The MTO Concept and Organisational Learning at Forsmark NPP, Sweden

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Abstract. The term "MTO" (Man-Technology-Organisation) has been widely used by Swedish utilities and regulators to describe knowledge and analytical techniques that focus on human and organisational factors and their relationship with nuclear safety. MTO was introduced in Sweden after the TMI accident as a concept similar to the "Human Factors" (HF) concept developed in the USA. It was the intent that the explicit mention of the three interrelated elements in the concept – Man, Technology and Organisation – would stimulate a comprehensive "system view" on nuclear safety. This view should go beyond a strict technological perspective to recognise and highlight human and organisational factors as important moderators of risk. In retrospect, the MTO concept has been successful in stimulating a socio-technological view of nuclear safety in Sweden – a general trend supported by international developments. A further step along this path has been taken with the LearnSafe project.

1. THE MTO CONCEPT

1.1. Introduction

The MTO concept can be looked upon as three domains: as methods, as a specialist domain, and as an over all system thinking that includes organisational learning. By providing examples and experience from the Forsmark nuclear power plant (NPP), we will illustrate how these different perspectives have been applied and what has been achieved over the years. The description of the MTO concept is a shortened version of a paper presented at the ENS Top Operation Meeting in Berlin 1999 [1]. The future development of organisational learning is illustrated by the description of the EU-project LearnSafe [2].

1.2. Domains of the MTO concept

MTO is associated with at least three different (but related) domains:

(a) MTO as a set of *analytical techniques.*
In this domain the MTO concept focuses on the methods that analyses the relationships between humans, their activities and the organisational and technological context in which these activities take place.

(b) MTO as a *human factors specialist domain.*
In this domain the MTO concept is foremost perceived as a *specialist domain,* supported by know-ledge in human factors, psychology and other human related sciences.

(c) MTO as a *metaphor* for *system thinking* about safety.
In this perspective is the MTO concept viewed neither as a set of specialist domains, nor as a set of specific methods, but rather as a general attempt to develop a safety culture thinking that focuses on the entire socio-technical system (including technology, human factors and organisational issues).

The difference between the three domains may be difficult to grasp at first. MTO methods do, after all, require a system perspective if they are to be applied successfully. Experience supports the conclusion that misunderstanding and neglect of the necessary system perspective are not that uncommon when HF or other MTO methods are applied. A result of this may be neglect of the organisational context in which MTO methods are used. Another result can be that MTO issues are dealt with too much in isolation.

1.3. Management Support

Management attention, understanding and commitment are key issues. Without this commitment and support, the MTO concept would still have been viewed as nothing more than a set of methods or as "those specialists who know something about humans".

The introduction of the MTO concept had already from the beginning in 1988 a strong support from the senior management at the Forsmark NPP. The strong support explains the positive attitude to the concept, especially in the operating departments. People who have experienced different cultures and who have worked in different parts of the organisation are the ones who most readily understand the MTO concept in a broader sense. However it is undeniable that personality factors also have a role to play – some people seem to have an aptitude for understanding and accepting a "system perspective" and are therefore attracted by the MTO concept.

Despite this, some people still have a limited perception of MTO. To change their perception from a focus on individual techniques to a broader view is far from easy as it relates to the way the nuclear industry is traditionally organised. The introduction of the "safety culture" concept has made it easier to support a system-oriented MTO approach. Pressure from the regulators to focus on MTO issues has also promoted the development of the concept. Although regulatory pressure may help to develop MTO, there is also a risk that the utilities will simply comply with regulators' views without gaining a real insight into what MTO represents in a deeper and broader sense.

Financial pressure, a deregulated market, competition and other external factors may also represent threats to the time needed for co-operation and the discussions needed for a system perspective to emerge. On the other hand, these changes may also lead to the need for more cost-effective strategies in which a system perspective and effective co-operation are necessary in order to save money and to avoid mistakes. The LearnSafe project aims to find those strategies.

MTO methods should not be introduced without account being taken of the context in which they are to be used. A root-cause analysis methodology, for example, is of no use if it is not supported by the necessary organisational arrangements.

It is important that people constantly feel involved in the work. Human factors people must be used more as *facilitators* than "doers" in this process. Line organisation staff can carry out many of the MTO-related tasks. External support is necessary in this process, but people must feel that they "own" the methods.

2. METHODS AND TOOLS USED AT THE FORSMARK NPP

Analytical methods using human factors specialists have been developed to support:
- Root-cause[1] analysis.
- Analysis methods used in the retrofit design process.
- Organisational assessment analysis methods.

2.1. Root-cause analysis

Root-cause analysis was introduced at the Forsmark NPP and other Swedish NPP:s in the mid-eighties, and is now well established. The technique most often used has its origin in the HPES method [3] developed by INPO in the USA.
To qualify as a root-cause method, the method must clearly identify the very basic causes of an event. Earlier versions of the MTO analysis method allowed the analyst to stop too early in the analytical process and to concentrate only on direct causes. The reasons for this could be the unease that the analyst may feel when the root cause of an event is found to lie with the management. Another reason for not following the chain of events and causes to the root could be the abstract nature of cultural and organisational issues. The methods are in themselves also partly responsible for failures to find basic root causes. The HPES methodology, and similar methods involve nothing that really forces the analytical process to include higher management levels – much is up to the judgement of the person performing the analysis.

To facilitate the root-cause analysis the method used at Forsmark has the following features:

- The manual used to support the process has a simple "accident cause" model that describes the differences between direct causes and root causes. In the cause-event diagram, a "line" is used in order to separate direct and root causes. In the space above the line are causes relating to safety management, organisational culture, internal control systems etc. shown, below the line are more direct causes shown.
- There is a distinction between "barrier functions" and "supportive functions". Barrier functions are defined as those activities or processes that are designed to *capture* a deviation or fault, while supportive functions are things that are implemented to *support activities so that errors do not occur in the first place.*
- A third change has been to look at the ASSET [4] methodology, developed by IAEA, in order to support the analysis with questions such as *"Why was the event not prevented?"* This and similar questions have been valuable in supporting a more in-depth analytical strategy.

If event analysis is to be successful, it is important to support a collective awareness that a system perspective on safety is necessary in order to understand the underlying MTO-related causes of an event. Such a perspective emerges partly from co-operation between specific competence's found in the organisation. While it is possible to develop a system perspective through theoretical training and education, it is hands-on analytical activity that transforms such theoretical knowledge into real insights. Event analysis provides a very good benchmark for checking theory against observations and is therefore an important tool in the process of learning to think in a system-oriented way.

[1] The term root cause is used to describe basic causes supposed to be under control of the own organisation.

2.2. MTO Methods used in the retrofit design process

Another set of MTO methods and tools is used in the design process for control-room retrofits and modernization's. The application of these methods and the use of the analysis tools aim to enhance the control room's usefulness, ergonomics and working environment. The application of the MTO concept is highly relevant in this work, both as a specialist domain and – perhaps to a greater extent – as a general system perspective.

There is sometimes a tendency to overly separate ergonomic issues from the broader context. One of the lessons learned is that the organisation of retrofit projects, such as the modernisation of control rooms, is highly dependent on the establishment, organisation and utilisation of different competence's, such as operator experience, instructor competence, HF competence, IT competence etc. In order facilitate the integration of all these specialist domains and applying a system-oriented approach has a new method been developed. This method is called MANFRED and has been developed to support the process for modifications affecting the control room and other parts of the plant, which have an HMI (Human-Machine Interface). The MANFRED process is integrated into the overall change management process.

2.3. Organisational assessment

Methods and tools based on the MTO concept are also used to carry out organisational assessments, for example as part of periodical safety reviews. An example of the application of such methods and tools is the organisational assessments performed as part of the mandatory periodic (repeated every 10 year) safety review, PSR (ASAR). Another example is the structured assessments made before organizational changes are performed.

3. METHODS FOR PROMOTING MTO AWARENESS

Nuclear safety needs competence from many areas in order to create useful strategies and risk estimates.

A strategy to support system thinking and organisational learning is needed. Setting up seminars, creating MTO groups, supporting human factor methods, integrating the MTO concept with quality concepts etc. and, most important, letting people with different and varied competence's be part of this work will all facilitate learning. The organisation should develop an "open mind" with respect to how different competence's can be used in the analysis of risk. Such initiatives might include experiencing feedback and exchanging experiences with other nuclear utilities as well as co-operating with universities, consultant organisations and other sectors.

3.1. The LearnSafe project

LearnSafe is a EU-project financed by the European Union and a group of European utilities and organisations, including WANO. The project has 14 partners representing five countries, it is co-ordinated by VTT Automation in Finland.

The main objective of the LearnSafe project is to create methods and tools for supporting processes of *organisational learning* at NPP:s. Organisational learning has become increasingly important for the nuclear industry in its adaptation to changes in the political and economic environment, changing regulatory requirements, a changing work force, changing technology, and the changing organisation of NPPs and power utilities. The danger during a

rapid process of change is that minor problems may trigger a chain of events leading to actual degrading of safety and/or diminishing political and public trust in the safety standards of the particular NPP, utility or corporation.

The focus of the project is senior managers at NPPs and power utilities who are responsible for strategic planning and resource allocation. This focus was selected with the understanding that their decisions, approaches and attitudes have an important influence both on the safety and the economy of the NPPs. The LearnSafe project will develop methods and tools, which can be used in the management of change, and in ensuring an efficient organisational learning. Project results will include recommendations and inventories of good practices.

The project is set up in two major phases, which cover both theoretical considerations and empirical investigations. The first phase places an emphasis on management of change and the second on components of organisational learning. Both phases start with the creation of data collection instruments to be used in the empirical part of the work. The second include the development of methods and tools, which can be applied by the NPPs themselves in creating efficient processes of organisational learning.

One important feature of the project is a continuous interaction between the researchers and managers at the NPPs in addressing issues connected to organisation and management, which are important for safety and efficiency. Preliminary results of the project will be presented and discussed in small workshops during the project, to ensure that relevant problems are addressed and solved in a practical way.

Five milestones are identified. The first milestone is the selection of a research model including a framework of concepts and phenomena to be considered in the project. Tools for describing organisations and data collection instruments for the first empirical phase are also a part of the first milestone. The second milestone marks the completion of the first major theoretical and empirical phase of the project. The third milestone and the mid-project evaluation is based on the finalised analysis of NPP approaches to change and the data collection methods and tools to be used in the second phase of the project. A mid-project seminar for a larger audience for presenting preliminary project results is also planned. The fourth milestone marks the completion of the first major theoretical and empirical phase of the project. The fifth milestone is connected to the completion of the project. A final seminar will be used to collect comments to a draft final report. It is the intention to place the completed final report in the public domain after due review by project partners.

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