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History Does Not Have to Repeat Itself: 20 Years Contribution of the Online DECHEMA Incident Database

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The value of learning from process safety accidents and incidents is unquestionable. Databases can accumulate these lessons and function as a source of collective memory on what can go wrong in safety. Although there has been a number of other incident related databases established around the world during the last decades, the DECHEMA Incident Database differs significantly from them. This is true mainly in terms of: procedures for guaranteeing standardized, high quality, usable information in the database; measures for guaranteeing anonymity to the companies that submit their internal incident reports for consideration to the database and dissemination activities, in particular within the chemical industries.
The paper describes how a database can support process industries to learn from the mistakes of others by providing them a relatively low amount of high quality high relevance information. The paper then discusses how the DECHEMA Incident Database meets those requirements, its structure and its functions.

1. Introduction

It is argued that experience is the best way to learn. Yet industry can't afford to allow itself experience incidents for the purpose of learning on how to improve or maintain their safety. This is true not only in terms of potential financial losses, but also in terms of regulatory implications, societal reactions and environmental damage. Instead the relatively painless step of learning from the mistakes of others is much more attractive and comes at incomparably lower costs.
The main challenge of learning “the easy” way is to find a trustworthy/high quality source with an adequate quantity of reports on incidents and accidents of high learning value that is continuously updated and structured in a user friendly way.

2. How can an incident database benefit industrial process safety

An incident database, depending on how it is structured, managed and used, can be a reference point of collective memory and specific knowledge for an almost unlimited range of safety specific questions and issues. Examples of areas that the use of an incident database can benefit might include:

- Risk assessment: An incident database can be an important source of information for risk assessment tools. For instance, safety incidents of the past may bring into your attention fragments of chains of events that can potentially lead to a major accident in your business. This will help you better understand and prohibit such chains of events. In some cases past incidents might reveal to you hazards you were not aware of (so called “unknowns unknowns”) or give you insights on areas you know you lack important information (so called “knowns unknowns”). They might help you realize that a certain equipment or process is relevant to an already identified risk or that you need to better understand a certain aspect of a (chemical, thermal, etc.) process in your plant.
- Awareness (employees and management): An incident database is also a link to reality: Each incident in the database is primarily a collection of undisputable facts – observations that were made in a plant, in real life conditions – on what has gone wrong. Thus the database can be used as a convincing voice that risks do, in fact, exist, and that resources need to be devoted to reduce those risks.

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- Training: An incident database contains condensed knowledge on what has gone wrong in real life. Each sentence in the database has ideally gone through an intensive process, in which highly competent safety experts have studied and improved every aspect of it for the information to be of high quality, relevant and understandable to the database users. As such this knowledge can be used also for training purposes both within a plant (operators, new members of accident investigation teams, etc) as well as in service providers (e.g. consulting), authorities and in the academia (e.g. in the frame of a university lesson on safety).
- Safety management system: The new knowledge gained by the lessons learnt from past incidents might significantly contribute to the improvement of the safety management system of a company, e.g. by revealing relevant leading indicators, or weaknesses of the emergency plan and response, or the need for changes in the maintenance program in connection to safety related equipment.

A further interesting aspect is connected to the expert team responsible for the content quality of the database. If this team is managed well, through the enormous experience and knowledge they will gain with the years, they will eventually become a powerful driving force of developing further knowhow and best practices on incidents investigations.

Another benefit of using such a database is the very process of interacting with it: Asking the right questions, when searching for relevant information; searching for potential connections between what happened to other plants in the past and what can happen to yours in the future, is a process that leads to a deeper understanding of the processes and equipment of your plant.

Database attributes as enablers

Important for the materialisation of the above benefits are the following eight attributes of an online database:

- Accessibility: Maximum impact can be reached only if the database is fully accessible to everybody without any charges or other restrictions (open access). Offering to the public such an important source of information for the prevention of safety accidents is in the spirit of two of the main stakeholders: the industry (e.g. in the frame of the “responsible care” initiative) as well as the public authorities (e.g. in connection to the Aarhus Convention).
- User Friendly: The database’s interface should be intuitive, easy to understand and fast to use, ideally independent of the experience level of its user.
- Data quality: Any incident report within the database should provide information that is: (i) *specific*, i.e. only relevant information for understanding the incident is included; (ii) *valid*, i.e. the incident report is based on facts, minimizing the room for interpretations, (iii) *complete and comprehensive*, i.e. it should provide all the information required for the reader to understand what happened and what to learn by the incident. Comprehensive means also that the lessons learnt should cover all areas relevant to the user (e.g. technical as well as management aspects). (iv) Understandable, i.e. it is written in a way easy to understand by the reader independent of his/her level of experience or expertise.
  Keeping the same *level of details* between the incident reports as well as accepting incident reports submitted only from *high quality sources* (i.e. from the internal accident investigation team of the affected enterprises, rather than printed articles in the media) is a further aspect of data quality.
- Data quantity: The higher the number of single cases (different scenarios) covered by the incidents of the database the higher is the value for the users. Yet, to avoid providing the user with a long lists of incidents, of which only a very small fraction are useful, the following two limitations are necessary: The database should be able to deliver incidents coming from the relevant industry sector only, e.g. the chemical industry. Also due the much higher frequency and very different character of occupational incidents, there should be a clear distinction in the database between occupational and process safety incidents.
- Involvement of the industry: Databases built as an industry-wide project are most likely to succeed in particular in terms of acceptability (more users) and data quality (report submissions by the industry). For the same reasons the database should be open to all relevant industries for the submission of incidents and have as low barriers for the submission of new incident reports as possible. Aspects to consider in connection to the latter, as recognized by van der Schaaf and Kanse (2004) are: Data security and confidentiality (e.g. to prohibit a “blame culture” to become a problem); communication (to make people aware that they can submit data); and making the submission process easy and fast.
- Transparent workflow: Communicating openly the workflow from the submission of a report up to its inclusion in the database is important for the users to assess the expected quality of the data in the database.

- Standardization: The database should contain data written in a standardized way (text fields, level of details, language, quality of information) and grouped according to a standard system of categories (e.g. explosion) and subcategories (e.g. ignition source: electrostatic discharge) for it to be workable.
- Search Engine: A comprehensive search system is important. This system should allow both a search according to a Boolean logic (AND, OR, NOT) allowing the use of both predefined keywords/categories as well as free text. The search engine should ideally use a ranking system to deliver also incident reports that are not searched for but most probably would interest the reader.

3. Existing databases on process safety accidents and incidents

In Europe today a limited number of incident databases exist in the field of process safety. Some databases were created in the frame of research projects and were discontinued after the projects. Other are offered commercially, i.e. fee based, and are excluded here (e.g. the database FACTS in The Netherlands). Those databases that are free of charge and continue to exist today differ significantly in terms of scope, structure as well as data quality and quantity:

eMARS (website: https://emars.jrc.ec.europa.eu/) The Seveso Directive requires Member States to report to the European Commission (EC) following a major industrial accident. Based on the information provided by Member States the EC evaluates this information, details lessons learnt from it, and disseminates the results to the Member States and industry. For this purpose the EC maintains the Major Accident Reporting System (eMARS) database at the Major Accident Hazards Bureau (MAHB) of the EC's Joint Research Centre.

The main strength of this database are that it contains all major accidents collected by the authorities within the European Economic Area and also some accidents from the OECD and UNECE member states. Jacobsson et al. (2010) highlighted three weaknesses: (i) Since Seveso is a goal oriented and not a prescriptive Directive, the details and quality of reporting to eMARS vary considerably between the member states. (ii) The level of learning is found to be in general rather low due to the lack of deepness in analysis of underlying causes. (iii) Only few near misses are reported.

ZEMA (website: http://www.infosis.uba.de/index.php/de/zema/index.html) By German law (§ 19 StörfallV) in this database all major accidents within Germany are collected. The reports are provided by the national competent authorities. Because the reports are provided to ZEMA in a relative short time after the event, and major accidents are often based on complicated chains of events, the reports are often not complete and comprehensive enough for a reader to analyze them in depth. Also the data are provided online only in German language, which may be prohibitive for potential readers with another native language.

KAS-AS-ER (website: http://www.infosis.uba.de/index.php/de/aser/index.html) Accidents that do not fall in the § 19 StörfallV definition of Major Accidents, but also near misses that could be influential to process safety are collected by the above mentioned database of the Commission on Process Safety (Kommission für Anlagensicherheit - KAS). KAS has the role by law (article 51a of the German law BImSchG) to advice the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) on process safety, and so the main scope of this database is to reveal (and document) areas where the national legislation potentially needs improvement (changes or clarification). Also incidents that took place outside Germany are evaluated for this purpose. The database and its content are in German.

ARIA (website: http://www.aria.developpement-durable.gouv.fr/about-us/the-aria-database/?lang=en**)**

The ARIA (analysis, research and information on accidents) database is operated by the French Ministry of Ecology, Sustainable Development and Energy. It lists accidents that correspond to a broad spectrum that go beyond process safety and includes transport of dangerous goods, safety of pipelines and storage facilities. The database contains reports on over 40,000 accidents and incidents, of which about 37,000 in France – and it is not exhaustive. Each incident report is offered both in English and France language and can be several pages long.

4. The DECHEMA Incident Database approach

For anyone seeking to assess the risks and prohibit accidents from happening, lessons learnt from near misses represent a significantly richer source of information than major accidents are. This is because near misses occur with a much greater frequency and thus they can reveal more possible paths to a potential major accident. Recognizing this fact, DECHEMA initiated in 1996 an online open access Database for Incidents in the chemical industries. One characteristic of this database is its minimalistic approach: Incident reports are listed only if they are unique, i.e. they are mot duplicating observations described in other reports in the database. Also the incident reports are reduced to a minimum text, but adequate to support the reader to understand and use the lessons learnt.

This project has being actively supported from the very beginning by VCI (the German association of chemical industries). All these years the VCI company members have been voluntarily providing information on their process safety incidents as well as near-misses to enrich the content of the database.

4.1 Quality control and further development

A working party with the name “Lessons from Process Safety Incidents” is responsible for the data quality control as well as for further guiding the development of the database. The working party consists of nominated representatives from industry, authorities, research and education as well as the Chairman of the Committee for Incident Evaluation (AS-ER) of the above mentioned Commission on Process Safety (KAS). The representation of KAS within the working party is an active link to the German lawmaker.
The working party can also invite to their meetings further experts as guests, when and if necessary to better perform the working party’s tasks. The work in the working party is voluntarily for its members, the meetings are not open to the public and the minutes are confidential. DECHEMA actively supports the working party in the following ways:

- The working party is fully integrated in the Safety section of ProcessNet (see: http://www.processnet.org/process_net/en/SIT.html) which links them to the large pool of ProcessNet technical committees (approximately 100 committees) and of ProcessNet personal members (more than 600 professionals in Safety in a total of more than 5,000 in ProcessNet covering a large range of expert areas related to chemical engineering).
- The meetings are supported by a secretary office that organizes the practical aspects of the meetings (invitations, rooms, etc.)
- A DECHEMA staff member acts as main contact person for the database, keeps the minutes of the meetings, collects and distributes information to the working party members and in general supports the chairman in his function.

4.2 How the database is enriched with new incident reports

Step 1: Submission of the incident report: easy, fast and without any requirements
Not only VCI member companies, but any chemical industry worldwide can submit a report on a process safety incident or near-miss to the database. Submitting a report to the database is neither time consuming, nor difficult: The submission consists of a short email to Dechema-Ereignis-DB@dechema.de with the incident report as attachment and – where applicable – any additional supporting information. Submissions both in German and in English language are accepted. In practice the incident report has been originally created for the internal needs of the company according to their internal guideline. Such a document would be acceptable as is, there are also no requirements on the format of the submitted report.

Step 2: Anonymisation of the submission source and distribution of the report to the working party
The email with the submitted report is then automatically forwarded to the technical officer of the working party “Lessons from Process Safety Incidents”. He/She anonymizes the event description, gives an internal submission number to the report and distributes the text to all the members of the working party. Anonymization means that information is erased that could reveal any of the following: (i) the person who submitted, (ii) the year, and (iii) the location or the company where the incident took place.
Initially the technical officer will keep at a secure place accessible only to him the information of who submitted this report, for the case that the working party will need to have more information to analyze the incident (see step 4). As soon as the decision is taken to accept or reject the report for the database, the information on its source will be permanently erased and from that point in time it is not possible for anybody to identify who submitted the original text.

Step 3: Preliminary evaluation of the report
The members of the working party “Lessons from Process Safety Incidents” preliminary study the report, discuss what is described within it and finally decide on the following two questions:

(1) If the report contains information of value to operators, planners, maintenance engineers or researchers in terms of improving process safety in principle
(2) If the report offers added value to the database, i.e. if it highlights aspects not previously covered by an existing report in the database

Only if both questions are answered with a yes the report will be further considered (Step 4) otherwise no further action is taken.

Step 4: Preparation of the final version for the database
Each submitted report becomes a small independent project for the working party. A working party member (project owner) is assigned to one or more of these projects. He or She will lead the discussions and any other necessary activities on the corresponding submitted report up to its final revision and acceptance or rejection by the working party. This process continues as long as necessary and, depending on the complexity of the discussions and the quality of the submitted information, may take several years. The final version of the text may differ considerably from the original version (e.g. by describing more causes and different lessons learnt).
Should important questions arise for fully understanding the incident, the technical officer will contact the person who submitted the original report and request the missing information. In case the submitting party is not able or willing to provide the missing information in any form, the submitted report is rejected and no further action is taken.
The preparation of the final version of an incident report for the database takes place in three phases:

(i) Content. This phase contains the following three actions:
   a. Incident reconstruction: The reported facts in the submitted text are carefully reconstructed by the project owner and the result is presented and discussed in detail by the working party. The goal is to understand beyond any reasonable doubt what happened and why. The lessons learnt are discussed from different perspectives. Attention is given that the report is plausible, understandable to the wider safety community and complete for the purpose of the database.
   b. Reduction: Every piece of Information that is not absolutely necessary for the reader to understand the report is omitted from the text.
   c. Abstraction: The text is rephrased where applicable, to support easier abstraction by the reader, without him or her losing the possibility to understand the incident or the relevance of the lessons learnt. Examples: The substance names are often omitted in order for the reader not to focus only on the substances involved and are replaced by the relevant hazard characteristic (toxic, corrosive, flammable). Any photos (e.g. of failed equipment) originally submitted with the report are omitted, if the text can be understood well enough without them.

(ii) Structure: The standard structure required by the database is applied to the text of the revised report: title, sequence of events, cause(s), lesson(s) learnt.

(iii) Translation: Provided all the members of the working party have approved the content and structure of the revised report, the project owner will finally provide also the translation of the text, so that the report will be available on both the English and the German language. Also the translation will be discussed and approved by the committee.

Step 5: Dissemination activities
The new incident is listed in the database and this is communicated though the database's newsletter. A copy of the final report is sent also to the VCI offices in Frankfurt. VCI forwards this to all their member companies.

4.3 The DECHEMA database http://www.processnet.org/en/incident_db

The database is publicly available and currently provides more than 140 short, focused, and easy to understand incident analyses. After an online registration you will receive an automatically generated notification (newsletter) for every new incident added to the database. Access, research and the newsletter are free. Specific information can be found quickly using the search functions. 150 descriptors are classified into the following categories:

»» Basic operation / process
»» Affected part of the system (e.g. dryers, heat exchangers, filters, reactor)
»» Hazardous characteristic / material property (e.g. toxic, corrosive, flammable)
»» Cause / Effect
»» Other (e.g. handling, weather)
»» Free-form text

For instance, a search for incidents that are classified as "electrostatically chargeable" in the hazard features/substance properties category, provides a list of relevant incident reports that can be opened as .html pages or pdf files.

5. Conclusions

The statistics of the last decades prove that Europe enjoys a high level of process safety in the chemical sector. This high level must be sustained and further improved. The media love to report major accidents and

over emphasize risks. In today's world even a single major accident can gain a tremendous public attention and lead to emotional rather than fact based discussions.
Many companies have procedures in place to analyse their accidents and near misses and understand their lessons learnt. Other companies are not big enough to afford the cost of such procedures. In both cases, learning through own experience is not the fastest and most economic way to improve safety. A lot of the accidents and incidents that happen around us every year could have been avoided, if the causes and lessons learnt of past incidents in other companies had been known. In this context, a database of process safety accidents and incidents uniting the experience of a whole industrial sector can play a central role.
The example of the DECHEMA database shows that such projects can be sustained successfully for long time and is also an example of a long term voluntary commitment of the industry to share safety relevant information without restrictions.

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