New Methods in Safety Promotion

Suokas J.
VTT Automation, FIN-33101 Tampere, Finland

Introduction

The presentation will first give a review of some developments in new technology that will affect process or occupational safety. These may change current work practices or they may introduce new threats or opportunities to safety management. After the short technology review, safety management and the current research in some industries and in transportation are discussed.

Some trends in technology and in industry

Information technology is making new breakthroughs in many areas. New applications in control, information distribution and presentation as well as in training have been launched and new products will come to the market. In software engineering, the use of a module-based structure and the use of the same software modules in several applications or versions will become more common. This is one way to improve productivity in software engineering. At the same time, more complex and more critical systems are controlled by software. These trends increase the importance of software dependability. There is a need to systematically and formally verify the dependability of the software structure and functions, from the requirements and specifications through to the software code.

The internet will have a significant impact on the production and accessibility of services. As the security of the internet increases, more services and trade will be transferred to the internet. The role of services as a competitive factor in machine and plant deliveries will increase. Customers are interested in getting added value through expert services which can be provided by the machine or the component manufacturer, designer or maintenance company through the internet. Faster networks and mobile communication will enable this development. One effect on safety could be easier and faster access to good experts to study the criticality of a production disturbance or a failure, and remote consultation on the best choices for remedies.

Mobile networks will develop globally and locally. Mobile networks and GPSs (Geographical Positioning Systems) will affect the development of autonomous machines. When the machines also obtain reliable technology for the observation of the

operating environment, they can be used in hostile areas where man could not enter with conventional machine automation. Autonomous mobile machines will also introduce unmanned production like already has been done in the manufacturing industry.

Local networks will undergo dramatic change when new tools such as, e.g.the Bluetooth is taken into use. The Bluetooth can be considered to be a local radio that can send and receive information and form a wireless local network. This will enable the easy and flexible collection of new information from existing systems when new cables are not required. For example, more information from the operation history for fault diagnosis can be collected from machines.

New integrated sensors will result in more accurate, cheaper and faster measurements. Especially SOI (Silicon On Insulator) technology has shown good results in many applications. This leads to dramatic increase in the use of sensors which together with wireless networks enables the cost effective collection of information from machines, plants and locations. In cars, new sensors have been used to increase safety. Typical examples include the activation of air bags and anti-locking brake system (ABS). New applications include anti-spin systems which automatically ensure that the drive wheels receive exactly the right amount of power to retain a firm grip on the road.

Process industry

Process industries are becoming larger in terms of production volumes. In basic process industries the economy of scale is a key competition factor. This means high investments and high requirements on safety and dependability. This results to a situation where even shorter disturbances result in larger economic losses and motivate investment in risk and dependability management. This has impacts on the use of risk (and dependability) analyses in plant design. At the same time, the economy of risk analysis itself must be improved. Better information and results are expected with less manpower and costs.

This means that there is a need to **develop flexible risk analysis methods**. They have to fulfil conflicting needs, such as high coverage in the identification of important hazards and their causes with accurate assessment of risks and dependability on one hand, and a need for a small amount of manpower and less calendar time. New methods to describe production systems must be developed and taken into use to provide a better basis for systematic hierarchical risk analysis. Some examples of this trend have already been published.

Another trend in the process industries at least in Europe, is the change towards high-value special chemicals and more customer-oriented production. This means more investments in the development of new chemicals and in the new processes to produce these chemicals. Here, there is a need to already study the risks systematically in the laboratory when new chemicals and new processes are developed. **The principles and means of inherently safer technologies will become important** in these industries.

Customer-oriented production will also require flexibility from the production system itself. It is also possible that the use of batch processes will become more common. These trends put greater requirements on the process automation. **New methods to extract safety requirements from the process system and to transform these into accurate specifications for automation design are needed**. Here, risk analysis can be one important tool to determine the hazards and their causes and then convert this information into a useful form for use in automation specification

Lead times will become shorter in all industrial applications. This will also be the trend in plant design and construction. Here, **new methods for process development and plant design are required.** One trend will be to better embed safety and dependability in design. Some examples of this development have been reported. This may also result in a new design culture.

Another trend is concurrent engineering where several parts of the process plant are designed in parallel. This places more demands on the specification of the design tasks and a good understanding of the plant objectives. One effect will also be the requirement for common design databases where several designers can follow the progress of other design teams. Distributed data systems will be in use where a design can take place at the same time in different towns, or even countries. Also, the customer can better follow the progress with these distributed data systems.

This also requires more from the designers. They have to better document their design giving a better possibility to other design teams and the customer to follow and to understand their design. **Risk analysis may be carried out with distributed data systems on the basis of design documents. New software tools for carrying out risk analyses based on design documents are needed.**

The profits in bulk type processes are decreasing. This will mean less green field investments in Europe and in the USA. The investments are focused on bottle-necks at existing plants. Also, **ways of expanding the economic life-time of ageing process plants will be developed**. Here, maintenance and systematic engineering will be developed. Risk and dependability analyses together with the more systematic collection and use of operational and maintenance data will be important areas of development.

Process integration, in order to reduce the use of energy and raw materials as well as to improve the yields, will develop further. Process integration will result in more complex plants and new dependencies between different parts of a plant. When the installations become more complex, design becomes more difficult. Then, there also is a need for a systematic and more extensive risk analysis that covers all the process parts which may lead to disturbances or which may be influenced by disturbances in different parts of the process.

The management of process disturbances will improve. Today, process automation provides as much information as the user needs, and sometimes even more - making it difficult to find what pieces of information are the most important for the decision making. The findings of risk analyses, which have been carried out during plant design,

may help in the investigation of plant disturbances. They can also form part of the information used for training the operators. These new ways to use risk analysis results will effect the documentation of risk analysis. The results and assumptions have to be documented better than previously for later use. The risk analysis results also need to be in electronic form in order to enable a link with process automation.

New emergency management systems will evolve. Geographical Information Systems (GIS) produce new challenges to collect and store data on process plants, chemicals, and people. When real-time meteorological data is integrated with this system together with gas release and dispersion models, the consequences of releases can be estimated on-line.

When all the necessary measures have been taken into account in the development of new processes and the design of new plants, the management of the operating plant still remains. Integration of safety and environmental factors in plant management systems will become more important. Safety will become a part of the management culture. In some phases of the development, there may be a separate safety culture similar to a quality culture. However, the ultimate goal will be the **integration of safety, the environment and quality into the overall management culture of a company at all organisational levels**. This trend requires new thinking and new risk analysis tools and practices in different companies and for different company cultures.

Companies concentrate on their core businesses. This leads to a situation where **several companies operate on the same industrial site**. One is producing chemicals, one energy, one pulp, and subcontractors take care of the maintenance. Here, more information exchange, definition of terms of co-operation, and joint management are needed. This means new challenges for the management of operations and safety at the site.

Manufacturing industry

Risk analysis has been used only in a few cases in the design of new production lines and plants in the manufacturing industry. Automated production lines have been the first examples where systematic risk analyses have been carried out. The use of **new modelling techniques, such as three dimensional plant models and virtual reality**, have produced new opportunities to investigate hazards during the design of new plants and production lines. The first applications have shown the obvious advantages of these techniques and their wider use is most likely during the coming years. This will also mean the development of new methods and tools to identify hazards and their causes.

In the manufacturing industry, there is a trend of growing investment cost. This means an increasing interest to study risks and dependability factors during the design. Automated warehouses and production lines as well as investments in expensive machines are examples where this becomes important.

The attempts at **unmanned production or partly manned production** result in a need to study the possibilities of production disturbances in a systematic manner. Risk and dependability analysis will be important tools in the considerations.

Machines and products

The EU's **machine directive** has required the manufacturer to identify the hazards and assess the risks of a machine and to document these considerations as well as to warn the user about the remaining hazards. Checklists have been developed to assist the investigations. However, in complex situations a risk analysis is still needed.

Companies will develop guidelines on systematic **safety management during product development and design**. Existing risk analysis tools may be slightly modified and new tools would be developed especially to better consider the user interface and the activities of the user of a machine or a product. The results of the safety studies will be used to improve the product. However, one very important application of the results will be the improved product documentation and especially the development of user information.

The first examples of where the manufacturer of a machine has been asked to give a **dependability guarantee** have been observed. When machines are used, for example, in construction, there may be major penalties if the lead time of the construction site is longer than that agreed in the contract. This development has raised the interest of machine users to ask about guarantees for the dependability of the machine. Here, the manufacturers will be more interested in risk and dependability studies. **Formal dependability management systems will be developed**. The car industry has been a front runner in this area.

In the EU, there have been discussions to **extend the use of risk assessment to consumer products**. In this area, a similar development which has already taken place in machine design and manufacturing since the implementation of the machine directive can be expected.

Automation

Some of the needs to study risks in the design of process automation have already been described under process industry.

There is also a need for cost effective tools to study the dependability of the automation system itself. This can be a time-consuming task today and quicker systematic methods would be welcomed.

The design of **batch processes,** and their automation, results in new requirements for the description of the system due to the time dependencies. This results in new

requirements to the methods to investigate the hazards and dependability. Some examples of this development have been reported.

The development and increasing use of programmable electronic systems, field buses, and software in general will require considerable effort to develop suitable methods for the systematic identification of hazards. Most likely, new ways to describe the automation system and the software need to be developed.

Transportation

In **marine traffic**, the International Maritime Organisation (IMO) has developed new requirements that include a **Formal Safety Assessment (FSA).** This is required when a change in a passenger ship is planned. With a FSA, the designer or ship owner has to show the cost effectiveness of the proposed change. This will clearly increase the use of risk analysis in shipyards and shipping companies.

Risk analysis may also be a tool to investigate the hazards of an operating ship and the operations of a shipping company. The aim can be the development of systematic safety management and integration of safety in different operations, such as the purchase of new equipment, training of personnel, etc.

In **railways**, the UK legislation was the first to require the preparation of safety cases. This was a part of the privatisation programme in the UK in the beginning of 1990's. Later, some of these ideas have also been considered, for example, in Finland and Sweden. Here, new methods for the systematic investigation of hazards and the assessment of risks are under development.

From Safety Management to Safety Leadership

Finally, I would like to raise one important topic – safety management. There are many books describing the elements of safety management. The British Health and Safety Executive has published a well-known document on their recommendations on this topic. There also exists the British standard BS 8800 that gives more detailed guidelines on safety management.

In quality management, the trend today is away from standards and to the use of the Malcolm Baldridge or similar system to evaluate the quality management of a company. This also gives a good basis for the evaluation of safety management system. The Malcolm Baldridge guidelines do not give instructions on how different things should be done. They systematically ask you to explain how you perform the management of your operations and demands justification as to why you have concluded to those practices. It also asks about how systematically you have applied the agreed principles, and what the targets and results have been.

These are tools that give support in developing safety management systems. However, rather little is written on safety leadership. That is, how to get people at all levels in a company to work according to the agreed principles, to maintain high skills and motivation, and how to assure continuous improvement in the everyday performance. My suggestion is that, besides the developments in technology and methods described above, one of the next important issues to study and to develop should be safety leadership.