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# ***Learn Safe***

**LEARNING ORGANISATIONS FOR NUCLEAR SAFETY**

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**Deliverable 1: The research frame of LearnSafe  
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## THE RESEARCH FRAME OF LEARNSAFE

### 1 INTRODUCTION

The LearnSafe project has been divided into two major phases of theoretical and empirical investigations. The first phase is devoted to *management of change* in the understanding that the adaptation to changed environmental conditions provides one of the major challenges to the nuclear power plants today. The second phase is devoted to *organisational learning* as being the most important process to develop and maintain in pursuing a continued improvement of performance measured in terms of both safety and efficiency.

The present report has been written as a part of the Workpackage 1 to establish a research model and a practical framework for further activities. It can also be seen as an introduction to concepts and models, which are used in the theoretical part of the project. It is not intended to provide a comprehensive review of all relevant models, but it is instead intended to provide a short exposition of some of the background thinking to serve as a frame of orientation for practitioners involved in the project.

The intent of research frame is to provide the ground for a common understanding of the concepts, influences and models that are discussed in the project. Thereby it is also supposed to support an in-depth discussion of research questions and project findings.

### 2 ISSUES, INFLUENCES AND MODELS

LearnSafe was established based on the understanding that organisation and management is important for the *safety* of nuclear power plants. The selected focus on the senior managers at the nuclear power plants and the corporate offices is connected to a perceived need to give them better methods and tools for assessing *organisational performance* and for planning and implementing *organisational changes*.

There are a large number of issues that have to be considered in managing a nuclear power plant. *Goals* have to be defined and communicated to the organisation, *plans* for future activities have to be created and implemented, *resources* have to be allocated and all these activities have to be *followed up* to create a ground for further actions. In this process the management has to be sensitive for possible misunderstandings in communication, for the workload of key persons and for alternative solutions to approach emerging problems.

The LearnSafe project is concerned with issues that are within the *span of control* for the managers involved to make it easier for them to manoeuvre in a crossfire of demands to avoid situations, which may lead to a chain of events which may have an impact on safety. It is the assumption of the LearnSafe team that *awareness* and *understanding* of important issues and how they may influence performance can make it easier for managers to find satisfactory solutions to many of their day-to-day problems. It is the intent of the LearnSafe project to collect such challenges together with mechanisms, by which they may influence safety either on a short or on a long term.

In some instances it may be possible to give more detailed account of how various issues interact, to provide models that can be used to build scenarios to be considered in a more systematic manner during organisational change. Such models can in many circumstances

provide forecasts of possible difficulties, which may be encountered; thus enabling organisations to utilise a proactive approach to organisational change. Models can also provide a more comprehensive understanding when several issues are interacting. In the use of models of organisational interactions it is important to note that no single model can address all needs, but it is instead necessary to use several different models to provide a multitude of views.

### **3 THE RESEARCH FRAME**

An important part of the LearnSafe project is to establish a framework for describing essential characteristics of organisations and management processes that can be used to direct evolutionary processes in preferred directions. This framework will be used in the project to structure both theoretical and empirical work. It is the intention that the project builds on this framework and extends it to reflect concepts and understanding of both practitioners and researchers participating in the project.

#### **3.1 Five interacting systems**

The framework is based on the five interacting systems of technology, individual, group, organisation and environment. In one sense this is a slight extension of the MTO (man–technology–organisation) concept to include also group dynamics and the societal environment in which the nuclear power plants operate. This framework can in a restricted sense also be seen as a model of the objects of study, management processes and the organisation at the nuclear power plants.

##### *3.1.1 Technology*

This system includes, but is not only restricted to plant design, buildings, equipment and degree of automation. An important part of the technology system is also connected to the procedures, their structure, content and format as well as to the plant documentation system. The technology system of today is characterised by the rapid development in communication and information technologies that has occurred during the last twenty years.

##### *3.1.2 Individual*

Considerations for the individuals include motivation, commitment, qualifications and experience. Important are also individual risk perceptions and attitudes. Identity and thinking styles of people also have an influence on the individuals behaviour in different situations. An individuals teamwork skills, work orientation and commitment are further characteristics to be taken into account in this connection.

##### *3.1.3 Group*

The group is an important intermediate between individuals and the organisation. Group size and composition are factors, which influence interaction styles and communication. Group norms are influenced in relationship to other groups, status in the organisation and the role and purpose of the group. People typically participate in several different groups and they may in these take up different roles depending on the situation.

### 3.1.4 Organisation

The organisation includes management activities such as creating visions, defining goals and developing strategies. The organisation also includes the management of resources, capabilities and practices as well as defining norms and ideals. Other important components are leadership and the creation of a reward and punishment system. It also includes approaches and solutions such as outsourcing of activities and the use of contractors.

### 3.1.5 Environment

The environment includes factors beyond direct management control such as the legal system and the regulatory frame. Relationships with suppliers and customers as well as with the public and media are particularly important when considering the environment. The educational system, labour markets and trade unions as well as the local and national governments are also important in this connection.

## 3.2 Three views of the organisation

The five interacting systems can be viewed in different ways. Each view concentrates on certain aspects of the system, which in different situations emerge as the major contributor to observed behaviour. In this connection a difference is made between three different views: the administrative the political and the cultural view.

### 3.2.1 The administrative view

The administrative view is typically reflected in organisational charts giving an account of authority and responsibility. It also includes the documentation of regulation, policies, procedures and practices. The administrative view is also reflected in descriptions of work processes and activities. The cycles of goal setting, planning, implementation and evaluation is another example of an administrative view taken on the systems above.

### 3.2.2 The political view

The political view is concerned with differing interests, conflicts and negotiation. It is also concerned with the emergence and disruption of confidence and trust among people in and between groups. Power structures and power games people play are also included in this view. The concept of social capital has sometimes also been associated with this view.

### 3.2.3 The cultural view

The cultural view is concerned with how people understand and make sense of their environment. This view includes artefacts such as visible products, behaviour, organisational structures and processes. The cultural view includes shared values such as strategies, goals and philosophies as well as basic underlying assumptions such as unconscious, taken-for-granted beliefs, perceptions, thoughts and feelings. Myths and heroes have sometimes in this connection been associated to deeply held attitudes and beliefs.

## 3.3 Organisational failures

Failure models have been developed both for technical and human systems. Technical failure models identify mechanisms such as production defects, ageing and wear as causes for failures in the components. Failures could be deterministic when they occur as triggered by

environmental conditions or they could be probabilistic when there is a mechanism of chance involved. Technical failure models provide a basis of the deterministic and probabilistic safety analyses as carried out in the nuclear industry.

Human errors and organisational failures could in the same way as technical failures be considered through their origination mechanisms, which are influenced by situational conditions. Models of human errors have been developed based on various assumptions, but today there is a large consensus that human errors occur due to systemic reasons. The trigger mechanism is then a resource and demand conflict, where the human operator or decision-maker is caught in a situation, which he cannot manage. The likelihood for such situations is sometimes evaluated through an assessment of various *performance shaping factors*.

Organisational failures are closely related to human errors, but they are seldom possible to attribute to single events or individuals. They can more generally be seen as flaws in organisational practices, which at some point in time place individuals in situations they cannot cope with. Organisational deficiencies can thus be seen as triggers of failures in important functions, on which individuals in the organisation depend for guidance and support in their activities. These functions are expressed both explicitly in procedures and instruction and implicitly in practises and organisational culture.

Reason<sup>1</sup> suggests that one way of representing the aetiology of an organisational accident is the 'Swiss cheese' Model. Within this phenomenon the defences, portrayed as cheese slices, are shown as intervening between the local hazards and potential losses. Each slice of cheese represents one layer of the defence. In an ideal world all of these layers would be intact. However, in reality each layer has holes or gaps; these gaps are created by active failures (the errors and violations of those at the human- system interface) and by latent conditions arising from the failure of designers, builders, managers and maintainers to anticipate all possible scenarios. The holes due to active failures are likely to be relatively short-lived, whilst those arising from latent conditions may lie dormant for many years until they are revealed by internal audits or incidents and accidents. Reason believes that it is also important to note that, unlike the holes in Swiss cheese slices, these defensive gaps are not static, especially those due to active failures. They are in continuous flux, moving around and opening and shutting according to local circumstances. This metaphor also makes it clear why organisational accidents are rare events i.e. for such a disaster to occur it requires the lining up of all the holes to permit a brief trajectory of accident opportunity.

Organisational practices and systems are supposed to create necessary preconditions for high performance over extended periods of time. One of the most important management tasks is therefore to assess their functionality and initiate improvements whenever necessary. This implies a definition of the performance to be achieved in terms of requirements and goals together with a continuous evaluation of this performance. Avoiding organisational failures may therefore be seen as the task of defining standards both for work processes and for the output they produce, to identify and correct flawed processes and to ensure that the improvements made are sustained over time.

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<sup>1</sup> Reason, J. (1998). Achieving a safe culture: theory and practice. *Work and Stress*, Vol. 12, No. 3, p. 239-306.

### 3.4 Generic dilemmas of management

Management of organisations in general and nuclear power plants more specifically involves the task of finding an operational balance with a large number of sometimes conflicting requirements. These can be thought of as generic dilemmas of management, which have to be understood, resolved and integrated in practices and activities. One example is the balance between safety and efficiency, which has to be approached in a way not to let one compromise the other.

Other balances to be found in the day to day operation is for instance a simultaneous focus on traditions and renewal as well as an emphasis on both formal and informal management methods. In a learning organisation both self-confidence and willingness to listen should co-exist for the best performance. Efficiency can be achieved only if internal competition is channelled into co-operation between groups and individuals. Nuclear power plant organisations are by necessity centralised, but decision making should still be distributed to a level where necessary information is available. Procedures and practices should involve discipline, but still allow for flexibility and innovation. Managers in various positions should maintain an overview, but not lose their focus on important details. Finally there should be a continuous evaluation of both short and long term priorities.

One of the main challenges for managers is to identify such dilemmas and to find suitable balances, which can be proceduralised and communicated to the organisation in an understandable and acceptable manner. It can be assumed that an efficient identification and management of these balances is one of the root causes of good performance in organisations. It is the intention in the LearnSafe project to investigate what kinds of dilemmas are relevant in the nuclear power plants and how they are resolved.

### 3.5 Organisational learning

Learning is a hypothetical construct i.e. it can not be directly observed but can only be inferred from observable behaviour; learning normally implies a fairly permanent change in a persons behavioural performance. Espejo et al<sup>2</sup> suggest that the essence of organisational learning is the ability to adapt to change which is a prerequisite for the survival of an organisation in a changing environment. Argyris<sup>3</sup> suggests that 'Organisational learning is a competence that all organisations should develop.' He believes that the reasons underlying this premise is that the better organisations are at learning the more likely it is that they will be able to detect and correct errors. Cox and Cox<sup>4</sup> suggest that one of the characteristics of low accident plants was their focus on organisational learning. They believe that, in terms of safety, learning means that an organisation deliberately collates, analyses and disseminates all its performance data, including its accident and incident data, so that the whole organisation and its employees may learn from the incidents that have occurred.

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<sup>2</sup> Espejo, R. Schuhman, W. Schwaninger, M. and Bilello, U. (1997). *Organisational Transformation and Learning: A Cybernetic Approach to Management*. Wiley.

<sup>3</sup> Argyris, C. (1993). *Knowledge for Action: A Guide for Overcoming Defensive Behaviours*. San Francisco: Jossey-Bass.

<sup>4</sup> Cox, S., Cox, T. (1996). *Safety Systems and People*. Butterworth-Heinemann: Oxford.

The concept of organisational learning has been used in different ways and in different disciplinary traditions. Most scholars confronted with the wide range of literature concerned with organisational learning have problems organising and grouping the array of contributions.<sup>5</sup> The divergence of perspectives has increased and as yet no single analytical or conceptual model serves as a framework for research conducted within the realms of organisational learning. Moigeon and Edmondson<sup>6</sup> suggest that the concept of organisational learning is presented in the literature as occurring at different levels of analysis from individual to organisations and as applying to such disparate processes as diffusion of information within an organisation, individual interpretative processes and interpersonal communication, and the encoding of routines in an organisation. Finally, in some conceptions organisational learning is prescriptive and elsewhere is the basis of a descriptive theory.

Models of organisational learning typically rely on representations of the learning cycle – *observation, assessment, design and implementation*. The implementation at the end of the cycle represents a new change in the system. Argyris and Schon<sup>7</sup> believe that *single-loop learning* is sufficient when error correction can proceed by changing organisational strategies and assumptions within an unchanged framework of norms for performance. However, in some cases error correction requires an organisational learning cycle in which organisational norms themselves are modified. This process involves *double-loop learning* i.e. the conflict itself must be recognised. They suggest that if double-loop learning does occur it will consist of the process of inquiry by which individuals will confront and resolve their conflict. Therefore, double-loop learning strives to resolve inconsistency with organisational norms and make new norms more effectively reliable. On a senior management group level double-loop learning may involve a redesign of earlier organisational practices and the creation of new versions to be shared within the organisation.

The five systems and the three views above will be combined with models of organisational failures and generic management dilemmas to identify couplings between factors that are applicable to organisational learning. One important result of the project is an identification of impediments and barriers for organisational learning together with approaches for handling such barriers. In this connection it is important to note that it is very seldom that a problem can be approached with one single solution, but instead several solutions have to be combined to yield the wanted outcome.

#### 4 ON THE USE OF THE RESEARCH FRAME

The research frame is intended to provide a basis for the discussion of issues, how they influence each other and possible models that can be used to explain observations collected from the participating nuclear power plants. This section is at this stage intended only to provide some examples of reasoning about issues closely connected to the content of LearnSafe.

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<sup>5</sup> Pawlowsky, P. (2001). The Treatment of Organisational Learning in Management Science. In Dierkes, M. Berthoin Antal, A. Child, J. and Nonaka, I. (Eds.) Handbook of Organisational Learning and Knowledge. Oxford: Oxford University Press.

<sup>6</sup> Moigeon, B. and Edmondson, A. (1996). Organisational Learning and Competitive Advantage. London: Sage.

<sup>7</sup> Argyris, C. and Schon, D. (1978). Organisational Learning: A Theory of Action Perspective. Reading Mass.: Addison-Wesley.

There has been a concern that *organisational drift* may cause problems in a period of rapid change. Organisations conduct continuous explorative searches for better efficiency. The practice is that safety impacts will be evaluated thoroughly before any of the suggestions are implemented. If a change in comparison with earlier practices is perceived to be small, it may be accepted with a more cursory analysis. If the *safe operational envelope* has not been defined in enough detail there is a danger that a series of decisions that are rational in the small may bring the organisation into a region where safety has been compromised. When cases of organisational drift have occurred they seem to be related to deficiencies in communication, an absence of clear safety norms and insufficient management oversight.<sup>8 9</sup>

One problem in the nuclear power plants today seems to be that people have very much to do. This may lead to an increased *shortsightedness* in activities, where people are able to respond only to the most urgent demands. This shortsightedness may lead to a viscous circle of decreasing performance, increasing backlogs and regulatory concerns that in turn increases the load on the personnel. To break out from such a viscous circle it is necessary to have a strategic view, to set goals and priorities that are realistic, and to invest time and resources for more sustainable solutions.

Many organisational deficiencies can be traced back to difficulties in *communication*. If the vertical communication in an organisation is not truthful and efficient there is a danger that misunderstanding and distrust emerges between the management and lower parts of the organisation. This danger can become very concrete during large reorganisations. Different cultures and an absence of a common language may bring impediments into horizontal communication to cause corresponding difficulties in co-ordination of work. A deficient communication may also bring in uncertainties in the position and use of various instructions.

## 5 CONCLUSIONS

The difficulty in approaching the influence of organisation and management on the safety of nuclear power is that the issues have many facets. It is necessary to include many different aspects, which in addition are difficult to measure on any objective scale. Still there is a need for finding a suitable structure for how the issues relate to each other.

This report is intended to establish a basis for further considerations in the LearnSafe project. It is also intended that the research frame is a living document within the project by updating it at regular intervals.

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<sup>8</sup> Andognini, G. C. (1999). Lessons from plant management for achieving economic competitiveness for evolutionary reactors, pp.330-337 in Evolutionary water cooled reactors: Strategic issues, technologies and economic viability, IAEA-TECDOC-1117.

<sup>9</sup> John S. Carroll, Sachi Hatakenaka (2001). Developing a safety conscious work environment at Millstone nuclear power station, in Wilpert, B. & Itoigawa, N. (eds.): Safety Culture in Nuclear Power Operations, Taylor & Francis, London, ISBN 0-415-24649-0.