

DEVELOPING BEST PRACTICE SAFETY PROCEDURES THROUGH IT SYSTEMS

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The paper presents the joint research of Romanian and foreign specialists in the design of a structure for developing and disseminating optimal best practice safety procedures (BPSP's) using the existing safety experience from Europe and Romania. This step will be a great leap forward towards Romania's safety integration into the European Union. The BPSP's are developed gradually, starting with a primary frame model (PFM) and a expert structure that helps towards the integration of existing European BPSP's and also towards the development of Specific Frame Models (SFM) that will develop into optimally BPSP's in time, by adding safety knowledge layers. At the end of the development of frame structure, a national IT system will be developed around a BPSP server that will store the PFM, SFM's and the BPSP's developed around the time and will disseminate them to all the interested parties.

Best practice safety procedures, IT structures, expert systems, frame structures, knowledge layers

GENERAL ASPECTS

"Knowledge is worth thousand pounds; especially when you need it and when you don't have it" says an old Romanian proverb. Safety knowledge is worthless; considering the possibility to save lives and to eliminate/reduce occupational accidents and incidents, everyone must be interested in obtaining and using safety knowledge.

However, there is a slight paradox regarding the useful safety knowledge, in the right place and at the right time – if apparently, safety knowledge is available for everyone, everywhere, in large quantities, in reality the phenomenon of "knowledge disappearing" is met very often when safety problems must be solved quickly and efficiently. Figure 1 illustrates this aspect.

Safety knowledge is needed:

- At the right place;
- In the right moment;
- In a right format.

So we could speak about useful safety knowledge (USK) as the safety knowledge that is fulfilling all these requirements.

Using cognitive psychology studies[1] we could connect our USK with two basic knowledge processes used to perform tasks:

- External representations-used to be a memory aid;
- Mental images-match external representations in the extraction of information about perceptual relations

Using the system approach we could see that mental images are extensively used by workers in order to keep and improve safety as perceptual relations are defining the workplace.

In this respect we could also speak about safety functional information[2].

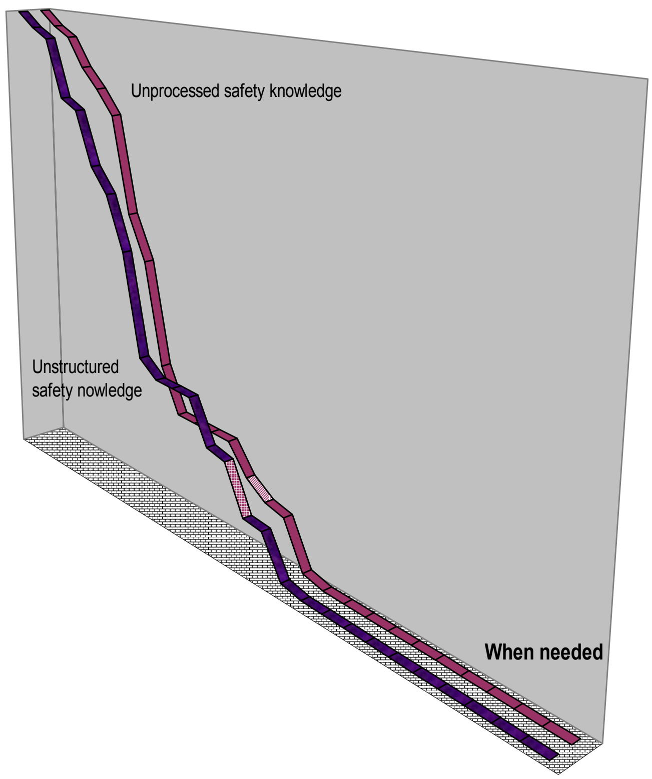

Figure 1. The loss of unstructured safety knowledge and unprocessed safety knowledge in time

Why does the big store of existing knowledge lie fallow? One reason is that relevant findings are not easily accessible at the time decisions need to be made. The existing knowledge is difficult to tap into. It is dispersed in inaccessible reports, obscure journal papers, remote libraries, and in unknown people's heads. The existing knowledge, therefore, is of limited practical use to people who need to make safety-related decisions here and now. The question is how do we put safety knowledge into the hands of the decision makers so that safety is explicitly and quantitatively considered?

While much of what we know about safety lies unused, that must not deter us from continuing to increase our knowledge. The development of safety knowledge is often a long process filled with imperfect data and analysis tools. It is only through continual reexamination of the existing knowledge base and the conduct of new research that we are able to improve on our knowledge.

At the state level, information systems and knowledge-based decision making have traditionally suffered from fragmentation and overlap. Many groups with different objectives have been collecting safety-related information for decades. Unfortunately this information is owned by groups who

- are part of a variety of state or local bureaucracies;
- are often unwilling or unable to coordinate and share information for the purpose of making better safety decisions in general and specifically better safety decisions, or
- have been rewarded for individual accomplishments rather than for statewide programs.

Since the mid-1960s, technology has provided the means to share information by establishing common reference points and system platforms. However, the owners of data systems have been reluctant to share their information because of a perceived loss of control as well as the inability to see the benefits of knowledge-based decisions. The costs associated with bringing divergent systems together always provided the necessary rationale for business as usual and the many database owners did not present a united front when approaching top management for the funds to achieve the desired goals. This situation was compounded by the perception that sharing information represented loss of control and, therefore, a diminishing ability to reach the goals for which the data were originally established. The concept of knowledge-based decisions was either ignored or not comprehended.

As technology has expanded and resources have diminished, there has been some movement toward sharing data systems and establishing knowledge-based information systems. However, significant institutional barriers to the full use of information decisions still exist.

SAFETY KNOWLEDGE AS A NEED

The ability to anticipate the safety consequences of an action could be defined as *safety knowledge*. The richer the body of safety knowledge, the larger the scope of rational safety management.

It would be difficult to make the case against knowledge-based safety management. But the most of safety activities cannot (yet) be called knowledge based because there are two types of impediments.

The first type has to do with inadequacies of knowledge. To serve day-to-day decision making

- Knowledge must exist,
- Knowledge must be practically available, and
- Professionals must be trained to be safety knowledgeable and able to apply that knowledge to decision making.

The second type involves the reluctance to use explicit safety knowledge even when available. Organizational self-interest and the inertia of habit or ingrained professional practice are sometimes barriers.

These two types of impediments are interrelated. It is difficult to ask an organization or profession to use explicit safety knowledge if the knowledge does not exist or is not easily available, or if trained people can not be hired. Conversely, safety knowledge will not come into being, nor will professionals be trained in safety, if organizations make no use of safety knowledge and if professions do not insist on it.

FACTUAL SAFETY KNOWLEDGE AND THE SAFETY MANAGEMENT PROCESS

Factual knowledge is the most used by professionals in their daily activity. Regarding safety, it could be presumed[3] that the most of the existing and immediately usable knowledge is factual.

Many attempt to influence safety by premeditated actions and programs. The set of all these premeditated prevention actions and programs could be considered as the *active* part of safety management. Then, there is the set of activities and programs that influence safety but which are not premeditated as far as their safety consequences go. The set of all their actions constitutes the *passive*[4] part of safety management. The actions by both the active and the passive parts of this amorphous safety management system jointly determine the safety future of a country: how many will be killed, how many injured, how much property destroyed.

Two prototype styles of safety management can be taken into account, marking two ends of a scale.

The *pragmatic style* stems from the confluence of two main sources. It rests on widespread popular beliefs about safety, and on the self-interest of organizations. The popular beliefs may pertain to the safety effect of police enforcement, of passing laws, of firmer punishment of better safety education etc. The self-interest of organizations may pertain to the need to show concern and initiative, and to maintain a budget, influence, manpower or income. Actors and organizations adhering to the pragmatic style appear to do what is widely believed to be right. It is good public relations.

The *rational style*, in contrast, is rooted in the idealistic desire to reduce the harm of accidents efficiently. One wishes to foresee the consequences of decisions and actions, to balance costs and gains, and to improve the management of safety in the light of what can be learned from experience. Figure 2 presents the two styles.

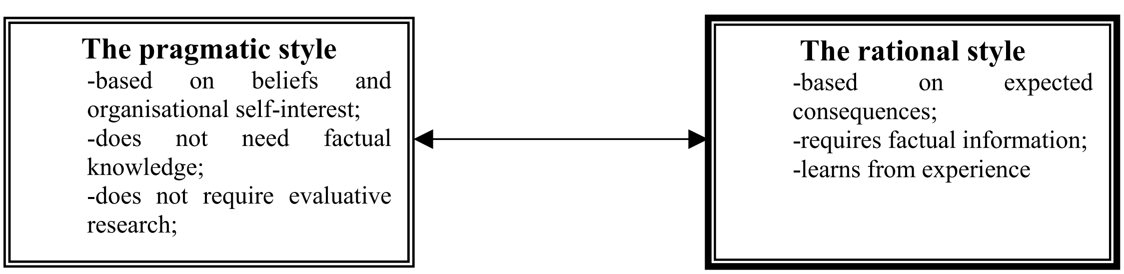

Figure 2. Two safety management styles

It is obvious that the most efficient[5] and computer friendly management style is the rational one.

Whether a real actor or organization is close to the pragmatic end of the scale can be ascertained by asking a few questions:

- Does the actor or organization require that extant factual knowledge about the safety consequences of decisions be ascertained?
- Does it employ or buy advice from people who have been trained in and have acquired factual knowledge about safety?
- Does it do evaluative research to learn about the success or failure of its actions?

If the answer to these questions is "NO", the style of the actor or organization is close to pragmatic. If the answer is "YES", there is still no assurance that the style is close to rational. In the amorphous and multifaceted safety management system there is one common trait - most decisions are made by the managerial and political echelons, few are made by the professionals who are the carriers of factual knowledge. In the delivery of health it is accepted that decisions about diagnosis and treatment rest with professionals trained in the matter. In safety delivery decisions unfortunately, the decisions are finally taken by the accountants. Therefore, even if factual knowledge is available to those making decisions, it's influence on the decision making is impossible to ascertain.

SAFETY KNOWLEDGE SPECIFIC TASKS

For the purposes of this paper we can identify four top level safety knowledge subtasks:

- *Propose*–the Propose subtask is responsible[6] for proposing prevention solutions; typically the proposals are partial, attempting to satisfy some of the safety goals; in this respect a safety goal hierarchy will be developed, considering the possible effects on the human operator, starting with death and ending with slight discomfort; during the process, there will be many instances of the propose task;
- *Verify*–takes partial or complete safety specifications and checks to see if the main safety goals are satisfied;
- *Critique*–if a Verify action identifies some safety goals not satisfied the Critique subtask attempts to determine why-to determine which of the safety commitments is responsible for the failure;
- *Modify*[7]–makes use of the results of Critique and makes changes in the general safety design

Safety problem solving takes place in the context of an external world that we perceive and act on multiple modalities and image and reason in multiple modalities as well[8].

KNOWLEDGE DIRECTED INFORMATION PASSING

Suppose a piece of unstructured knowledge that states "If history of noxious exposure consider changement of workplace" But what if there is no mentioning of noxious exposure in the worker record, even if the workplace analysis indicated chemical risks ? We could expect that a competent safety specialist could infer possible noxious exposure, considering workplace analysis and indicate the need of changing workplaces. Mittal[9] noted that inference involved in such exercises is not classificatory but involves a form of generic task named knowledge directed information passing.

The knowledge about each safety concept –the general safety domain knowledge could be stored in a frame structure –the well known safety concepts could be organised as a frame hierarchy.

This reasoning model involves accessing a frame that stores the desired datum or information on how the datum value could be obtained, including possible default values.

Best practice safety procedures are a perfect application of knowledge directed information passing.

BEST PRACTICE SAFETY PROCEDURES

Best practice safety procedures could be described by their ability to stimulate the mental images and external representations of the workers in order to assure, preserve and improve safety at their workplace. In order to do this BPSP must:

- Be the most efficient and safe way to perform an activity;
- Be as explicit as possible;
- Specific;
- Be training friendly[10]- a procedure that can not be easily explained and understood is not worth to be included as BPSP;
- Be traceable considering the logic flow of the work process;
- Be formulated in an understandable language;
- Take into account all the significant risks at the workplace and offer efficient methods in order to eliminate/prevent/reduce them;

Of course that there are many other attributes of the BPSP. The above mentioned attributes were considered significant in connection with the IT system[11] for developing BPSP that will be sketched below.

BPSP's are developed taking into account three elements:

- The development and dissemination at the enterprise level of a primary frame model[12] (PFM) for BPSP; the PFM will direct the development of BPSP's considering all the required elements;
- The development of extensive checklists in order to help the BPSP builders to collect all the necessary data for their procedures, taking into account all the elements of man-machine system:
    - The human operator;
    - The task;
    - The machine;
    - The work environment;
- The development of an expert system[13] that will use as an input the developed checklists and will generate, on the PFM basis, activity specific frame models (SFM)-the base for the future BPSP's; one of the specific subcomponent of the above

mentioned expert system will allow the import of foreign specific BPSP; the way from SFM to BPSP involves adding safety knowledge layers to SFM by all the safety specialists(willing to help) involved in a specific activity; in order to stimulate our safety specialists, the BPSP's could be used freely by the participants at their development.

Figure 3 shows the stages of development of the IT system.

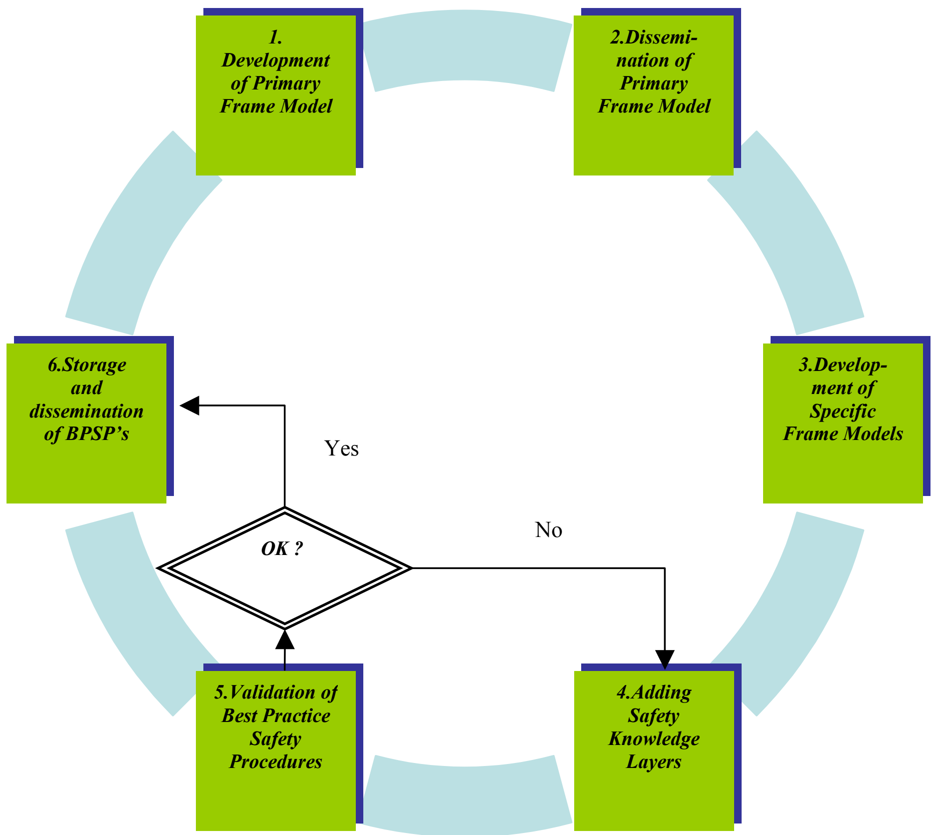

Figure 3. Steps in the development of BPSP's

It is easy to see that the process is tuned so that the developed procedures will be optimal . Step 5 is required as a supplemental check-up[14] in order to store and disseminate just the best procedures developed .If the procedure is sufficiently evolved it will be stored in the BPSP server; if not, it will be presented to more specialists in order to add supplemental safety knowledge layers.

Figure 4 shows the Primary Frame Model. The model is built as a general support structure[15] for the design and development of Specific Frame Models, so as that the developers will be sure that all the necessary aspects are included in their procedures.

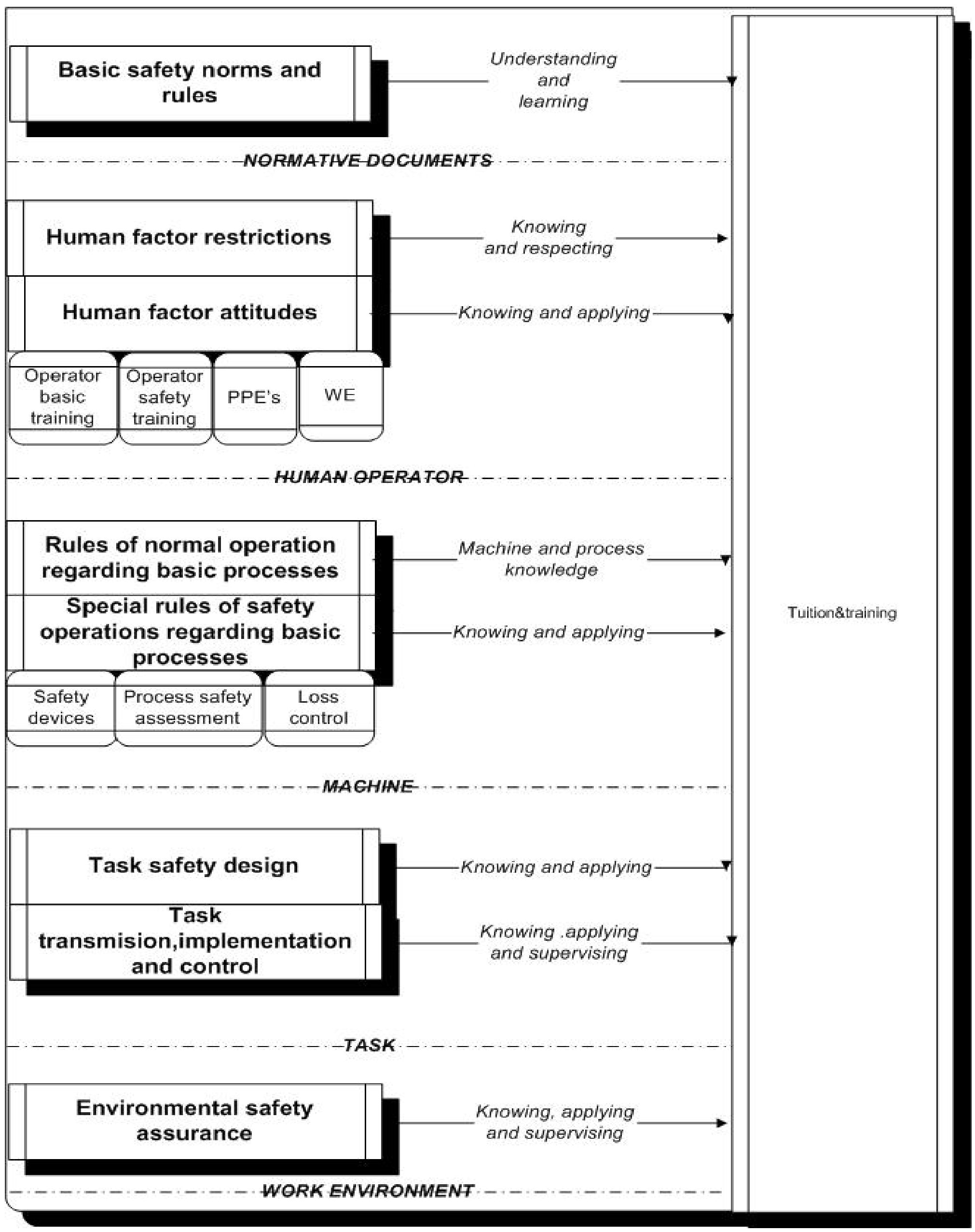

Figure 4. The primary frame model

Figure 5 shows the process of development of a best practice safety procedure, using all the elements mentioned above.

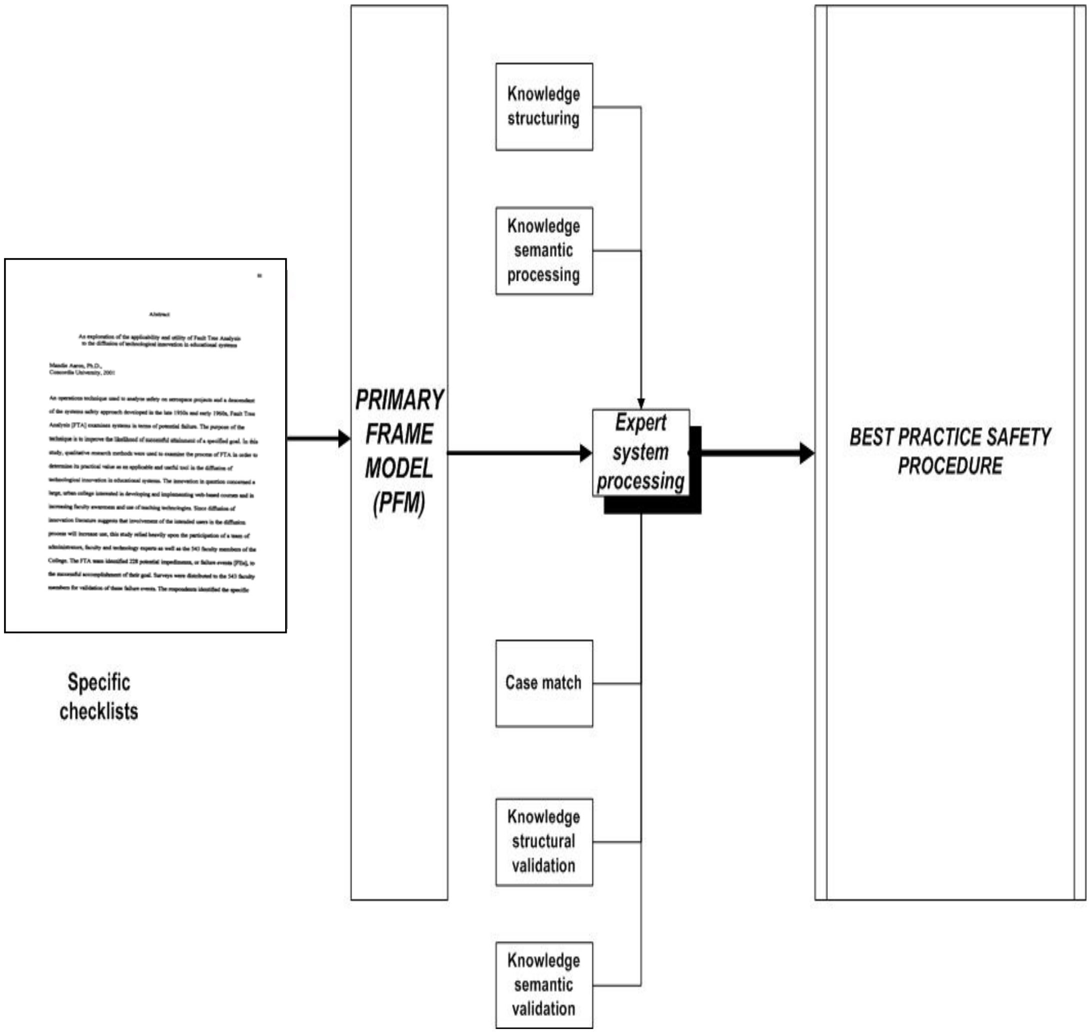

Figure 5. Development of a BPSP

Figure 6 shows in detail a checklist screen. The user (and further SFM and BPSP developer) is supposed to have all the necessary safety knowledge in his domain, at his workplace. This knowledge is collected and processed in a natural way[16].

Figure 7 presents the preliminary result of a system run-up, concerning the human component.

This result is further processed[17] taking into account PFM and also the other components of man-machine system-resulting specific frame models and at the end of the way the best practice safety procedure. Expert systems are the best tool for acquiring and preserving knowledge. The expert system used logic blocs as shown in figure 8.

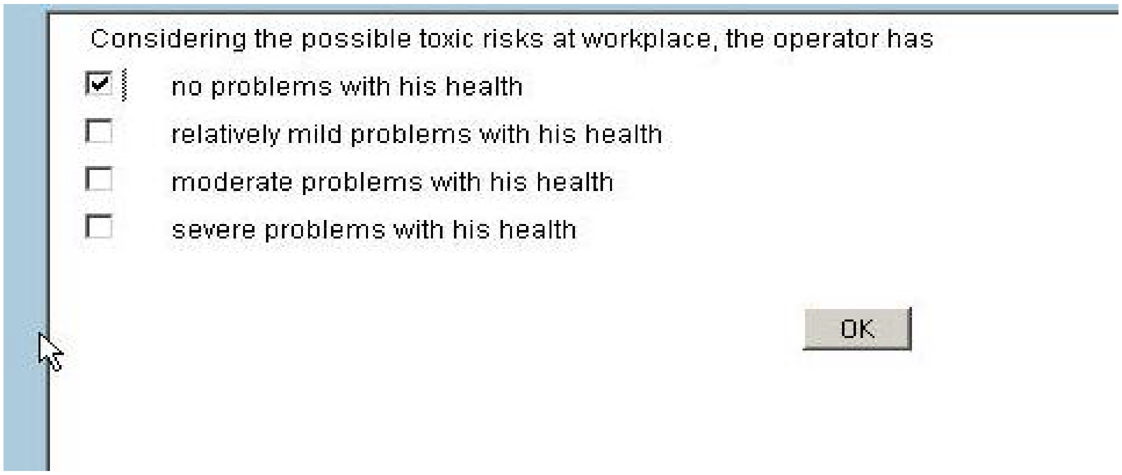

Figure 6. A safety checklist screen

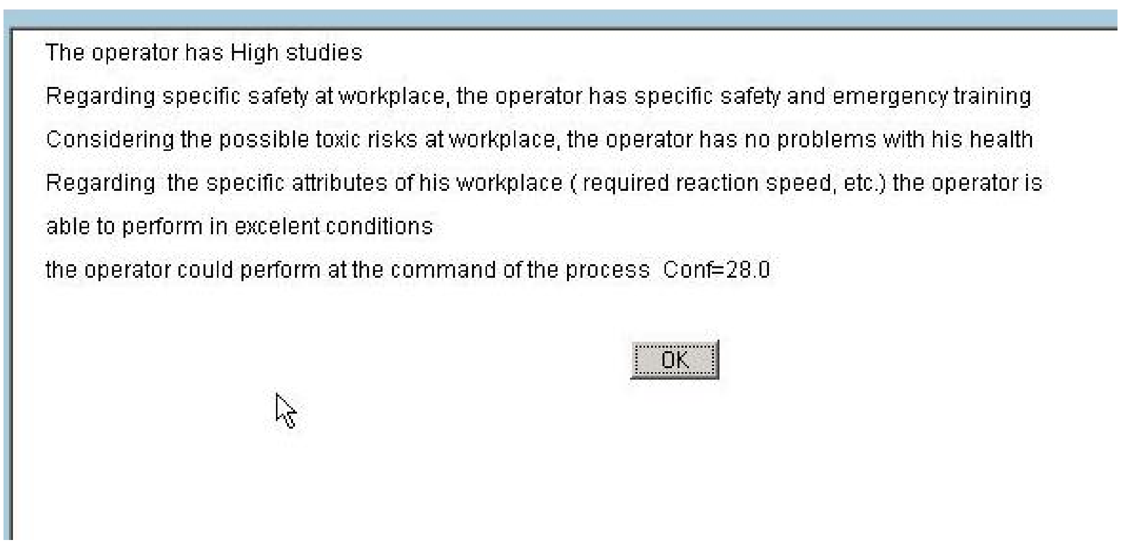

Figure 7. A preliminary result

There are two key components to improving the safety knowledge base of the system

- the development of improved analysis methods;
- the collection of better data.

Over the past decade, the safety analysis field has seen clear advances in the use of more appropriate methods.

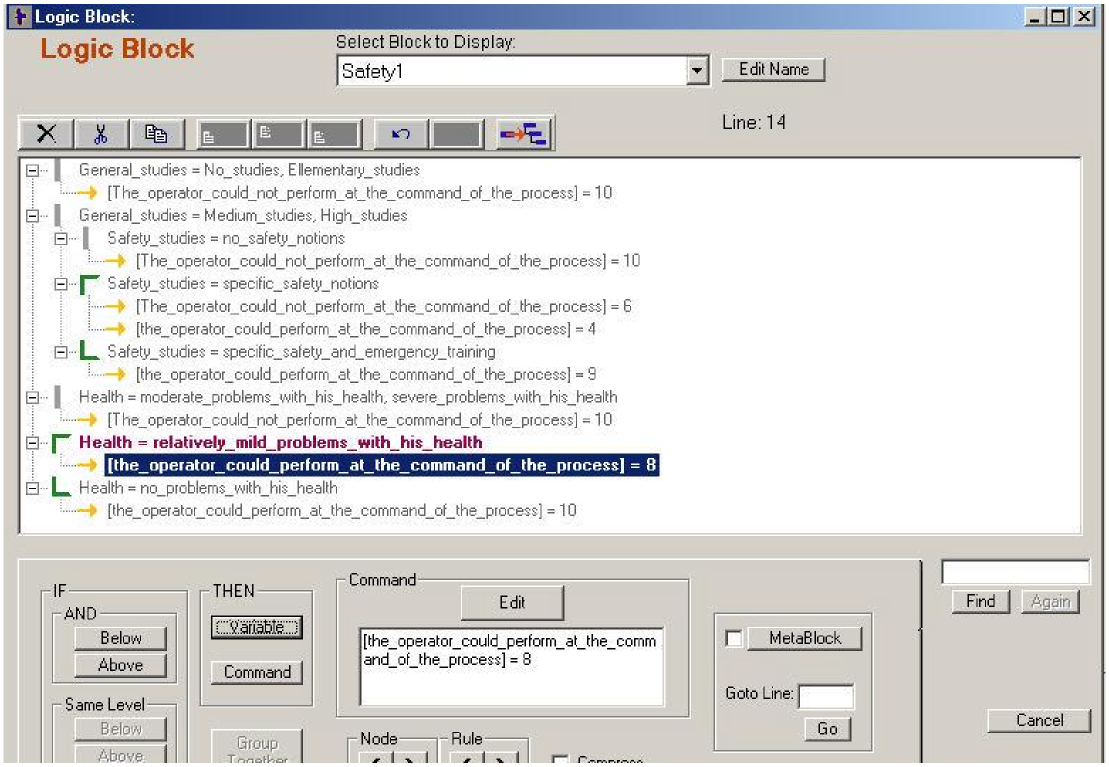

Figure 8. Logic block

There is now nearstandard use of more appropriate Poisson and negative-binomial models in research studies, the introduction of Bayesian procedures, and innovative use of other statistical methods such as metanalysis.

There continue to be needs for further improvements, primarily the development of a similar reference concerning safety modeling and the development of improved problem identification methodologies.

Unfortunately, it does not appear that the second component of improved safety research—safety data—is enjoying the same pace of advancement.

CONCLUSIONS

The research regarding best practice safety procedures is in a middle stage-involving the fine tuning of the primary frame model and also of the expert system. The research was supported by the Romanian National Research Institute for Occupational Safety and by our research partners from Germany and Austria.

The final development of this best practice system will contribute to the improvement of safety and health in our country, considering best practice safety procedures as:

- The safe way to do things at the workplace;
- A specific safety document, more accurate and precise as the normative one;

- An efficient training tool;
- A dynamic check-up instrument in order to control safety at workplace;
- A quality booster-best practice procedures being included usually in the Total Quality Management Systems.

Also under development, some tools that allow the Internet knowledge mining after significant safety knowledge that could be included into our BPSP's will be ready probably in 2004.

The development of our fully functional prototype to a national scale implies some important aspects as:

- The acceptance of best practice safety procedures as a modern and efficient safety instrument;
- The usage of such instrument at the floor level of the enterprise for:
  - Training;
  - Performing;
  - Control.
- The existance of necessary resources.

The development and implementation of this tool at a national level needs an significant investment, considering the size of the approach, the resources needed and the human contribution. The development of such system could be an international joint project, considering the possible safety benefits.

Of course that there are many problems regarding the development and implementation process and more. For example, one big issue is the property of best practice safety procedures. In this case, a mixed approach, starting with a free access for the developers of procedures and including then usage taxes on various levels will be the most appropriate in our opinion. Safety is invaluable and the avoiding of incidents and accidents will bring important benefices. The final ideea will be the development of a safety knowledge sphere, based on BPSP, with regional storage servers and BPSP development packages in every significant enterprise in Romania.

A connexion with existing or future safety networks (SafetyNet,S2S, HarshNet, Prism) will be invaluable to bring foreign experience into our BPSP's.

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