**EUROPEAN COMMISSION**

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

# L'earnSafe

## LEARNING ORGANISATIONS FOR NUCLEAR SAFETY

## CONTRACT N° FIKS-CT-2001-00162

## THEORETICAL APPROACHES TO ORGANISATIONAL LEARNING

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**12.8.2003**

**List of content:**

# Theoretical Approaches to Organisational Learning.

## 1 INTRODUCTION

Learning, at all levels of employment, plays an important role within high-reliability organisations. Such high-reliability organisations include, amongst others, the nuclear industry, the chemical and pharmaceutical industry, civil aviation and fast earth-bound traffic and oil and gas drilling and transport. Organisations within the nuclear sector, are required to 'manage safety as a major component of operations, and therefore must learn from precursors and near-misses rather than exclusively by trial and error' (Carroll, 1998). 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 as a result of past experience (Anderson, 1995). Espejo *et al* (1997) 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. While, Argyris (1993) 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 (1996) 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.

The link between individual and organisational learning occupies a critical position within many theories of organisational learning. Many theorists believe that organisational learning begins with the individual; Simon (1991) rejected the notion that organisations themselves learn, claiming that 'all learning takes place inside individual human heads' thus he proposed that organisations learn through the learning of their members. Dixon (1999) believes that each member of the organisation has the capability to learn and an organisation learns through the capability of its members. Therefore, organisational learning is not simply the sum of all that its members know, rather it is a collective use of this capability of learning (Dixon, 1999). McClellan (1983) suggests that to understand how organisational learning differs from individual learning it is helpful to think of organisational members having meaning structures. Private meaning refers to the way in which each individual within the organisation constructs meaning for themselves i.e. they make sense of what is happening in the organisation, with their co-workers, with their customer's etc. Accessible meaning is that which individuals make available to others within the organisation; while collective meaning is that which organisational members hold in common i.e. these are the strategies, norms and assumptions which specify how the work gets done and what work is important to do. Some theorists however, argue that organisations themselves actually learn. Such theorists view organisations as systems of interpretation and 'just as individuals have brains and beliefs they suggest that organisations have cognitive systems and memories……..world views and ideologies' (Hedberg, 1981).

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 (Pawlowsky, 2001). The divergence of perspectives has increased and as yet no single ana-

lytical or conceptual model serves as a framework for research conducted within the realms of organisational learning. Theories of organisational learning can be seen to originate from six differing schools of thought. Some of the major traditions that have proposed theories of organisational learning include the Management Science view, the MIT tradition, the Social Process approach, the Resource Based view, the Knowledge Creation and Transfer approach and finally, the Knowledge Management view.

## 2 APPROACHES TO ORGANISATIONAL LEARNING

### 2.1 The Management Science View.

Cyert and March (1963) coined the term 'organisational learning' in their early research which focused upon a stimulus-response behavioural approach to learning. The approach was based upon a contemporary conceptualisation of decision making within organisations. Cyert and March's understanding of organisational learning appears to be based on the existence of external shocks i.e. an uncontrollable external source of disturbance or shock to the system which makes adaptation necessary. They postulated that the organisation has a number of internal decision-making variables and decision-making rules. Each combination of external shocks and decision variables in the system changes the state of the system. Cyert and March (1963) believed that organisations learn by memorising disturbances and reaction combinations according to decision variables. Cyert and March suggest that the outcome of organisational learning is an adaptation or change to rules and standard operating procedures. Pawlowsky (2001) believes that organisational learning from this perspective is not dependent on an increase in knowledge of its members, rather it is concerned with organisational memorisation of S-R combinations.

Levitt and March (1988) developed this concept of organisational learning further by suggesting that 'organisations learn by encoding inferences from history into routines that guide behaviour.' Routines generally included forms, formal rules, procedures, conventions, strategies and technology as well as informal beliefs such as frameworks, codes and cultures around which an organisation is constructed. Such routines are considered independent of individuals within the organisation and are believed to be capable of surviving considerable turnover in organisational actors. A central message of this approach is that learning from experience leads to predictable traps i.e. when organisations build up experience in given routines they become less likely to actively seek better alternatives. Levitt and March (1988) suggest that these dynamics create built-in barriers to learning at an organisational level described as 'superstitious learning' and 'competency traps.'

### 2.2 The MIT Tradition.

Argyris (1978) defines organisational learning as a metaphor whose spelling out requires a re-examination of the very idea of organisation. He suggests that a collection of individuals organises when its members develop rules for collective decision, delegation and membership; in their rule-governed behaviour they act for the collectivity in ways that reflect the task system. Argyris believes that organisational theories of action can be inferred from patterns of organisational action. Each member of the organisation constructs his or her own representation or image of the theory in use of the whole organisation; however, that picture is always incomplete. Organisational members strive to complete it and to understand themselves in the context of the organisation. The Organisations theory in use, which is continually constructed through individual inquiry, is encoded in private images and in public maps. Argyris believes that such images and maps are the media of organisational learning. As individuals modify

their maps and images of the organisation they bring about changes in the organisations theory in use.

Organisational learning occurs when individuals act on their images and on their shared maps with expectations of patterned outcomes, which their subsequent experience either confirms or disconfirms. Argyris suggests that when there is a mismatch of outcome to expectation (error) members may respond by modifying their images, maps and activities so as to bring the expectations and outcomes back into line. This learning is generally regarded as single-loop (Bateson, 1960) i.e. there is a single feedback loop which connects detected outcomes of action to organisational strategies and assumptions which are modified so as to keep organisational performance within the range set by organisational norms. Argyris (1978) believes that single-loop learning is sufficient when error correction can proceed by changing organisational strategies and assumptions within a constant framework of norms for performance. In some cases however, 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. Argyris suggests 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.

## 2.3   The Social Process Approach.

Miner and Mezias (1996) proposed that studies of organisational learning underwent a 'quiet revolution' that overturned the previously dominant model which implicitly conceptualised learners as individual actors processing information and or modifying their mental models and instead substituted it with an image of learners as social beings who construct their understandings and learn from social interaction within specific socio-cultural settings (Bruner and Hastes, 1987). Learning is not perceived as a way of coming to know the world rather it is a way of becoming part of the social world. Gherardi *et al* proposed that learning is therefore a primary way to engage with others in an ongoing practice i.e. it is what enables actors to modify their relations with others while contributing to the shared activity. When the social perspective is applied to learning attention shifts from the processing of information and the modifying of cognitive structure to the processes of participation and interaction that provide and sustain the proper context for learning. Within Gherardi *et al*'s framework of organisational learning language is of central importance i.e. it is conceived as the main way of acting in the social world instead of being merely intended as a medium of knowledge transmission.

The community of practice has been conceptualised as an informal aggregation defined by its members in the shared way in which they do things and interpret events (Lave and Wenger, 1991). The idea of communities is useful as it enables researchers to understand the process by which the transmission of tacit knowledge and knowledge in action takes place. Social processing approaches to organisational learning suggest that knowledge within a community of practice is not retained in the form of any sort of cognitive structure or plan of action. Rather it is best understood as a custom or 'habitus' sustained collectively by its members; such customs or 'habitus' are defined as systems of durable, transposable sets of principles which generate and organise practices and representations that can be adapted to their outcomes without presupposing the conscious pursuit of ends. The habitus guarantees the correctness of practices and their constancy over time even more so than formal rules and explicit norms. Knowledge within the community of practice is encoded in artifacts in ways that can be revealing. The notion of legitimate peripheral participation focuses on the relationship between learning and the organisational situation in which such learning occurs; it defines learn-

ing as a form of co-participation in some of the actual practices of the workplace rather than in terms of the acquisition of abstract knowledge. Thus participation in the cultural environment and practice in which the knowledge exists is an epistemological principle of learning; the social structure of this practice, its power relations and its conditions for legitimacy, define the possibilities for learning (Lave and Wenger, 1991).

## 2.4    The Resource Based View

Penrose (1959) was a pioneer in the development of learning and knowledge theories of the firm. He argued that the firm is fundamentally a repository of knowledge and that learning is central to the firm's growth. Penrose believed that 'the firm is both an administrative organisation and a collection of productive resources, both human and material.' He defined resources as 'the physical things that a firm buys, leases or produces for its own use and the people hired on terms that make them effectively part of the firm.' While services are the contributions these resources can make to the productive operations of the firm. Penrose (1959) postulated that services rendered by resources are considered the primary inputs to the firms production processes and are firm specific in that they are a function of the knowledge and experience that the firm has acquired over a period of time. Penrose suggests that having acquired resources for actual and contemplated operations a firm has an incentive to use as profitably as possible the services obtainable from each unit of each type of resource acquired. In Penrose's view, a firm possesses idle resources primarily due to learning that enables the organisation to utilise its resources more effectively and more efficiently than it had been able to in the past.

Penrose (1959) suggests therefore that increases in knowledge can increase the range or amount of services available from each resource; of the services available only a few can be profitably used by a given firm at a given time. Some of the services may be alternative uses of the resource; some of them may be suited only for products which the firm cannot profitably produce under the circumstances; some of them may be useful only in combination with other types of services which the firm can not obtain at the time. Thus the possibilities of using services changes with changes in knowledge. Penrose also claims that there exists an interaction between knowledge possessed by the firm's personnel and the services obtainable from its material resources. The knowledge possessed by an organisations personnel tends to increase automatically with experience therefore the available productive services from a firms resources will also tend to change. Penrose believes that in addition changes in 'objective knowledge' are also likely to occur. Objective knowledge does not automatically increase; rather the search for objective knowledge is deliberate and voluntary and at the same time it is part of the normal operations and thinking of businessmen.

The services that resources yield will depend on the capabilities of the people using them, but the development of capabilities of personnel is partly shaped by the resources that they deal with; the two together create the special productive opportunity of a firm. Penrose also claims that experience of the external world may also become part of the firms stock of knowledge and consequently may change the significance of resources to the firm. Knowledge of markets, of technology being developed by other firms and of the tastes and attitudes of consumers are of particular importance. Thus, according to Penrose knowledge is considered a key resource for an organisation to gain competitive advantage over its competitors.

## 2.5    The Knowledge Creation and Transfer

Many theories of organisational learning are somewhat limited i.e. they treat organisational learning as a black box leaving the processes involved in learning therein and largely unex-

plained. Knowledge creation theorist attempt to overcome such shortcomings by attempting to uncover the concepts behind the knowledge creation process within organisations. Nonaka *et al* (2001) attempt to explain the processes involved in the knowledge creation process. The approach defines knowledge as 'a dynamic human process of justifying personal belief towards the truth' (Nonaka and Takeuchi, 1995.) Knowledge creation is seen as a continuous, self transcending process by means of which one transcends the boundary of the old self into the new self by acquiring new context, a new view of the world and new knowledge (Nonaka *et al*, 2001). Nonaka *et al* (1998) proposed three layers of knowledge creation which interact with each other in order to form the knowledge spiral that they believe actually creates knowledge. The three layers included in the model are (1) the process of knowledge creation through socialisation, externalisation, combination and internalisation (SECI) and the knowledge conversion process between tacit and explicit knowledge; (2) *ba*, the platform for knowledge creation; and (3) knowledge assets or the inputs, outputs and moderator of the knowledge creation process.

The three layers must interact with each other organically and dynamically; thus, knowledge is created by means of interactions between explicit knowledge and tacit knowledge ('knowledge conversion.') The knowledge assets of a firm are mobilised and shared in *ba*, where the tacit knowledge held by individuals is converted and amplified by the knowledge spiral through the socialisation, externalisation, combination and internalisation of knowledge. The spiral becomes larger in scale as it moves up the ontological levels. The creation of knowledge is a dynamic process, starting at the individual level and expanding as it moves horizontally and vertically through communities of interaction that transcend sectional, departmental, divisional and even organisational boundaries. Nonaka *et al* (2001) suggest that 'organisational knowledge creation is a never-ending process that up-grades itself continually.' An organisation that is building upon its existing knowledge assets creates new knowledge through the SECI process that takes place in *ba*. The knowledge created then becomes part of the knowledge assets of the organisation and the basis for a new cycle of knowledge creation. There are four types of knowledge assets (experimental, conceptual, systemic and routine) that form the basis of the knowledge creating process. To manage knowledge creation and exploitation effectively a company has to map its stocks of knowledge assets. Nonaka *et al* (2001) propose that such processes are best managed through middle-up-down management style and within a hypertext organisational structure.

Teece (2001) suggests that the importance of knowledge to competitiveness, the distributed nature of competence within the firm and the availability of tools to assist knowledge transfer has sharpened the competitive importance of achieving knowledge transfer inside the firm. Teece (2001) believes knowledge that is trapped in the minds of key employees, in filing cabinets and databases is of little value unless it is supplied to the right people at the right time. Information 'float' (the time between knowledge creation and transfer) is extremely costly in terms of opportunity costs. 'Gate keepers,' 'translators,' 'internal knowledge brokers' and other specialists in knowledge/ technology transfer are often needed to effectuate transfer. On the other hand external transfer of knowledge occurs as either a result of deliberate transfer (under learning and know-how agreements), inadvertent transfer (such as spillovers in the context of alliances) or imitative activities of competitors. The external transfer of knowledge is frequently aided by licensing and technology transfer agreements.

## 2.6   The Knowledge Management View

Davenport and Prusak (1998) suggest that 'all healthy organisations generate and use knowledge. As organisations interact with their environments they absorb information and turn it

into knowledge, and take action based on it in combination with their experiences, values and internal rules.' Davenport and Prusak (1998) believe that knowledge is generated within an organisation using five modes: acquisition, dedicated resources, fusion, adaptation, and knowledge networking. Acquired knowledge does not have to be merely newly created knowledge. Davenport and Prusak suggest that the most direct and often most effective way to acquire knowledge is to buy it i.e. to buy an organisation or to hire individuals that have it. Davenport and Prusak (1998) also propose that a customary way to generate knowledge in an organisation is to establish units or groups specifically for that purpose (research and development units). Knowledge generation using the process of fusion purposely introduces complexity and often conflict to create new synergy. Such an approach to knowledge generation brings together people with different perspectives to work on a problem or project forcing them to come up with a joint answer. Adaptation refers to organisational generation of knowledge as a result of external forces. In some cases external forces such as new products from competitors, new technologies and social and economic changes drive knowledge generation because firms that don't change in response to changing conditions will fail. Finally, networking involves the generation of knowledge through informal, self-organising networks within organisations, that may in time become more fomalised. Davenport and Prusak (1998) believe that 'spontaneous, unstructured knowledge transfer is vital to a firms success.' They believe that conversations in common areas such as drinks machines or cafeterias are situations in which transfers of knowledge take place. Davenport and Prusak postulated that organisations can encourage serendipitous knowledge sharing across the lines of departments by creating locations and occasions for workers to interact informally. Thus, knowledge transfer is believed to involve two actions: transmission (i.e. sending or presenting knowledge to a potential recipient) and absorption by the particular person or group. Davenport and Prusak (1998) suggest that 'since knowledge and the value of harnessing it has always been with us, it must be the availability of new technologies [or 'techknowledgies'] that has stoked the knowledge fire.'

Knowledge management technologies 'capture, store and distribute structured knowledge for use by people.' It is the value added by people – context, experience and interpretation – that transforms data and information into knowledge it is the ability to capture and manage those human additions that make information technologies particularly suited to dealing with knowledge. While technologies designed for managing data are structured, typically numerically orientated and address large volumes of observations, knowledge technologies deal most frequently with text rather than numbers. Davenport and Prusak believe that the role of people in knowledge technologies is integral to their success. One of the best known approaches to using technology in knowledge management is the repository of structured, explicit knowledge. The best example of a broad knowledge repository is the Internet. Some organisations have concentrated knowledge domains rather than a community of expert users. This is the best situation for expert systems, which enable the knowledge of one or a few experts to be used by a much broader group of workers who need the knowledge. Constrained-based systems provide an alternative option for companies with focused knowledge environments, which are typically suited to situations with high levels of data but normally less quantitative data than that required by neural networks. Real-time knowledge systems are used to manage knowledge if the user has little time and smarter users. Case-based reasoning applications are a branch of artificial intelligence that is commonly found in customer service and support process firms. Finally, long-term analyst systems such as neural networks are also used to manage knowledge. One aspect of such systems is that they 'learn' i.e. their classification becomes more accurate with more cases. Davenport and Prusak believe that balance is necessary in using the different approaches to knowledge management.

# 3   ORGANISATIONAL LEARNING IN PRACTICE.

Failure within a nuclear facility could have potentially disastrous implications and should therefore be avoided. However, Sitkin (1992) proposed that an emphasis on failure is an essential prerequisite for effective organisational learning. He believed that successful outcomes have four associated liabilities; firstly he suggested that success can lead to complacency i.e. it is often difficult to get people or groups to pursue new ways of doing things when the current ways are relatively successful, 'if it ain't broke don't fix it'; Sitkin also believed that success can restrict search and lead to low levels of attention; thirdly, he proposed that success may lead to risk aversion within the organisation; and finally homogeneity was identified as a further liability of success. Sitkin (1992) therefore, suggested that an alternative to success was strategic failure. He proposed a number of benefits of intelligent failure which included an increase in attention and a quicker response to the processing of potential problems; ease of recognition and interpretation of problems; a stimulation of the search process; an increase in motivation to adapt; the development of risk tolerance; and finally, failure was identified as being a more effective means of pursuing learning. Sitkin suggested that the presence of failure led to an increased resilience when employees are confronted with novel situations, 'people can cope with surprise better when they have repeated exposure to it' (Weick, 1985). Thus, Sitkin believes that an organisation will learn more effectively from experiencing failure rather than success. Even within high-reliability organisations were the specter of catastrophe makes failure difficult to routinise, it is essential that large scale problems be reduced to more manageable levels to permit experimentation (Leary, 1988). Within the nuclear industry a Behavioural Safety process has been implemented, which not only trains employees in the safe way to perform an act but also informs individuals on the unsafe way to perform the act.

Weick (2001) believes that organisations in which reliability is a more pressing issue than efficiency often have unique problems in learning and understanding, which if unresolved can affect their performance adversely. One such unique problem is that a major learning strategy, trial and error is not available to them because errors can not be contained. Weick suggests that the more willing an error is to propagate, the less willing the system is to use trial and error to understand the source of the error. Due to this limitation high- reliability organisations potentially know little about the very events that can be most damaging to them. As a result of limited use of trial and error many high-reliability organisations use unconventional means to achieve error free performance. Since learning and reliable performance is difficult when trial and error is precluded such reliable performances become dependent on the development of substantial substitutes to trial and error. Weick suggests that substitutes for trial and error come in the form of imagination, vicarious experiences, stories, simulations and other symbolic representations of technology and its effects. Weick believes that a system that values stories is potentially more reliable because people know more about their system , know more about the potential errors that do occur because they know that other people have already handled similar errors.

March *et al.* (1991) examined how high-reliability organisations can convert meager experience into interpretations of history by experiencing infrequent events richly and thus learn from their experiences. They believe that organisations attempt to pool historical events across diverse contexts as well as treating unique historical events as detailed stories rather than single data points. Organisations elaborate experience using a number of different methods. Experiencing more aspects of experience is one method by which organisations attempt to elaborate their meager experience. Characterising history as small samples of unique occurrences overlooks a wealth of experience that is represented in each historical event. Organisa-

tions may also attempt to experience more interpretations of unique incidents. Organisations often augment history by attending to multiple observers or interpretations. The consequences of an action are experienced differently throughout the organisation. Because individuals and groups experience historical events differently they learn different lessons from the same experience. As a result, organisational experience leads to a variety of interpretations and an organisations repertoire may include a variety of possibly contradictory story lines. Finally, by experiencing more preferences an organisation is able to elaborate its experience. Organisations discover values, aspirations and identities in the process of experiencing the consequences of their actions. They learn how to distinguish success from failure and thus affect considerably the other lessons that they take from their experience.

March *et al* proposed that high-reliability organisations use a series of techniques to aid the learning process (simulating hypothetical events/ near histories and hypothetical histories). Using the first technique organisations define and elaborate a class of historical non-events i.e. events that almost happened. Whilst the second technique is used to define and elaborate a class of hypothetical historical non events i.e. events that might of happened under certain unrealised but plausible conditions. Using these two alternative perspectives on history, organisations are able to produce a clearer understanding of unique experiences and events. These techniques allow organisations to expand their comprehension of history by making experience richer by considering multiple interpretations of experience, by using experience to discover and modify their preferences, and by stimulating near events and hypothetical histories. Such methods aid organisational learning within high-reliability organisations enabling them to learn even though their history offers only meager samples of experience.

Carroll (1995) believes that learning from practical experience is of greater importance in more complex work environments. In predictable environments where relationships among actions and outcomes are known, designers and managers can arrange physical and human resources to deal with routine situations, and performance rules can be automated or proceduralised. However, in less predictable and more ambiguous situations actors must be able to change the performance rules, arrangement of resources, and equipment as practical experience accumulates. Carroll, through his research in nuclear power plants, describes how organisation members make sense of practical experience and how their sense making affects decisions and actions and thus organisational learning and improvements through time. Carroll begins by identifying a number of major strategies for learning from operating experience used within the nuclear power industry. During the 1980s (post TMI), plants and utilities followed a strategy of incremental improvement through sharing of experiences, analysis of problems and corrective actions taken, exchange of 'best practices' across plants and the development of lists of performance indicators, desirable structures and effective procedures. Nowadays however, a more proactive strategy for learning is possible. Learning within the nuclear power industry is unique i.e. actors in such high-hazard organisations cannot learn from trial and error as the risks of error are too high. Instead they must therefore draw upon their experience of minor incidents. Learning without any incidents is also used within the nuclear power industry and is achieved with the use of formal simulation models, analogy or imagination. The use of such proactive strategies for learning 'presupposes a better understanding of the system of equipment and people as they work together, building on and transcending the logics of equipment design and person-machine interaction' (Carroll, 1995). The incident review process is one method of achieving new understandings of systematic problems using this understanding to improve operational effectiveness. Carroll suggests that workers at all levels are continually making sense of their own and others experiences and problems and thus developing and reflecting on work practices.

Geler and van der Heijden (2001) propose the use of scenarios to aid the process of organisational learning. They suggest that over the years a typology of scenarios and their uses has emerged i.e. framework and project scenarios. The practical use of framework and project scenarios, if executed properly, offer management one of the few organisational learning tools that has the potential to integrate the thinking of both the world of business and the world of management. The use of scenarios puts an important emphasis on the future (or rather the many possible alternatives of the future). To use scenario planning is to acknowledge that many different futures are feasible and that sound management requires preparation for their possible occurrence. Geler and van der Heijden believe that scenario planning essentially prepares an organisation for change and is thus a valuable device within the current climate where major structural change has become a normal feature of business life.

Geler and van der Heijden (2001) recognise The Shell Group as a pioneer of scenario planning. The framework approach to scenario planning was part of a long term process with the purpose of providing a structured way to become aware and learn more about the world in which The Shell Group operate. Framework scenarios were typically published, presented and circulated throughout the organisation and would be used to provide a background for strategic planning for the future. On the other hand, the project approach would be invoked as specific issues arose. The exercise would generally begin with the expression of concern over a particular issue. These scenarios helped Shell in both identifying and evaluating options, and enabled users through an iterative processing of research questions and consideration of related research to identify both predictable structure and irreducible uncertainty within a situation (Geler and van der Heijden, 2001). Geler and van der Heijden concluded their research with The Shell Group by suggesting that scenarios help in the process of experiencing i.e. they affect managers perceptions of the world; they also help in the process of reflecting on experience, adapting mental models and creating organisational action. In this way they suggest that, scenarios contribute substantially to the overall process of organisational learning.

Drawing upon the resource-based theory of the firm Roux-Dufort and Metais (1999) were able to develop a conceptual framework to show how organisational learning helps companies build a set of embedded knowledge assets. The evolution of such core competencies seems dependent on the ability of the firm to maintain a high level of organisational learning. Roux-Dufort and Metais explored how EDF, the most powerful French electricity producer and supplier, has learned from the disasters of Three Mile Island (1979) and Chernobyl (1986) to improve and continuously enrich its core competence in risk and crisis management. Roux-Dufort and Metais (1999) believe that crises, despite the negative and destructive effect they bring forth, are unique opportunities to learn and change the way the organisations see the world; paradoxically a crisis can often be at the origin of competitive advantage if it is linked with a proper organisational learning process. Roux-Dufort and Metais (1999) believe that the desire to learn and understand in order to ensure EDF its nuclear safety without any possible risk of failure has pushed it to implement organisational learning procedures at two levels. They suggest that the most visible of these is the desire to develop a new knowledge base and competence in the management of risks and crises. Roux-Dufort and Metais highlight EDF's implementation of the past incident analysis technique which was inspired by the TMI disaster and which provides organisational members with a better understanding of internal past crises as well as incidents that have occurred nationally and internationally. This incident analysis process is more than just a creation of a register of knowledge the technique encourages the mixing of existing competencies, which had in the past been unconnected. Roux-Dufort and Metais (1999) believe that the learning process of EDF goes beyond simple readjustments to its trajectory in the management of installations. The crises of TMI and Chernobyl permitted EDF to enrich its frame of references and operations.

## 4    IMPLICATIONS FOR SAFETY.

Organisational learning is extremely important within high-reliability organisations where safety is a number one priority.

* Low accident plants have been characterised as having a focus on organisational learning.

* Organisations that effectively learn are better able to detect and correct errors.

* Learning organisations focus on organisational culture to make learning part of 'the way we do things around here'.

* Organisational learning allows plants to learn from their own mistakes as well as the mistakes of others to ensure such incidents are avoided in the future.

* Learning organisations encourage openness and reporting of incidents, which is important because if we are unaware of mistakes/ incidents then we can not learn from them.

* Research within the realms of organisational learning has led to the development of alternative methods of learning that can be utilised within high-reliability organisations to improve both safety and reliability within the sites.

* Learning organisations are more prepared to deal with incidents i.e. people know more about the systems that they are operating, therefore they are better equipped to cope when errors occur.

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