

Keeping and Improving Process and Plant Safety Competence – What is Needed, What Should be Done?

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In March 2004 with the position paper "Maintaining and improving competence in safety engineering" of the DECHEMA/GVC Research Committee "Safety Engineering in Chemical Plants", an initiative came up against the tendency that more and more process and plant safety (PPS) orientated professorships turn to other more fashionable research topics. The Research Committee was concerned that PPS in both academic teaching and research could suffer a negative development - despite of its importance. In 2009 a corresponding Dutch initiative followed. To bring these both and other similar initiatives together, within the 8th European Congress of Chemical Engineering held in Berlin in September 2011 a two days special session on PPS competence was jointly organized by EFCE, ProcessNet and EPSC. All presentations and conclusions drawn by the organizers (the authors of this paper) are electronically available.

The paper addresses the before mentioned initiatives, highlights views and results from the ECCE 8's special session on PPS competence, and indicates steps necessary to be taken and recent developments.

1. Two initiatives - one message

"The chemical industry and process engineering equipment manufacturing are important contributors to Germany's economic strength and employment. To ensure further development of this industry it is important that current and future factories designed, built and operated in Germany continue to operate at very high levels of safety. Safe facilities not only protect people and the environment against harm, they are also more efficient, since defects always mean downtime and financial loss. Safety engineering therefore promotes integrated process understanding." This is the first paragraph of the position paper "Maintaining and improving competence in safety engineering" of the DECHEMA/GVC Research Committee "Safety Engineering in Chemical Plants", March 2004 (DECHEMA/GVC, 2004). What this paragraph says holds not for Germany only, but for many other countries. Obviously, also the reasons why such a position paper was found to be necessary hold for the situation in other countries: independent of the German initiative in 2009 a similar Dutch initiative became public (AGS, 2009). Both initiatives will be outlined in the subsections below.

1.1 DECHEMA/GVC position paper of March 2004

DECHEMA is the German Society for Chemical Engineering and Biotechnology, GVC the Chemical and Process Engineering Society of the Association of German Engineers (VDI). Key messages of DECHEMA/GVC's position paper were:

- Safety engineering must keep step with technologic developments in process and plants technologies.
- Safety engineering must be an integral component of the chemical and process engineering disciplines in university education.

- The necessary transfer of competence can only be maintained with a combination of research and teaching.
- There is concern, that safety engineering is no longer being developed to the degree that its importance merits.

In a roundtable discussion in November 2004 with representatives from industry, academia and ministries it was shown where such a concern came from. Figure 1 illustrates how a map of research institutes - from academia, government and private sector - may change when public funding of a certain research area is omitted. From 1985 – 1995 relevant safety research was funded nationally with increasing yearly volumes up to 7 million Euros. In parallel a European “Major Technological Hazards” program made per annum 5 million Euros available. After these programs expired, implications seen were a decreasing number of safety related submissions of lectures and posters of DECHEMA’s annual conferences (from more than 40 in 1995 to 15 in 2004) and also unsatisfactory applications on relevant positions in industry, science and administration. Today only 8 university institutes with relevant research are left (only 4 with main focus on safety) - from 26 before.

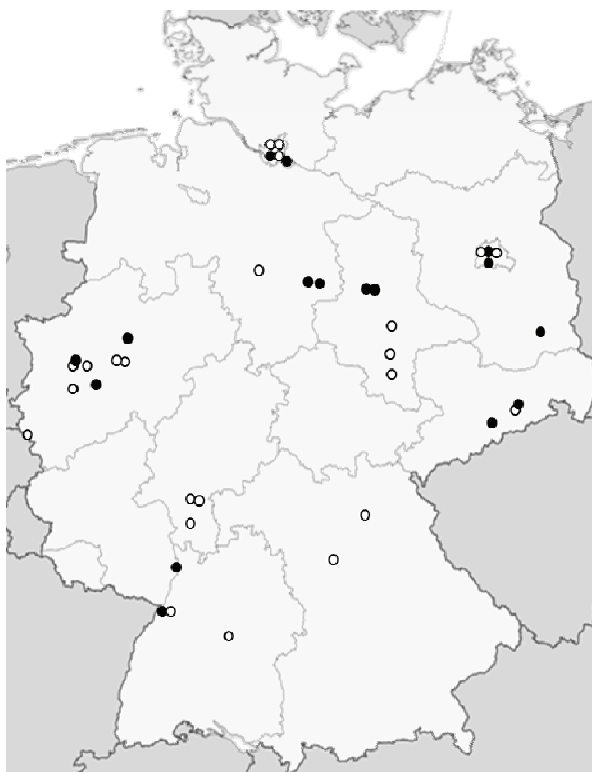


Figure 1: Safety research in Germany - map of institutes until 1995 (filled and open dots) and today (open dots); map author: NordNordWest; institutes: Oberhagemann (2004), Schuster (2004), DECHEMA (1995-2005)

In order to prevent loss of competency in process and plant safety, the position paper suggested to use the DECHEMA/GVC "Safety Engineering in Chemical Plants" research committee in exercising the tasks of a competency alliance which was to

Indicate training deficits and work towards their mitigation,

Indicate and prioritize key areas of safety engineering research,

Contribute to making existing knowledge, experience and new findings available, and to explain the application thereof, particularly to SMEs.

Further, the position paper suggested an initiative for securing financing for necessary research projects in safety engineering by bringing together representatives of ministries which assign and distribute public subsidies, representatives from VCI (German Chemical Industry Association), as well as decision makers from major chemical industry companies.

The last paragraph of the position paper reads "By making these suggestions the DECHEMA/GVC "Safety Engineering in Chemical Plants" research committee wants to make a contribution to maintaining and

improving competence in safety engineering in Germany. In the interest of safeguarding the future, industry and policy makers are called upon to take up the aforementioned suggestions.”

The idea behind these proposals was to strengthen process and plant safety competence at the universities both in research and teaching. However, the Federal Ministry of Education and Research (BMBF) did not participate in the roundtable. Since then the initiative tried to get the BMBF on board, via personal contacts, panel discussions, writing the Minister etc. Until now, the position of BMBF in short was as follows: industry itself is responsible for operating their plants safely - funding safety research explicitly between 1985 and 1995 was meant as a stimulation after a number of severe industrial accidents - teaching is primarily a matter of the German Länder - chemistry related safety research is funded, but in connection with innovations as micro process engineering or nanotechnology.

1.2 Dutch advisory report of 2009

“Strategic Approach for Safe Chemical and Energy Industries. Knowledge about safety and hazardous substances for the Netherlands of 2020.” was the full title of the AGS’ advisory report of 2009 (AGS, 2009). AGS is the Hazardous Substances Council of the Netherlands. At the 13th Loss Prevention Symposium Oostendorp et. al (2010) presented details on the report including the underlying bibliometric analysis in the safety and hazardous substances knowledge domain with the three sub-domains hazardous properties of substances/system safety/process safety. One interesting result of the bibliometric analysis is reproduced in Figure 2, showing the publication activities in the safety and hazardous substances domain of selected countries.

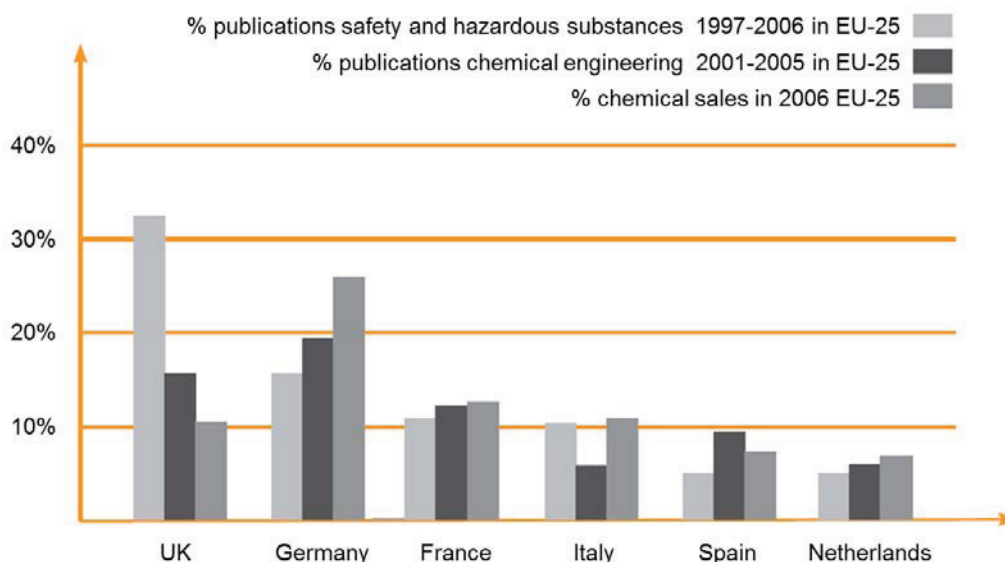


Figure 2: Contribution of six EU countries in percentage of the total number for all EU-25 countries to publications in the safety and hazardous substances domain, to publications in the chemical engineering domain and to the sales of chemical companies (Oostendorp et. al, 2010)

Recommendations and views from the summary of the report can be condensed as follows:

- A critical research mass as a means of safeguarding the university focus – research and education – on safety should be created.
- A threefold increase of university research is estimated to be required.
- This critical mass requires a certain minimum of fixed public financing for fundamental research to safeguard the independence of the research and the focus on the subject for a longer period of time.
- Government and parliament should enter into discussions with the 3TU Federation (three leading universities of technologies) on this subject.
- A focus on safety in the curriculum of relevant universities – including process technologists, chemists, civil engineers and urban designers – should be better safeguarded.
- A fixed percentage of the ongoing public/private research programs should be spent on safety and hazardous substances.

- A public/private coordinating body should be created to administer the above percentage from public as well as from private funds.

However, also the Dutch initiative did not proceed successfully until now.

2. ECCE 8's special session on process and plant safety

After both the German and the Dutch initiative did not progress, the idea was born between ProcessNet (a joint initiative of DECHEMA and VDI-GVC) and EPSC (European Process Safety Center) to raise the discussion on process and plant safety on a European (and wider) level and to organize a special event for the 8th European Congress of Chemical Engineering (ECCE 8), which was jointly organized by EFCE (European Federation of Chemical Engineering) and ProcessNet. The conference took place from 25th to 29th September 2011 at the International Congress Center ICC Berlin. Not everybody expected the two days special session with the provoking title "Process Safety Competence – European Strength degrading to Weakness" to prove to be a big success, but it was. The participation over both days made this session to one of the Top 10 of the whole conference. The organizing committee of the session (authors of this paper representing EFCE Working Party Loss Prevention, ProcessNet and EPSC) obviously had advertised the event successfully by inviting to discuss questions like

- Is 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 on average joined the special session with speakers from Belgium, Denmark, Germany, the Netherlands, the United Kingdom and the United States and a panel discussion at the end. The abstracts, presentations and conclusions drawn by the organizers are electronically available (Schmelzer et al., 2012). Important statements and findings are reproduced below.

2.1 Key issues and results

"Avoiding accidents – process safety competence could make the difference" was the opening lecture given by Manuel R. Gomez from the U.S. Chemical Safety and Hazard Investigation Board (CSB), unavoidably telling stories of accidents and what went wrong in each case. Often it was a lack of process safety competence. What competence from a pedagogic and scientific point of view was, explained Peter Dehnhostel, professor emeritus of vocational and work pedagogy, using the definition of the European Qualifications Framework "the proven ability to use knowledge, skills and personal, social and/or methodological abilities...". And Niels Jensen, Denmark, member of EFCE Working Party Loss Prevention, reported on his study where in Europe a degree in PPS can be got: "You are lucky if you live either in France, Germany, Hungary, Norway, Russia, Scotland, Spain or Sweden because then you can study process safety without travelling to a foreign country."

With the subsequent talks a wide spectrum of institutions and companies presented views on PPS competence: ProcessNet, AGS, TU (Technical University) Berlin, IChemE (Institution of Chemical Engineers), EPSC, CCPS (Center for Chemical Process Safety), DECHEMA, BG RCI (statutory industrial injuries insurance - Berufsgenossenschaft - for raw materials and chemical industries), EFCE Working Party on Education, Dutch Ministry of Social Affairs and Employment, CEFIC (European Chemical Industry Council), BASF, Total Petrochemicals, and OECD Working Group on Chemical Accidents. Lectures and discussions made clear, that PPS competence is something multifactorial:

- Steps of competence development are the general education, vocational education and training, higher education, and further vocational education and training - every step taking advantage of the former.
- Accordingly, the institutions imparting the necessary competences are school, universities, other educational bodies, and the enterprises themselves.
- PPS competence and a highly developed safety culture have to be understood as key assets of chemical and petrochemical industries.
- Best practices and standards help to improve performance in each of the areas "education and training", "process and plant design" and "operation and management".

Over the two days, the organizing committee of the special session identified a number of views which seem generally accepted by the auditory and in the concluding panel session. In the preface of the booklet on the session these views were summarized as follows:

- 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.
- Today's 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 extent 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 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 organizations and industry associations.

2.2 How to proceed?

No question, that all societal areas and stakeholders mentioned above are bound to their individual tasks and goals. And insofar as process and plant safety is part of these tasks and goals, they contribute to ensuring the necessary level of safety – sometimes the efficiency could be better. However, universities and professors enjoy relatively great freedom in what they do in research and teaching in detail. When the panel discussion came to the decreasing interest in process and plant safety at the universities, a panel member put it in a nutshell: "Professors go where the money is." Therefore, the final key messages of the session's organizers to all stakeholders in process and plant safety were:

- Continue and strengthen existing initiatives developing systematic approaches to create and maintain process safety competence for design and operation.
- Support the idea of an European university curriculum on process and plant safety for relevant bachelor and master degrees, preferably with EFCE taking the lead.

3. Outlook

For the time being, three activities with respect to the university area are under the way in Germany. Firstly, ProcessNet's new curriculum on process and plant safety recommending both bachelor and masters modules is nearly finished and will be made available in the course of this year (ProcessNet, 2012). Secondly, a Center of Safety Excellence shall be established at KIT (Karlsruhe Institute of Technology). Thirdly, ProcessNet plans an exchange of ideas with German professors of chemistry, chemical engineering or similar disciplines to agree on the need to have process and plant safety incorporated into every relevant bachelor or master degree program. And finally, the EFCE Working Parties on Education and on Loss Prevention are intending similar initiatives at European level. Details will be reported later. However, it seems to be widely recognized that there are unfavorable developments and that countermeasures have to be taken.

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