



**EUROPEAN COMMISSION**

**5th EURATOM FRAMEWORK PROGRAMME 1998-2002**  
**KEY ACTION : NUCLEAR FISSION**

**LEARNING ORGANISATIONS FOR NUCLEAR SAFETY**

**CONTRACT N° FIKS-CT-2001-00162**

**REFLECTIONS ON ORGANISATIONAL STRUCTURES  
IN NUCLEAR POWER PLANTS**

**Björn Wahlström, VTT Industrial Systems**  
**Carl Rollenhagen, SwedPower AB**

**2.12.2003**

**Summary:** This working paper has been written to invite to a discussion of organisational structures in high reliability organisations. It is based on information collected in the Learn-Safe project. Due to the background of the two authors the content of the paper gives a reflection of ongoing discussions in Finland and Sweden. The paper is mainly based on inputs from the nuclear industry, but is hoped also other high reliability organisations would find the ideas interesting and useful.

**List of content:**

Reflections on organisational structures in nuclear power plants .....	1
1 Introduction .....	3
2 Organisations at nuclear power plants .....	3
2.1 An industry in change .....	3
2.2 A functional way to organise .....	4
2.3 Recent organisational innovations .....	4
3 Characteristics of safety oriented organisations.....	5
3.1 General principles of organising work .....	5
3.2 Safety management .....	5
3.3 Regulatory oversight .....	6
4 Rethinking organisational structure .....	7
4.1 Operational challenges .....	7
4.2 Pros and cons of hierarchical organisations .....	7
4.3 Matrix organisations.....	8
4.4 Network organisations.....	8
4.5 Division of work.....	8
5 Characteristics of efficient organisations .....	9
5.1 Ensuring quality of work.....	9
5.2 Decreasing uncertainty .....	9
5.3 Efficient communication .....	10
5.4 Understanding the business .....	10
5.5 Decision making.....	10
6 A discussion .....	11
6.1 Organisational complexity .....	11
6.2 Leadership .....	11
6.3 Use of information .....	11
6.4 Dilemmas of management.....	12
6.5 Preconditions for organisational safety .....	12
6.6 Visions for the future.....	12
7 Conclusions .....	13
Acknowledgements .....	13
Appendix. Balancing dimensions in organisational design .....	14

## 1 INTRODUCTION

LearnSafe<sup>1</sup> has been investigating processes of *organisational learning* and *management of change* at nuclear power plants across Europe. The focus of the project has been upon senior managers at nuclear power plants, who are responsible for strategic choice and resource allocation. This focus was selected due to the importance of their role in decisions, approaches and attitudes that have a large influence on the safety and economy of the plants.

The nuclear industry has a special position as compared with other safety related industries due to various reasons. Firstly the risk connected to the operation of nuclear reactors is undisputed and warrants a continuous management attention. Secondly public attitudes towards the nuclear industry have sometimes become highly emotional, where even small incidents get a large media attention. The operational environment of nuclear power has also changed considerably since its introduction, which has forced the industry to search new ways to adapt.

This working paper is based on information collected in the LearnSafe project on how senior managers at nuclear power plants view challenges within the industry and what kind of strategies they use to meet these challenges. Due to the background of the authors, views and ideas are based on discussions in Finland and Sweden. It is hoped that some of the ideas expressed can find also a broader interest. The intent of the paper is to invite to a discussion of pros and cons of various organisational structures and other organisational solutions that are used in high reliability organisations.

## 2 ORGANISATIONS AT NUCLEAR POWER PLANTS

### 2.1 An industry in change

Deregulation and the internationalisation of the energy market have introduced a considerable restructuring in the electricity supply sector. Opening the market for competition between plants and countries has at least initially brought electricity prices down to levels where pressures to decrease the operational costs at the nuclear power plant have been increasing. This short term pressure has sometimes been felt to be in conflict with the need for long term planning horizons at the nuclear power plants.

Another change is that the average age of the work force within nuclear power plants is increasing, which is a consequence of demographic changes in the work force at large. Upcoming retirements are seen as a threat to organisational knowledge. In hiring new personnel to the nuclear power plants an increasing difficulty has been seen, as young qualified persons tend to select other careers than employment in the nuclear industry. In some countries early closures of nuclear plants have introduced difficulties in motivation, which affects also personnel at other plants.

When present plants are approaching mid-life there is a mounting pressure for them to modernise. New information technology offers opportunities to change not only instrumentation and control systems, but also utilise integrated information systems in work processes and activities. This provides a potential to improve operating practices, but the new systems also pose new challenges for nuclear power plants.

---

<sup>1</sup> The project FIKS-CT-2001-00162 "Learning organisations for nuclear safety" has been funded by 5th Euratom Framework Programme during the years 2001-2004. Additional information on project goals and results can be obtained at the web-site at the address <http://www.vtt.fi/virtual/learnsafe/>.

The producers of electric power have responded to the changes in their operational environment with various organisational changes. There have been merger and acquisitions in which new large multi-national utility companies have been formed. Individual power plants have outsourced many of their less important activities as a strategy to keep focus on their core business. In view of the demands set on nuclear power plants it is clear that this change process requires a balance between traditions and renewal.

## **2.2 A functional way to organise**

The nuclear power plants have traditionally organised themselves functionally into operations, maintenance and technical support. This organisation has also been reflected in the line organisation with a plant manager and senior managers of operations, maintenance and technical support, which often forms the senior management group. This organisation had the benefit of providing clear lines of authority and reporting within the organisation. Unfortunately this organisational structure sometimes leads to compartmentalisation and difficulties to bridge organisational borders.

One amendment to this line organisation was introduced by the need to have a safety and quality unit, which should have independence from the other organisational units. The way safety and quality activities are organised at the nuclear power plants show some variation, which is induced by national regulation.

This general structure has typically been used also at sites with multiple identical units. At sites with multiple non-identical units it has been typical to introduce some kind results orientation between the units to promote benchmarking and gradual improvements in a friendly competition between the units. This arrangement has also proved to increase the individual commitment of the personnel to the units, but it has sometimes made it more difficult to move people between the units.

In the wake of the restructuring of the electricity supply there are today companies with multiple sites of nuclear power and the question is then how synergies between such units can be created. There are obvious synergies in for example procurement, where larger volumes can ensure more competitive prices. Other possibilities are to use specialised nuclear competencies for several sites, but differences in plant technologies may offset this benefit. Co-ordination of annual refuelling outages and the use of own personnel on several sites can also give advantages.

## **2.3 Recent organisational innovations**

The organisational climate before the deregulation was oriented very much towards safety and quality and one may even claim that the attitude "only the best is good enough" existed at the plants. At that time the engineering department had an important position within the organisation. When signs of a coming deregulation were seen, it became evident that a better cost conscience had to be created. One innovation in this direction was the introduction of the so called "buy and sell" system, which implied that operations was given the power to buy services that the maintenance and the technical support departments were selling.

Another innovation was a transfer to performance oriented management methods, which implied goal setting and more detailed planning efforts within all activities. One part of this transfer was connected to the introduction of the so called balanced score card concept to support the goal setting and the prioritization in various activities. At the same time a larger emphasis on the cash flow of the nuclear power plants was placed to be able to select between alternative investments and to time them better.

Process orientation of work activities is a third innovation coming from the conventional industries that has got an increasing attention also at the nuclear power plants. The basic idea is to look at work activities as processes that are aimed at certain achievements regardless of organisational borders that have to be crossed. The process orientation was in the conventional industry primarily introduced to streamline the main production processes from orders to delivery. The main production process at the nuclear power plants is well streamlined and process orientation was therefore directed mainly to the support processes.

The ageing personnel at the nuclear power plants has brought in human resource management as another important activity in ensuring that the plants can be operated for their remaining lifetime. There are many components in this activity of which one is concerned with competence inventories and another making the nuclear power plants attractive places to work at. In this development the nuclear power plants have also made review all activities to separate between tasks that have to be produced in their own organisation and tasks that can be bought from the outside.

### **3 CHARACTERISTICS OF SAFETY ORIENTED ORGANISATIONS**

#### **3.1 General principles of organising work**

It should be possible to bring in organisational innovations also to safety oriented organisations, but it is clear that the costs of unsuccessful organisational experiments can be dire. The nuclear industry has widely applied a kind of cautionary principle during organisational changes with small scale changes initially and a thorough collection of experience before actual full scale implementation. It is also a common custom to rely on proven solutions from other nuclear power plants.

One principle that has not been compromised is to have a clear line of command and reporting for operational decisions. This solution implies a traditional line organisation, where everyone has one and only one superior. A common practice is to have this line of authority and responsibility clearly described in writing as a part of the management system. Many plants separate between responsibilities given in a procedure of delegation as opposed to tasks given with the power of the line organisation. A delegation can be thought as a two-sided contract, which has to be understood in the same way by both parties.

The separation between different modes of operation introduces specialised organisational solutions at the nuclear power plants. Preparedness for disturbances and emergencies for example, have their own prescriptions in procedures and instructions. The annual refuelling shutdown brings in a third dimension into the operation, which is characterised by a momentary increase in the work force through outside contractors working at the plant for the duration of the outage.

The work order system at the nuclear power plants is used to ensure a good co-ordination of all activities during operation. Without such a formal system it would be very difficult to keep track of the sometimes isolated activities out in the plant. The work order system is operated through the main control room and it typically gets additional manning during the refuelling outages.

#### **3.2 Safety management**

Safety management is sometimes used as a concept encompassing all activities, which more or less directly are connected to activities ensuring that the plant can be operated safely. Qual-

ity assurance and control, event reporting and analysis, feedback of operational experience, etc. are examples of activities that are included in safety management. It is also a common practice at the nuclear power plants to have a safety committee, which is given responsibility to take stand on various issues related to nuclear safety.

The quality system has a large influence on safety related activities, because a common requirement is that work activities should be described in detail in instructions and handbooks. These are used as references in periodic audits carried out for all parts of the organisation to ensure that actual practices are in concordance with the descriptions. Observed deviations should introduce either a change in practices or in instructions.

Safety and quality issues are typically organised to be independent and to provide a direct connection to the most senior manager at the nuclear power plant. Another kind of independence is typically built into inspections and reviews to ensure that proposals and reports always are viewed with fresh eyes. Occasionally these reviews are given to external reviewers when it is difficult to find duplicate expertise within the own organisation.

Many of the activities within safety management are given to specialised organisational units, because they rely on methods and tools that for their use require specialised knowledge and skills. In spite of this division of work, the common view today is that safety and quality is something that everyone in the organisation is responsible for. This view has largely been integrated into the concept of safety culture, which is seen as the attitudes of people to give issues important for safety the attention they deserve.

### **3.3 Regulatory oversight**

Regulatory oversight is used within all safety related industries, but one may claim that nuclear regulators go more in detail both in setting regulatory requirements and in ensuring that they are fulfilled. The regulatory inspections introduce the need for a large transparency in documents and records that would be difficult to achieve without formal procedures for tasks and activities. A typical organisational arrangement is that the safety and quality department is given responsibility for the regulatory interface.

There are large variations in national systems of regulatory oversight. Some of the systems give rather detailed prescriptions on solutions to be used for different purposes, where others regulate on a more generic level. When detailed requirements are given it is easier for the nuclear power plants to find acceptable solutions and for inspectors to have clear acceptance criteria. More generic requirements may on the other hand promote innovation and thereby give the industry better opportunities to search for better solutions.

As a response to the organisational changes within the nuclear industry, many regulators in Europe have introduced the requirement that the nuclear power plants should give notifications and present a safety case on large organisational changes. This requirement may have reduced a willingness to experiment with totally new organisational structures, but its salient intent was apparently to stress the importance of a proper planning of any organisational change. In the countries, where this regulatory requirement has been introduced the nuclear power plants have created their own internal procedures for organisational change.

## **4 RETHINKING ORGANISATIONAL STRUCTURE**

### **4.1 Operational challenges**

There are many operational challenges at different levels, but the perhaps most important is to ensure that the nuclear power plants can be operated for their full technical lifetime. This is possible on a deregulated market only if the plants can be competitive as compared with other forms of electricity generation. Nuclear power plants have their own cost structure, which have both pros and cons on an open market, but it is clear that competitiveness has to be searched for through a high availability and favourable structure of operational, administrative and maintenance costs. Additional benefits may be sought in extending plant lifetimes or modernising the plants to get additional generation capacity and/or lower operational costs.

One important cost component in any company is connected to the preparedness for unexpected demands on resources. If it is possible to decrease uncertainty by more accurate planning it may be possible to decrease idleness in various work activities. Outsourcing of less critical activities can serve as a mean to allow senior managers to concentrate on the activities that are important. Outsourcing may also decrease prices for services that are bought in competition. A drawback of outsourcing is that activities that are bought typically necessitate more accurate planning and supervision of work.

A third operational challenge is to make incidents and accidents very unlikely, because already a minor incident may due to regulatory intervention become very expensive. This challenge feeds back to the competency of the personnel at all levels and its successful handling relies on a sound safety culture. Unfortunately there are no good indicators by which safety culture can be reliably assessed.

### **4.2 Pros and cons of hierarchical organisations**

The hierarchical line organisation is today seen as old fashioned by many organisational consultants. For the nuclear power plants the clear line of authority and reporting is certainly an asset and it seems difficult to believe that regulators would accept anything else at least in a short or medium term. The question then is to what extent it can be amended with other organisational structures to enhance organisational efficiency.

One problem with the classical hierarchical organisation is that it may not foster commitment on lower organisational levels. This problem has successfully been approached using delegation of responsibilities and work. One may actually argue that empowerment of lower levels in the organisation through delegation of important tasks can serve as a welcome stimulus for reflection and innovation. One may actually talk about applying a principle of subsidiarity, which means that decisions should be made on the level, where enough information is available to make proper decisions.

Another weakness with the hierarchical organisation is that it may stimulate compartmentalisation and internal competition. Nuclear power plants are crucially depending on a successful co-operation of several groups of people and it is therefore important that such co-operation is facilitated. One possibility to increase a mutual understanding and co-operation is to establish multifunctional groups that are given specific tasks to solve. Such groups are used for many purposes at the nuclear power plants and they are often successful when given the proper guidance.

### **4.3 Matrix organisations**

Matrix organisations have been proposed as an extension to the traditional line organisation. Matrix organisations are motivated when there is a need for more than one dimension according to which specific work activities should be adapted. This is the case for example on a site with multiple units, where people are expected to maintain both contacts to a specific unit and to people with the same profession. In this case it is evident that a person working mainly on one unit will create a good understanding of its physical properties and history, but it is also important that s/he will maintain contacts to colleagues to get professional impulses. This allocation to unit or function introduces a need for a kind of dual loyalty.

The difficulty with matrix organisations is that it is almost impossible to give two or more dimensions of loyalty the same strength. This means in practice that one of the dimensions will become dominant. In most of the cases, where matrix organisations have been introduced there is at least an implicit assumption that the dimension controlling the resources is the stronger one.

Process orientation can, when it is combined with a line organisation, be seen as a special form of a matrix organisation. This is the case especially when process owners are appointed with the responsibility to ensure a smooth functioning of their processes.

### **4.4 Network organisations**

Network organisations have been suggested as an organisational structure relatively recently. Network organisations build on the metaphor of independent intelligent agents that interact, all with their own sets of practices and goals. Simulations of such networks have shown that rather simple action algorithms can produce astonishingly complex behaviour. This would at least in principle propose that an organisation built on these concepts can meet requirements on requisite variety, i.e. the control system should have a complexity that matches the complexity of the controlled system.

Network organisations are built on a set of meeting places, where negotiations take place and agreements are made. These meeting places could in principle be regular or virtual meetings that are supported with various information technology tools. A network organisation has the benefit that it allows a rich interconnection among the members of the organisation, but it is also characterised by unpredictability, which may make it less useful for nuclear applications. It seems however feasible to bring in some features of network organisations, when new organisational structures are discussed.

### **4.5 Division of work**

In deciding on future organisational structures at the nuclear power plant various ways to solve the division of responsibilities and work will be a crucial question. This question will involve a resolution of issues like what has to be produced internally and what can be bought from the outside. It will involve a pondering of what kind of human resources will be needed on the plant sites and what kind of work can be done remotely over an information network. It has also to address the need for how certain specialist functions can be combined with generalists to make the organisation interfaces efficient.

Division of work has also to do with roles to be taken in various phases of an important decision process or project execution. In an initial phase it may be necessary that someone is taking the role of the devils advocate to ensure that all possible threats have been considered and

acted upon in a proper way. In a later stage undue criticism of earlier solutions, may have a devastating effect on work.

Specific competencies may become scarce especially in situations, where something unexpected has happened or during specific phases of large projects. Committed personnel are likely to be flexible in adjusting their work load, but it is important to remember that a high work load can make the work prone for errors. It is therefore necessary to restrict high work loads by a careful planning and to ensure that there are slacks in resources. In allocating tasks and activities within the organisation it may also be necessary to take a broader view, for example not always to use the persons or groups that may be the most skilled, but instead use tasks and activities as opportunities to educate and learn.

## **5 CHARACTERISTICS OF EFFICIENT ORGANISATIONS**

### **5.1 Ensuring quality of work**

Efficient organisations have to find the correct balance between quality of work and resources spent for achieving a sufficient quality. The definition of sufficient quality can sometimes be defined in a straightforward way, but more usually it is difficult to find unambiguous definitions for what can be considered as acceptable for tasks and activities. The requirement that work should be completed correctly the first time, not to necessitate rework, is however straightforward as a general requirement.

Definitions of sufficient quality and procedures to reach that quality rely on concepts like total quality management (TQM). TQM is often defined as cycles of planning and actions that go through steps of considering mission and goals, plans of actions, operational results and improvements. The TQM concept is closely related to the principle of continuous improvements that many nuclear power plants have adopted as a bearing principle in their work. Quality assessment and control is at the nuclear power plants built on formal systems as defined in documents and handbooks. The quality system also sets requirements on audits by which actual practices are compared to prescribed practices. Results from quality audits are typically assembled and reported at a special review meeting to the senior management.

A common complaint regarding quality systems in use is that they are bureaucratic and stifle innovation. There are differences in attitudes towards the quality systems at the nuclear power plants. With due account of the needs to ensure correctness and transparency in tasks and activities, there seems not to be any other possibility than to have a rather formal system. On the other hand some of the criticism may be justifiable, because the quality systems should be understandable and accessible for their users. In order for the quality systems to be accepted and used, the senior managers have to show their commitment to them.

### **5.2 Decreasing uncertainty**

Decreasing uncertainty is an important objective in all activity planning. If an upcoming need is detected in time, it is always easier to approach it and to find solutions. If no prior preparations have been made, there is always the risk that ad hoc solutions may prove untenable and to require much rework before sustainable solutions have been found. On the other hand it is also evident that all factors cannot be taken into account in beforehand and it therefore has to be flexibility in selecting specific actions along the route in a problem solving process.

An important strategy in coping with uncertainties is to have enough slack in resources to account for contingencies. Without a slack the organisation could be strained to a point to in-

crease the likelihood for errors and failures even to the point of a break down of important functions.

### **5.3 Efficient communication**

Efficient organisations are characterised by efficient internal and external communications. Communication relies both on a common language and on efficient communication channels. At nuclear power plants there are many different professions that have to give their contributions to the common whole and this implies that they should be able to understand each other and the work activities their colleagues are involved in.

There are different channels for communication such as eye-to-eye communication, telephone calls, e-mails, memos, reports, etc. Communication could take place informally when people meet or formally for example when a meeting is called together. An efficient organisation typically uses all available communication channels in a selective way in recognition of their efficiency for different purposes.

To ensure an efficient communication within an organisation it is sometimes necessary that senior managers intervene for example by establishing task forces for selected issues. A large participation of the staff in the process of operative and strategic planning has also a secondary objective to ensure efficient communication over organisational borders.

### **5.4 Understanding the business**

There have been many studies within the management sciences trying to understand why some organisations seem to be more efficient than others. The perhaps most important characteristic is that efficient organisations have a good understanding of the business in which they are, of their own strengths and weaknesses and of their situation at a specific point of time. Given such an understanding it should be possible to allocate resources wisely between needs for improvements within the plant, personnel and organisational practices.

A proper understanding of the business can also give the management the necessary insights for the allocation of attention, resources and time to convey to the personnel their vision, goals, situational awareness and analysis of alternative development routes. If such messages are understood and accepted by the personnel it is easier to get commitment from people. When these components are in place the senior management can create a capital of confidence, which can make even large changes and sacrifices in the organisation are possible.

### **5.5 Decision making**

Decision making is an important activity in all organisations. Research in decision making has brought many different models to support decision maker in their task to find the best solutions to upcoming problems. One important component in understanding decision making is the recognition that decision makers always are resource restricted and that decisions have to occur in real time. The resource restriction implies that there is a trade off between expectations for better decisions and the use of additional resources in searching for them. The real time requirement implies a similar trade off between postponing a decision to be able to do better or doing it too late with dire costs.

In nuclear power plants decisions are made continuously in different parts of the organisation. A large amount of the operational decisions are controlled strictly by instructions in a recognition that pre-thought sequences of actions are more reliable than ad hoc decisions during a rapidly evolving sequence of events. These decisions presume clear associations between

symptoms and actions. In operational decisions, where the time frame is days and weeks, more deliberate ponderings may be used. Decisions on a strategic level may have influences that stretch over several years.

A present trend at nuclear power plants is to delegate decisions down in the organisation. This strategy has the obvious benefit of engaging larger groups of people in the decision making and thereby unloading senior managers to enable them to focus on strategic issues. This delegation is not unproblematic, because it can sometimes tend to alienate senior managers from the day-to-day problems on an operational level.

## **6 A DISCUSSION**

### **6.1 Organisational complexity**

In assessing the situation of the nuclear industry today and comparing it with a situation some decades ago, there are many new demands that the management has to address. The most obvious change is that today it is necessary to do more with less people. This is evidently possible only by major improvements both in organisational practices and in the competency and skills of people. In assessing the changed situation it seems that organisations today rely more on personal initiatives of people and less on instructions given by superiors at various levels in the organisation.

One may also say that the operational environment of the nuclear power plants has become more complex over the years. This implies according to the principle of requisite variety that also the organisations that are controlling the plants have to become more complex. It therefore seems to be obvious that the application of various organisational innovations will force organisations to adopt a larger diversity in structures. This is again in turn expected to increase the demands on people.

### **6.2 Leadership**

The increasing organisational complexity will increase the demands also on senior managers. They have to have the insight and knowledge to see the large trends in the operational environment of the plants and to be able to translate them into a language that key persons can understand, accept and communicate further down in the organisation. Furthermore they have to have status, integrity and patience in putting themselves at stake as paragons for the whole organisation.

It is evident that requirements on senior managers have risen to a point, where it is getting less likely that single individuals can be found who have all the needed traits. This suggests that leadership in the future will be some sort of collective leadership of persons all with their own roles and responsibilities. This again places new demands on the senior management group as a collective entity in understanding and trusting each other.

### **6.3 Use of information**

Organisations will in the future have a growing need for information, i.e. data in context. This need will most likely be supplied with various applications of new information technology. Present information systems often have various flaws in their user interfaces, which imply that users often resent them. A future reliance on new systems can only build on the assumption that they are easy to use and give a true support to their users.

The information systems should also be built with the understanding that too much information can be as bad as too little information. It is necessary to design the system with the general principle in mind that correct information should reach receivers when they need that information. This will in the future most likely rely on users defining their own needs and searching for information when they need it.

#### **6.4 Dilemmas of management**

Management of organisations in general and nuclear power plants more specifically involves the task of finding a balance between a large numbers 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 of these is for instance the balance between traditions and renewal when organisational changes are entered. Examples of such balances are given in the Appendix.

One of the main challenges for managers is to identify such dilemmas and to find suitable points of balance, which can be proceduralised and communicated to the organisation in an understandable and acceptable manner. It can actually be assumed that an efficient identification and management of these balances is one of the root causes of good performance in organisations.

#### **6.5 Preconditions for organisational safety**

There are two basic components in organisational safety. On one hand the organisational design should be made with safety in mind and on the other the strengths and weaknesses of a specific organisation should be possible to assess. Following well known safety principles for the design of technical systems, one may propose that organisations should have a *defence-in-depth* and there should be *barriers* erected to protect from errors and failures that may occur. It would also be beneficial to have the conditions from which no deviations are allowed stated in an understandable way.

The need for assessing strengths and weaknesses of organisations is two-fold, because sometimes there is a need to make predictions on how a new organisation can be expected to perform and sometimes one is interested in assessing capabilities of an existing organisation. Unfortunately there are no good tools by which such assessment can be made and managers therefore often have to rely on their intuition in organisational designs or in assessing organisational performance.

#### **6.6 Visions for the future**

It seems likely that nuclear power plants in the future will use more networking both internally and externally. The extent to which present hierarchical structures will be abandoned is however more unclear. The need to have a clear line of authority and responsibility for operational decision that have a span from minutes to a few hours will most likely tend to conserve at least a part of the hierarchical structure. On the other hand there are clear benefits in promoting networking and personal initiative in maintenance and technical support activities.

Regardless of the selected organisational structure it is important that it can be communicated and understood and this may actually be the limiting factors in a development towards more complex organisational structures. In a selection of people for key positions in a networked organisation it may be necessary to have more refined methods both to ensure that they have the necessary capabilities and to give them a better training. An additional question is connected to regulatory acceptance of more complicated organisational structures.

## **7 CONCLUSIONS**

In considering various organisational structures within the nuclear power industry one of the main challenges seem to be how a clear line organisation can be maintained and combined with features of more complex organisational structures. One problem is that whatever amendments are made to a hierarchical structure, they tend to weaken it and make it more difficult to understand and control.

It seems also necessary to find a suitable trade off between order and predictability on one hand and flexibility and innovation on the other. The requirement that only proven organisational designs should be allowable also creates a dilemma, because someone has to be the first. Regulatory oversight has an important role in enforcing planning and assessments, but conservativeness should not be allowed to freeze all organisational developments.

There is a need to open a discussion on future leadership, because it is not likely that single senior managers would have the ability to meet all the requirements that are placed on him or her. The composition of the senior management team together with the combination of roles and skills is therefore an important issue to resolve.

### **Acknowledgements**

The contribution of the whole LearnSafe-team in providing ideas and input to this paper is gratefully acknowledged. A list of the LearnSafe-team members can be found at the web-site <http://www.vtt.fi/virtual/learnsafe/>, which in addition also contains information on results from the LearnSafe-project.



## EUROPEAN COMMISSION

**5th EURATOM FRAMEWORK PROGRAMME 1998-2002**  
**KEY ACTION : NUCLEAR FISSION**

### APPENDIX. BALANCING DIMENSIONS IN ORGANISATIONAL DESIGN

The table below illustrate some of the balances senior managers are forced to take a stand on.

<b>Balance</b>	<b>Rationale</b>
traditions – renewal	Renewal without a proper consideration of traditions can be dangerous. Traditions without renewal can stifle organisational efficiency.
self-reliance – willingness to take advice	Organisations have to rely on their own skills and knowledge, but that should not prevent them from listening to outside advice.
co-operation – competition	Members of an organisation are expected to co-operate, but sometimes a friendly competition can be a trigger for increased performance.
confidence and trust – inspections and reporting	An organisation relies on confidence and trust between its members, but this will not make inspections and reporting unnecessary.
consensus – constructive disagreement	An organisation relies on common views among its members, but this should not hinder people to express their views on various issues.
flexibility – planning	Planning is a strategy in decreasing uncertainty, but plans are not sacred and they should be possible to change whenever necessary.
diversity – congruence	Diversity can give a valuable richness, but congruence in practices is easier to manage.
satisfaction with the present – search for something better	The best can be the enemy of the good, but being satisfied will stop the search for something better.
learn by doing – learn before doing	The best way for people to learn is by doing, but that implies that they will make mistakes now and then.
believe what people say – believe everything people say	People usually bring forward what they think is true, but sometimes they have the wrong impression of things.