

Brightsite

Transforming industry

HSE management in the Artificial Intelligence era

A promising, predictive process safety model is under development

Chemelot has set itself the target of becoming the safest, most competitive and most sustainable site in Western Europe by 2025. Brightsite is helping Chemelot achieve this by means of various projects. One of the things we are focusing on as part of program line 4 'Securing integral process safety and societal acceptance' is the development of a predictive model for process safety. An initial version has already shown that modeling that is assisted by Artificial Intelligence and Machine Learning provides opportunities that will enable significant safety improvements in the chemical industry.

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Major challenges for HSE management

The chemical industry is investing heavily in robust HSE (Health, Safety and Environment) management systems, as well as in initiatives that will bring about a continuous increase in process safety. In the years to come, HSE management will be faced with major challenges due to the increasing complexity resulting from digitalization and the emergence of new technologies. This changing situation means that conventional HSE management systems may no longer be suitable as a means of identifying and assessing risks. "At the same time, production facilities are generating large amounts of data, but at the moment, we are utilizing only a fraction of that data and that's a missed opportunity. We are looking to see whether we can make use of that data in order to optimize process safety and if so, how we can achieve that," explains Esta de Goede, program line manager of Brightsite's program line 4.

Predicting in advance instead of explaining afterward

At present, HSE management primarily focuses on explaining how and why an incident was able to occur, after the incident itself has taken place. And though prevention is always better than cure, predicting incidents in the chemical industry is difficult to do. Up to now, only a limited amount of research has been carried out worldwide into the predictive modeling of incidents. The most recent studies have shown that if sufficient data is available, Artificial Intelligence (AI) and Machine Learning (ML) technologies are successfully able to classify different types of incidents and identify patterns that exist in the causes of incidents. "At

the moment, we're carrying out research into the ways in which AI and ML can be used to identify hidden patterns in sets of safety data. Right now, it isn't possible for those patterns to be identified by human operators. What we are aiming to do is to develop a predictive model," says Johan van Middelaar, Brightsite Program coordinator and Senior Advisor for Safety and Environment at TNO, by focusing on future risks that exist within a circular and sustainable economy.

Promising initial results

According to Van Middelaar, what has been achieved within Brightsite is a revolutionary process. "To develop the model, we need data and in order to obtain that, we have entered into a collaboration with a company named AnQore. As part of that collaboration, we are examining what (hidden) patterns our model is able to find within AnQore's safety data. What the model has to do is to learn, step by step, how valuable data is as a means of forming predictions," explains Van Middelaar. "Before starting out on such a process, it is certainly difficult to assess how or when incidents will occur. At AnQore, we are interested in the application of AI, which is why we are happy to be taking part in this project," says Gui Hoedemakers, the HSE Manager at AnQore. "Right now, we still need to teach the model a number of things, but once it knows how our world works, the model will be able to help us learn from incidents, without the incidents actually having to take place." And the initial results are very promising. "Even with a limited quantity of data, we have found that the model can already recognize patterns and trends, which is why we are now proceeding with the development of the predictive model. Not only for Chemelot, but also in collaboration with other partners from within the chemical industry in the Netherlands," adds De Goede.



Combining different types of data

When an incident occurs, it often forms the net result of a variety of factors. Hoedemakers continues: “For example, the incident could be caused by overdue maintenance combined with an order that almost exceeds the plant’s production capacity, and the net result of these unfavorable factors can then give rise to a dangerous situation.” To identify situations of that type, it is a case of combining different sources of HSE-related data. “These could include ‘historical’ data (such as incident reports), operational data, maintenance data and real-time (sensor) data (see Figure 1). What we need to do is ascertain which sources are important and what methods can be used to search through, analyze and assess the data. Even though we will be in a position to identify generic factors that apply across the chemical industry as a whole, the sources and methods that are important will be different for each process and every production plant. Ultimately, our activities will result in a company-specific model for each plant, together with a generic component (see Figure 2). A plant will be able to utilize the company-specific component to carry out advanced analyses. Thanks to our collaboration with AnQore, we are currently developing the initial blueprint,” says De Goede.

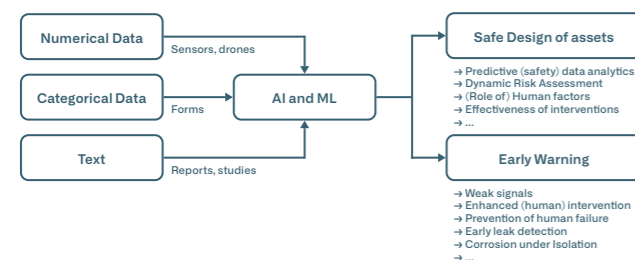


Figure 1: HSE management powered by AI. Combining various types of data.

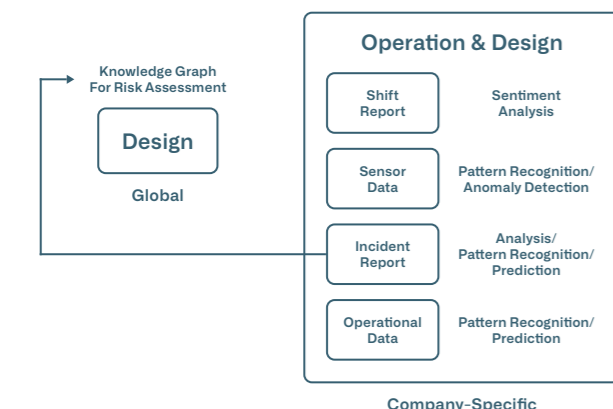


Figure 2: Model development. Multi-layer Dynamic Early Warning System.

Designing process plants for increased safety and security

“We are developing the predictive model step by step (see Figure 3). The initial, company-specific, phase, known as Safety Stethoscope, is ready. We will then expand this to include information from other data sources, including technology, behavior and procedures. Our aim is that within two years from now, we will have developed a model that is capable of identifying potential risks in advance,” explains Van Middelaar.

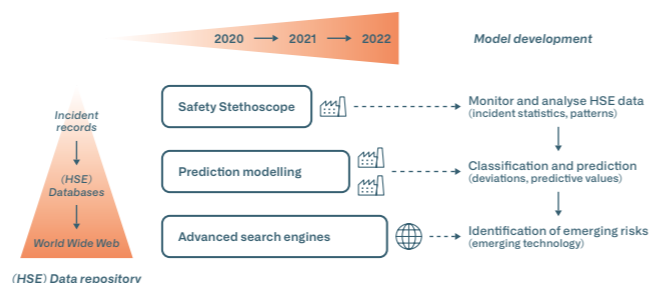


Figure 3: Model development. Technical Readiness Planning.

A model of that type will provide companies with additional information and insights that are not available to them at the moment. The fact that they will be able to rely on predictive factors will enable designers to design process plants with increased safety and security in mind. What is more, recognizing patterns and non-conformances that exist within processes will provide greater insight into how incidents occur, which will in turn enable companies to trace developing incidents and rectify any situations that deviate from the requirements. “Incorporating a wide range of data from other companies will help the model develop to maturity. That is the reason why we are inviting partners from the chemical industry to join with us to help develop this model further,” emphasizes De Goede.

“Due to increasing complexity it is more and more difficult for humans to take the right decisions on their own.”



Future-proofing by keeping tabs on the latest technologies

“Not only will a model of this type improve the safety of existing processes, but it will actually be essential as a means of keeping tabs on processes that are becoming increasingly complex all of the time. The latest developments include the emergence of new technologies that allow the (chemical) recycling of plastics, or the energy transition technologies that owe their existence to plasma conversion. New technologies always go hand in hand with ‘unknown’ or ‘emerging risks’, and when these are combined with digitalization, increased automation and the emergence of autonomous systems and robots, increasing complexity and a lack of transparency then result. One of the consequences of all of these developments is that it is increasingly difficult for humans to take the right decisions on their own,” explains Van Middelaar. “Making use of innovative, data-driven technology to aid decision-making then becomes indispensable.”

A predictive model as an aid

“An AI model won’t replace human beings, but is intended to assist them. Human interpretation and actions will continue to be needed. Technology can help us to maintain a more effective

overview of complex items, but the subsequent decisions will be taken by human operators. The model must therefore be regarded as an aid for our human personnel,” says Van Middelaar. In Hoedemakers’ view, the solution lies in a combination of technology and behavior. For example, the model is able to predict where and when a blockage will occur. “Workers can then respond to this and prevent the blockage. It may even set them thinking and cause them to ask themselves: ‘Can’t we do this in a different way, by preventively cleaning the component concerned from time to time or by applying different, less demanding process conditions?’. Using technology in this way also creates awareness about how a hazardous situation develops and how it can be prevented (including by means of behavior),” says Hoedemakers.

A contribution toward safety and sustainability

We are convinced that predictive modeling using AI and ML technology will provide additional opportunities to further enhance safety in the chemical industry by improving safety by building it in right from the design stage and by preventing incidents by acting upon ‘early warnings’. In our view, predictive modeling holds all of the potential that will enable it to become a game-changer in the field of HSE management. Not only do models of this type contribute toward improved safety performance, but they also increase overall effectiveness and save raw materials. Viewed from that perspective, the model will make its own contribution toward sustainable development.

Program line 4 'Securing integral process safety and societal acceptance'

At Brightsite and on the Chemelot site, safety is a matter of top priority. We also endeavor to be a good neighbor, both to our on-site neighbors and off-site neighbors. Our objectives are as follows: By 2025, Chemelot will be the safest, most competitive and most sustainable chemical and materials site in Western Europe. By 2050, Chemelot will have successfully implemented and maintained the most stringent safety standards. Chemelot will be the market leader in terms of safety and will share its expertise with others. Brightsite's program line 'Securing integral process safety and societal acceptance', known as 'Safety and Society' for short, which focuses on securing integrated process safety and societal acceptance, will contribute toward this.

"We are convinced that predictive modeling, using Artificial Intelligence (AI) and Machine Learning (ML), will provide additional opportunities to further enhance safety in the chemical industry."

Does your company recognize itself in the working method of Brightsite?

The first steps toward the development of our predictive model have already been made and the time has now come to train and further develop the model, in collaboration with partners from the chemical industry. Would you like to know more about predictive modeling and/or work with us to develop and apply the model on a practical level? If so, please get in touch with us.

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