Abstract: For assessing risks in all environments it is often necessary to use a systematic approach of modeling and simulation with the aim to simplify this process in the framework of designing new technological lines, machines, equipment and processes. Also an experiment on a real technological device can be used as the basic scientific method of research when assessing and evaluating risks in the industrial processes. However, experimenting with technological equipment which uses hazardous substances is very risky and can be the source of an accident, or disaster, e.g. the disaster at the nuclear power plant in Chernobyl in 1986.

Key-Words: Risk Assessment, Software Products, Crisis Management.

1 Introduction

Industrial risks are very closely linked with the technological processes and equipment which have become the subject of assessment and solution as well as permanent monitoring from the side of the companies and selected bodies of the state administration [12].

For assessing risks in the industrial processes it is often necessary to use a systematic approach of modeling and simulation with the aim to simplify this process in the framework of designing new technological lines, machines and equipment. Also an experiment on a real technological device can be used as the basic scientific method of research when assessing and evaluating risks in the industrial processes. However, experimenting with technological equipment which uses hazardous substances is very risky and can be the source of an industrial accident, e.g. the disaster at the nuclear power plant in Chernobyl in 1986.

In the case of a model it is a simplified depiction of an original, a real system (of the environment), i.e. an isomorphic depiction of a real system. In this case the isomorphism is understood as an objective difference and at the same time the functional identity of the original (real) system and its depicting model. It is a certain kind of analogy (similarity) which enables the real system to be investigated by expressing, characterizing and defining only its purposefully selected important properties (it simplifies it in this way), the elements, sides, relationships and linkages. The model is an important segment between the reality and theory about the reality, with an irreplaceable mission in the process of cognition. Modeling is at the same time the key component of the system approach. It means the model is a simplified representation of its original.

The term model developed from the Latin word modus, modulus which means sample (picture), method. Gradually this term was taken over by the individual European languages to designate a sample, an imitation, a prototype of the original.

Modeling and simulation are two relatively independent; different terms as to their contents which have, however, in a great many cases, a close time continuity.

Modeling is a process of creating (designing) a model. The verification of its validity and detecting the level of model’s similarity with the original should be part of this process.

Simulation is a process linked with the using of an already created model (verified and prepared for usage), a process for generating (creation of accidental scenarios) a real situation on the corresponding model with making use of various input data.

Due to these facts modeling and simulation are understood in a very close linkage. The process of modeling thus precedes the process of simulation and their mutual relationship is determined by the level and possibilities of accessible scientific knowledge and technical means.
The content and procedure of these activities is a complicated creative activity for a person as well as whole teams which can be very effectively supported by utilizing the current information technologies. Due to the great number of types or categories of the models there are also a great number of modeling methods. In the conditions of the risk assessment of industrial processes it is necessary to emphasize the possibilities of modeling and simulation for the results to be applicable in analyses which are the basic material for the assessment reports, and often have an effect on the financial means expended or on beginning (finishing) concrete activities linked with these processes.

Modeling of industrial processes can be divided into the following steps:

- stating the purpose of the model,
- defining the internal links, relationships, constants and variables in the processes modeled,
- the analysis of the risk factors,
- selecting the most suitable model type,
- working out a draft of the model,
- defining the inputs and outputs of the model,
- the formal verification of the model’s performance,
- the verification of the model’s functionality.

The following step after creating the model is its implementation in simulation.

Most simulations of industrial processes utilized for risk assessment work currently with information technologies and makes use of the accessible software.

The basic step is thus the selection of a suitable (and accessible) software product. On one hand it has to fulfill the prescribed requirements and on the other hand it has to be suitable (it has to have sufficient capacities) for simulation in the given area of the industrial processes according to the conditions determined. Simulation is then realized with the help of the program chosen, with utilizing concrete input data acquired from real industrial processes. Thanks to these specific software products we can avoid creating a model of the industrial process being assessed.

The instruments that can be used to reduce risks threatening the critical infrastructure can include technical means to deter, detect, verify, signal and eliminate an intruder (mechanical and electronic means) and they can also include activities of security services (e.g. intervention of security corps and armed forces) [5].

2 Software Products for Risk Assessment

Software is becoming yet more and more frequently part of the support of decision-making and simultaneously its tool. In the process of the risk assessment it plays an important role especially because the speed of this data processing is incomparable compared with human capabilities. In recent years simply implementing the computer technique and improving the software have becoming an inseparable part of the processes connected with assessing the risks and supporting the decision-making process in general. Another reason for utilizing the software support are the dramatic changes, the environment in which the industrial processes operate and the technological development itself. These types of software can be classified according to several criteria. One of them is the type of risk being assessed. According to this criterion we classify the software into the following groups (examples in the brackets):

- the overall analysis of effects, leakage, evaporation, dispersion, fire, explosion, vulnerability (ALOHA, Whazan, Phast, Safeti, Riskat, Effects(Damage, RiskCurves Spocrates, IAEA – TECDOC – 727, TerEx, Rozex, Fluidyn),
- the dispersion of heavy gas (Denz/Crunch, Charm, Slab),
- the discharge in two phases (Deers, PipePhase),
- the computer programs known as the so called integrators of risk (Safeti, RiskPlot II, RiskCurves and @Risk),
- the risk calculation in designing, industry and environment (RMPlanner, Hazard-Review, Risk Radar, FaultrEase, Cegis FaultrEase, AgRisk, Site Safe, Boss, DNV Risk Management Software, EquiS – Environmental Quality Information System, RBBA, GoldSim),
- the risk calculation for the area of pipelines (Bass-Trigon Software, Boss, Pods),
- the risk calculation for the need of hydrology (Hfam, Hydron, Hydra),
- the calculation of the seismic risk (SMA, HCLPF, CDFM, IPEEE, SPRA, PSA),
The risk calculation for the needs of healthcare and protection of employees (NPDES DMR, Human Exposure Assessment Modeling, Software Toolbox, EMS, IRAPh),
the calculation for a terrorist attack (VRA),
The risk calculation in the area of finance and trade (Cobra, Algo Suite Solutions, Quantum Sierra, Sierra Treasury, Sierra ASP, Cost-of-Risk-Analysis, Lattice Financial Software, STP, SunGard, Data).

From the point of view of the risk assessment the software can be used for:
• the analysis of effects and impacts of individual types of risks,
• the probability calculation of the rise of an emergency.

The first group of software for analyzing the effects and impacts of individual types of risks will be dealt with in the next part of the text. For calculating the probability of an emergency we can mention the following types of software:
• Risk Spectrum – software for FTA, ETA, FMEA (www.riskspectrum.com), the most widespread software of the reference types of software worldwide,
• SAPHIRE – software provided by the company Lockheed martin USA for the state administration in the USA (www.saphiresoftware.com),
• Reliability Software and Safety Analysis Tools – reliability software (www.itemsoftware.com),
• UnRiskIT – used especially in the petrochemical industry (www.unriskit.com).

For assessing the risks we can use:
• the freely accessible software products,
• the commercial software products.

The freely accessible software products were and still are being made to order for the governmental agencies (especially in the USA) or they are outputs of scientific projects funded by the European Commission or other grant agencies. They are also accessible in freeware form or programmed by enthusiasts and accessible as open source. The most well-known freely accessible software products are as follows:
• CAMEO,
• ALOHA,
• MARPLOT.

Among the main reasons why we have recently recorded such a great shift in using the information technologies - especially the software for supporting the decision-making as well as the risk assessment – are the constant development, the stricter conditions from the side of the state administration and from this fact the resulting investments in this area. New software products are continually being developed. The software products ALOHA, TerEx, Rozex, Safeti, Phast, Whazan, Effects, Damage, Riskat, and others are used for assessing effects and impacts worldwide.

Even today some processors have their own procedure which suits them best. The experts in physical chemistry and chemical engineering can afford to use traditional procedures which are, however, time consuming. In the past the methodology IAEA-TECDOC-727 was used in Slovakia and in the Czech Republic. However, it was not properly applied because it is determined for other purposes, and not for a detailed analysis of the individual risk sources. In the Czech Republic they most frequently use ALOHA and TerEx, less so Save and Rozex. There are also special methods that occur, e.g. the method of the gas industry in Europe for assessing the danger of storing LPG (it is not freely accessible). In Slovakia the program Safeti is preferred and used by several companies in Slovakia. For this purpose the program @Risk can be used, but in Slovakia for the time being it is not being used to a great extent.

For analyzing the technological processes in the industrial environment, specifically of the chemical technological processes, CAMEO and ALOHA are the suitable software products. They contain the databases of chemical substances and agents which the emergency departments of the companies can use not only for analyzing and assessing the risks but also in the phase of reaction towards a crisis phenomenon. Around the world, the software products of the Swedish company Relcon are often used – Risk Spectrum, as well as the American products e.g. SAPHIRE (Systems Analysis Programs for Hands-on Integrated Reliability Evaluations), version 6.0 created by the firm Lockheed Martin Idaho Technologies Company, Inc.

The methodological manual of the Ministry of Environment of the Slovak Republic (Kandráč, 2001) says: “The calculation of the reach of the
dispersion scenarios in dependence on their nature is a relatively complicated thermodynamic and hydrodynamic problem; therefore there are neither any “calculator” formulae nor calculations for it.” Various institutions have developed empirical mathematical models or models based on experiments which are able to forecast the development of concentration in the dispersions. Several types of software have been developed which enable, based on the input data of the processor of the emergency, scenarios of dispersion (temperature, pressure, quantity of the substance escaped, wind speed, etc.) to model the reach, doses and concentration profiles and to display the results both in a text and graphical form. The Czech commercial program Rozex or TerEx and the freely accessible American program ALOHA belong among the best accessible. From the point of view of assessing the technological processes in the industrial environment especially ALOHA or, thanks to the Slovak version, TerEx and Rozex seem to be optimal. Apart from them there is a whole range of other software products which are more demanding from the financial point of view but from the graphical and user side they are far more straightforward.

3 Problem Solution by Selected Software

Terex 2.8.5 is program that can be characterized as a simulation tool for the speedy determination of impacts, or for prognosing the effects of performing hazardous substances or explosive systems, especially when misused by terrorists or used by the army in the case of an attack with chemical weapons. The model is created by computer simulation and linking with maps and with a direct display of the results on a map. It is a commercial product of the company T-Soft.

TexEx is determined especially for:
- the operative usage by the troops of the integrated rescue system in the case of an attack,
- the rapid determination of the extent of the threat and the realization of subsequent measures for population protection, especially the area struck and the necessary evacuation.

The forecast of impacts and effects is based on a conservative prognosis. In practice it means that the results correspond with the conditions under which the maximal possible impacts and effects on the environment develop, i.e. the worst possible variant.

This output without any subsequent assessment on the maps is inadequate in the case of a lack of time (which can occur during emergencies) and unnecessarily prolongs the decision-making process. However, if this output is connected with the appropriate maps based on which it will be displayed in the form of a sketch, the user obtains further precious resources for the crisis management.

The tool TerEx is determined for modeling the leakage of hazardous substances and explosives with detailed plotting of the reaches on the maps.

The program product TerEx in the version 2.8.5 is in the basic offer based on the following applications (modules) (see Figure 1):
- the map,
- the accident events,
- the hazardous substances,
- the accident models,
- the guide.

![Figure 1 Working environment of the program TerEx](image-url)
We can position the epicenter of the event on the map and draw the situation modeled.

The module Accident Events (Havarijné udalosti) enables to save and to return again to the accident events modeled.

The module Hazardous Substances (Nebezpečné látky) is determined for selecting the dangerous material which is subsequently used for the calculation of the results of the accident event. The user is presented with hazardous substances defined in the substance database of the TerEx programme, namely from the list of the standard types of accidents. The function “Search” which immediately finds the entered name of the substance or its part can be used by the user for an extended system of searching in the list of dangerous substances.

The model Accident Models (Havarijné modely) is determined for a direct selection of the corresponding accident model. Out of the offer the user classifies the corresponding model by which he/she assesses the accident events. The direct selection of the model is complicated for the user due to its ability to select the model for assessing the accident events correctly. When any doubt regarding the correct selection of the model arises, it is better to use the module “Guide” (Sprievodca) in the basic offer of TerEx which can lead the user step by step to using the correct model.

The module Guide (Sprievodca) is determined for a consecutive (step by step) selection of the accident model through the basic data about the industrial accident. The consecutive selection is realised by answers to questions in three steps. They are answers to questions connected with:

- the broken equipment,
- the type of accident,
- the hazardous substance.

Based on the answers to the given questions, the model for assessing the accident event with a corresponding offer of parameters is defined. These parameters correspond with the commonly used transportation method and using the corresponding dangerous material in the technological processes. If any need to change these parameters arises an immediate realisation is possible. In the “Accident Models” we can find a specialised group “Explosives” (Výbušniny). The module leads the user to the application of a correct model for assessment.

TerEx offers the user the possibility to assess five basic accident events:

1. The models of Toxi type – they assess the reach and form of the cloud which are given by the chosen concentration of the toxic material.

2. The models of Uvce type – assess the reach of performing of the air shock wave triggered by the detonation of the substance mixture with the air for models with individual types of accidents.

   a) The types of the Plume model
   - a long-term leakage of the gas to the cloud,
   - a long-term leakage of boiling fluid with a rapid evaporation to the cloud,
   - slow evaporating of the fluid from a pool to the cloud.

   b) The accident types of the Puff model:
   - a single leakage of gas to the cloud,
   - a single leakage of boiling fluid with a rapid evaporation to the cloud.

3. The models of Flash Fire type – assess the size of the area threatening persons by a flame zone – the Flash Fire Effect:
   - Bleve – endangering a tank by a large fire or an explosion of the expanding vapours of a boiling fluid.
   - Jet Fire – a long-term leakage of gas with blazing, threat by jet fire.
   - Pool Fire – a fire of a pool, fluid or boiling fluid.

4. The model of Terror type – assesses the possible impacts of an explosive system detonation based on a condensed phase, used with the aim to threaten the surroundings by detonation.

5. The model of the Poison type – assesses the reach and shape of the cloud (the contaminated space) after using the main poisonous substances.

TerEx enables the evaluation and simulation of:

- the reach of the explosives,
- the reach of explosion of the substances,
- the single leakage of poisonous substances,
- the thermal radiation.
4 Conclusion

The Need for Software Tools for Risk Assessment Process is today a must. Software is a very good instrument for the support of decision-making process. However, it shouldn’t be underestimated, or and even worse, it shouldn’t be overestimated. The software is “only” a support. The most important part of the process is to master the theory properly, to have sufficient knowledge and experience about the area which the user wants to solve through these instruments, and a subsequent application for identifying, analyzing and assessing the risks with correct usage of the software as an aid tool in this process.

One of the causes of the rise of industrial accidents is also the failing of the human factor [11]. But this bring us to different topic and it needs much more discussion then is possible here.

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