials Technology and Testing	88
Mechanische Verfahren Mechanical Processes	404	Biotechnologie Biotechnology	154*)
Thermische Verfahren Thermal Processes	437	Sonderschau / Special Show "Chemistry ... for Renewable Resources and Energy"	95*)
Pumpen, Kompressoren und Armaturen Pumps, Compressors, Valves and Fittings	960		

*) einschl. Profilgruppe / incl. profile group

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  (e.g. BG RCI, NAMUR, VCI, VDI, VDE, ISSA Section Chemistry, EPSC)

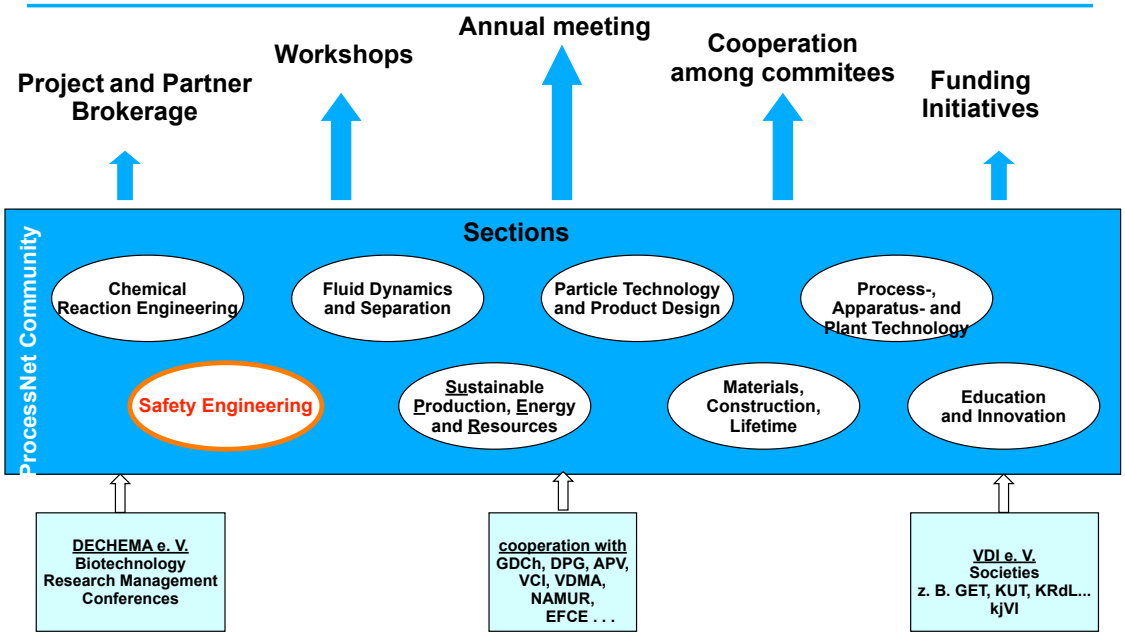
But most importantly, DECHEMA provides the safety community with

- **ProcessNet: a neutral plattform for initiation / support of**
  - **political initiatives**
  - **research, networking etc.**
  - **public as well as non public (i.e. confidential) discussions within the community**

  ⇒ **many more activities (e.g. publications, events, initiatives) by the ProcessNet-Section Safety Engineering!**

DECHEMA

A dynamic platform for interdisciplinary activities



PROCESSNET
EINE INITIATIVE VON DECHEMA UND VDI-GVC

ProcessNet in numbers

ProcessNet	2010
Sections	9
Committees within these sections	93

Well over 5.000 specialists are members of the ProcessNet-Community

Section Safety Engineering: > 1000 members*

(*including the VDI-GVC safety community; Status: 01.09.2011)

PROCESSNET
EINE INITIATIVE VON DECHEMA UND VDI-GVC

Committees of the section Safety Engineering (Status: Aug. 2011)

	- Steering committee	Pfeil, Berlin
permanent commitees	**9 Working parties**	
	- Safeguarding of Industrial Process Plants by Means of Process Control Engineering	Matalla, Ludwigshafen
	- Releases and Impacts of Hazardous Materials	Schalau, Berlin
	- Electrostatics	Schwenzfeuer, Basel/CH
	- Lessons from Process Safety Incidents	Schmelzer, Leverkusen
	- Chemical Process Safety	Moritz, Hamburg
	- Risk Management	Leimer, Höllriegelskreuth
	- Safe Design of Chemical Plants	Schmidt, Ludwigshafen
	- Safety Parameters	Schendler, Berlin
	- Preventive Industrial Fire Safety	Wehmeier, Lampertheim
usually for 2 years	**4 Working groups**	
	- Teaching Profile of Safety Engineering (since 2009)	Schönbucher, Essen
	- Maintenance Support IEC 61511 (since 2010)	Weidlich, FFM
	- Application of Process Control Engineering in Explosion Safety (since 2010)	Matalla, Ludwigshafen
	- Source Term	Schönbucher, Essen

PROCESSNET
EINE INITIATIVE VON DECHEMA UND VDI-GVC

DECHEMA

…supports Plant Safety since 1978

ProcessNet / Section Safety Engineering

- **Public events:**
  - **Joined organisation of safety conferences in Germany**
    e.g. Fachtagung Köthen 2010
  - **Organisation of safety-colloquia and other safety related public events**
- **Publications**
  - **Coordinated publication of research papers by the safety community,**
    e.g. 30-years anniversary of safety at DECHEMA: over 60 papers in 5 journals!
  - **Safety books (proceedings, monographies, etc.),**
  - **the biannual newsletter of the section „safety engineering“,**
  - **guidelines**

✓ **Proposal for a curriculum for university safety courses** (1997 and 2011)

✓ **Initiative „Maintaining and improving competence in safety engineering„**

DECHEMA

ProcessNet-annual meetings

25. - 29. September
together with ECCE-
European Congress of Chemical Engineering
and ECIB –1st European Congress
of Industrial Biotechnology
in Berlin

2011

10.-13. September
togehther with the
30. DECHEMA-annual meeting
of Industrial Biotechnology
in Karlsruhe

2012

PROCESSNET
EINE INITIATIVE VON DECHEMA UND VDI-GVC

http://www.dechema.de

http://www.ProcessNet.de

Thank you for your attention!

DECHEMA

Promoting incident prevention – decades of experience to share

Dr. Gerd Uhlmann
BG RCI Maikammer
Paper 2972 by

The statutory accident insurances all together are, after the state educational institutions, the largest educational institution in Germany.

Their training and continuing education is an integral part of the legally required prevention to protect workers against accidents, work-related illnesses and occupational diseases.

As part of the prevention work of the German Social Accident Insurance Institution for the raw materials and chemical industry (BG RCI), training and further training of managers and employees of member companies, plays for more than 45 years an outstanding role.

The training and further training on occupational safety and health is closely linked to the supervisory and advisory business of BG RCI in the companies themselves, as well as the accompanying activities of specialized departments of the BG RCI. Requirements as well as measures and activities for the protection of employees in the chemical industry are inextricably linked to the safety of people, environment and property as well as outside the plant; therefore our training program provides to a large extent also these objectives of plant and process safety.

Our activities

Our activities are divided into:

- Target group seminars
- Seminars for fields of expertise
- Company related seminars

Target group seminars are aimed at managers at all levels, occupational safety and health specialists (OSH specialists), safety representatives, councils and various specialists, e.g. Engineers, electricians, planners and other services.
The qualification consists of basic courses, advanced seminars for these specific target groups and a wide range of seminars to which the target groups, when the conditions apply, can access.
One focus of the target group training consists of industry specific qualification of OSH specialists.
This is at BG RCI almost exclusively of issues, which are assigned to the subject plant and process safety:

- Fire and explosion protection
- Explosives
- Biological Safety
- Pressure equipment / inspections and approvals
- Plant and Process Safety
- Machinery of the chemical industry

Company related seminars

With this type of seminar, which currently accounts for almost 40% of our activities, we support companies from an operating size that allows a sufficient number of seminar participants from one company or one corporation.
In these events very specific process safety / plant safety issues can be discussed – after consultancy with the specific company and the relevant prevention branch of the BG RCI- depending on interest and desire.

Benefits of these seminars:

1. There is a greater flexibility in the choice of topics (based on one respective company)
2. The possibility of undisturbed discussions exists between managers, specialists and operational staff on daily problems of the respective company.
3. Since all the participants come from the same company, there is usually a greater openness in the discussion of specific events or real weaknesses. This is particularly in the area of process safety / plant safety of particular importance.

Seminars with focus on technology

The HAZOP seminar on risk assessment in chemical plants is our oldest one. Many member companies use this weeklong event, which is realized by five tutors from the practice, for basic training of employees who will later participate in HAZOP teams. Although the "basic version" of HAZOP is trained, through the support of tutors from different companies most of the tasks are assured to be worked in a small group, which guarantees a broad experience exchange regarding variable or flexible HAZOP application and other aspects of process safety.

Course description ***"HAZOP"***:

- Introduction with examples
- Tasks of the moderator
- Practical experience of member companies
- Case Study: In sections under constant editing tutorial support in small groups
- Systematic analysis procedure: alternatives, benefits, limits

Another special seminar covers – but in a compact form – the application of other methods for risk assessment of plant and process safety (FMEA, LOPA, ZHA, F+E- index)

Other seminars focused on technology:

"Safe operation of chemical processes – focus: Exothermic reactions"

- Basics of exothermic chemical reactions, heat balance and scale-up
- Safety analysis methods
- Case studies, analysis of incidents
- Safety concepts for reaction, storage and distillation
- Computer based simulation

The participant will receive an insight into the problems of exothermic chemical reactions taking into account the normal operation and upset operation process in a holistic process based and risk-based safety concept.

Fire and explosion protection in the chemical industry

The explosion-protection issues, with particular reference to plant and process safety, we devote to four types of seminars: a connected trilogy for engineers as well as a compact seminar for operational managers.

"Explosion protection in the chemical industry – Technical Basics"

- Basics of explosion protection (hazard identification, assessment, safety parameters)
- Avoiding hazardous explosive atmospheres
- Inerting
- Avoiding effective ignition sources
- Reliable explosion protection
- Explosion-proof construction, explosion venting
- Explosion suppression, Explosion Isolation

"Explosion protection in the chemical industry – Technical Specialties":

- Applied principles (practical examples)
- Explosion protection by means of process control systems
- Explosion protection in the thermal exhaust air cleaning (Case Study)
- Non-electrical equipment
- Control of static electricity problems (experimental lecture)

"Requirements of explosion protection according to applied regulation"
Complementary seminar for the formal requirements of the regulations

"Explosion protection for industrial experts" (foreman):
In this compact seminar, the focus is on the practical detection of potential problems caused by the risk of explosion.
A brief overview of the technical principles of explosion protection and the formal requirements of the regulations are intended to enable the operational managers in a position to properly assess risks and to obtain the adequate assistance from explosion protection experts.

Closely linked with the explosion protection is the subject of industrial fire protection, because fires are often the result of explosions.

The seminar **"Fire protection in the chemical industry"** covers:

- Statutory and private law rules
- Structural fire protection
- Operational fire protection
- Emergency response planning
- Fire extinguishing mediums, fire extinguishing systems, personal on fire
- Fire protection concept

Basic information about explosion protection and fire protection are taught in all the (target groups)-basic courses for operational managers and safety representatives in the form of an experimental lecture with a focus on professional-specific risk assessment.

Seminars with focus on organization

Based on the fact that a large proportion of unwanted events – with or without personal injury – occur not in normal operation, but for maintenance, servicing and repairs, and during construction and after changes, a special focus lies also in our training program in this part of the company practice.
I would like to put special emphasis on the seminar :

"Safety during maintenance and modification of chemical plants":
(Seminar for operational managers)
Content:

- Release notes
- Maintenance and management of change in complex systems
- Risk analysis on a case study
- Conflict area safety – costs – schedules – availability
- Enforcement of occupational health and safety measures

In 2011 we dedicate this issue – because of special importance and contractor-problematic – an additional workshop, with the inclusion of the sectors of metals and construction, as most of the contracting companies for these tasks are not a members company of the BG RCI (but are members of the relevant specialist German Social Accident Insurance Institution).
The issue of safety on construction sites in the chemical industry is also a large part of the training of OSH specialists.
Specifically in relation to construction sites are also "classic" occupational safety issues become part of plant and process safety, e.g. the risk of collision losses in the range of internal transport and traffic.

Further seminars on organization with considerable focus on the concerns of process safety / plant safety include for example:

“Occupational Health and Safety Management”
“Risk assessment in practice”
“Tools for professional safety work”
“Emergency Management”

All management or organization seminars focus on the theme of relationships, this means there are fewer individual problems treated, but the whole work system recorded.

Examples include the human-technology interface, the interaction of the various organization units (e.g. production, logistics and distribution), the communication and the interaction of its own employees and departments with external partners and contractors.

The inclusion of the employees in design and change of processes also is of special importance.

Since executives and management seminars place a special emphasis on continuous improvement – and less on the observance of regulations, in such events seminar- methods like experience sharing sessions and workshops are standing in the foreground.

Communication with coaches and other seminar participants, the discussion about successes and failures of implemented measures, together with real incidents or near misses, making contacts and finding of potentially useful information sources represent the main usefulness of these events.

Seminars with focus on people (human factors)

The protection of the people themselves, but also the protection of uninvolved people as well as the environment and property against the consequences of people’ s incorrect actions are the focus of our seminars on health and safety.

In many ways, this also affects plant and process safety issues.

Despite modern technology and largely secure technic the (plant and process -) safety is still significantly affected by fitness and qualifications, but also affected by peoples’ performance. This is e.g. influenced by communication, motivation and physical and mental health of employees. Significant aspects (and especially with regard to the interests of plant safety) are for example

- Leadership – communication – information – instruction
- Individual-performance, self-assessment of employees
- Excessive and low demand (e.g. during monitoring activities)
- Physical health or problems
- Mental health or problems
- Problems, hazards, limited responsiveness and performance due to alcohol, drugs and medicines

Our programme offers various seminars and seminar groups that are devoted to this wide and important topic. Examples include:

“Conversation techniques in occupational health and safety”
“Instruct employees effectively”
“Psychology in occupational safety – motivation to achieve safer behaviour”
“Fit and healthy at shift work”
“Introduction to Conflict Management”
“Drug use in the organization”

and other services

Methodology, experiences, benefits and limitations, outlook

Our modern seminar program uses all the (educational and technical) possibilities of adult education, in addition to presentations and workshops, discussions and case studies, all applicable media such as video, Internet, self-learning CDs, simulators, visual aids in a display case, practice fields (that are operated active modules), experimental lectures.

Especially when it comes to plant and safety, the availability of practical active modules is very limited. Of course, no demonstrations with real plant parts or equipment can be carried out, which can pose some risk. This must remain a focus of the work-related instruction in the workplace. We are however dependent on relatively few simulations and experimental lectures. The methodologies as well as the seminar programme are constantly being evaluated and developed. This is done in close cooperation with the companies themselves, the BG RCI‘s industry prevention in the company plants, as well as our special departments (e.g., for plant and process safety in general, pressure vessels or explosion protection) and numerous external experts.

Our speakers are primarily from the active practice or from consulting companies, thus the reference to reality is given as much as possible.

Seminar materials and handouts to rework are mostly part of current professional publications, which are constantly updated by the BG RCI in collaboration with numerous experts drawn from industry.

Especially in further training courses, a great challenge to every instructor is the intension to have a similar competence level in the group..

On the subject process and plant safety we frequently reach limits. The heterogeneity of participants with regard to pre-experience, expectations and work-based or professional environment is very high.

A further problem is the legitimate desire of current participants to practice examples that are close to reality.

On the subject plant and process safety we get to limits:

BG RCI does not operate any plants!

All information on technology, organization, successes and failures, events and near-misses must come practical, credible and understandable from outside.

Last but not least, our efforts have only a limited and sustainable impact, for us difficult to estimate: improvements and success through training and further training are always influenced to a very large extent by the seminar participants’ determination and also by the professional environment, i.e. from the boundaries of workplace practices.

Therefore, I finally address four petitions :

A further improvement of our seminars or its’ sustainable value requires from our member companies:

1. Continue to provide skilled speakers from the industry that are close to practice
2. A further optimized, i.e. target group-oriented pre-selection of seminar participants
3. To provide practice-oriented training material in the future (examples, incidents/accidents, pictures, videos, this is of particular importance for plant and process safety)
4. Increased theming or follow-up of seminar contents after the seminar has finished.

If these conditions are met: the continuous development of effective support for effective prevention in our member companies through training and further training with the BG RCI is guaranteed.

BG RCI

8. ECCE, Berlin 2011

Promoting incident prevention – decades of experience to share

by

Dr.Gerd Uhlmann

BG RCI

gerd.uhlmann@bgrci.de

Seite

BG RCI

BG RCI :

- Supervisory and advisory business in the companies
- Training and further education
- Specialized departments of the BG RCI

Industrial Safety Standard

Industry :

- Safety concept
- Safety technology
- Safety organisation
- Experts
- Experience, training and further education of the employees

Seite

BG RCI

Our activities :

- Target group seminars
- Seminars for fields of expertise
- Company related seminars

Seite

BG RCI

Target group seminars :

- Managers at all levels
- OSH specialists
- Safety representatives
- Works councils
- Specialists : e.g. engineers, planners, electricians and other services

Seite

BG RCI

Qualification of OSH specialists

Industry specific qualification by the BG RCI :

- **Fire and explosion protection**
- **Explosives**
- **Biological safety**
- **Pressure equipment / inspections and approvals**
- **Plant and process safety basics**
- **Machinery of the chemical industry**

Seite

BG RCI

Company related seminars

- **Seminar participants from one company only**
- **Possibility of undisturbed discussions between managers, specialists and operational staff**
- **Greater flexibility in the choice of topics**
- **Greater openness in the discussion of specific events or real weaknesses**

Seite

Focus on technology

Special seminar: HAZOP

- Introduction with examples
- Task of the moderator
- Practical experience of member companies
- Case study : under constant editing tutorial support in small groups
- Systematic analysis procedure: alternatives, benefits, limits

Another special seminar on risk assessment methods:
Content : FMEA, LOPA, ZHA, F+E-Index

Seite

Special seminar :

Exothermic reactions

- Basics of exothermic reactions, heat balance, scale-up
- Safety analysis methods
- Case studies, analysis of incidents
- Safety concepts for reaction, storage and distillation
- Computer based simulation

Seite

BG RCI

Explosion protection (for engineers)

Seminar : Explosion protection-technical basics

- Basics of explosion protection (hazard identification, assessment, safety parameters)
- Avoiding hazardous explosive atmospheres
- Inerting
- Avoiding effective ignition sources
- Reliable explosion protection
- Explosion-proof construction, explosion venting
- Explosion suppression, explosion isolation

Seite

BG RCI

Explosion protection

Further seminars :

-Technical specialities (for engineers)

-Requirements of explosion protection according to applied regulation (for engineers)

-Explosion protection for industrial experts (for foremen)

Basic information about explosion and fire protection :

taught as experimental lecture in all basic seminars for safety representatives and operational managers

Seite

BG RCI

Fire protection

Seminar : Fire protection in the chemical industry

- Statutary and private law rules
- Structural fire protection
- Operational fire protection
- Organizationel fire protection, emergency response planning
- Fire extinguishing mediums/-systems
- Personal on fire
- Fire protection concept

Seite

BG RCI

Focus on Organization :

Example - Seminar for operational managers:

Safety during maintenance and modification of chemical plants

- Release notes
- Maintenance and MOC in complex systems
- Risk analysis on a case study
- Conflict area safety-costs-schedules-availability
- Enforcement of occupational health and safety measures

Seite

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Focus on Organization
(further seminar examples)

- **Safety on construction sites**
  (part of the training of the OSH specialists)

Special seminars for example :

- Occupational Health and Safety Management
- Risk assessment in practice
- Tools for professional safety at work
- Emergency Management

Seite

BG RCI

Focus on people in our seminars

Protection of people (in the plant) themselves

but also :

Protection of

-uninvolved people

-environment

-property

against the consequences of people`s incorrect actions

Seite

BG RCI

Focus on people

Significant aspects in our seminars :

-Leadership – communication – information - instruction
-Individual-performance, self-assessment of employees
-Excessive and low demand (e.g. during monitoring activities)
-Physical health or problems
-Mental health or problems
-Problems, hazards, limited responsiveness and performance due to alcohol, drugs and medicines

Seite

BG RCI

Focus on people

Our programme offers various seminars and seminar groups :

- Conversation techniques in occupational health and safety
- Instruct employees effectively
- Psychology in occupational safety – motivation to achieve safer behavier
- Fit and healthy at shift work
- Introduction to Conflict Management
- Drug use in the organization

-and other services

Seite

BG RCI

Methodology, experiences, benefits, limitations of our seminars

All modern possibilities of adult education are used

- Constant evaluation and development
- Speakers primarily from the active practice

Problems / limitations :

-Often no similar competence level in the groups
-Limitation of practice-examples - close to the reality
-No demonstrations with real plant parts or equipment

Seite

BG RCI

Practical effekt of our seminars :

Quality of our seminars

Participant`s determination

sustainable achievement ?!

Boundaries of workplace practices

Seite

BG RCI

Thank You

for Your attention

Seite

Teaching Safety in Chemical Engineering – What, How and Who?

Dr Martin J. Pitt
Chemical & Biological Engineering
University of Sheffield
Sheffield S1 3JD, UK

Martin Pitt is Chairman of the EFCE Working Party on Education, and has over 30 years experience of teaching safety to chemical engineers in universities and industry.

The Chemical Safety Board of the USA reported on the T2 Laboratories explosion that neither the chemist nor the chemical engineer in charge were aware of the dangers of runaway reactions. They recommended that this should be added to all Bachelor degrees in chemical engineering. UK courses have long been required to include a substantial safety component: the situation in other European countries varies, but incidents such as the Toulouse explosion have increased interest.

It is not a matter of telling students to be safe, it is giving them the capability of increasing safety in their professional work by knowledge, skills and awareness. This is not a trivial matter. There are three things to determine: the syllabus, the method of delivery and the people needed to do it.

Some options will be discussed, based on the author's experience and recent Workshops on safety teaching run by the Working Party on Education, along with work by other bodies.

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Chemical & Biological Engineering.

Teaching Safety: What, Who, How?

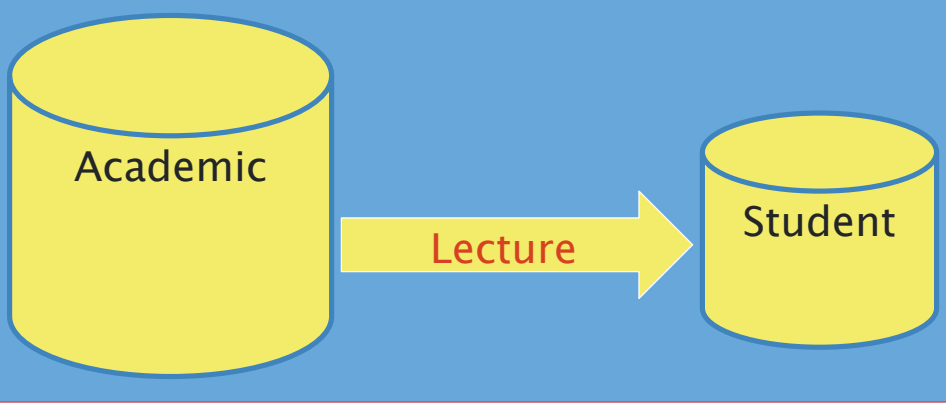
And When?

Martin J. Pitt

The University Of Sheffield.

Hazop on the Degree Course

- Intention:
  FLOW of safety knowledge to student.



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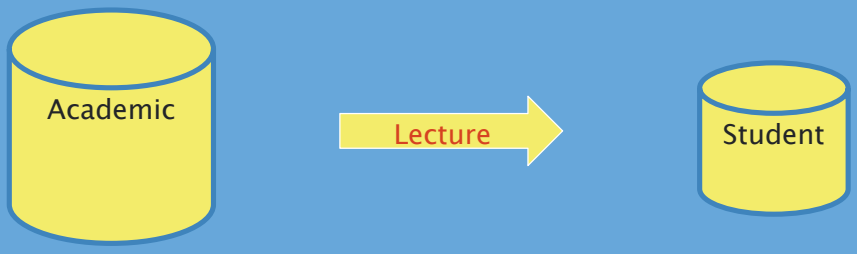
DEVIATIONS

- NO FLOW because:
- NO LECTURE
- NO KNOWLEDGE in academic
- Student NOT PRESENT



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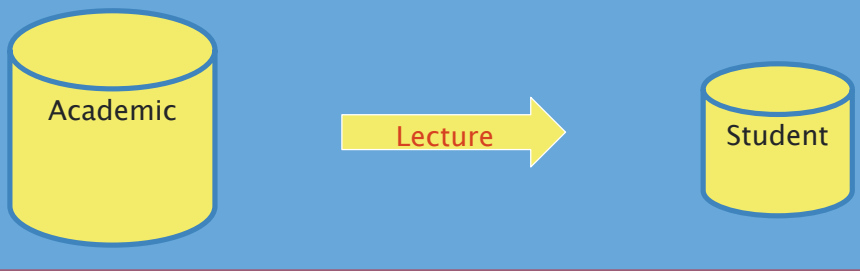
DEVIATIONS

- LESS FLOW because:
- INEFFECTIVE TEACHING by academic
- LACK OF EFFORT by student



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DEVIATIONS

- OPPOSITE FLOW =
  at the end the student knows less

- OTHER FLOW =
  the student learns unsafe practice

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Cycling 101

1. Rotational inertia
2. Multiple rotations in a gravitational field
3. Dynamic control of oscillating metastable systems

.....

20. Cycle safety

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Lecture 20: Cycle Safety

- Failure modes of bicycle components
- Probability calculations
- Incidents:
  1903, 1940, 1974
- Pictures of dead cyclists

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WHAT do we mean – safety?

- It is easy to tell someone to BE safe.
- More useful to tell them HOW to be safe.
- Much harder for those whose actions affect other people, perhaps years later.
- The costs we will see now, the benefits never.

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HOW do we teach it?

- Or should we teach it at all?
- Is bad teaching better than none?

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Confucius (about 500 B.C.)

- Learning without thought is labour lost.
- Thought without learning is perilous.

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Alexander Pope (1711)

- A little learning is a dangerous thing;
- .....
- While from the bounded level of our mind Short views we take, nor see the lengths behind,

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Learning depends o

- Prior knowledge
- Motivation
- Memory
- Understanding
- Intellectual engagement

Different learning is possible at different times in the career.

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Skill

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Safety is the hardest subject

- It covers other subjects
  - –technical and human
- And the interactions between them
- Small amounts of ignorance can be fatal
- Success cannot be measured
- Nobody knows it all

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T2 Laboratories 4 killed

- Chemical Thermodynamics
- Chemical Kinetics
- Physical Thermodynamics
- Heat Transfer
- Process Control

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WHO?

- Needs to learn?
- Should do the teaching?

- Students
- Operators
- Chemical Engineers
- Other professionals
- Management
- Academics

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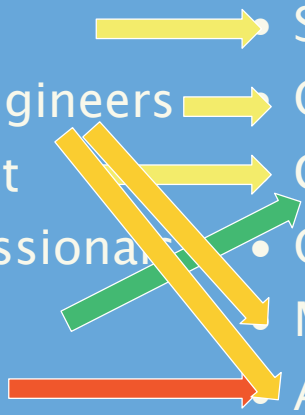
WHO?

- Academics
- Chemical Engineers
- Management
- Other professionals
- Operators
- Students



- Students
- Operators
- Chemical Engineers
- Other professionals
- Management
- Academics

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Training and Education

- **TRAINING** prepares you for the anticipated. Understanding is not strictly necessary. "Obey the rules!"

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Training and Education

- **EDUCATION** prepares you for the unexpected. Knowledge and understanding are required "Understand the rules and how to vary them."

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For Example

- Substance A is corrosive, so rubber gloves and goggles must be worn.

- Substance A is hydrochloric acid, so has certain properties in contact with other substances and if heated.

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Training

- For the certain, e.g. protective clothing:
  needs to be in good time, practical.
- For the unlikely emergency:
  needs to be repeated yearly;
  go through the motions as far as possible.

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Continuing Professional Development

Different Requirements Methods

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Knowledge decays

- If thoroughly learned, the half-life is about 18 months to 2 years. (Education)
- If not reinforced or used, 6 to 10 weeks. (Training)
- Skills (physical or mental) need to be practised to be maintained.

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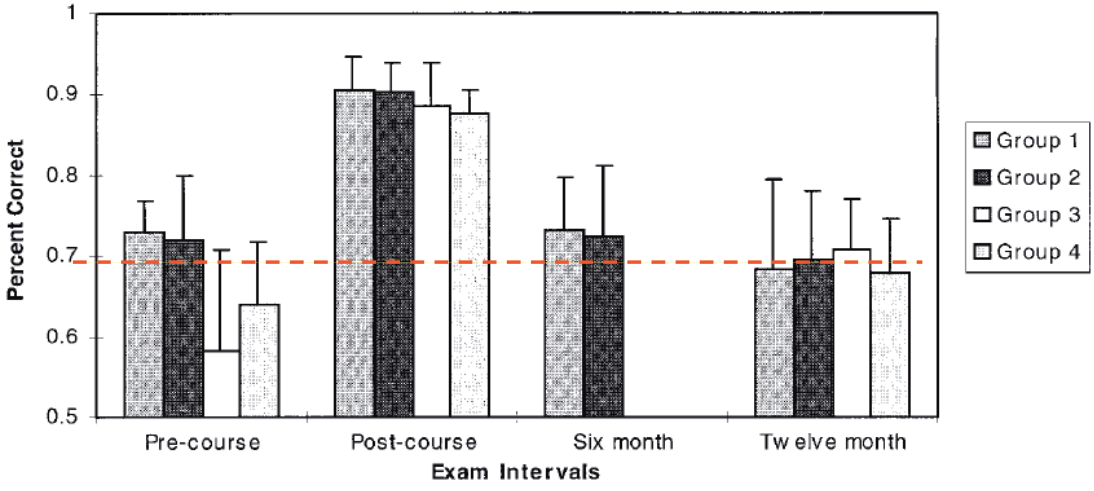
Effect of training on



Su et al (2000) Academic Emergency Medicine, vol 7 no 7 p779

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New Chem Eng Graduate

BIG COMPANY

- Formal training
- Group teaching is economic
- Safety office
- Many colleagues
- Experienced Mentor
- Range of technical support

SMALL COMPANY

- Ad hoc training
- Sending individuals on courses problematic
- Part time Safety Officer
- Few colleagues
- Sink or Swim!
- Limited support, probable multi-tasking

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Safety and Competence

- Correct calculations lead to safe design
- Skilled workers lead to safe installation
- Good workplans lead to safe operation

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To follow rules – it helps

- To understand why the rule is there
- Don't just tell people the rule
- Give them the reason or consequence

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No Smoking

Reason	Consequence
• It is the arbitrary rule	• You will be punished
• To deny you pleasure	• You will be punished
• To protect your health	• You will be punished
• Not to be offensive	• You will be disliked
• Not to set off smoke alarm	• Evacuation and disruption
• Sensitive material	
• Flammable material	• Contamination of product

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Effective Safety Education

- Should be in your own language
- Think of...
- Foreign students or workers
- Illiterate, blind or deaf workers
- Managers who are not chemical engineers

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Some Traps

- Familiarity
- Magic Paper
- Big Danger
- Small Danger
- Hazop


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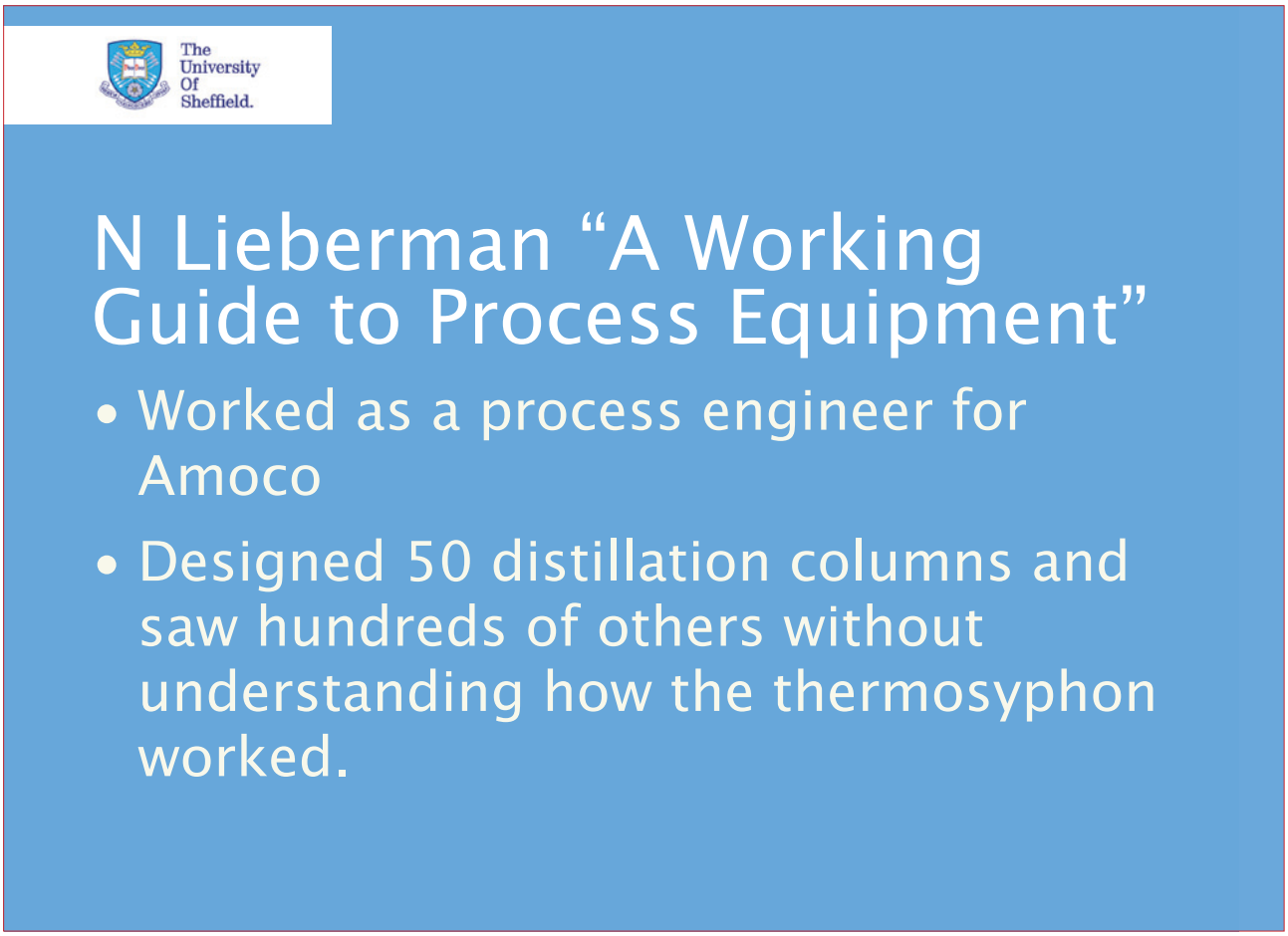
The Familiarity Trap
• We've been using xxxxxx for years.
• I am a qualified engineer/ chemist/ etc.
• The design procedures work.
• The management system works.
• We've never had a problem.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N Lieberman "A Working Guide to Process Equipment"
• Worked as a process engineer for Amoco
• Designed 50 distillation columns and saw hundreds of others without understanding how the thermosyphon worked.

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The Magic Paper Trap

- Permits to work
- Certificates of safety
- Legal compliance

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The Big Danger Trap

- We focus on one danger and overlook others, or pay insufficient attention to them.


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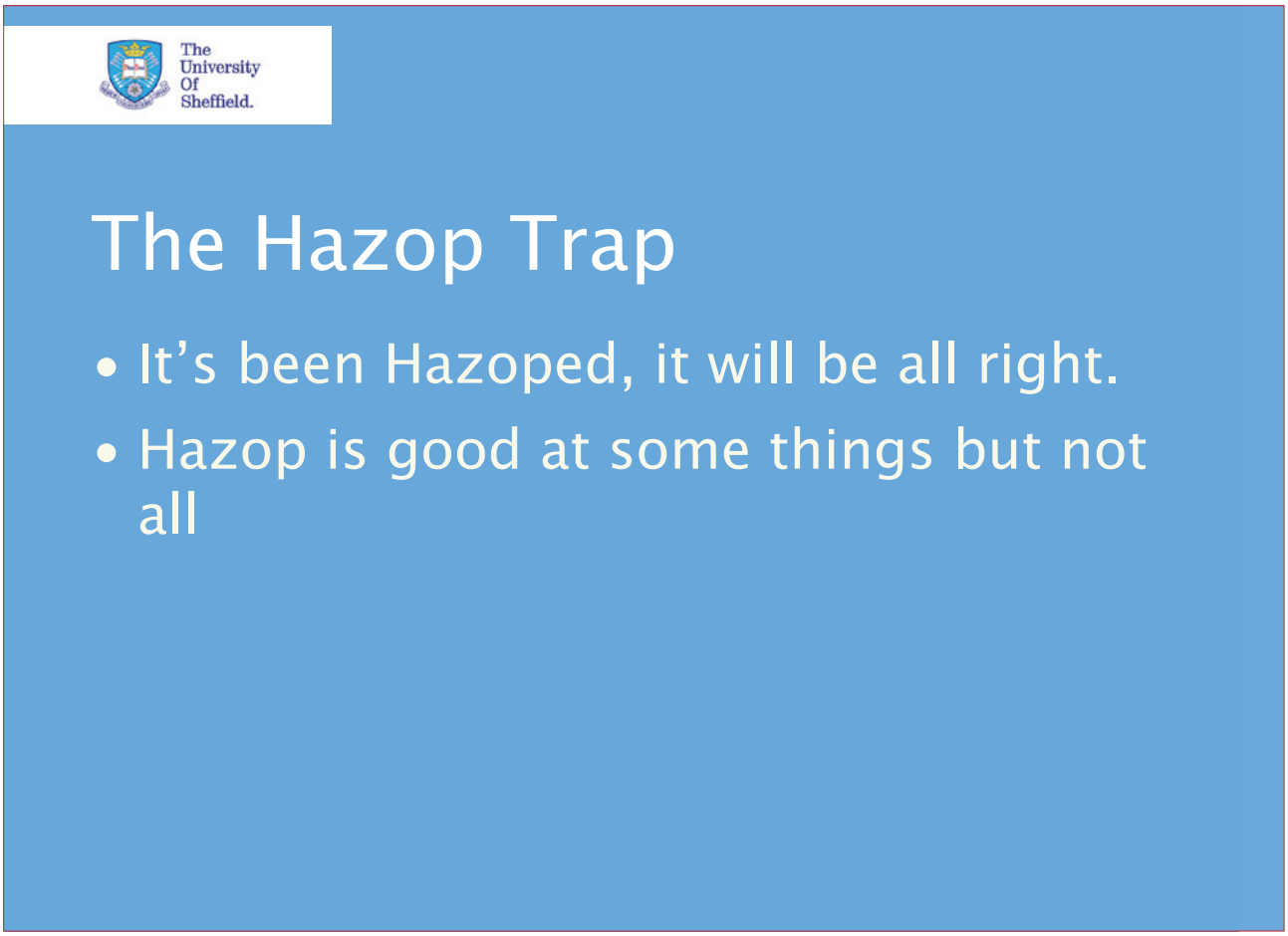
The Small Danger Trap
• We spend our time on lots of things we can understand.
• Do not take time to consider more complex interactions or major hazards.


The University Of Sheffield.
The Hazop Trap
• It's been Hazoped, it will be all right.
• Hazop is good at some things but not all

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Universities

- Universities should provide the deep knowledge of the basic subject, and teach the students how to learn.
- New graduates need an appreciation of the range of hazards, and an awareness of techniques to deal with them; but do not have the experience for much more.

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Industry

- By providing Summer or year places for students, industry can make better, safer graduates.
- Training should be provided for immediate safety issues, and graduates must also have the opportunity for more education.


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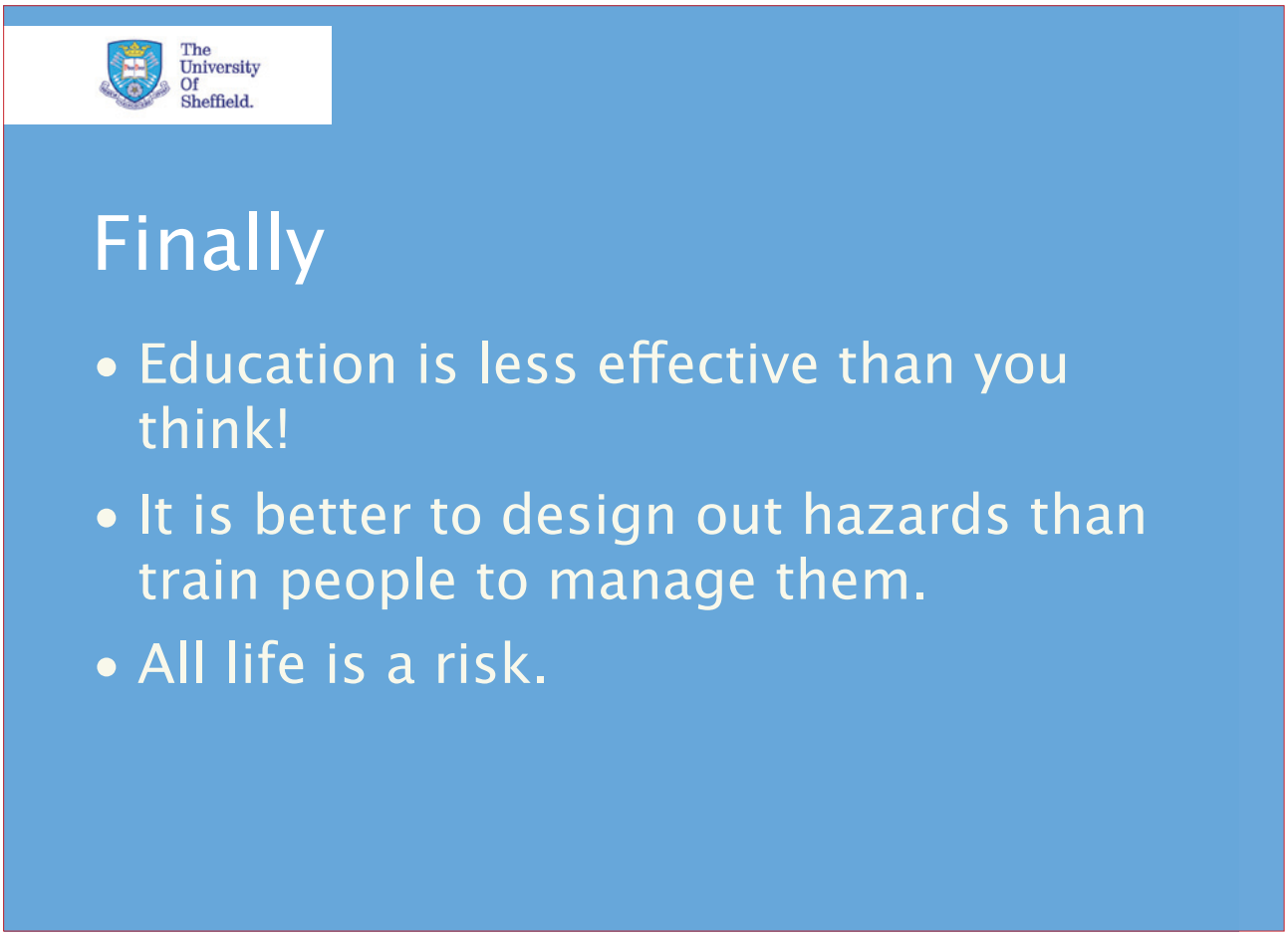
Managers
• Need to take time to learn about safety themselves, especially when taking on new responsibilities.
• Need to include employee training and education as part of safety policy.


The University Of Sheffield.
Finally
• Education is less effective than you think!
• It is better to design out hazards than train people to manage them.
• All life is a risk.

Process and Plant Safety competence – the authorities view

Ing. JHG Slijpen

Head Inspection Team MHC-South, Directorate for Major Hazard Control, Dutch Labour Inspectorate, Ministry van Social Affairs and Employment

Needs and coverage of PPS competence needs for authorities developing legislation, performing inspections and their oversight duties
What does Europe (or which parts of EU) need to achieve and maintain appropriate PPS competencies?

Arbeidsinspectie
Ministerie van Sociale Zaken en Werkgelegenheid

8th European Congress Chemical Engineering

- Process Safety Competence
- Authorities view in Europe

Jan Slijpen
Head Inspection Team
MHC-South-NLD
Directorate
Major Hazards Control
Dutch Labour Inspectorate

I. Major Accident Fire in Netherlands
II. MH-accident Prevention
III. Efficiency of Supervision
IV. Competences for Supervision

02/13/12

Personal Information

Education: Chemical Engineering
Additional: Risk Management, OSH Management, Occupational Hygiene, Process Safety, Social Skills, Lead Auditor, Management Skills

Experience:
- Chemical Industry: Environmental + Safety Engineer (5 years)
- National Government (DLI): 30 years in total
  - Several positions with the Dutch Labour Inspectorate
- International Experience (ILO, OPCW, EC): 10 years in total
- International Project Leadership: 4 years in total

Current Position: Head MHC-team South-Netherlands (12 inspectors): 8 years

Special Task: Trainer on Seveso-II + OSH (also internationally)

Introduction

Major Accident Fire in The Netherlands 2011

Data

- Date: January 2011
- Time: afternoon

Nature of company

- Medium-size company: 50 employees
- Storage / Handling Hazardous Chemicals
  - Pesticides, minerals and cleaning materials
  - Flammable and toxic chemicals
- Family-owned Company
- Activities
  - Storage and Packaging
  - Filling of Bags and Drums
- Low Knowledge and low Awareness of Process Safety

Features of Major Accident Fire

Type of major accident: Fire

- Combustion of huge amounts of Chemicals
- Smoke contained toxic combustion products
- Small Explosions (drums)

Direct consequences

- No employees injured
- No direct consequences onsite nor in neighbourhood

Fire Fighting Approach

- Insufficient Information about chemicals onsite
- Fire combat initially with water spreading the fire
- Coverage with foam at the end
- Continuous measuring of toxic substances

Emergency Response

Chaos

- Communication and information problems
- Several websites providing contradictory information
- Technical problems with official government website: www.crisis.nl
- Press: approaching different authorities

Social media

- Social media
  - Twitter: efficient communication medium
  - Many people rely more on Twitter than other communication media

Supervision History

Inspection History

- All inspections at company led to enforcement activities
- Enforcement activities haven't led to sufficient compliance
- Safety culture and leadership is of reactive nature

Conclusion for Major Accident Fire:

- Company's Prevention Policy for MH-Accidents inefficient
- Inadequate Safety Management System
- Leadership and Safety Culture hamper improvement of Process Safety
- New Supervision and Enforcement Strategy needed for such companies

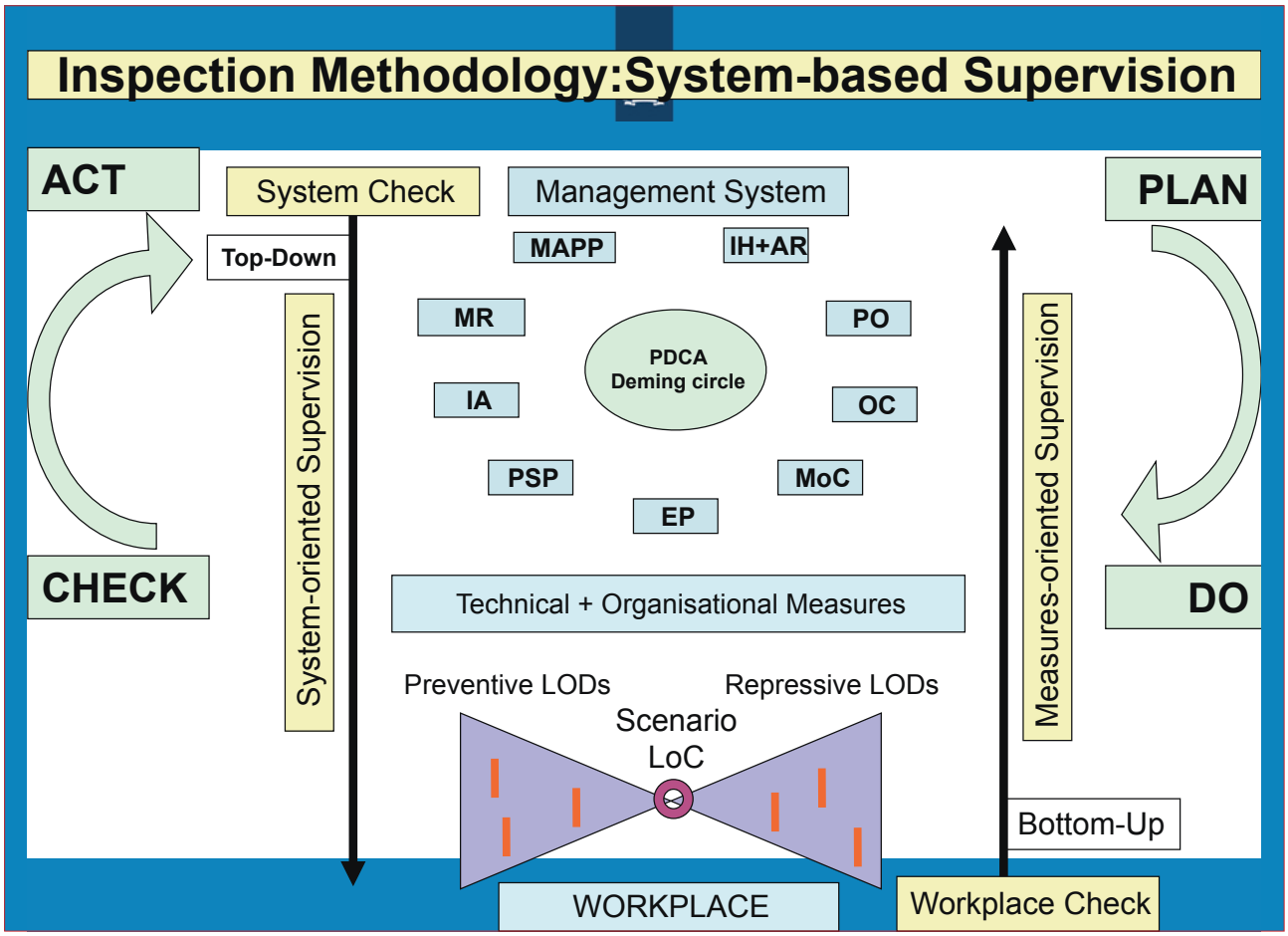
What is needed to prevent such MH-Accidents

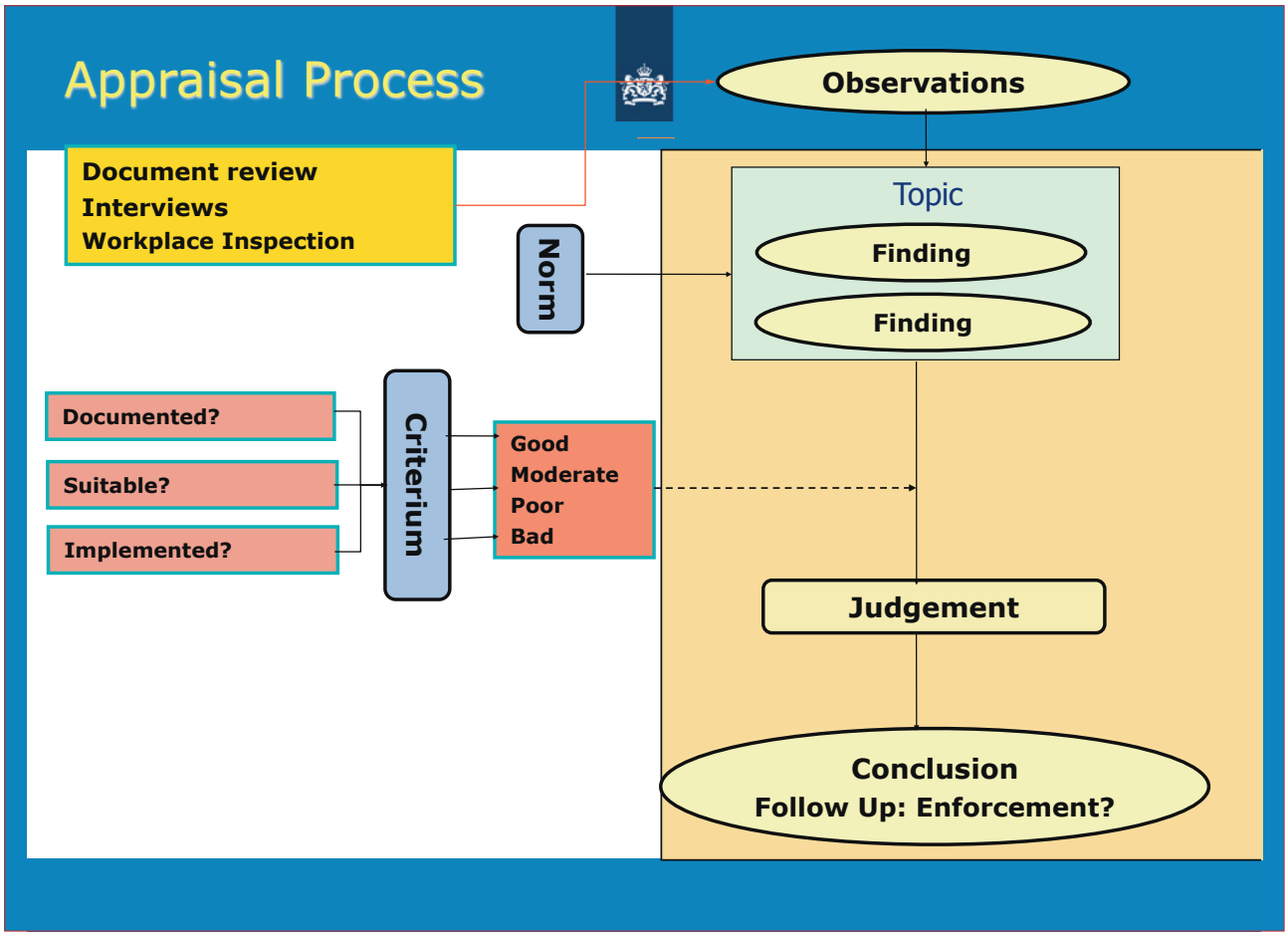
At the Company Side

- Process Safety Policy: Major Accident Prevention Policy (MAPP)
- Appropriate Safety / Risk Management System
- Appropriate Technical Knowledge and Expertise
- Trained and skilled workers with appropriate Competences
- Well-balanced Safety Culture + Leadership in Process Safety

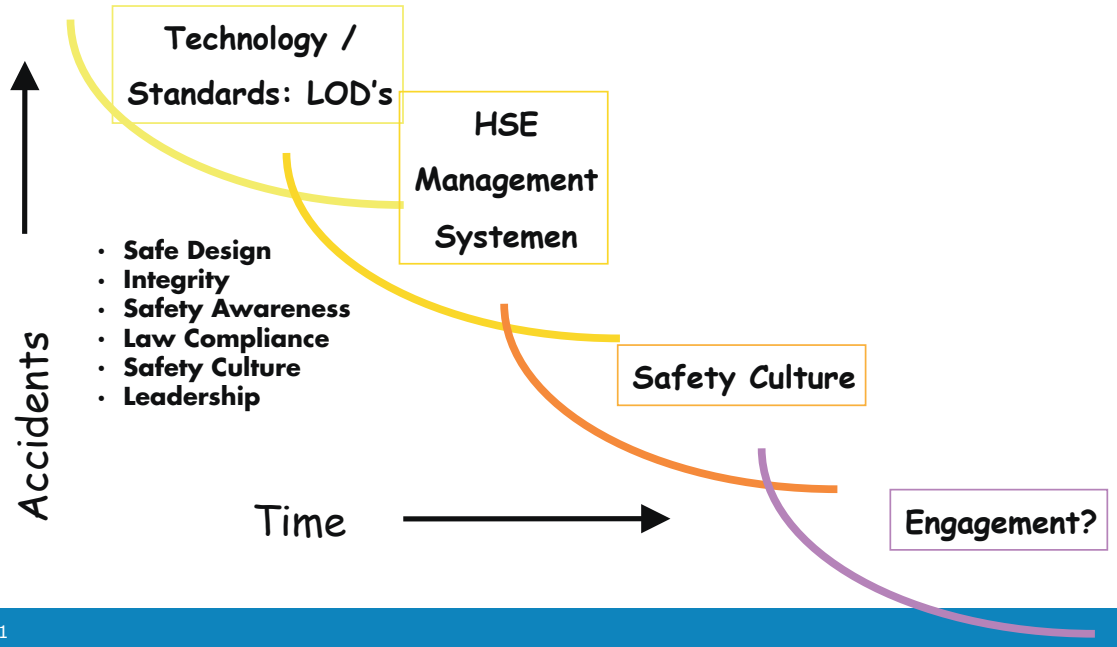
At the Authorities Side

- Competent and Qualified Supervision / Inspection Authorities
- Competent and Qualified Inspectors, in particular for MHC-inspections
- Appropriate Inspection Methodology for Process Safety
- Appropriate Methodology for Investigation of MH-Accidents
- Appropriate Enforcement Strategy
- Continuous and assured (Refreshment) Training Programs


Inspection Methodology:System-based Supervision
ACT
System Check
Management System
PLAN
Top-Down
MAPP
IH+AR
MR
PO
PDCA
Deming circle
IA
OC
PSP
MoC
EP
CHECK
System-oriented Supervision
Technical + Organisational Measures
Measures-oriented Supervision
DO
Preventive LODs
Repressive LODs
Scenario
LoC
Bottom-Up
WORKPLACE
Workplace Check


Appraisal Process
Observations
Document review
Interviews
Workplace Inspection
Norm
Topic
Finding
Finding
Documented?
Suitable?
Implemented?
Criterium
Good
Moderate
Poor
Bad
Judgement
Conclusion
Follow Up: Enforcement?

Risk Management Development



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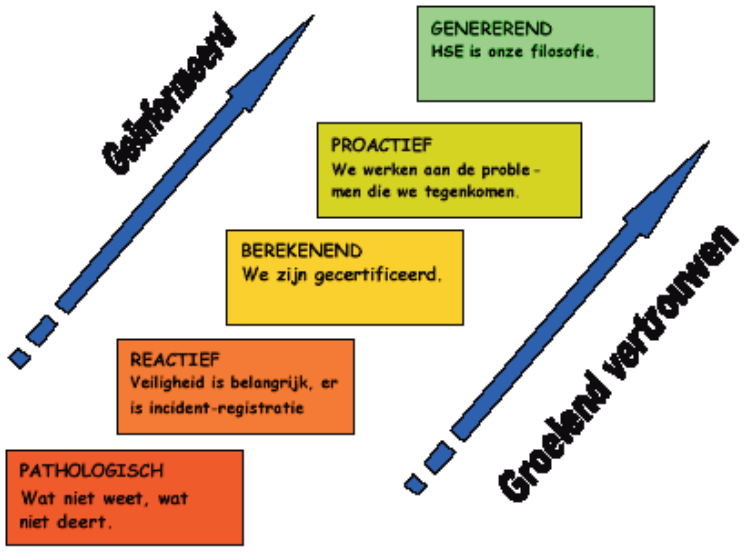
Safety Culture Ladder



Supervision

Aim of Supervision

- Contribution to Prevention / Reduction / Control of Major Hazard Risks
- Enhancement of Law Compliance
- Enforcement and Restoration of Violations

Supervision Approach

- Risk-based
- Information-based
- System-based
- Trust-based
- Enforcement-based
- Unannounced

Competences

Definition of Competency

A competency is a cluster of:

- *related knowledge, expertise, skills and attitudes*
- *that affects a significant part of a person's job,*
- *which combined with the requirements for that task*
  - *can be measured and compared to accepted standards and*
  - *which can be improved through training and personal development.*

Competences

Competent Inspection Authority

- Sufficient Competent Staff
- Minimum number of Seveso sites under supervision
- Competent MHC Inspectors
- Continuous and assured (Refreshment) Training Program
- Assured Work Procedures
- Appropriate Inspection Methodology
- Appropriate Enforcement Strategy

Basic Requirements MHC Inspectors

- Bachelor or Master Degree in:
  - Chemical, Mechanical or Electrical Engineering
- Master degree in Health and Safety Management
- Work Experience in relevant industry
- Specific Training in supervising Major Hazards Control

Inspectors Duties

1. Analysing + Assessing Quality of Process Safety Studies (PSS)
2. Analysing + Assessing Quality of Lines of Defences (LODs)
3. Analysing + Assessing Suitability of the Maintenance Management System (MMS)
4. Analysing + Assessing Suitability of Safety Management System / Risk Management System (SMS / RMS)
5. Analysing + Assessing Suitability of Major Accident Prevention Policy (MAPP)
6. Drawing Conclusions from Supervision / Inspections
7. Enforcing Law Violations, if and when needed

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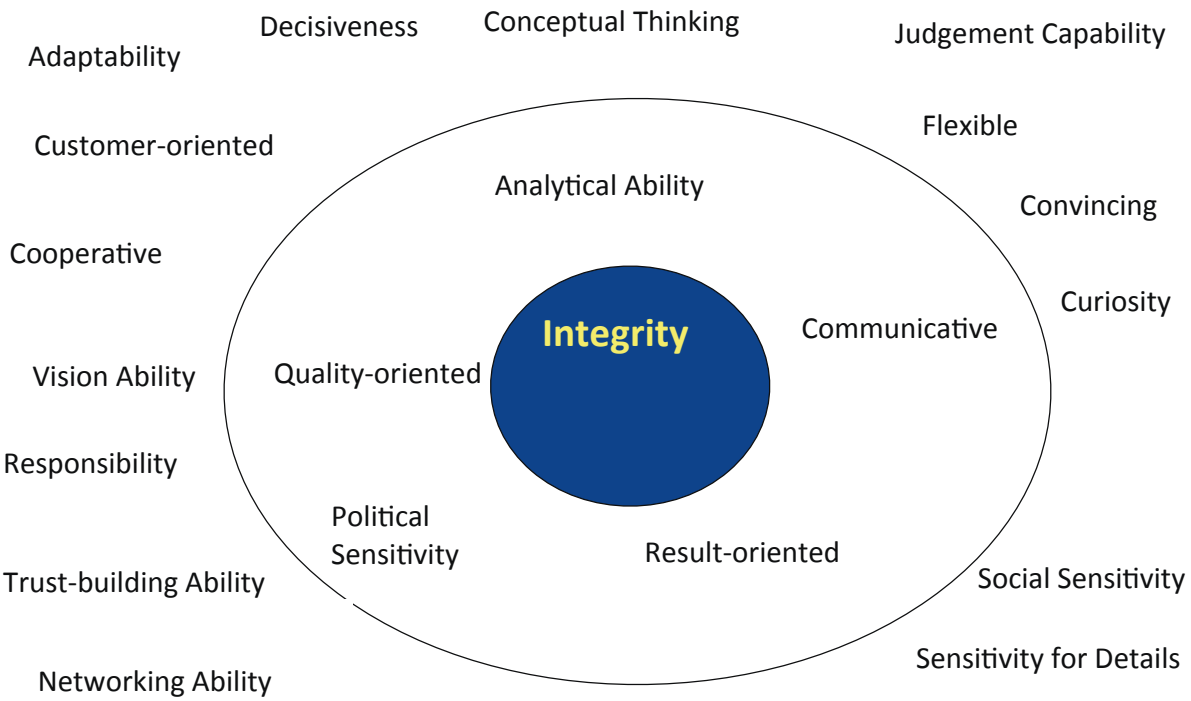
Competences

Inspectors Competences

- Functional Competences (job skills)
  - Knowledge
  - Experience
  - Job skills
- Personal Competences
  - Generic Personal Competences
  - Core Personal Competences

Competence Diagram



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Competences

Inspectors Core Personal Competences

1. Analytical ability
2. Communicative
3. Quality oriented
4. Result oriented
5. Political sensitivity

Knowledge

Knowledge Domains

- Legislation
- Technology
- Safety Technology
- Safety Management
- Inspection Techniques
- Work procedures (ISO 9001)
- Investigation Techniques
- Audit Techniques
- Interview Techniques
- Reporting Skills

Questions?

21

Process and Plant Safety Competence – How to sustain this success factor for European Chemical Industry

Dr. Peter G. Schmelzer
CEFIC, Chair of Issue Team on Process and Plant Safety
Bayer AG, Chair of Bayer Group PPS Committee
Bayer HealthCare AG, Leverkusen, Head of global HSE Platform

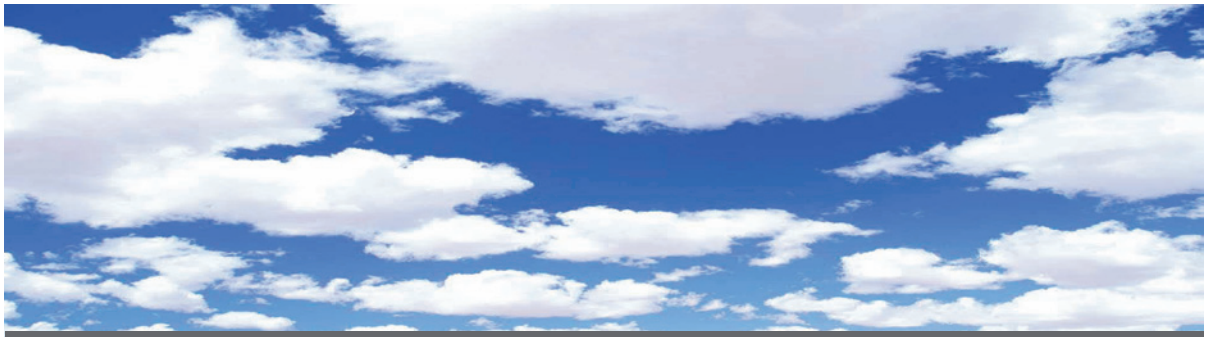
Europe's Chemical Industry is important part of an increasingly more global acting industry and delivering important products for the worlds societies and population. Be it as supplier of intermediates for industry partners or for final products. There is almost nothing women or men do today which is not involving chemical industry products. With this comes a tremendous responsibility regarding the assurance of continuous and sufficient supply of materials and goods because economies and individuals deeply rely on availability and quality. With this comes the request and obligation to produce materials and goods thus the likelihood of negative impact to people, to the environment or to assets from the manufacturing processes etc. is reduced as far as reasonably practicable. Adequate and increasingly higher performance regarding process and plant safety is rightfully so expected by societies and the individual customer and citizen: PPS performance is an important success factor for industry.

First of all it is of paramount importance to acknowledge that Process and Plant Safety performance depends on people. People who in different phases of the process of risk identification, assessment and mitigation determine the level which PPS performance can be achieved.

Secondly we have to account for that we depend on the quality of organizational as well as on technical processes. Such as e.g. the systematic and thorough hazard identification and risk evaluation criteria and process, or such as the proper design and availability on demand of a safety critical devices, or such as a proper operation and maintenance approach in the manufacturing facilities themselves, etc. etc..

Industry in any case requires appropriately educated people to develop and maintain each safety critical process. Depending on the level of qualification which is available from public education and training systems industry is more or less developing specific skills themselves by using again publically available training institutions, associations or on the job with own facilities.

Industry associations (e.g. Cefic or national industry associations etc.) and industry funded or sponsored institutions play an important role in this context since decades. Either as a source for education, standardization and experience exchange platform. One important question is, if the system of education sources from the public, industry and other institutions meets the requirements of today and tomorrow or needs adjustment and/or specific additional attention.



Process and Plant Safety Competence – How to sustain this success factor for European Chemical Industry

Dr.-Ing. Peter G. Schmelzer, Bayer HealthCare AG
Chairman CEFIC Issue Team Process and Plant Safety

cefic*

Process Safety Competence - European Strength degrading to Weakness?
8th ECCE, September 28th+29th 2011, Berlin

* Conseil Européen des Fédérations de l'Industrie Chimique

Competence

Ability of an individual
to perform a job properly.

Observable
- abilities,
- skills,
- knowledge,
- motivations or traits

needed for successful
job performance.

Geri Winkler on top of Mount McKinley

Ensuring PPS competence in operation (simplified)

1. Defining / reviewing the job requirements and responsibilities
2. Hiring / Contracting; Job Rotation; Succession Planning
3. Identifying gaps between employees capabilities / competencies and job requirements
4. Closing identified gaps with additional education / studies:
   - external or internal courses
   - on the job training
   - participation in experience exchanges

It's people who need and create PPS competence

People involved in

- Human Resources
- Training / Education
- Research
- Process Development, Plant / Process Design
- Construction
- Operation
- Maintenance
- Procurement
- Decommissioning
- …

People working at

- Schools, Universities, Training Institutions
- Research Centers, Laboratories
- Industry
- Authorities
- NGOs
- 3rd Party Inspection companies
- …

PPS competence – must have solid foundations

People involved in

- Human Resources
- Training / Education
- Research
- Process Development, Plant / Process Design
- Construction
- Operation
- Maintenance
- Procurement
- Decommissioning
- …

People working at

- Schools, Universities, Training Institutions
- Research Centers, Laboratories
- Industry
- Authorities
- NGOs (including industry associations)
- 3rd Party Inspection companies
- Consultants
- …

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Competence is about people

Performance of the system
benefits from

employees
and
business partners

who
are particularly fit for their duties
and
work on **common grounds**

People working at

- Schools, Universities, Training Institutions
- Research Centers, Laboratories
- Industry
- Authorities
- NGOs (including industry associations)
- 3rd Party Inspection companies
- Consultants / Contractors
- …

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Industry fostering the "common grounds"

- Universities / Schools
  - Cooperation, research activities, …
  - Practica, workplaces, sponsorship, master / PHD theses, …
- Cooperation with external partners
  - e.g. operator and engineer training …
- Institutions, Associations, Training, e.g. …
  - IChemE (in Germany e.g. DECHEMA, ProcessNet, …)
  - EPSC
  - EFCE
  - Cefic, national chemical associations, …
- Working on Standardization, Legislative Initiatives
  - ISO, CEN, Namur, …
  - National and EU governmental bodies

The operator needs to cover all bases

People involved in

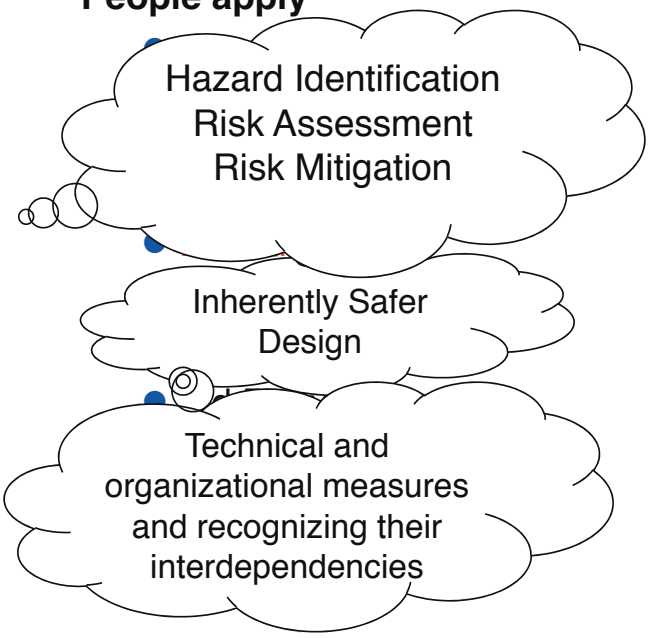
- Human Resources
- Training/Education
- Research
- Process Development, Plant / Process Design
- Construction
- Operation
- Maintenance
- Procurement
- Decommissioning
- …

Keys to high level Process & Plant Safety

People involved in

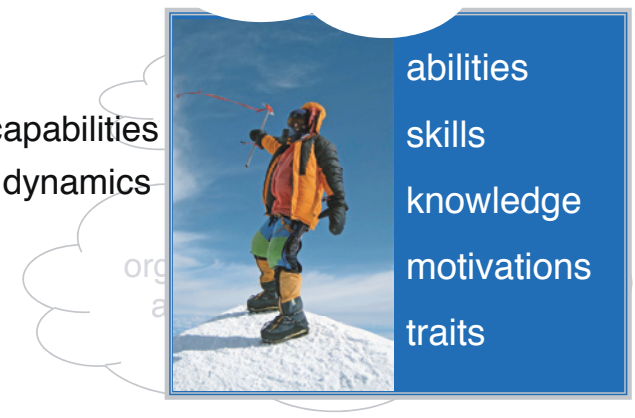
- Training/Education
- Research
- Process Development, Plant / Process Design
- Construction
- Operation
- Maintenance
- Procurement
- Decommissioning

People apply

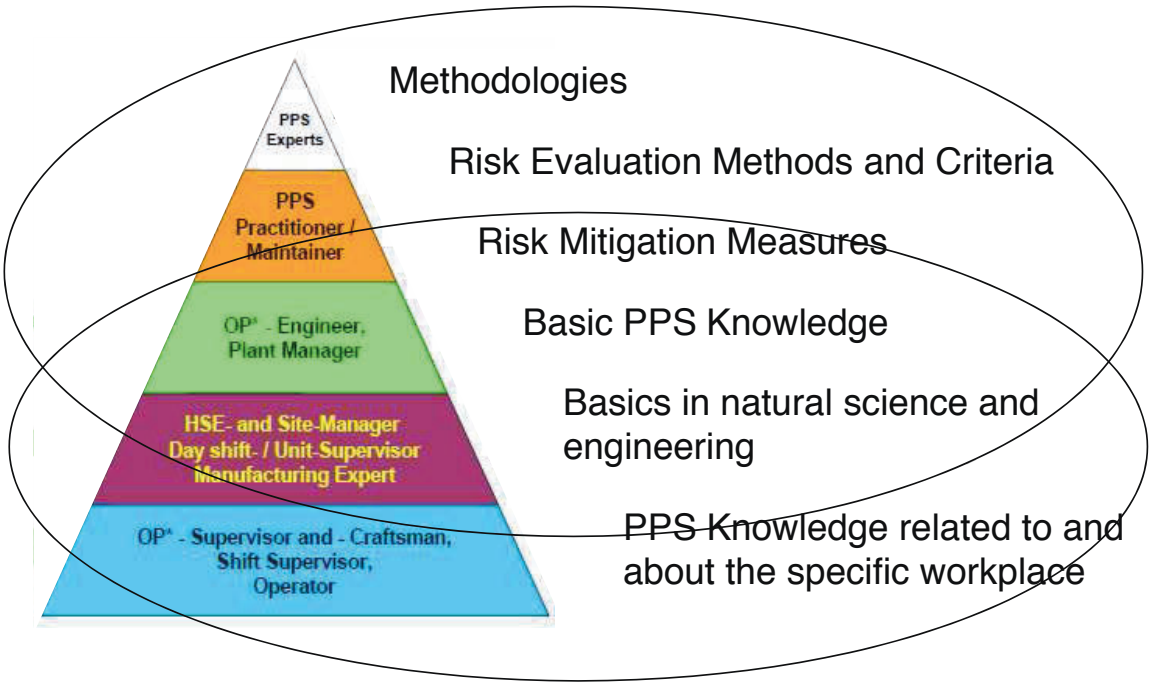


Key competencies to ensure Process & Plant Safety

- Substances, Process
- Interdependencies of substances, materials, process conditions etc.
- Technical installation / capabilities
- „normal“ operation incl. Start-up and Shut-down
- Deviations from “normal” →Emergency Response
- Organisational means / capabilities
- Human Behavior, Group dynamics
- Legal Requirements
- Work Environment
- Public Expectations
- …



PPS competence must rely on in-house training



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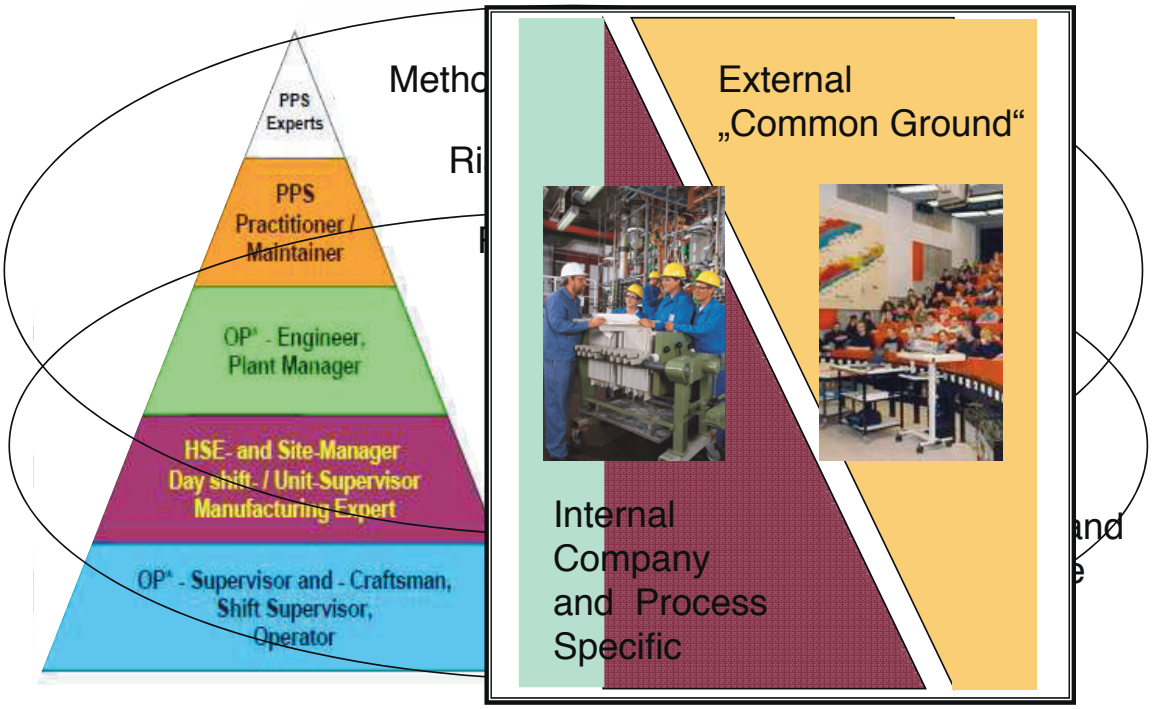
PPS competence must rely on in-house training



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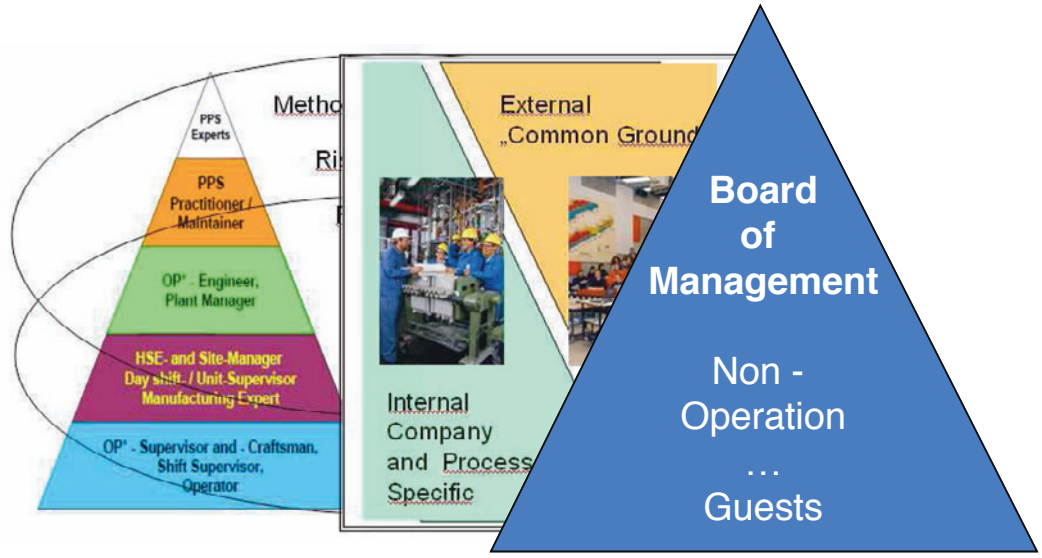
PPS competence outside industrial operation



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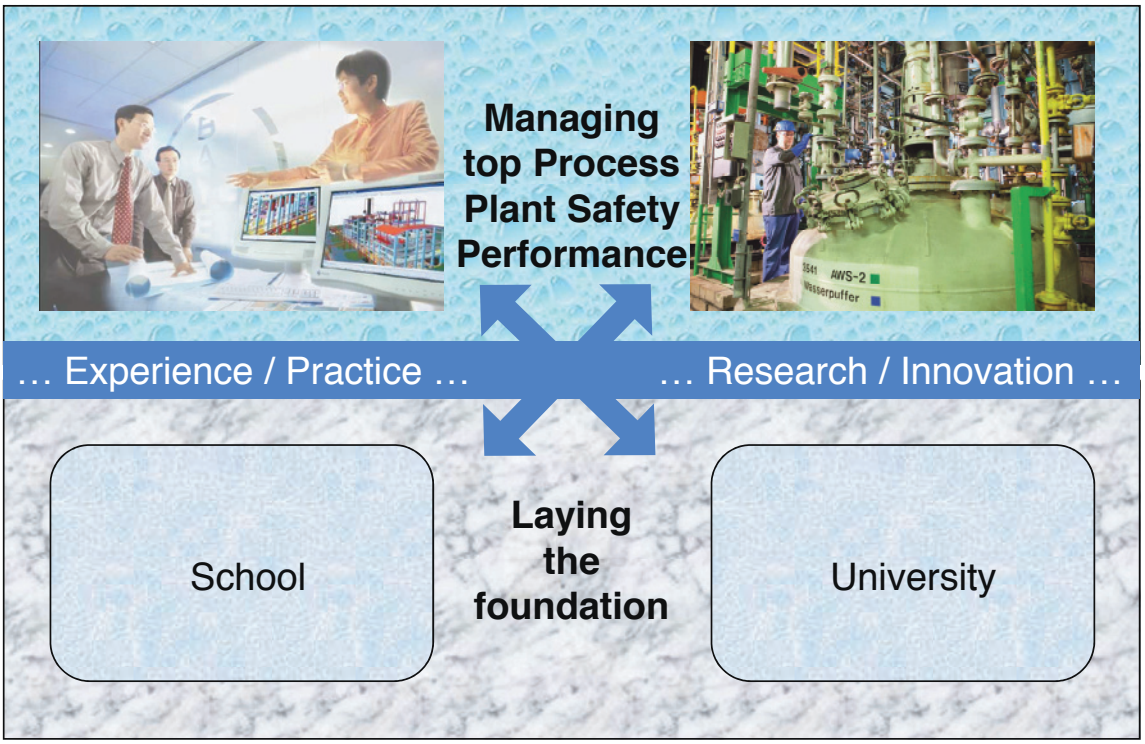
Building blocks for PPS competence



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Fit for the future

- On the basis of the already high level of achievements Industry is committed to develop PPS knowledge, competence and performance further
- Industry regrets the decrease of number of universities and institutions providing a comprehensive curriculum for PPS as part of engineering and natural science studies
- Efforts of all stakeholders regarding PPS would be more efficient and effective, if
  - more engineering and natural science students have thorough basic knowledge regarding process and plant safety
  - more opportunities for specialization on process and plant safety at universities is provided

High Process Safety competence – a valuable asset for a chemical company

Dr H.V.Schwarz
VP process safety BASFgroup
BASF SE
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The value of high process safety competence is illustrated by looking at the example of BASF, the world's largest and most diversified chemical company.

BASF looks back at a long history of improving process safety after a traumatic explosion in 1921.

The main hub, Ludwigshafen has achieved a leading position through forming and following industry trends like higher automation, systematic hazard analysis, building high competence of its employees and management focus on implementation.

It's strong safety culture is founded in leading process technologies and deep technical knowledge of its employees. Learning from accidents of the past and throughout the industry, statistical analysis of small incidents, and consequent management of safety hazards with the help of a semiquantitative risk matrix, as well as cooperation with other leading chemical companies are key elements of BASF's competence in process safety. On a personal level, process safety competence of production and engineering employees and process safety experts is kept up by training- and awareness programs. A strong set of corporate guidelines provides guidance in processes like new plant design, facility siting, management of change, updating of existing facilities.

Recent challenges are arising from efficiency pressures in operations and maintenance, a growing number of sites and cultures through acquisitions and globalization, which forced the company to strengthen its process safety organisation and develop process safety competence in many new employees globally.

There is a growing realization that process safety is closely linked with plant reliability, as well as enterprise risk management and therefore a 'must' for the economical success of the company. Add this to the core of process safety, the protection of employees and neighbors from chemical hazards, and it becomes evident that process safety has become a core value and receives the clear and uncompromised support of BASF's top management.

Based on this strong culture, the potentials for further improvement are seen **in the skills and knowledge of employees**, like strong individual understanding of processes and their risks, knowledge of process safety approaches and techniques in plant operation, more efficient use of detailed incident data as a source of learning, more consequent Management of Change, as well as in **further technical advancement**, such as further automation, including in older plants, further improved hazard identification methods, including the hazard analysis of transient state, and a stronger economical motivation of further improved process safety, with even less downtime from incidents.

ECCE, Berlin, Sept 29, 2011

High Process Safety Competence a valuable asset for a chemical company

Dr Hans V Schwarz
(BASF SE, GUS/A)

9/2011

BASF
The Chemical Company

Process Safety Competence…
Process Safety at BASF SE, Ludwigshafen

BASF
The Chemical Company

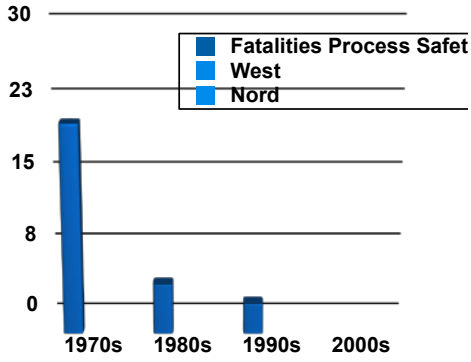
- BASF organizes EHS work under the framework of „Responsible Care“ Initiative, an independent industry approach

- High priority for Process Safety is integral part of BASF´s “DNA” since **1921 explosion** in Ludwigshafen Oppau.
- Optimization of Process Safety remains a continuous effort
  - Safety has priority over production targets
  - Synergies of *Safety* and *Production* (mostly or partly ?) pay the bill

Process Safety Competence…
Process Safety development BASF SE, Ludwigshafen

BASF The Chemical Company

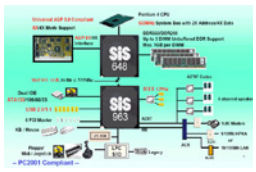
- **‚Process Safety' hugely improved since beginnings**
  - 1890s: ~ 1% of employees killed per year !
  - 1950s/60s: Yearly fatalities ‚normal' on larger sites
  - 1970s to 2000s: Western countries:
    - – Fatalities became a rare exception
    - – Reduced number of major incidents
  - Last decade:
    - – Still some high profile incidents
    - – Increasing publicity
    - ➔Pressure for further improvements

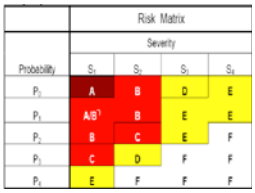


Process Safety Competence…
Improvements driven by industry trends

BASF The Chemical Company

- **More reliable equipment**
  - Materials of construction, advanced gaskets
  - Mechanical equipment design; ‚Intelligent equipment'
- **Automation, narrower process control**
  - Control systems, sensors allow narrower process control
  - Less people in the plants (→ less injuries)
- **Systematic hazard analysis methods, like HAZOP**
  - Broadly used since the early 90's
- **Management focus**
  - Safety given priority, larger role in company image
  - Industry initiatives beyond ‚compliance'
- **Regulation**
  - Plant inspection programs; targets replace rigid rules





Process Safety Competence…
Improvements depend on Culture and Competence

BASF The Chemical Company

- Commitment of top management leads to better **Safety Culture**, which in turn sets the frame for further improvements
  - Basis for development of **competence of the organisation** (processes, which support process safety)

- **Competence of the workforce** is the most important enabler for high quality in the actual tasks:
  - Process design for inherent safety
  - Design of instrumented safety systems
  - Hazard Analysis / Safety Reviews
  - Management of Change
  - Measurements of substance safety properties
  - Incident analysis, data evaluation
  - Development of company guidelines and rules

H.Schwarz, KUT/P, 6/2005 Folien/polioles safety project 2005.ppt 5

Process Safety Competence…
Competence of the organisation example: BASF

BASF The Chemical Company

- Decentralization of the expert organisation
  - Regional hubs of experts
- More formal approach to ensure sufficient qualification of ‚decentral' experts
- Globalized mandatory guidelines, regional differentiation with ‚successfull practises'

H.Schwarz, KUT/P, 6/2005 Folien/polioles safety project 2005.ppt 6

Process Safety Competence…

Process Safety Competence development example: BASF

BASF The Chemical Company

- **Functional groups (production, maintenance engineering,..) receive specific training (knowledge, awareness)**
  - Production employees, all levels
  - Production leadership functions
  - Maintenance employees and managers
  - Engineering employees and engineering managers
  - Executives with production responsability
  - Executives in general management functions

Difficulty: Getting agreement on manadatory training

- **Process Safety specialists and experts**
  - Come from defined career tracks (production, engineering, maintenance)
  - Receive in depth process safety education
  - Participate in continuous learning

Difficulty: Getting consistency throughout the company

H.Schwarz, KUT/P, 6/2005 Folien/polioles safety project 2005.ppt

Process Safety Competence…

What makes a good process safety expert ? (= competent expert), ***example: BASF***

BASF The Chemical Company

- **<u>Career background:</u>**
  - Solid academic education in science, or engineering:
    - chemistry, physics, thermodynamics, kinetics,
    - related engineering disciplines,…
  - Some years in R&D, process development,…
  - Several years in **production or maintenance role**

- **<u>Job specific:</u>**
  - Training in methods and concepts (hazard analysis, incident analysis, process safety management,…)
  - Growing **experience** in process safety

	Risk Matrix			
	Severity			
Probability	S 1	S 2	S 3	S 4
P 0	A	B	D	E
P 1	A/B	B	E	E
P 2	B	C	E	F
P 3	C	D	F	F
P 4	E	F	F	F

- **<u>Academic training in process safety:</u>**
  - Doesn‘t play a significant role in BASF so far
  - Could provide conceptual understanding
  - Could help improve safety attitudes of new hires if integrated in engineering and science degrees

H.Schwarz, KUT/P, 6/2005 Folien/polioles safety project 2005.ppt 8

Process Safety Competence…

Training, safety education ***example: BASF***

- **Experts, production-, technical- professionals: BASF SE uses training from**
  - Own process safety department and own firebrigade
  - BG RCI (e.g. PAAG HAZOP class)
  - Dechema process net (e.g. training for expert in specific topics)
- **Executives:**
  - Events targeted at leadership ‚behaviour'
  - Discussion groups executives with process safety leadership
  - Regular information on important incidents and KPI trends
- **Operators:**
  - Plant internal training
  - BG RCI
  - Awareness programs through Safety department
    - (recently: 2500 operators in ‚Sicher 11')

Process Safety Competence…

Event 'SICHER 11 Schau hin: Sichere Anlagen!' ('Watch, safe plants !') For plant operators, Ludwigshafen

- **Part 1:** Experimental presentation on fire and explosion hazards

- **Part 2:** 6 information boots on **focus topics where operators can influence process safety** in their plant (derived from incident statistics)
  - ELEKTROSTATICS
  - ALARMMANAGEMENT
  - PRODUCT RELEASES
  - OPERATING ERRORS
  - STARTUP and SHUTDOWN in CONTINUOUS PLANTS
  - RUNAWAY REACTIONS

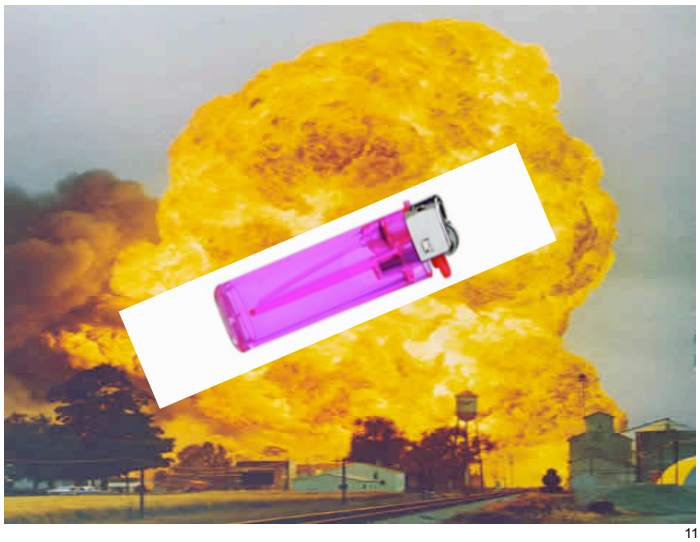
- Participation of 2400 operators in 14 events
  - Very positive feedback

Process Safety Competence…

Event 'Sicher 11' targeted at Operator awareness examples of 2 topics

BASF The Chemical Company

- **Runaway Reaction:**
  - **Animation**
- **Bleve Explosions:**
  - **Foto of exploding tankcar**
  - **Experiment Cigarette lighter**



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Process Safety Competence…

Sicher 11: Schau hin – Sichere Anlagen
Goal

BASF The Chemical Company

What will be different in one year (or in two) regarding the Safety culture in the plants?

What are the indicators for changing Safety culture in the plants ?

H.Schwarz, KUT/P, 6/2005 Folien/polioles safety project 2005.ppt 12

Process Safety Competence…

Challenges for further process safety improvements

BASF The Chemical Company

- Achieving **consistency** throughout the organisation
  - Regional cultures; variations between sites, departments
    - – Openness to learn from errors differs widely between countries, companies, and even different plants within same company
  - Acquisitions
- **Developping and** m**aintaining competence of workforce**
  - Demographics
  - Acquisitions
  - Organisational change
    - – Productivity driven reorganizations of manufacturing, maintenance, expert services

H.Schwarz, KUT/P, 6/2005 Folien/polioles safety project 2005.ppt 13

Process Safety Competence…

Lack of competence plays a role in historical large incidents

BASF The Chemical Company

- Oppau 1921, BASF: **Ammonium Nitrate explosion**
  - > 1000 t Ammonium Nitrate exploded
  - **Lack of understanding product properties, consequences of a process change**
  - Large offsite impact, 1 km Radius of destruction
  - 560 Fatalities

- Bhopal 1984, UC: **Methyl-Isocyanat release**
  - 30 tons of MIC released (highly toxic gas)
  - **Operator Mistake, (Sabotage ?)**
  - **Leadership failure**
  - Large offsite impact, 3 km Radius
  - 2500 Fatalities, 300 000 injured

H.Schwarz, KUT/P, 6/2005 Folien/polioles safety project 2005.ppt 14

Process Safety Competence…

Examples of incidents, last decade

BASF The Chemical Company

- Toulouse 2001, AZF: **Ammonium Nitrate explosion**
  - 300 t Ammonium Nitrate exploded
  - Lack of understanding of product properties
  - offsite impact; 0,5 km Radius of destruction
  - 30 Fatalities
  - Similarities to 1921 BASF accident;

- US, Texas City 2005, BP: **Refinery explosion**
  - Explosion after liquid release from flare
  - Startup, Management of change, Safety Management system
  - 16 Fatalities; 2 Billion $ damage

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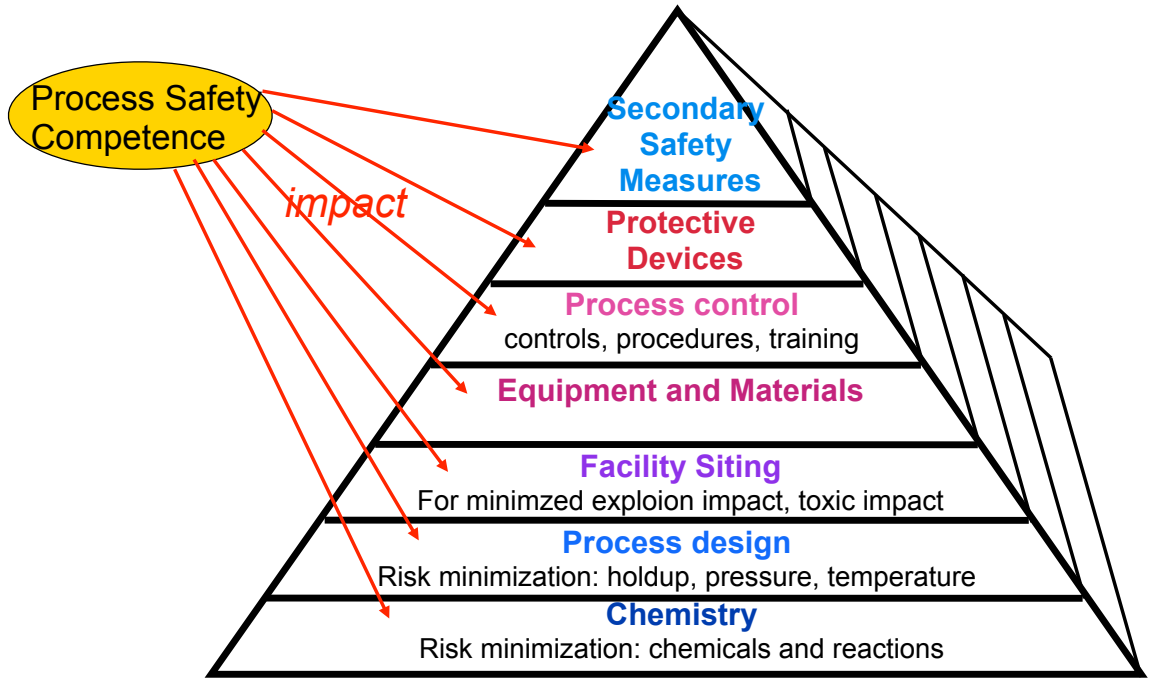
Process Safety Competence…

Competence impacts plant design

BASF The Chemical Company



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Process Safety Competence…

Globalisation is a challenge for development of Competence

BASF The Chemical Company

Welds Process design Automation

Small company in Asia

BASF

Process Safety Competence…

Competence is the basis of superior solutions

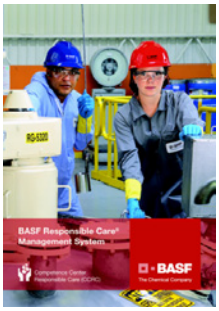
BASF The Chemical Company

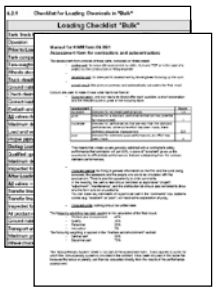
- Secondary Containment, T+ Material
  - All equipment with T+ material in containment
  - Defined airflow, 10 air changes/hr, offgas to destruct system,
  - Resists100 mbar blastwave

Process Safety Competence…

Good guidelines require Competence

Responsible Care Management System → BASF Group Directives → Requirements → Successful Practices





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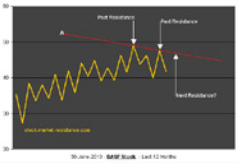
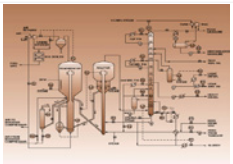
Process Safety Competence…

Significance of process safety for the chemical industry today

- High **awareness** from the operator to the board and **Management commitment** to plant safety. Safety gets ‚top priority', ahead of ‚throughput'
- Competence in Process safety leads to **less incidents**, and avoided costs from incidents



- Competence in Process safety (PS) contributes to **reliability** and on-stream time of plants, with an associated economic payback



- Improved PS has positive effect on **public image** of chemical industry
- Being in control of PS is a necessary condition of **company sustainability** *(Union Carbide !)*, and a ‚must' for a **high stock valuation** *(BP !)*

Stock value	*1 mth after inc.*
BP 2010	- 40 %
BP 2005	- 10 %

➔**High Process Safety Competence is an asset for a chemical company**

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Process Safety through Operational Management

Herman Van Roost

After 30 years of automation, the process industry has reached unprecedented levels of sophistication and intelligent control. A lot of effort was successfully spent to enhance the reliability of both process and control equipment.

During the same period, the role of human intervention with the process has changed from production support activities towards “abnormal situation management”. To that extent, it is today realized that the residual need for human presence in our plants is fundamentally driven by Process Safety, to cope with situations which are not foreseen by the automated system.

This changed role of the human operator s and technicians is so crucial and irreplaceable that it requires a highly reliable performance of them. Faced with this new requirement, today’s operational management is challenged by the question how to maximize their people’s positive impact on the process rather than minimize their disturbance. The management’s limited success is visible through a continuing series of Process Safety incidents which become a threat for the very acceptance of the process industry in the modern world.

Other industries like the nuclear and aviation industry have been in the same situation many years ago . They found effective improvement recipes in the field of Human Factors, which describes the capabilities of the “human machine”. Many Human Factors applications and solutions in these industries are readily available for simple translation to the process industry.

Doing so, it is striking how the modern subject of Human Factors appears to re-introduce the old concept of “Rule Based Management”, and confirms on scientific basis the overwhelming importance of management and supervision in order to be successful in achieving Process Safety.

TOTAL PETROCHEMICALS

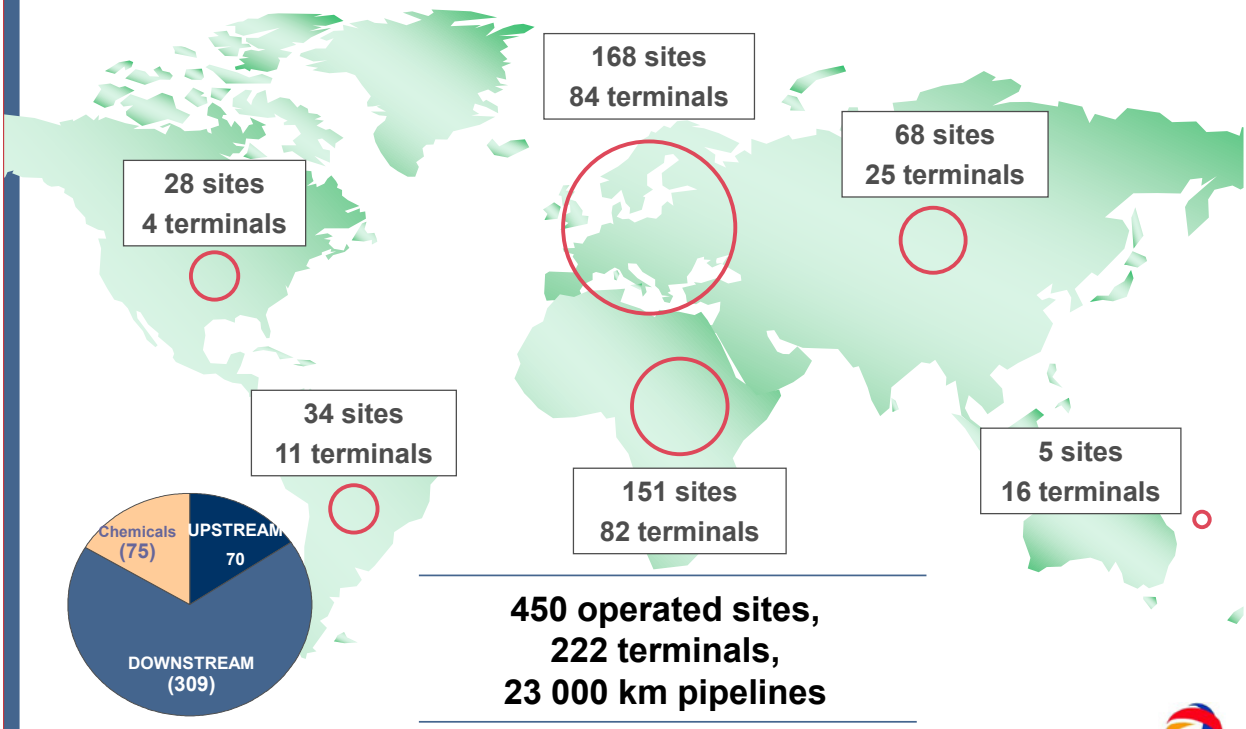
Process Safety through Operational Management

Herman.van-roost@total.com

8th Annual Congress of Chemical Engineering, Berlin, September 29th , 2011

TOTAL

TOTAL : hundreds of high risk installations worldwide



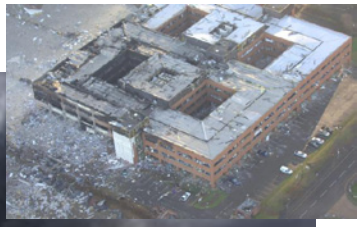
450 operated sites,
222 terminals,
23 000 km pipelines

2

TOTAL

For all : “Safety first” = also “survival first” …

(the duty of every business)



TOTAL

Incident Investigation : huge effort at Total

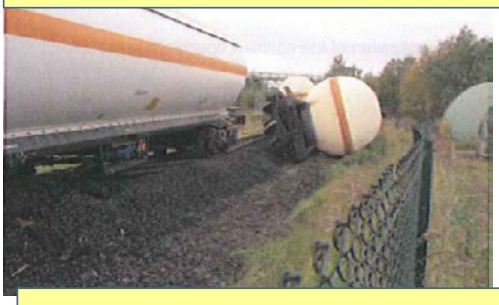
- All new incidents have already happened before…
- Central effort to extract the full learning potential of every incident : “REX” = “Return of EXperience” from sites are challenged, translated and distributed to all sites.
- Opportunity for the involved site to transform their problem into something positive for Total Petrochemicals.
- Strong focus on High Potential (HIPO’s) : often Process Safety

But how effective are we ?

TOTAL

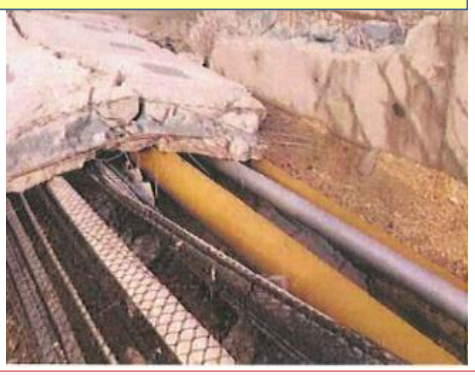
Why didn't we see these coming ?

LPG derailment by push & pull without break connection between 2 locomotives



Unadapted tractor for heavy load on unbreaked wagon, almost damage to hydrocarbon pipes

Collapse of new storm basin during first test, damage to hydrogen line with leak



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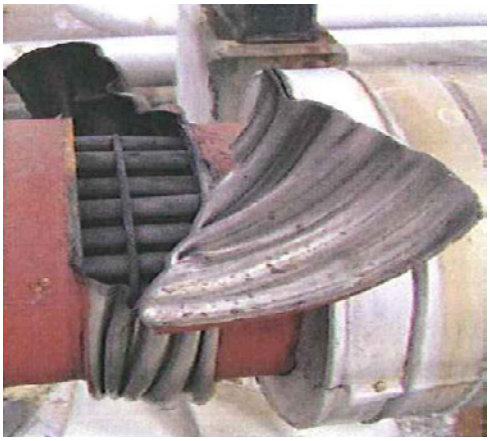
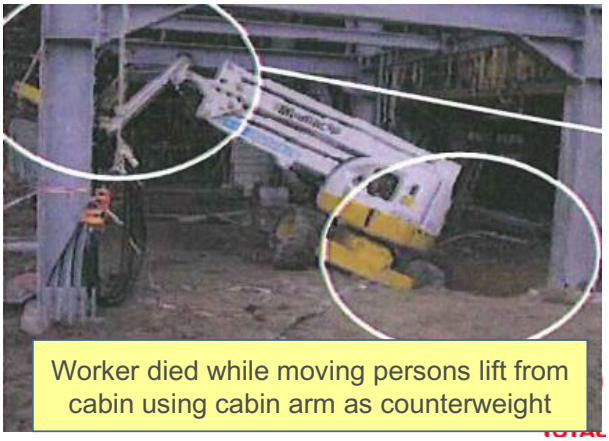
Why wasn't this prevented ?

5 ton benzene spill by rupture of bellow after visual misalignment (15mm)



Crane without support shoe on unstable ground : disaster just avoided



Worker died while moving persons lift from cabin using cabin arm as counterweight

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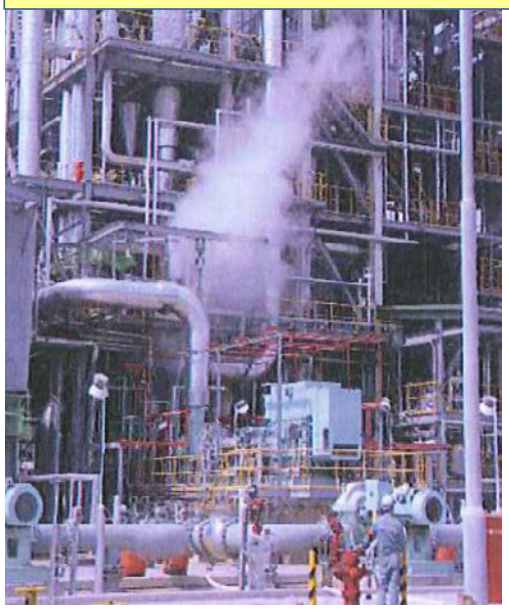
Do we continue mastering the basics of our profession ?

500 kg propylene cloud during 1 hour after contractor removed valve on reactor body under pressure



2 operators died and 6 got burnt by explosion of superheater during startup

2 workers wounded by explosion of sulphuric acid tank in which hydrogen had formed by adding water

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Common findings

as produced by actual Incident Investigation system

Root causes for human error :

- Lack of Competency
- Procedure not followed
- Procedure incomplete

Which people ?

- Contractors
- Maintenance technicians
- Operators
- …

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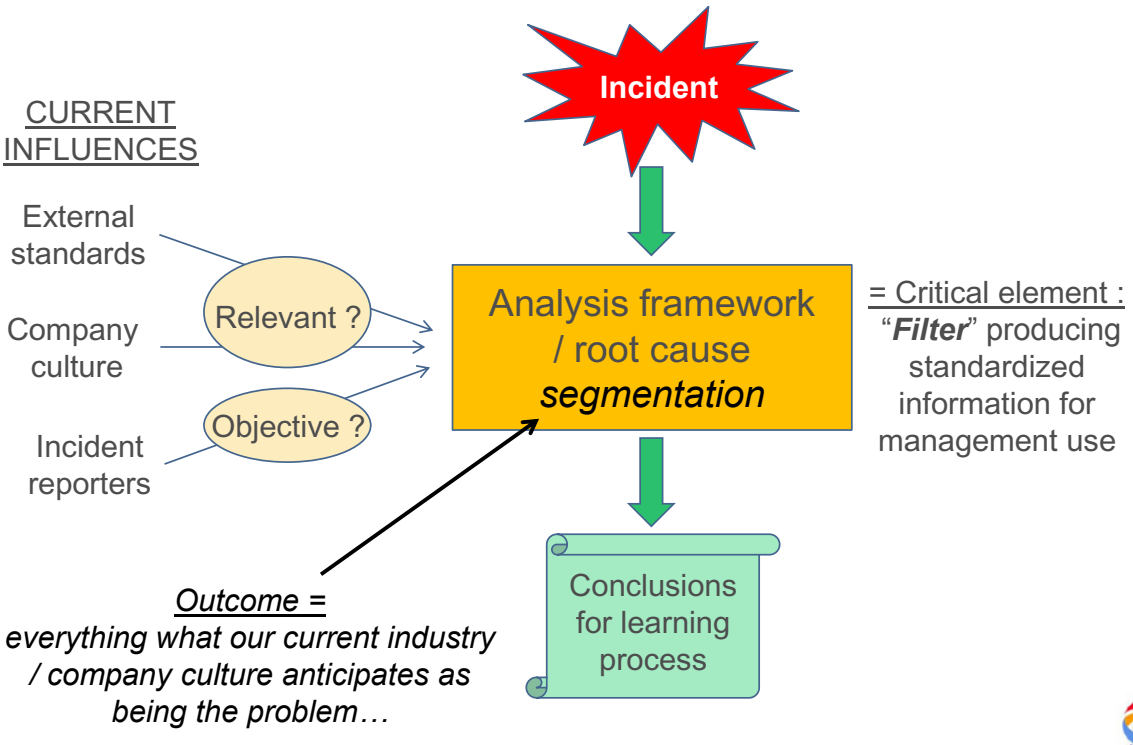
TOTAL

Could we be mislead by our Incident Investigation?



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TOTAL

Abnormal situation Management Consortium's detailed 2008 survey on public and shared member incidents revealed a key insight :

ASM Key Message

- Current incident reporting approaches **do NOT effectively capture the influence of human reliability** on process safety or abnormal situation management performance

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TOTAL

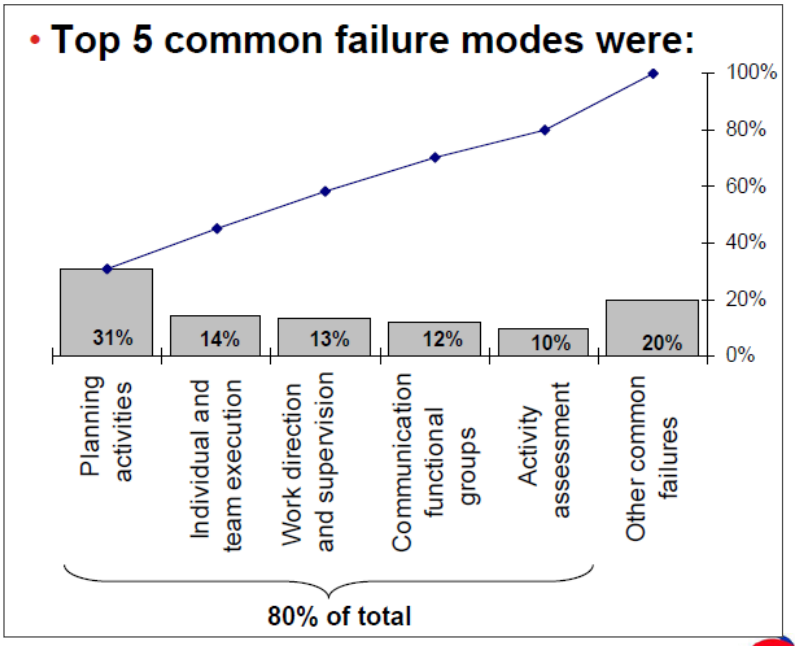
ASM Consortium "deep dive" on communication and coordination failures

14 selected incidents

207 failures

80% = 5 failure modes

- Top 5 common failure modes were:



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TOTAL

"Deep dive" insight

- Common root causes show why failures occurred across incidents

Significant contributor (>15%)
Substantial contributor (>10%)
Moderate contributor (>5%)
Not a contributor (0%)

Root Cause	Combined for Top 5 %	Planning activities %	Individual and team execution %	Work direction and supervision %	Communication between functional groups %	Activity assessment %
No SPAC	12.2%	20.4%	8.6%	7.8%		15.2%
Crew teamwork needs improvement	11.1%	7.4%	15.5%	17.6%	6.5%	12.1%
SPAC not followed	8.8%	7.4%	19.0%	7.8%		9.1%
No communication	8.4%	6.5%		5.9%	32.6%	
No supervision	7.4%		12.1%	19.6%		15.2%

SPAC – Standards, Policies, Administrative Controls

Who is in charge of this ?

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TOTAL

Incident Investigation Paradox

1.
- Up to 80% of all incidents are related to human error
- Up to 80% of all human error is related to organizational matters

2.
- Up to 80% of all incidents are related to worker's behavior
- Worker's behavior is overwhelmingly influenced by their management

- **So :**
  - ***Why are organizational / managerial matters not the primary criterion of the incident investigation ?***

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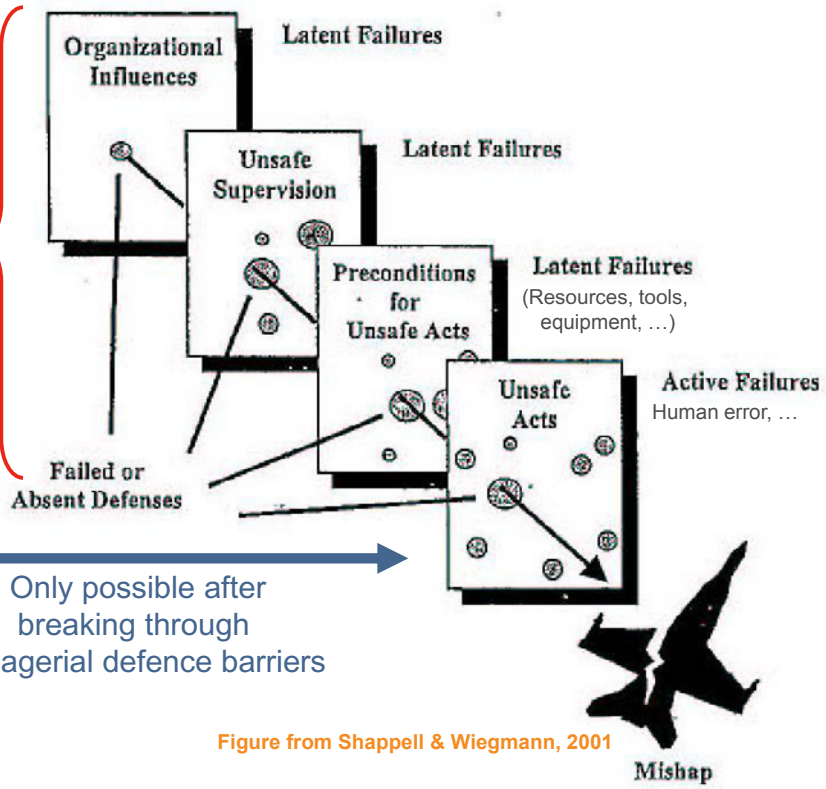
TOTAL

Management emphasis on Human Error approach in the Aviation Industry

Managerial defense barriers



Cockpit failures

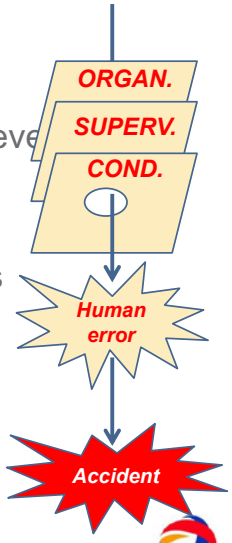
Only possible after breaking through managerial defence barriers

Figure from Shappell & Wiegmann, 2001

14

The Operational Management as Defense Barrier

- **High level mission :**
  - *Conduct the operations at a high standard of excellence (total safety and effectiveness)*
- **<u>All</u> accidents can be prevented by ensuring**
  - That every hazard is identified
  - That effective organizations (rules) are in place against eve hazard
  - That the rules are effectively implemented
  - That all conditions are adapted to the work requirements
- **Also human error …?** **YES**
- **How about risk and probability considerations ?**



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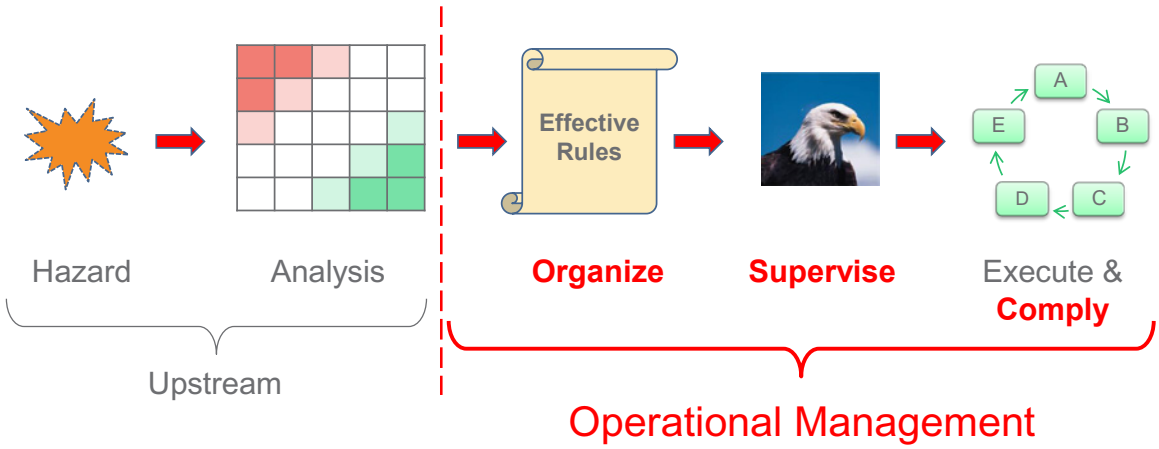
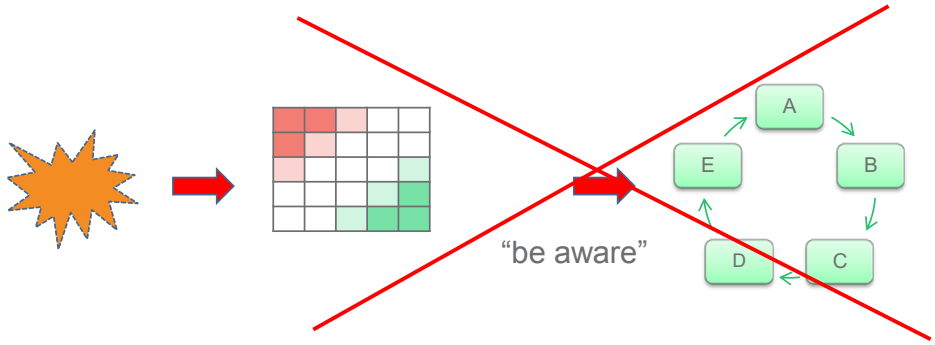
Message : Operational Management = *Rule* Based !



TOTAL

Without good rules and compliance : *"stuck in the matrix"*



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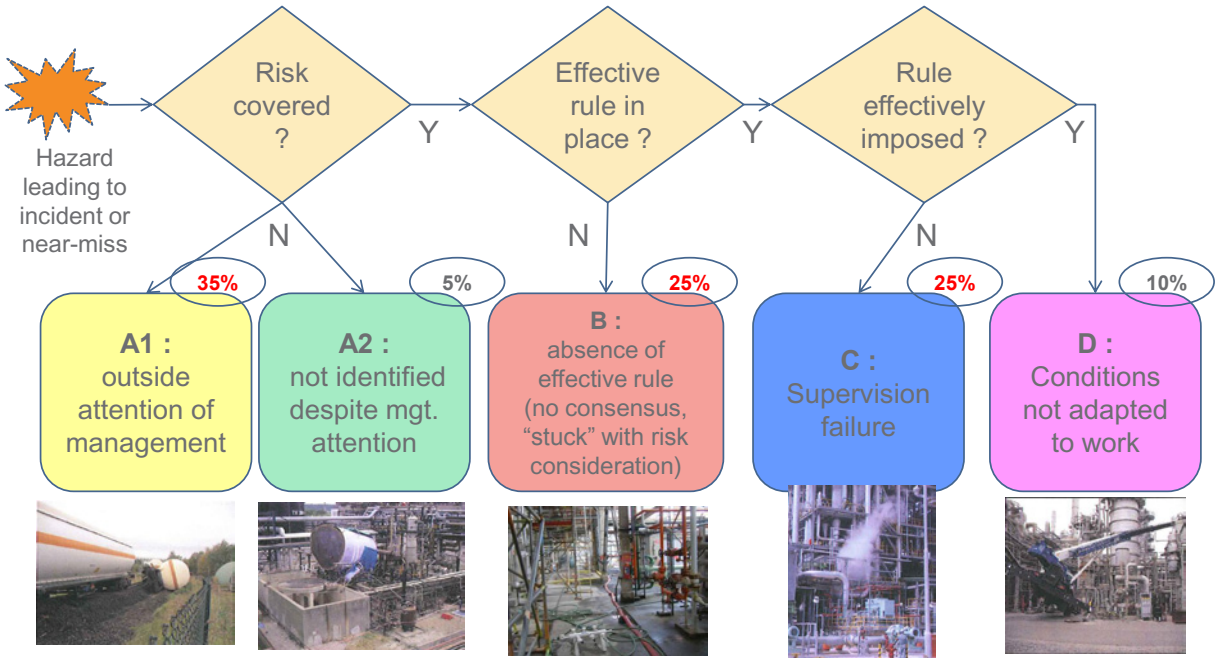
Operational decisions require guidance with rules, not just *risk considerations and awareness*

- *Should I wear a hard hat on a production site, to reduce the risk of being injured by falling objects, or not?*
- *Is it too hot to work in the normal way, or not?*
- *Am I too fatigued to fly this aircraft, or not?*
- *Should I stop a process now because of the risks involved, or not?*

TOTAL

Effectiveness of Managerial Defense Barriers as *relevant segmentation* for incident investigation



- **Advantage : categories identify clearly the corrective action to be taken, by the resource which has the single most direct impact : the operational management**

18

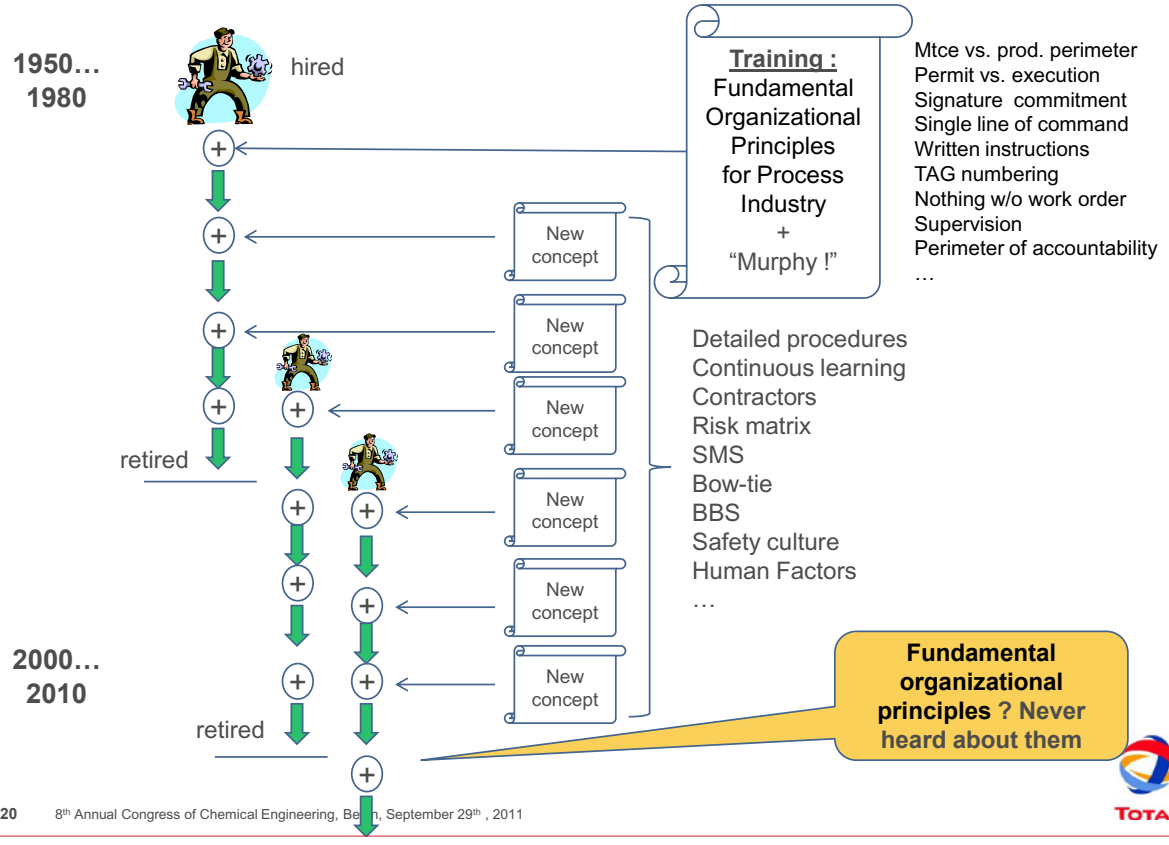
TOTAL

Observed recent tendencies undermining the excellence of the *human manager*

- **Effect of outsourcing and lump sum contracting**
  - Considered "not core" for the company : human (managerial) reaction = focus on other aspects which have hierarchy attention
  - Contractual result = prescribed : human reaction "not my problem any more" (mgt. failure cat. A1)
  - After a while : "we are not competent for this, we have no professional experience"
- **Risk and probability considerations in operations :**
  - Message to the young manager = whatever you do, these (the matrix) are the probabilities that incidents happen in your area … and everyone knows it and agrees
  - Degradation of good rules by "add-on" in order to move at lower risk position in matrix
  - Human reaction : " despite the 10^{-4} it happened in my duty : just bad luck"
- **Audits focused on administrative 'management *systems*'**
  - Instead of detecting field weakness to trace underlying management problem
  - General score system leading to "congratulations" may stop the learning and reduce the essential "sense of vulnerability"

TOTAL

Organisation's competency evolution



TOTAL

What are "good rules" for the Process Industy ?

- **Simple to understand**
- **Universally applicable**
- **Focused on avoiding human error : *Organizational Layers of Protection***
- **Not necessarily the most efficient way to do things, but their universal application generates *overall predictability of the complex reality and overall efficiency***
  - Cfr. Airplane landing
- **Specifically reinforcing Process Safety (the heart of our profession)**
- **"Organizational layers of protection" : not just any rule, but part of a "constitution for the process industry" to which all procedures, organizations and work methods should comply**

TOTAL

Conclusions

- **Operational managers are HUMANS too !**
  - Not immune to human errors
  - Subject to Human Factors
  - Needing guidance and clear expectations framework to perform well
- **Their impact is huge : probably most important improvement tool**
  - Much more direct than "show commitment"
  - Should not be placed in the role of "observers of their department"
- **Operational Management performance vs. high expectation standard should be part of any Incident Investigation**
- **Modern concepts like BBS, risk matrix etc.**
  do NOT replace good organization and RULES
  but come on top of it…

TOTAL

Attachment

Organizational FUNDAMENTALS For the Process Industry

TOTAL

1. Leadership, organisation and accountability

- **Strict role separation : Operations vs. Maintenance / Construction**
  - Each has it's own accountability perimeter and demonstrates "ownership behaviour"
  - Formal interaction and hand-over between all perimeters
  - Each equipment is, at any moment, either in Operations or in Maintenance / Construction perimeter
- **Operations = overall coordinator**
  - Strong « ownership » behaviour required, both day and shift organisation
  - Keeps overall view on perimeters (which equipment or zone is « owned » by whom), their coherence and compatibility with evolving process or operations status
  - Access and occupancy control on operations perimeter
  - Requires to be informed of any event with potential impact on the process even without being the initiator (e.g. electrical operations or tests, …)
- **Clear line of command within each accountability perimeter**
  - No confusion who gives which orders
  - No contradictions
  - Domino system towards plant / site manager
  - Contractors : report / belong to 1 single functional accountability perimeter

TOTAL

2. Safe work procedures and work permits

- **Single set of coherent procedures and instructions**
- **All non-routine work (°) is based on safe work procedure and permit**
  - "Permit" = second person implication + analysis + prevention + personal authorisation
    - Signed paper = 1) necessary "gate to work" and 2) for traceability, to support process quality
  - Single scope and planning definition ; change requires new permit
  - Authorisation : independent from work execution ; proper level
- **"Special Works" requiring special permit**
  - Installation not de-energised
  - Hot work – confined space entry – roof access – elevated work – line opening
  - Hot tapping – excavations – vehicles in process areas – use of heavy construction equipment
  - Fire system impairment – relief valve isolation – interlock bypassing – electrical test / switch / maintenance potentially causing interruption
  - Use of ionizing radiation (effect on instruments)
- **Standard process in place to authorize any deviation from existing procedure**
  - Objective to realise equivalent safety level
  - Incl. procedure review and start of change process, *prior to deviation*

(°) including « 1st line maintenance » (small works by operators)

TOTAL

3. Safe work practices

- **All non-routine work (°) is formally initiated, approved and registered**
  - Mentioning equipment TAG nr.
  - Proper description of required work
- **Golden rule of first choice : installation de-energised**
  - "Visual physical separation" criterion
  - Complementary protective measures : first common, then personal
  - Written justification if "Golden Rule" not applied
- **"Special Works" require special coordination (operations - maintenance)**
  - Could be common supervision, standby, open communication line, hierarchy attention, …
  - See list on previous page
- **Changes to the work plan require new authorisation**
  - Any relevant deviation from defined work description
    - equipment TAG – area – timing – method – resources …
- **Individual signature = personal commitment**
  - In interaction between operations – electrical – maintenance – construction
  - Within each function's accountability perimeter
- **Paperwork is complete before work execution**
- **Work execution follows strictly the permit prescriptions**
  - Both common and personal protection measures

(°) including « 1st line maintenance » (small works by operators)

TOTAL

4. Proper plant and equipment status

- **Each equipment is in a well defined accountability perimeter**
  - Operations – Maintenance / Construction
  - Coherent with available paperwork
- **Accountability perimeters in the field are indicated and respected**
  - Working area indication
  - Energy status of equipment
- **Field equipment is properly TAG numbered**
  - Coherent with up-to-date plans and registers ; no confusion possible
- **Good housekeeping**
  - Clean and organised working areas
  - People and materials logistics
- **Proper lighting**

5. Proper operational communications

- **Proper shift transfer**
  - Each new shift is fully aware of the actual situation before it becomes “in charge” (and writes permits, initiates operations, …)
  - Function per function
- **Proper coordination with operational day organisation**
  - Daily instructions are clear, followed and result reported back
  - Written instructions, written feedback
  - No confusion between orders and information
- **Effective communication between operators**
  - Oral : two-way communication
  - Briefing – debriefing
- **Permanent coherence between field and control room**
  - Registers, logbooks, …
  - Proper and frequent operator tours
  - Effective inter-team (and inter-unit) communication
    - Two-way communication

6. Operations discipline and capability

- **Operations are conducted within formally defined safe operating limits**
  - Defined Process Operating Window : for all critical parameters
  - Process position is tracked and information is known
- **Complex operations are conducted with adapted formalism and preparation**
  - Formal initiation, operator assignment, status tracking, singing-off checklists
  - Verify initial “stable status” before start of procedural operation
- **Operations support tools are effectively used**
  - E.g. critical procedures are “at hand” during operation
  - Critical checklists are signed off after each step
- **Operators are aware of the field / process situation**
  - Information is correct, complete, “smart”, readily available and effectively used
  - Diagnoses are correct
  - Any recent changes are known, trained, documented
- **Operations are within the operation team’s capability**
  - Adequate resources are available
  - People are trained, concentrated, prepared, fit for duty (“permit to operate”)
  - Tools and environment are 100% adapted to the task, functioning and in good shape
  - Plant design and layout allows proper operability
- **Operator performance assurance**

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TOTAL

Training of engineers in safety and risk management: the OECD experience

Mark Hailwood
Chair OECD Working Group on Chemical Accidents
LUBW State Institute for Environment, Monitoring and Nature Conservation Baden-Württemberg
Karlsruhe, Germany

The training of engineers in risk assessment and risk management was the subject of an OECD Workshop organised under the auspices of the OECD Working Group on Chemical Accidents in Montreal, Canada in 2003. The conclusions and recommendations from this workshop consider the professional responsibility to society, as well as to themselves, their employers, their colleagues and other stakeholders, which is exercised by engineers. In fulfilling this responsibility safety and risk management considerations should be integrated into every aspect of engineers' work. Safety should not be considered as an add-on activity, nor should it be considered to be the sole domain of safety specialists.

It is recognised that engineers have different roles within organisations and enterprises. These may range from design, development and production activities to advisory, inspection and management roles. Engineers also work within government authorities, as consultants or within other safety related organisations such as third-party inspectors, insurance companies or training organisations. Thus safety relate activities of engineers are very often inter-disciplinary in nature and may diverge substantially from initial academic qualifications. In addition their work may require interaction with professionals from other fields such as legal, health, psychology, economics, etc.

The workshop recognised the need for continuous development through training, with the initial academic qualification being an initial phase within the professional career of an engineer. In a number of countries the professional status is recognised through professional organisations which accredit qualifications and monitor continuing professional development (CPD). In addition some countries require professional recognition as a precondition to being able to practice as an engineer.

The OECD Workshop took place over eight years ago, and even then it was clear that a range of challenges in relation to the education and professional development of engineers in the field of safety and risk management lay ahead. Amongst these are the continued threats of closure to academic chemical engineering departments and the retirement of professors over the years from within the field of process safety.

This presentation concludes with a few personal thoughts on potential future developments and challenges for process safety in an ever increasingly diverse world.

LUBW

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Training of engineers in safety and risk management: the OECD experience

Mark Hailwood

Chair, OECD Working Group on Chemical Accidents

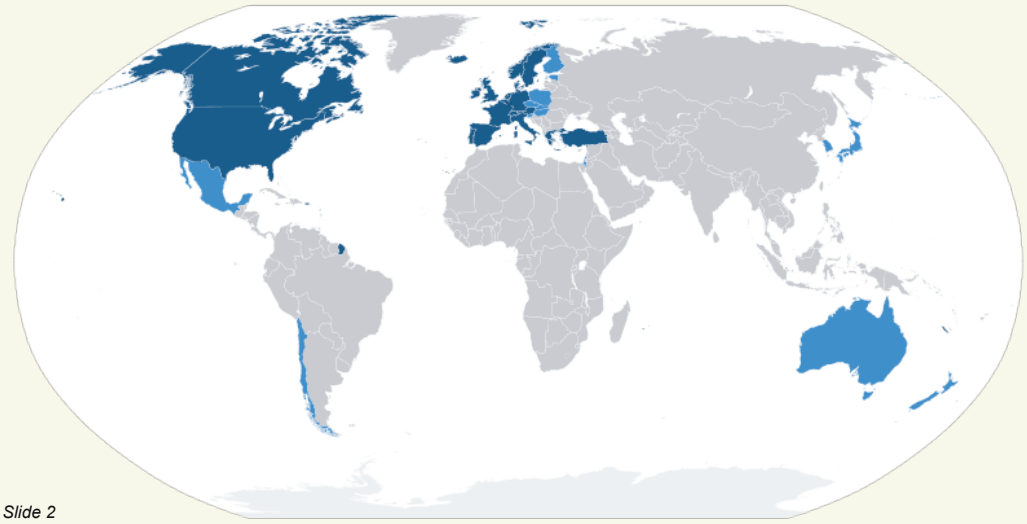
Referat 31 – Immissionsschutz, Umwelttechnologie

Baden-Württemberg

LUBW

Landesanstalt für Umwelt, Messungen und Naturschutz Baden-Württemberg

OECD
Organisation for Economic Co-operation and Development



Slide 2

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Motivation

- The OECD Guiding Principles for Chemical Accident Prevention Preparedness and Response (2nd Ed. 2003, Addendum 2011) describe fundamental aspects which have been developed in consensus.
- The OECD Chemical Accident Programme considers all aspects of chemical accident prevention, preparedness and response – the engineers responsible for risk management are an important part of this process.
- In 2003 needs for improved training in safety and risk management were identified – 8 years later the needs remain, however the conditions and constraints have shifted.

Slide 3

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OECD Workshop on Sharing Experience in the Training of Engineers In Risk Management, Montreal, Canada, 21 - 24 October 2003

- ethical and legal aspects related to risk management;
- risk communication;
- multi-disciplinary approach to risk management;
- training examples including harmonisation/accreditation of training courses;
- training of engineers working in industry and working as public authorities. Inspectors;
- research and development in risk management.

Slide 4

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OECD Workshop on Sharing Experience in the Training of Engineers In Risk Management, Montreal, Canada, 21 - 24 October 2003

- Report published in 2004
- OECD Environment, Health and Safety Publications Series on Chemical Accidents, No. 13
- http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV/JM/MONO(2004)4&docLanguage=En

Slide 5

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General Workshop Conclusions - selected

- Engineers have a professional responsibility to society, as well as to themselves, their employers, their colleagues, and other stakeholders, to take appropriate account of the potential for their work to create, increase or decrease risks to human health, environment, and property.
- Safety/risk considerations should be integrated into the core of every engineer's activities and not be considered an add-on activity. Nor should safety be considered a concern only of safety specialists.
- It was recognised that engineers may have different roles within organisations/enterprises

Slide 6

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General Workshop Conclusions – selected (2)

- Senior managers, designers, operators, maintenance and support personnel, and others should have an appropriate understanding of hazards and risks, as well as an understanding of the relevant aspects of risk management needed to carry out their roles and responsibilities with respect to safety.
- Engineers have a duty to identify safety issues and to provide leadership with respect to safety issues to others in their organisations and to their communities in general.

Slide 7

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General Workshop Conclusions – selected (3)

- As part of their training, engineers should be taught the skills necessary to persuade others to take into account, as appropriate, health, safety and environmental issues.
- It is important for engineers to be aware of the limits of their own knowledge and to seek ways of acquiring additional information.
- Because of the multidisciplinary nature of risk assessment and risk management, training activities should take this into account and integrate, to the extent practical, qualified and informed professionals from various engineering specialties and other sectors.

Slide 8

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Training related conclusions – selected

- It was suggested that most engineers working today had little or no exposure to the concepts of risk assessment and management during their undergraduate training and that further efforts are needed to address this.
- General consensus that the training of all engineers should, at a minimum, include concepts of risk and risk management, while recognising that specific training programmes should take into account the different educational systems in different countries/localities.
- The Workshop recommended university courses related to risk management involve students from all engineering specialties. It was noted that **chemical engineering** courses have generally made greater strides than other engineering courses in incorporating practical training related to risk management into their overall programme.

Slide 9

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Training related conclusions – selected (2)

- Participants suggested that training in risk management should not be limited to engineers but should also be available for business managers as well as for other professionals such as lawyers, economists, chemists, biologists, etc.
- It was recognised that programmes and methods for training of engineers have been expanding and evolving in light of the diversity of risks in a modern society and consequent increased demand. Such risks involve, for example, genetically modified organisms, terrorism, computer security, pandemics, as well as risks in the nuclear, chemical and transport fields.

Slide 10

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Training related conclusions – selected (3)

- The Workshop also noted that concepts of safety and risk, including risk assessment and management, should be introduced to all students in schools and universities (in addition to specialised engineering courses) in order to develop a safety culture in society generally.
- While universities and training programmes can provide a good grounding for engineers, it remains necessary for employers to provide additional training.
- Participants suggested that professional associations (e.g., engineering societies) should support the continuing training of practicing engineers in the area of risk management.
- Concern was raised about how to maintain and expand interest in risk management programmes, particularly with the resource limitations being faced by industry and universities.

Slide 11

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Eight years on – a personal view

- The first graduates from the Bachelor / Master programmes in Germany are now entering the workforce following the restructuring of university courses due to the Bologna Process.
  - Hazard Identification and Risk Management do not appear to have been integrated into these courses generally; neither as compulsory nor as optional elements.
  - There is a need to recognise that safety entails more than designing to accepted standards.
- The general public's view of engineers and engineering is that the subject is 'difficult', and that the financial rewards do not match the effort required.

Slide 12

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Eight years on – a personal view (2)

- Within the public authorities, partly due to financial cuts:
  - there is an ageing workforce;
  - those who retire are often not replaced;
  - specialists, e.g. in process safety, are not encouraged;
  - continual training in process safety / risk management is limited by available resources.
- There are concerns that more and more decisions are being made by lawyers, administrators, economists and politicians, and that the views of the engineering profession are insufficiently sought and often ignored.
- Engineers need to improve their communication (generally and in risk related issues) with all sectors of society.

Slide 13

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Eight years on – a personal view (3)

- Without (process) engineers with training and understanding in safety and risk management, both in industry and public authorities, we run the risk of having industrial sites:
  - Which are inappropriately designed,
  - Which are not adequately maintained,
  - Which are not properly licensed, and regularly overseen and inspected by the authorities,
  - In which accidents occur, that could be avoided and which will not be adequately investigated in the event.
- There needs to be a professional approach to furthering the needs of industry, authorities and society as a whole.

Slide 14

EPSC Award 2011

The European Process Safety Centre (EPSC) is a company member network dedicated to the development and promotion of best practice in process safety. The Centre is hosted by IChemE and was established by EFCE in 1992.

Each year EPSC acknowledges progress to a less hazardous Europe with the presentation of an EPSC Award to either an individual or team. The contribution may be in the form of a project, report, published paper, conference paper or book which, in the consideration of the EPSC Award panel, has considerably advanced the theory or practice of process safety.

The call for the EPSC Award 2011 puts a focus on achievements related to process safety competence, not excluding work which has general relevance to process safety. For the 2011 award, EPSC has chosen to recognise the work of Dr. Martin Glor in the field of electrostatic interaction between fluids and pipes. The study of charge accumulation in flammable liquids is well known to be a crucial issue in safe transport and storage of these materials. Martin Glor's work has extended knowledge on safe transfer of fluids, allowing experimentally validated safe limits to be set for aspects of handling non-hydrocarbon fluids, such as limits on flow speeds through pipes. Dr. Glor has a long history of safety research throughout his career, with a focus on electrostatics and explosives, has headed projects for many groups including Ciba-Geigy AG and the Swiss Institute for the Promotion of Safety & Security. He is currently senior expert and CEO of a process safety consulting firm.

Index of Speakers, Chairpersons, Panelists

Lee Allford is a chartered chemical engineer who joined the European Process Safety Centre (EPSC) in 2000 as Operations Manager in the development and promotion of best practice in process safety across Europe. He has supported numerous EPSC working groups on process safety topics, written & edited member reports, and given papers and presentations at international meetings and conferences. He is currently a member of the editorial panel of the IChemE publication Loss Prevention Bulletin (LPB). Prior to EPSC he worked for RTZ Chemicals, Diageo & Vivendi in line management and site based staff roles including that of process improvement, quality management and asset maintenance.

Peter Dehnbostel is professor emeritus of vocational and work pedagogy from the Helmut-Schmidt-University, Hamburg, currently teaching at a number of other universities and involved in different projects. After an apprenticeship, he studied mathematics and social sciences at the Free University Berlin with graduation in mathematics, followed by doctorate and habilitation at the Technical University of Berlin in the field of vocational education. Today Peter Dehnbostel has over 35 years of experience in teaching in the tertiary sector and in the field of vocational training and also in research, innovation, development and quality assurance mostly in the sector of vocational education, further education and organisational development.

Paul Delanoy worked for about 10 years as an Industrial Chemist, initially at British Sugar Plc and later with the Dow Chemical Company where he still works today. In 1993 he moved to a role as a Production Engineer. Subsequently, he added units from a Chemical Engineering Degree to his existing Chemistry degree and completed the Institution of Chemical Engineers (IChemE) Design Project (for which he was awarded the IChemE MacNab medal) in order to make this equivalent to a Chemical Engineering Degree and qualify as a Member of the IChemE. At the end of 2003, after about 10 years experience in various Chemical Engineering roles, Paul moved into Process Safety as a Process Safety Technology Leader. This role has evolved with time and Paul currently works as a full time Subject Matter Expert specializing in Human Factors and Process Risk Assessment. Paul is involved in several projects for the European Process Safety Centre (EPSC) and is a member of the EPSC Management Board.

Michael Dröscher is the current president of the German Chemical Society (GDCH). His academic career started at Mainz University where he studied chemistry and got 1975 the doctor degree in physical chemistry. He habilitated 1981 at the University of Freiburg in macromolecular chemistry and became supernumerary professor at the University of Münster in 1988. In 1982 Michael Dröscher entered Hüls AG, Marl, which later merged in Degussa-Hüls AG and finally became Evonik. His final position at Evonik was Vice President Innovation Management Chemicals.

Ursula Fischbach is member of the Industry/Seveso working group of the European Environmental Bureau (EEB) and the environmental organization BUND (Friends of the Earth Germany). She graduated 1973 in physical chemistry at the Goethe University in Frankfurt on the Main, received her doctor degree in 1977 at the Technical University of Darmstadt, and continued scientific research in climate and CO2 modeling. Presently her main activities are related to labor and environmental protection. Ursula Fischbach represents BUND in the Commission on Process Safety at the German Ministry for the Environment, Nature Conservation and Nuclear Safety.

Andreas Förster works for DECHEMA since 1997. He is currently the head of two departments “Research Management and Conferences” and “chemical engineering”. Andreas Förster has a diploma in chemistry and holds a PhD in the field of Physical Chemistry, both at the University of Würzburg. From 2006 to 2010 he was managing director of the German Bunsen Society for Physical Chemistry. Since 2010 he is managing director of fms (Forschungsgesellschaft für Messtechnik, Sensorik und Medizintechnik e.V., Dresden) as well as of ProcessNet.

Manuel R. Gomez joined the staff of the CSB in 2004 and currently serves as the Director of Recommendations. He has more than twenty-five years of experience in occupational and environmental health and safety. He holds a Doctorate in Public Health from Johns Hopkins University, a Master's in Environmental Health from Hunter College of the City University of New York, and an Undergraduate Degree in Biochemistry from Harvard College. He is a Certified Industrial Hygienist, a member of numerous professional societies, and the author of a book and numerous scientific papers and presentations. Manuel R.Gomez previously served as the Director of Scientific Affairs for the American Industrial Hygiene Association. He was responsible for the society's expert technical committees, laboratory accreditation activities, and voluntary consensus standards program.

Mark Hailwood graduated with a degree in Applied Chemistry from the University of Salford in 1989 and was awarded the degree of MPhil in 2000, having completed his dissertation researching the implementation of the Seveso Directive within the EU-15 states. Since 1991 he has worked for the German State of Baden-Württemberg in the field of Major Accident Prevention. His role is to advise the state Environment Ministry and State Inspectors on the application of Major Hazards Legislation and on process safety generally. Particular fields of interest are safety management systems, hazard identification and risk assessment, human factors and risk communication. Mark has been involved in a wide range of international activities with the European Union (EU), United Nations Economic Commission for Europe (UNECE), United Nations Environment Programme (UNEP) and the Organisation for Economic Cooperation and Development (OECD). He is currently the chair of the OECD Working Group on Chemical Accidents.

Niels Jensen is currently retired, which gives him time to blog about safety on Safepark Consultancy's website. His professional career that shaped his views on process safety involved almost a decade as a computer control engineer with Imperial Oil Limited in Canada, and two decades as an associate professor in chemical engineering at the Department of Chemical and Biochemical Engineering at the Technical University of Denmark. Niels Jensen has a Master of Science degree in Chemical Engineering from DTU, where the thesis was written under the supervision of professor Sten Bay Jørgensen, and a Ph.D. Degree also in Chemical Engineering from University of Alberta, where the thesis was written under the supervision of professors D. Grant Fisher and Sirish L. Shah.

Christian Jochum is Director of Centre for the European Process Safety Centre (EPSC) in Rugby/GB. He also chairs the Commission on Process Safety, which advises the German Federal Government in process safety issues. In 1969 Christian joined Hoechst AG, then a major international chemical and pharmaceutical corporation. After 10 years in pharmaceutical research and pilot plant operations he joined the safety department. 1988 – 1997 he was Corporate Safety Director for the international Hoechst group, including the responsibility for safety, process safety and industrial hygiene. Since 1997 Christian is working as a free-lance consultant, advising companies of different sizes and sectors as well as governmental agencies in safety, process safety, risk and crisis management issues. Christian holds a doctorate in chemistry and was honorary professor at Goethe University, Frankfurt(Main). He has been awarded with the German Order of Merit for his contributions to process safety.

Konstantinos Mitropetros has a diploma in chemical engineering from the Technical University of Athens, Greece and holds a doctorate degree from the Technical University of Berlin, Germany. His doctorate deals with explosion phenomena in bubbly liquids. After graduation he worked for six years at the Federal Institute for Materials Research and Testing in Berlin as a member of a team performing experimental and theoretical research on heterogeneous explosions. In 2006 he joined DECHEMA. Some of his current tasks are to support the ProcessNet section safety engineering and its committees; to represent DECHEMA at organizations in the field of industrial safety, such as the European Process Safety Centre; and to be responsible for the scientific program on industrial safety and security of the worldwide largest exhibition for the process industry ACHEMA.

Louisa A. Nara is the Technical Director of the Center for Chemical Process Safety (CCPS) for the American Institute of Chemical Engineers (AIChE). Louisa Nara came to AIChE/CCPS after 15 years with Bayer where she held positions of increasing responsibility including: Manager Process Safety and Crisis Management; Director of HSE, Security and Emergency Response at Bayer's largest US Manufacturing site; and, Director, Risk Management and Compliance, NAFTA. Prior to joining Bayer, she also gained significant experience in process safety, engineering, and HSE with Diamond Shamrock, PQ Corporation, and in private consulting. Her roles and responsibilities within CCPS include: overseeing the execution of projects in the CCPS technical portfolio; developing and enhancing CCPS's educational offerings; developing and deploying new tools; and, enhancing value for corporate sponsors. Louisa Nara holds a Bachelor of Science in Chemical Engineering from West Virginia University, a Master of Science in Environmental Engineering from Villanova University and is a Certified Compliance and Ethics Professional (CCEP).

Hans J. Pasman is member of the Dutch Council of Hazardous Substances, Research Professor at Mary Kay O'Connor Process Safety Center of the Department of Chemical Engineering of Texas A&M University and Emeritus Professor Chemical Risk Management of the Delft University of Technology in the Netherlands. Graduated in chemical technology at Delft University of Technology in 1961, with Ph.D. in 1964 while employed by Shell, joined the Dutch organisation for Applied Research, TNO, for research in reactive materials, explosions, investigation of industrial accidents and risk analysis. He was chairman of the International Group on Unstable Substances for 10 years, the European Study Group on Risk Analysis (1980-1985), a NATO Group on Explosives, and the Working Party on Loss Prevention and Safety Promotion in the Process Industries (1986-2004) and in this latter capacity in 1992 co-founder of the European Process Safety Centre.

Norbert Pfeil is chairman of ProcessNet's Safety Engineering Section. He graduated in chemistry in 1972 at the Technical University Berlin, got his doctoral degree in 1978 and worked since then with BAM Federal Institute for Materials Research and Testing. After more than 10 years in the field of pyrotechnics his responsibilities enlarged on the one hand to reactive materials in general and on the other hand to all regulatory areas relevant to dangerous substances and goods. Since 2003 he is member of BAM's directorial board with new responsibilities shifted to general management tasks.

Martin J. Pitt has degrees from the Universities of Aston and Loughborough and has a long-standing interest in chemical and chemical engineering safety. He currently teaches design and safety at the University of Sheffield, UK. He also gives lectures on industrial short courses and MSc modules. His experience includes being Safety Training Organizer for J. T. Baker Chemicals Ltd, project chemical engineering and being manager of a chemical plant as well as his academic career. He was for many years the only academic on the Committee of the Safety and Loss Prevention Subject Group of the Institution of Chemical Engineers (IChemE), running the website and organizing meetings, including those for other academics on teaching safety. He is on the organizing committee of the successful "Hazards" series of conferences. He is a long-standing member of the Committee of the Safety and Loss Prevention Subject Group of the Institution of Chemical Engineers, and is currently Chairman of the EFCE Working Party on Education. Since 1990 he is assistant editor of Bretherick's Handbook of Reactive Chemical Hazards.

Eddy De Rademaeker is Managing Director of Prevention Management International and Chairman of the Working Party on Loss Prevention in the Process Industries of EFCE. He holds a Diploma of Civil Chemical Engineering, from the State University Ghent and a Diploma in Safety Engineering/Management from the University of Antwerp. He has over thirty years of practical experience in safety management and is a certified Lead Auditor OHSAS 18001, and regularly acts as an expert witness for different courts in Belgium. He formerly held engineering and safety positions in the chemical and engineering industry and was Director Safety Services for the group of companies of Janssen Pharmaceutica N.V. (Johnson & Johnson).

Herman Van Roost studied at the University of Leuven (KUL) and holds a Civil Engineering degree in Electro Mechanics and Energy Conversion. From 1980 to 1996 he worked in the Antwerp petrochemical industry for Exxon Chemical and Fina, in several engineering and maintenance functions, and as Maintenance Manager and Plant Manager. Between 1996 and 2006 he occupied several business management positions within Petrofina and its successor company Total Petrochemicals. In 2007 Herman Van Roost returned to the industrial branch of Total Petrochemicals as General Manager of the corporate project 'Industrial Organisation and Competencies', and from 2010 he headed a strategic project on reshuffling the governance of the group's Antwerp site. Since 2012, he is in charge of new business development in the Middle East and North African region for Total Refining and Chemicals.

Peter G. Schmelzer holds a doctorate on chemical engineering from the University of Dortmund (1987). Today he is working for the Bayer Group. He has extensive professional experience as Plant and Process Engineer at many Bayer locations. During the last twelve years he has being intensively focusing on process and plant safety. His current field of responsibilities includes Health, Safety and Environmental Protection for the Bayer whole Subgroup HealthCare. He also leads the Bayer Group Community on "Global Process and Plant Safety". He is an active member, mostly as chairman, of many high level committees both within the Bayer Group (e.g. he is chair of the Process and Plant Safety Committee and community) as well as within several industrial associations and other NGOs like the VCI (Chair of the "Process and Plant Safety" committee), CEFIC (Chair of the "Issue Team Process and Plant Safety" committee), EPSC (member of the Steering Committee), EFCE (member of the working party "Loss Prevention") and ProcessNet (Chair of the working group "Lessons Learned"). Peter is also deputy chair of the well known "Major Hazard Commission" of the German federal environment ministry (BMU).

Jürgen Schmidt worked with BASF since 1993, after six years at Hoechst AG. His experiences are in developing safety concepts, consultancy of plant managers and performing research especially in the fields of model-based safety related process control systems, condensation of heavy volatile components in natural gases and the design and sizing of safety devices. Jürgen Schmidt studied process engineering at the Ruhr-University Bochum with a focus on thermal and fluid engineering, wrote his master thesis at the Texas A&M University and made his doctorate dealing with two-phase flows in pipes during his work at Hoechst AG. Since 2002 he lecture process and plant safety and is honorary professor at the Karlsruhe Institute of Technology. Within ProcessNet's Safety Engineering Section he is member of the steering committee, chairs the working party "Safe Desing of Chemical Plants" and is currently involved in elaborating process and plant safety curricula for relevant bachelor and master degrees. His international activities are in the standardization of sizing safety valves and in the European DIERS User Group.

Hans V. Schwarz is since 2010 as VP Process Safety the head of process safety globally for the BASF group (BASF SE, Ludwigshafen). His previous positions within BASF, which he joined in 1986, have been 2003 – 2010 BASF Polyurethanes (Brussels), first as Director Polyol Technology, later as Project Director supply chain optimization (project ‚Polyplex'); 1999 – 2003 BASF Corporation (Baton Rouge, USA) head of investment project for new TDI plant; 1994 – 1999 BASF Polyurethanes (Brussels) global technology management for TDI, MDI; 1991 – 1994 BASF Corporation (Baton Rouge, USA) Manager Technology & Production Isocyanates; 1986 – 1991 BASF AG (Ludwigshafen) manager process R&D and later plant manager high pressure pilot plant of the 'Ammonia Laboratory'. Hans holds a diploma in chemistry and a PhD in physical chemistry from the University of Heidelberg, Germany.

Jan Slijpen started his career in the industry sector as a Safety and Environmental Engineer for DSM. He initially graduated as a Chemical Engineer and studied Risk Management and Occupational Safety and Health. Today he is a highly experienced expert in the public sector for the areas Process Safety, Risk Management and Occupational Safety and Health. In the past 30 years he has been working for the Dutch Labour Inspectorate at several positions. His professional experience in the afore-mentioned areas includes working for the European Commission in several Central and Eastern Europe countries and for a number of UN organizations, like for the ILO in India. Since 2003 he is Head of a Major Hazards Control Inspection Team for the Dutch Inspectorate of Social Affairs and Employment at the Central Government. He continues to deliver training on Risk Management and Process Safety in a number of countries.

Jörg Steinbach is the current president of the Technical University (TU) Berlin, the university where his academic career started in 1975 with studies in chemistry, completed in 1985 with a doctorate on the safety of indirectly cooled semi-batch reactors. He then joined Schering AG advancing 1992 to the head of the plant safety section. In 1994 he habilitated in chemical engineering. 1996 he went back to TU Berlin as professor for plant and safety technology. To name a few of Jörg Steinbach's avocational activities: he is member of AIChE, the American Institute of Chemical Engineers, during many years he was member of the Technical Committee on Plant Safety at the German Ministry for the Environment, Nature Conservation and Nuclear Safety, from 2007 to 2009 he was president of the European Society for Engineering Education (SEFI), and currently he is chairman of AVI, an association for the accreditation of engineering curricula.

Gerd Uhlmann is head of the Training Center Maikammer of BG RCI, the statutory industrial injuries insurance for raw materials and chemical industries, where both managers and staff are educated in occupational health and safety including process and plant safety issues. Gerd Uhlmann started his tertiary education in chemistry at Clausthal University of Technology, finalizing with a doctor degree at Heidelberg University. Before he joined the Training Center Maikammer he worked for ten year with the former Hoechst AG.