Organisational Learning and Organisational Memory for SMS and FRMS

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EARLY DRAFT of HILAS Book Chapter
# Table of contents

1  **ORGANISATIONAL LEARNING & ORGANISATIONAL MEMORY FRAMEWORK** ........................................................................................................ 3  
   1.1 WHY BOTHER? ........................................................................................................ 4  
   1.2 ORGANISATIONAL LEARNING FRAMEWORK ........................................................ 5  
   1.3 TACIT KNOWLEDGE KEY TO ORGANISATIONAL LEARNING ...................... 6  
   1.3.1 Language - a modelling tool ......................................................................... 7  
   1.4 KEY PROCESSES IN ORGANISATIONAL LEARNING ........................................ 7  
   1.4.1 Single- and double loop learning ............................................................ 8  
   1.4.2 Learning Agency in Organisational Learning ......................................... 9  
   1.4.3 Learning content, or "what is there to learn?" ........................................ 10  
   1.5 ORGANISATIONAL MEMORY ................................................................. 11  
   1.6 SYSTEM OF ORGANISATIONAL LEARNING (SOL) ...................................... 13  
   1.7 RELEVANCE TO AVIATION: SYSTEMS VIEW ............................................. 15  
   1.8 LEARNING FROM THE OUTSIDE WORLD .............................................. 17  
   1.9 KEY ISSUES ................................................................................................. 17  
   1.10 SUMMARY ............................................................................................... 19  

REFERENCES.................................................................................................................. 20
1 Organisational Learning & Organisational Memory Framework

Learning is what we all do... as individuals and as groups of living species. We learn to design and operate complex operations and set up organisations that will do this for us. Aviation is about flying aircraft to transport valuable cargo: passengers, crew and products. The aviation system is typically a complex, high-reliability socio-technical system, in which human actors perform critical functions within organisations. And here arises a fundamental problem: organisations do not learn... or only through people who somehow are assigned to learn for the organisation. It is here that organisational learning (OL) becomes meaningful. And in order to avoid learning the same thing twice or more, the organisation needs a functioning and, therefore, accessible organisational memory (OM). Organisations that exist for a longer period of time do cope over time, but mainly thanks to individuals and groups of people who are devoted to run the system despite blockers and other inconveniences. Regularly, these organisations have human resources and communication channels in place needed for organisational learning, but are not aware of this, so that the learning is by chance rather than organised. These organisations can often improve significantly by understanding OL-principles and apply these in the set-up of their operations, by changing the scope and methodology of working by persons who already have been lined up for review of operational anomalies and coordination of change processes.

The aviation industry is faced with increasing demands for transportation while also facing a decrease in resources in practically all stages of transport operations. In the European strategy for air transport set out in "European Aeronautics: a Vision for 2020" (Argüelles et al., 2001) a target of an 80 per cent reduction in aircraft accidents is proposed as necessary to support the expected growth in traffic and a reduction in the number of accidents. In order to cope with this dilemma, technological innovations in aircraft and supporting systems are needed. However, these innovations must then be integrated into and maintained within a complex system comprising a multitude of interdependencies; an already complex system becomes even more complex.

Given the tightness of coupling (Perrow, 1984) between the organisations that produce the transport system, learning from experience cannot be wholly achieved by each organisation focusing on what happens within its own organisational boundary. Learning arrangements within the transport system need to accommodate interdependencies among and within organisations. This means that organisations must co-operate and share knowledge; a simple enough aspiration in theory, but one which is a challenge to achieve in practice, given the complexity of the setting.

To establish learning arrangements within complex settings, the principles of system theory, organisational learning and operational readiness provide a suitable theoretical basis. These principles have been applied within the HILAS project. This chapter paves the way to understanding the essence of learning by organisations in the aviation industry.
1.1 Why bother?
Organisations are man-made systems that exist to reach targets that relate to goals that together form the reason of the organisation's existence. As Stafford Beer has made very clear in his Viable System Model (VSM), any system exists within certain constraints that might shift over time, within an environment in coexistence with other systems that provide threats and challenges for the system's viability (Beer, 1979). For maintaining its viability, the system needs to learn from two different sources:

a) internally - through its internal radar function - about maintaining stable operations
b) externally - through its outside world radar function - about market position, regulatory development, technological advancements and opportunities and needs for strategic choices.

Typically, learning from its own operations is often associated with learning from accidents or incidents, but inspection and audits may also reveal instability trigger sources before the operational disturbance actually occurs. Likewise, learning from developments in the outside world is typically associated with business development, e.g. expansion, state-of-the-art technological advancements, forth-coming regulations and future perspectives. In order to remain viable it is crucial that interaction between learning from the outside world and the existing daily operations takes place in order to inform decision makers about feasibility and risks.

Thus, learning from operations and operational surprises is essential for fostering learning from the outside world about threats and challenges for the organisation in order to adapt to and survive in the changing world.

In essence, learning is a process of problem solving. The learning system faces a situation that it cannot or does not run away from, which needs to be understood in order to resolve the underlying problem of system disturbance. Once a lesson to learn has been identified, it must be implemented in order to learn and find out whether the lesson was indeed effective. An adequate lesson learned provides a potentially useable course of action when a similar situation occurs later on and maybe elsewhere.

Problems emerge from operations that wear out or that were not designed adequately, and which need to be solved to restore the operations to an intended level of performance; also, problems emerge from the changing outside world that needs to be coped with in order to adhere to the organisation's raison d'etre.

This chapter discusses principles of Organisational Learning, key functions, components and processes. It serves as a framework for other chapters and case studies in this book series.

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1 In the Viable System Model, Systems 1 produce what the whole system is meant for. Instability may occur but shall be damped by System 2 which is governed by System 3. System 3 supervises Systems 1. System 4 performs the function of exploring the outside world. Intensive System 4-3 interaction is then key to successful adaptation to the changing environment. System 5 embodies a strategic vision and will balance System 4-3 interactions. Learning internally is mainly associated with System 2 in the VSM; learning from the outside world is associated with System 4 in interaction with System 3.
1.2 Organisational Learning framework

This section provides theoretical underpinnings of organisational learning and learning by organisations. References provided lead to further background resources. First, general aspects are presented. A more operational approach is presented in section 1.6. Equally relevant is clarity about what there is to learn, by whom and when. Level and scope of learning in aviation links to the notion of obtaining operational readiness (OR) (see section 1.4.3) and maintaining it.

Organisational learning is an essentially human process: an organisation learns through people. If the successful approach (= lesson) is not retained for reuse in future, learning must be repeated when the problem recurs. However, the effectiveness of learning remains low when lessons are retained but cannot be retrieved for (re-)use in a timely way. In order to learn as an organisation, the organisation must organise its learning!

To be a "learning organisation" has been one of the highest ideals held up for companies to achieve in the last decade (Senge, 1990). Senge identifies five basic disciplines that together foster learning organisations: systems thinking, personal mastery, mental models, building shared vision and team learning. Learning organisations not only learn to adapt to the changing world, but also learn generatively. Argyris and Schön (1996) call this 'productive' learning which requires that an organisation is willing and able to change its values, means and targets when necessary in order to achieve its mission.

Argyris and Schön (1974, 1996) have researched how organisations learn effectively. Argyris built his systems approach on basic cybernetics as presented by Ashby (1956, 1960), on the work of Bateson (1972) regarding learning, and on that of Dewey (1938) about 'inquiry'.

"The term learning either means a product of the learning process – 'something learned' – or the process that yields such a product... An organization may be said to learn when it acquires information (knowledge, understanding, know-how, techniques or practices) of any kind and by whatever means. ...all organizations learn, for good or ill, whenever they add to their store of information, and there is no stricture on how the addition may occur. The generic schema of organizational learning includes some informational content, a learning product; a learning process which consists in acquiring, processing, and storing information; and a learner to whom the learning process is attributed." (Argyris & Schön, 1996, p. 3)

It may be said that the organisation will learn

"when its members learn for it, carrying out on its behalf a process of inquiry that results in a learning product... Inquiry does not become organizational unless undertaken by individuals who function as agents of an organization according to its prevailing roles and rules." (Argyris & Schön, 1996, p. 11)

The term 'inquiry' is used here in a more fundamental sense of:

"the intertwining of thought and action that proceeds from doubt to the resolution of doubt. In Deweyan inquiry, doubt is construed as the experience of a 'problematic situation', triggered by a mismatch between the expected results of action and the results actually achieved." (Argyris & Schön, 1996, p. 11)
Organisational Learning and Organisational Memory for SMS and FRMS

The output of such 'organisational inquiry' takes the form of a change in thinking and acting that yields a change in the design of organisational practices. Such knowledge can be stored in a way that is accessible, or can be assimilated into custom and practice.

1.3 Tacit Knowledge Key to Organisational Learning

Organisational knowledge about how to realise the organisation's objectives is represented through so-called 'theories-of-action' (Argyris & Schön, 1996). These include strategies of action, the values that govern decisions and the assumptions on which they are based.

A theory-of-action takes two different forms, that of an 'espoused theory' that is explicitly advanced to explain or justify a given pattern of activity, and, simultaneously, that of a 'theory-in-use' which is manifest only in action and may not be articulated or articulable. 'Espoused theory' is explicit and overt and 'theory-in-use' is implicit and tacit. The organisation writes down 'espoused theories' in its manuals and when it describes how something should be done. It is 'espoused theory' when an organisation states that it runs business processes on a zero-accident basis. However, the 'theories-in-use' reflect actual practice as conceived by the operative persons. They envisage how things are done best and act in accordance with their individual 'theory-in-use' of running processes.

This tacit knowledge is embodied in the persons who work for the organisation and know from experience what tasks are executed in what way in practice and why. Members of a successful team have highly similar or matching theories-in-use. It is ideal if 'espoused theory' is matched to the accompanying 'theories-in-use' so that the actual organisational operations fit the proclaimed, intended actions.

Schein (1992) makes a similar distinction in his analysis of organisational culture. What matters in organisational learning is that the theory-in-use is changed. The espoused theory should change too so that there is consistency between documentation and practice. However, it is all too easy to change espoused theory, by rewriting procedures, without changing practice at all; safety rules are notoriously subject to lip-service and not well followed.

The tacit theories-in-use, including norms and values regarding operational performance, are manifested in behaviour within the organisation. This hidden knowledge is part of the organisation's assets that needs to be mobilised when operational problems emerge or when the operation must convert into one that can stand future demands. In the case of problem resolution, tacit knowledge from actors in the work process may generate understanding of what the problem is and where it comes from so that options for treatment can be generated. Alternatively, tacit knowledge about current practices may also be useful for assessing what is feasible and needed to answer future demands.

Note that an espoused theory may have nothing to do with the way in which the organisation actually operates. It may be no more than the philosophy that is trotted out when someone from outside poses questions, or something which the organisation would like others to believe that they do.
1.3.1 Language - a modelling tool

Language is a crucial means in communication. It is a means of conveying message contents from a sender to a receiver. For humans, language primarily relates to words, their meaning and their use, also in combination to build more complex messages. Words are used to describe fiction and non-fiction, but such a description typically is linked to the originator's perception of the world on the one side, while on the other hand the meaning of the message depends on the mindset of the receiver.

Thus, language is a modelling tool of which there are assumptions behind words used and contexts captured! Any account in wording of a critical event (incident, accident, other) is in principle incomplete and suffers from the limitations of language to describe the operational realities in which the incident occurred. In this respect, the contents of an incident report are always limited, because tacit information about operational contexts is lost. Furthermore, we cannot take it for granted that different people assign the same meaning to a specific word, because each of these persons associates this word with a situational context that is unique. Therefore, when it matters, we need to provide context information that describes how a specific word is being interpreted, so that other persons can translate the original meaning within their own operational context.

1.4 Key Processes in Organisational Learning

Figure 1 depicts the key processes and actions to invoke and maintain organisational learning, see also (Koornneef, 2000; Koornneef and Hale, 2004a). Argyris emphasises that learning should be embedded in the whole organisation as a part of its normal operation. It is not an add-on extra. This means, in terms of safety, that there must be an intimate link between the risk assessment process, which specifies what hazard scenarios there are; the management process, which establishes control strategies and practices for them; the operational process which carries them out and the learning process, which evaluates, improves and fine tunes these controls.

![Figure 1. Organisational single- and double loop learning modified after Argyris (Koornneef, 2000)](image-url)
Organisational Learning and Organisational Memory for SMS and FRMS

Learning starts in an organisational unit that is performing activities for which its members already have a 'theory-in-use' in the form of routines, priorities and actions. These all set up expectations about how the activity will proceed and what consequences will arise from the actions taken. The activities are conducted with resources made available to the unit and under objectives, values and means, which are also given to or imposed on the unit. Basic resources are knowledge, technology and equipment, organisational structures, norms and rules, as well as the people who deploy these resources in working processes to realise the organisation's objectives.

One of the normal expectations is that accidents will not happen. Sometimes, however, an operational surprise occurs in the form of an unexpected outcome. For health and safety management we are interested in the surprises, which lead closer to danger. If the individual detects the surprise and changes the way of working as a result, individual learning has taken place. However, for organisational learning to take place, the individual must notify a relevant learning agency. This process of notification needs to have as low an inconvenience threshold as possible. Obstacles to reporting include fear of blame, undue administrative burden in addition to job workload, and experiences of hearing nothing from previous notifications. Figure 1 indicates that learning has not occurred until a solution is actually produced (Argyris, 1982, 1992) and has been implemented. The learning process 'ends' when the process outcomes match the expectations according to that part of the adjusted theory-in-use when it is next invoked. The backbone for identification of processes and provisions for organisational learning was provided by the SOL-model that depicts key elements and interactions in organisational learning processes, see section 1.6.

1.4.1 Single- and double loop learning

Argyris uses Ashby’s definitions of single and double-loop learning (Ashby, 1960). Ashby distinguished the adaptive behaviour of a stable system (in which all essential variables lie within their normal limits) from the changes to the definition of 'normal' itself. For example, the normal operation of a thermostat is qualitatively different from changing its temperature set point.

- **Organisational single-loop learning** (OSLL) affects strategies of action and underlying assumptions of theories-of-action. That is, it affects the way operational goals are achieved without changing goals or values themselves. Organisational single-loop learning products are visible in the organisation's theories-of-action, e.g. as minor modifications in a task protocol or different use of available resources.

- **Organisational double-loop learning** (ODLL) in contrast, affects norms, values and organisational targets that govern the organisational unit and its theory-of-action. Such changes actually mean modifications to the constraints for operations run by the unit, requiring adjustment of its theory-of-action and, thus, of the prevailing theories-in-use (Koornneef, 2000). Organisational double-loop learning

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2 Note that this description relates to learning from 'internal sources' as indicated in section 1.1. In section 1.8, we discuss how this relates to learning from 'external sources'
Organisational Learning and Organisational Memory for SMS and FRMS

requires that the organisation has a willingness to change its operations, also when appropriate, at the level of goals (Argyris & Schö"{o}n, 1996).

Individual single-loop learning occurs when an individual detects an operational surprise in the organisational unit and, therefore, must decide what to do - take action or not, notify or not. He or she may take immediate corrective action and the lessons learned this way, may then modify the individual's version of the applicable theory-in-use. Individual single-loop learning may be effective for the individual's operational actions, but does not count within the organisational unit of which the individual is a member: without notification, learning products produced by the individual are not adopted in the organisation's theories-of-action.

Notification is a prerequisite for organisational learning from instances of single 'surprise' experiences by individual members of the organisation. This individual experience of detection of an unanticipated change in events or conditions is essential for learning: without detection of an operational surprise, there is nothing to notify to a learning agency.

Learning how the organisation is learning is yet another important type of double-loop learning. This 'deutero-learning' (Bateson, 1972) is indicated when organisational single- and double-loop learning does not result in adequate 'lessons': in which case the configuration of the organisational learning processes, the composition of learning agencies, methods used for inquiry, or communication channels deployed may need revision.

1.4.2 Learning Agency in Organisational Learning

Organisational learning from individual surprises is based on inquiry by agents assigned to learn for the organisation (Argyris & Schö"{o}n, 1996). These agents may need to be grouped as a 'learning agency' (Koornneef 2000), also see Figure 1.

Both organisational single- and double-loop learning requires a 'designated' learning agency, i.e. people who learn on behalf of the organisation, to ensure that the learning experience becomes embedded in the organisation. The learning agency should have the task to perform an inquiry in the classical meaning of Dewey (1938) if the notification is not enough to act as the basis for adequate selection of treatment options.

There is a fundamental problem inherent in the notification process which is that the notifying message becomes divorced from its context in the process of communication, due to limitations of language as discussed in section 1.3.1. This complicates the process of learning by introducing variability in interpretation. Therefore, the learning agency has a role in recapturing and preserving the contextual information lost in the notification process. The closer members of a learning agency are to the work processes from which the notification originates, (again give same example as above e.g blocker report described in Chapter xx) the more the members’ expertise and tacit knowledge might be mobilised to understand the occurrence of an operational surprise. (is this like the HIT as described in Chapter xx)
 Whereas a learning agency generates options regarding operational problems for lessons to implement, line management or dedicated teams of change agents empowered with doing this as problem owner(s) must choose and implement the lessons selected.

1.4.3 Learning content, or "what is there to learn?"
When organising organisational learning, it is necessary to have an idea about what there is to learn from operations. Designers of learning systems need to ask, "what is there to learn, from what (critical) experience, in what operational process, by whom, and when"? One approach to answering these questions is to adopt the operational readiness perspective. From this viewpoint, learning needs to be targeted to the needs of entities that wish to establish, maintain or regain the 'operational readiness' of the operational process for which they are responsible. Operational readiness is about

"creating an organization that places the right people in the right places at the right times, working with the right hardware according to the right procedures and management controls". (Kingston et al., 2007)

The Operational Readiness model (see figure 2) is described by Kingston et al. (2007) and more comprehensively by Nertney (1987).

The "bull's eye" in the centre represents the intended work process that results from the outcomes of distinct design and development processes in which, if the work process is critical, the basic ingredients of work ('people', 'plant', 'procedures' (the PPP subsystems) and their interfacing interactions) need to be tuned precisely. Thus, if there is instability in the work process, the operational readiness is jeopardised and needs to be restored. Learning from operational experiences is all about this.

![Figure 2. Operational Readiness Model - Nertney Wheel (Kingston et al., 2007)](image)
The lifecycle of the PPP subsystems is represented as a progression from the conceptual design phase - the outside of the circle - through to the operational phase at the centre. The upshot of this is that lessons can be learned about any aspect of the PPP system and at any point in the lifecycle; the concept of operational readiness provides a simple framework for this aspect of organisational learning.

1.5 Organisational Memory

Learning from operational surprises is about finding solutions to problems that emerge in intended activities. Implementation of these solutions is essential for lessons to be learned (see section 1.4.3). In order to avoid learning the same lesson twice, if not more times, some form of accessible memory is needed.

A person uses her or his brain supported by memory, but for an organisation this is less obvious, because its members sooner or later will leave the organisation, taking their brain with them. Organisations demonstrate having organisational memory when characteristic features of the organisation remain over time, e.g. as in the case of family-owned corporations. Stein (1995) puts it this way:

"The persistence of organizational features suggests that organizations have the means to retain and transmit information from the past to future members of the social system. This capability we might call the organization's memory."

He provides in his review of conceptual foundations of organisational memory a working definition:

"Organizational Memory is the means by which knowledge from the past is brought to bear on present activities, thus resulting in higher or lower levels of organizational effectiveness". (Stein, 1995)

In the perspective of learning from operational surprises or incidents, the knowledge that we are interested in, which has to be memorised and reused, is about managing operational risks, about the way resources deployed in working processes to realise the organisation's objectives, might need to be modified.

Organisational Memory is manifest in many different forms, see also Koornneef and Hale, 2004b. For instance, experience built-up about how to fine-tune specific processes might be captured in updated operating procedures and training programs or in models governing process control systems, each form part of the organisation's memory.

Organisational Memory needs to be detachable from individuals, who sooner or later leave, in order to retain the experience and built-up knowledge in the long term. The tacit memory in the head of individual members of an organisation may be sufficient in the short term for learning from incidents. But in the long term, more tangible forms are needed in order to share and disseminate lessons learned. Retrieval of lessons from such a memory must be made easy. This means at least that memory must be easily accessible and must exist where it makes sense for users to look for it.

Numerous concepts exist about what Organisational Memory is, what it contains and how it might function, see overview by Stein (1995). Others point out that the most suitable
form and configuration of corporate memory depends on the purpose and how it will be used (e.g. Heijst et al., 1996).

Bannon & Kuutti (1996) argue that Organisational Memory when conceived as a passive repository of data, knowledge and information, is doomed to remain of little use. This is because users still have to interpret the data retrieved from the organisational memory (capitalise or not?), but often will have no cues about time, originator, context, etc., aspects which are essential to understand and use the information. They stress the active and constructive aspect of human activity in remembering, at both the personal and collective levels. This has implications for Organisational Memory, triggering us to focus on the way information is generated and stored, and subsequently is retrieved, interpreted and understood by other people in other settings at other times.

Konda et al. (1992) argue for a 'shared memory' that has two forms: vertical and horizontal. The 'vertical' shared memory contains the body of knowledge specific for one professional group or discipline. The 'horizontal' shared memory contains knowledge with a consensus and meaning shared by different professional groups participating in a particular design project, use process or operation (Bannon & Kuutti 1996). An example of what can be stored in this horizontal memory is the aims of and approach lying behind the process. The point here is that contextuality of information in memory is a necessity.

Bannon refers to Bartlett (1932), to emphasise that it is essential, when looking into the utilisation of organisational memory, to consider processes of memorising and remembering:

"But if remembering takes place in a different activity than the one where material has been stored, the material will be reinterpreted with respect to the new object of activity, and there is no automatic guarantee that the material is relevant anymore in the same way that it was in the context of storing it."

(Bannon & Kuutti 1996)

He observes that the attention for the contextuality of contents in organisational memory has been neglected in many studies.

Kuutti and Bannon (1996) conclude that

"in situational remembering the current 'facts' that have to be kept in mind need to be interpreted in the light of both past and future; and that they have to be contextualized within the activity where remembering is taking place."

Conklin (1997, 2001) emphasises the need to design organisational memory in a way that it captures informal context knowledge that makes formal knowledge (as made explicit in reports, books, etc.) meaningful. Illustrated by different project experiments, he demonstrates that one cannot create a useful organisational memory by just capturing lots of information. The data must be structured somehow in ways that preserve coherence and searchability. Although to date computer support methods and power have improved largely since Conklin's paper, allowing data mining, free text search, etc., human intelligence and effort will remain a key to intelligent retrieval of what is relevant and meaningful. Without informal knowledge, formal knowledge loses its meaning over time. In this context, he refers to "gate-keepers" in Japanese corporations: people whose whole job is to look out for relevant developments and foster technology transfer, i.e. cross-
fertilisation of knowledge among divisions and from outside the corporation. Conklin also identifies four main barriers for creating useful Organisational Memory:

1. *Informal organisational knowledge resists capture* of the formal information and knowledge. Making Informal Knowledge explicit, e.g. about the process of capturing the formal results, underlying assumptions, rationales, etc.; requires trust and time.

2. *Documents without Context* – context gives meaning to a document, and helps to makes it still meaningful when context changes in future; the context of the documents also reflects the process in which the document was produced.

3. *Time*, as knowledge loses its relevance, and thus its value, over time, while memory contents grow larger. Relevance and size of data stored in memory calls for smart way of finding relevant information in a huge depository of formal knowledge… the human memory has an extraordinary capacity for meaning, and thus for relevance, allowing a fast retrieval of relevant knowledge from its memory without being overwhelmed by irrelevant data. Efficient query strategies using Internet illustrate this issue.

4. *Litigious environments* that may create an economic incentive for Organisational Amnesia. Practices exist of organisational non-learning due to litigation threat pressure, e.g. by regular destruction of informal knowledge on notes just to avoid them to be found by an unfriendly lawyer leading to "don't want to know" organisational amnesia, see also Baram, (2002).

### 1.6 System of Organisational Learning (SOL)

Figure 3 depicts the basic elements and relationships from Figure 1 as an organisational process for learning. The work process consists of the activities in which the incident or accident occurs, during preparation, execution or aftercare of an intended action, such as fighting a fire or rescuing a driver out of his crashed car. It forms the anchor point for organisational learning: incidents occur in these processes in a given specific local and organisational context, and lessons need to land here to improve control of operational risks.

![Figure 3. Basic model of a system for organisational learning (SOL) (Koornneef et al., 2005)](image)

The Learning Agency is assigned to assess incidents or other operational surprises in order to generate lessons that can be learned by the work process units. The better the
members of the learning agency are informed about the daily contexts of work processes, the more easily and effectively the lessons can be formulated and adopted by work process management. Thus, a Learning Agency that consists of members who come from the relevant shop floor processes is in a good position to assess whether and how a potential lesson can be learned most adequately. These lessons are implemented into the work process and need to be stored in some form of Organisational Memory together with added-value data, e.g. on effectiveness or underlying organisational factors (Koornneef & Hale, 2004b). One reason is that a Learning Agency is a scarce resource that should not spend time on learning the same lesson twice. Equally important is that lessons learned by one organisation need to be accessed by people in another organisation. Examples of organisational memory are written procedures and protocols, training programmes, and group behaviour that has developed over time, e.g. in an apprenticeship or guild system. It is crucial that organisational memory is accessible to be consulted and reused.

The most important function of the learning agency is to compensate for the loss-of-context regarding the incident, which is inherent in any notification of an abnormal event or situation (Koornneef & Hale, 2004b; Argyris, 1982). In the case of learning from an accident in, e.g., a Maintenance Repair and Overhaul (MRO) organisation's own work process the loss of situational context might be small. However, potential lessons from accidents in similar operations elsewhere require a translation into the local conditions in order that the lessons are learned in the local operational units.

A systems model is proposed for HILAS, in which specific areas for support of learning processes can be identified. The handling of operational contexts in which experiences emerge is critical. As knowledge is often based on individual and context-based experience, skills and behaviour of employees, it is difficult to make such implicit knowledge more explicit. Also, it is hard to predict what knowledge will be relevant for whom and in what format in the future. Thus, in spite of all smart storage and distribution activities, only a small amount of codified knowledge is used in practice. In addition, Knowledge Management Systems (KMS) are often developed as search engines rather than systems that fit the daily work processes of knowledge working employees. This complex set of notions requires thorough understanding already in the phase of specification of requirements for a KMS at sector level, e.g. the level of the HILAS consortium. For more on the difficulties of implementing a KMS please see Chapter on Resilience Safety Culture.

The Learning Agency needs to be linked with relevant management that is empowered to make decisions that can change the conditions, goals or resources of the work process, so that organisational double loop learning might be enabled.

A dedicated Learning Agent is indispensable for the preparation and follow-up of the learning agency’s meetings and sometimes as moderator during them. This is necessary to keep the learning agency going, because other members have limited time. This person does not have to be explicitly be called a 'learning agent' and may already exists as a continuous improvement person.

The interactions between the elements in the SOL-model have a concrete form, which can be identified and assessed. These include notifications of operational surprises,
context information, and lessons to be implemented that flow between the work process and learning agency. The learning agency verifies data in, and fills the organisational memory with case data, lessons learned and classifying data, e.g. about contexts and root causes. When Organisational Memory is adequately accessible, the work process offers notification data to Organisational Memory and consults it for lessons that might be implemented.

Note that the SOL-model shows functions or roles and communication processes in organisational learning, not organisational or technological structures. For instance, the role of the learning agency might be fulfilled during a regular meeting switching to 'learning mode'.

1.7 Relevance to aviation: systems view

The aviation sector includes many kinds of organisations as indicated in figures 4 and 5. It is vital for the development of adequate learning processes for integration of Human Factor (HF) knowledge into the lifecycle of aviation systems that all these organisations are involved. Learning processes in aviation are a central issue. We make a separation between learning processes within organisations, learning processes between organisations at the process level of the sector (Figure 4) and 'learning processes' vertically in the sector (Figure 5).

Concerning the vertical learning processes in the sector, we refer to Rasmussen's system perspective for controlling safety (Rasmussen, 1997). In a systems perspective, the awareness exists that a socio-technical system, such as the aviation sector, is divided into levels (legislative [both national and international], regulatory, managerial, work planning and system operational) and that these levels need to have properly functioning coordination of safety, or in this case, of dynamic and updated knowledge about HF issues in the sector.
Organisational Learning and Organisational Memory for SMS and FRMS

Figure 5. A schematic vertical view of a sector (after Rasmussen, 1997)

The system faces different sources of stress that can affect safety or production performance, such as the fast pace of technological change, increasingly aggressive and competitive environments, changing regulatory practices and public pressure. If the system is to cope and adapt to these sources of stress, it is vital to have strong connections between the levels, in the form of good communication, goal directedness with feedback, learning and action within and across the levels. This will update the system more effectively, resulting in better understanding of the characteristics of the aviation system or sector that could cause HF problems and help identify the weak links when controlling the system's stress sources.

Initial fieldwork and documentation analysis to establish the current state of affairs with regard to organisational learning opportunities and knowledge management practices in aviation organisations gives rise to the following conclusions:

- The contextualisation of operational knowledge is crucial in two phases, i.e. when operational knowledge is generated and whenever this knowledge is going to be reused.
- The transformation of operational knowledge into design, needs to consider artifacts, such as flight deck technology, as well as work or business processes.
- Personalisation should complement codification (Hansen et al., 1999). Maybe expand a bit
- There is a potential to improve learning from experiences within partner companies (intra-organisational learning).
- Learning from experience between companies is underdeveloped (inter-organisational learning). Much effort is needed to improve the situation.
- In order to ensure that a systems such as HILAS functions as a sustainable multi-actor learning system that operates at industry level, a learning agency function is needed in which its members together have operational knowledge about the core business processes that generate learning opportunities.

This state of the art review has revealed a number of outcomes to guide future research and implementation opportunities in order to establish a flourishing HF network of
Organisational Learning and Organisational Memory for SMS and FRMS

European aviation partners. The expertise that is available within HILAS partners needed, during the project, to be 'mobilised' so that the HILAS consortium could learn from its operational knowledge.

1.8 Learning from the outside world

The above discusses principles of Organisational Learning from an organisation's own operational experiences within the framework of Operational Readiness, triggered by what already has occurred, also allowing proactive learning. As already pointed out in Section 1.1, learning from the outside world is at the least equally important for the organisation. An 'outside world' radar is the organisation's 'intelligence' function to identify and evaluate market developments, opportunities to improve its position among competitors, technological advancements as well as to inspire the organisation to new initiatives to enhance viability.

Principles of Organisational Learning described in section 1.4 and as depicted in Figure 1 still fully apply, but the scope and origin of OL-triggering signals is different, i.e. not coming from existing, internal processes. The organisation's 'intelligence' function, System 4 in the Viable System Model (Beer, 1979), becomes a learning agency in interaction with people who may have detailed knowledge and insight in current operations. This interaction (between Systems 4 and 3 in VSM) results in options to adapt current processes to answer to changed market demands or, for instance, to new operations in order to survive or to take the lead in the market.

Organisational Single Loop Learning is linked with small adaptations, e.g. directly due to a change in demand of a product or service. Organisational Double Loop Learning occurs when the organisations needs to make new resources available, changes targets, changes or initiates new operations in order to realise new goals. OSLL and ODLL also might occur when risk data from other parties comes in for processing by risk radar that focuses on learning about one’s own operations.

A Learning Agency for learning from the 'outside world' is more explorative, where inquiry by this Learning Agency regards the interaction with current operations to evaluate whether or not new development are worthwhile and feasible.

1.9 Key Issues

The present research has yielded the following insights. These need further attention with respect to sharing and transformation of lessons from experiences by actor organisations in the aviation industry.

1) From a theoretical point of view, learning is essential for viability and resilience of any organisation (Beer, 1979; Weick and Sutcliffe, 2007). For an organisation, learning opportunities emerge from different origins, such as operational experiences, signals from elsewhere, and technological developments. For this purpose, detection of problems as learning opportunities needs to be facilitated, also when problem detection is based on analysis of performance data from multiple partners or as incoming external HF knowledge.

2) Nowadays, aviation companies such as airlines, maintenance providers and manufacturers are sets of business units that need to interact. In practice, difficulties
that come to light when initiating and fostering intra-organisational learning, are very similar to the ones that have to be overcome for inter-organisational learning.

3) Learning is fundamentally a problem-solving process, where the 'problem' might be limited to assessing new incoming knowledge, e.g. on human resources or safety, for its relevance in current operations, but a lesson to be learned might imply a major design solution in future aircrafts. Lessons are learnt only by putting them to the test, i.e. through implementation in an operational process, design requirements and development of innovative ideas into practice. Organisational learning requires detachment of the learning from individual members, on the one hand by assigning people to the task of learning for the organisation, and on the other hand, by developing Organisational Memory. It helps when the team assigned to this "back-office" role has adequate factual and tacit knowledge about current processes and their operational contexts.

4) Organisational Memory exists in many forms, but in order to function, this memory must be accessible on demand by relevant parties, e.g. operators like pilots, maintenance personnel or line management, as well as support staff like work scheduling department, engineers and quality assurance personnel. Note that Organisational Memory and individual learning come together in training programs, in which training materials and training contents form a part of Organisational Memory and the individual needs to master the contents in order to become or remain qualified for the job.

5) "Context" is important for understanding signals within their originating settings. At least equally important is 'context' when assessing and selecting solutions to a problem, i.e. a "lesson-to-be-learnt" or other knowledge in one or more operational contexts: the lesson must fit operational conditions or it won't be learnt effectively. Learning a lesson depends upon the fit between the anticipated lesson and the context where the lesson is to be learnt. If there is a misfit, effective change might not happen although the lesson itself will still exist in organisational memory as a potential. As Korzybski (1958, p.58) said, "a map is not the territory it represents, but, if correct, it has a similar structure as the territory, which accounts for its usefulness" - so it is here, the lesson is not the learning; learning needs to be informed by the context.

6) Within each operational organisation, intra-organisational learning already raises the question of "which business unit can/should learn what (lesson) from performance data?". Because distinct units have different lessons to learn, there is also the emerging issue of transformation of information during processing of the initial performance data. Thus, the "context" issue is repetitive in the sense that potentially relevant business units or departments will interpret incoming data within their own normative framework, area of competence and operational settings. Further understanding of phenomenon will provide insight in the issue of 'transformation' of operational knowledge.

7) In the aviation industry, e.g. at HILAS level, inter-organisational learning is also at stake. Here the handling of context is equally important, but is complicated by two factors: potential conflicts of interest between partners, and different information needs (content and timing).
Organisational Learning and Organisational Memory for SMS and FRMS

8) Organisational Learning linked with risk decision making requires i) a shared understanding of the need for change in a company or industry, and ii) the capacities and analytical skills for transforming existing experiences and solutions for new customer services in order to respond to challenges (from changes in the operational environment of airlines and new opportunities stemming from technological and organisational innovations), (e.g. Beauchamp, 2007).

9) At an organisational level and at inter-organisational level, a methodology to bridge both the sharing of information on risks and capacities across the organisation, and the inclusion of them in a decision-making process needs to be introduced. This decision process needs to have an explicit methodology.

10) In the continuous process of creating and maintaining Organisational Memory, decision-making can stimulate the learning mechanism and improve the detection of potential conflicts as well as their resolution.

11) Organisational Learning from data collected at a system like HILAS level tend be initiated only when a user organisation has recognised a problem situation or a profit opportunity and expects that such information might be relevant. Thus, defining user profiles and context-indicators for knowledge, solutions or problems that are available for sharing across such a system would facilitate effective retrieval of relevant information.

12) Support departments need to function within each operational organisation for assessment and interpretation of incoming operational data and analysis outcomes. Selection or fine-tuning of data analysis modules also requires assessment by support department. Similarly, criteria for enabling sharing solutions to operational problems or imminent operational problems also require judgment by staff from support departments.

13) For organisations, it is vital to explore in the outside world what is going on and what opportunities emerge for sound developments. Part of the outside world is formed by competing partner organisations. Picking up lessons-learned by one organisation and shared through a KMS at an inter-organisational level with other organisations is a requisite for reuse, but also requires adaptation, e.g. by a Learning Agency, to fit the lesson-learned elsewhere to the own operational context.

14) Organisations need to have or assign an Organisational Learning point of contact as a knowledge broker between a KMS at an HILAS level and the organisation, and visa versa:
   • to be able to appreciate signals coming from HILAS level about new contents for relevance to the organisation
   • for supervising the sharing of lessons or problems with others

1.10 Summary
The aim of this chapter was to present the principles of Organisational Learning and Organisational Memory which leads to a number of generic requirements for a successful learning system in the aviation sector. On the basis of our analysis we derived a number of key issues for sharing and transformation of lessons from experiences by actor organisations in the aviation industry. These issues highlight the critical role of context
transformation, the use of performance data, and the sharing of knowledge among competitors.

References


Organisational Learning and Organisational Memory for SMS and FRMS


