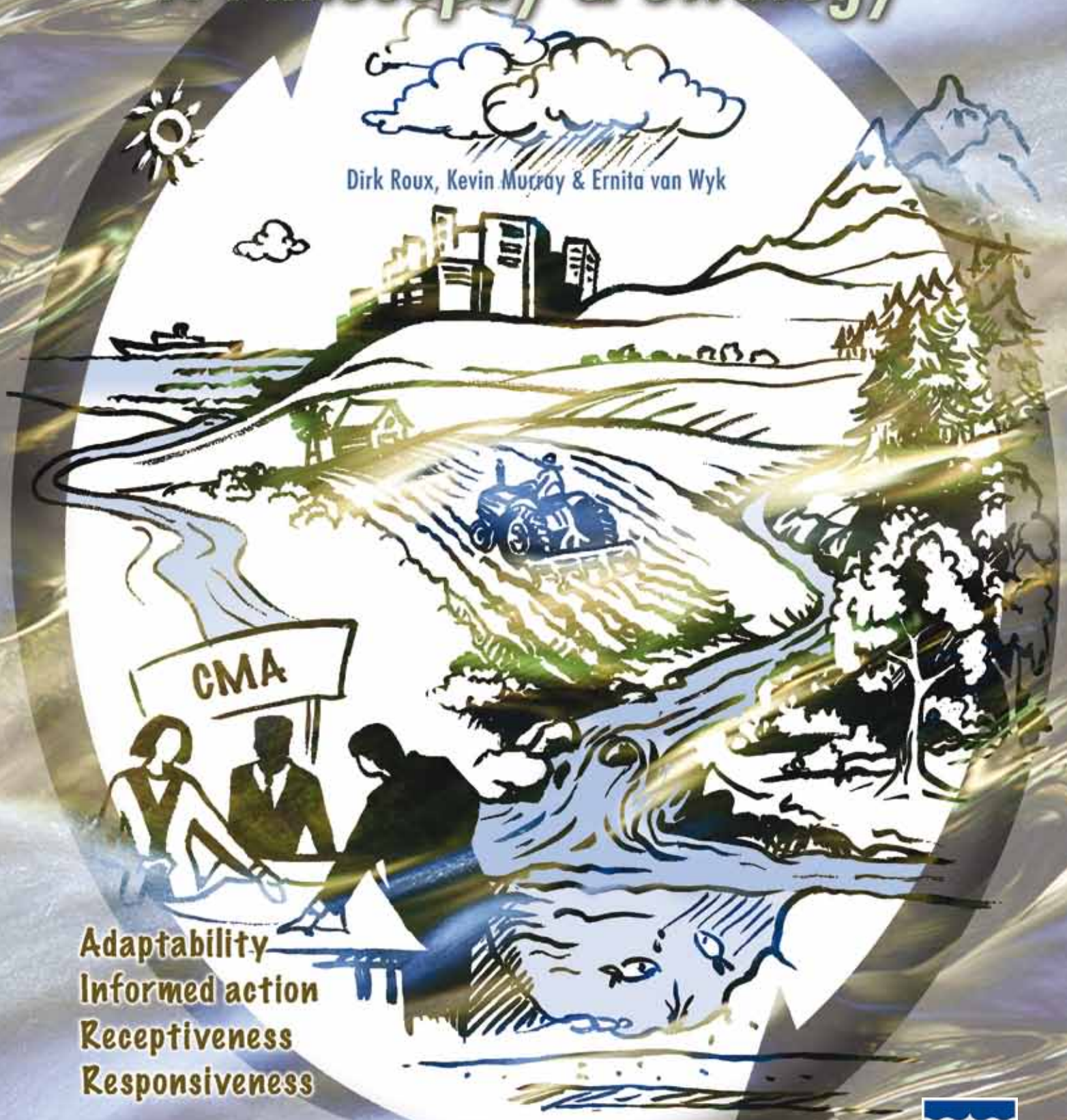
Enabling effective learning in catchment management agencies:

A Philosophy & Strategy

Dirk Roux, Kevin Murray & Ernita van Wyk



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WATER RESEARCH COMMISSION

Enabling effective learning in catchment management agencies:
A Philosophy & Strategy

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ABSTRACT

It is the responsibility of catchment management agencies (CMAs) to manage water resources in their respective water management areas. The nature of the functions they have to perform and the complicating and complex internal and external realities within which they operate create very demanding circumstances. It is therefore imperative that CMAs are effective learning organisations. This means they should be adept at acquiring knowledge, creating knowledge, transferring knowledge and, importantly, adapting when necessary.

This document provides some historical background to the knowledge movement and describes different types of knowledge. It also provides an encyclopaedia of terms that define various commonly-used terms and concepts in this field. It also further develops a series of well-defined learning ideals which provide a sound philosophical basis for both organisational and individual learning. These ideals include a common future focus, social knowledge sharing, empathy, learning by doing, prior knowledge engagement, patience, experimentation, positive persistence, transdisciplinarity, adaptability and synergism. Complexity, with its associated self-organisation and unpredictability, is also specifically acknowledged. Complexity-related ideals emphasise the sensitive persuasion necessary to manage self-organising systems, the importance of interpersonal relationships, and expecting the unexpected.

The challenging CMA circumstances, an understanding of which is based particularly on insights into the Inkomati CMA, require that the right people are nurtured in the right environment within the organisation. This means attracting and retaining the best minds. The right environment entails building knowledge breadth and depth, learning and unlearning, being able to respond rapidly when necessary but also making the time to reflect patiently, facilitating both individual and group learning, balancing the use of both theory and practice, building on prior knowledge yet also experimenting, and applying a mix of single-, double- and triple-loop learning.

Strategic adaptive management is assumed to be an appropriate framework within which to implement a learning strategy based on the above philosophy. The core purpose of the strategy is to encourage the CMA to explore and debate the above concepts and to develop a plan for their institutionalisation. This, in effect, requires the development of a learning culture. The first phase (adaptive planning) requires actions focussed on participative generation of a learning vision. This is followed by development of a common understanding of the CMA context as well as a series of operating principles like the learning ideals above. Specific learning-related objectives should also be developed. The second phase (adaptive decision-making) then involves developing a detailed management plan that realises these objectives. This should be monitored at regular intervals, at various levels, using structured reflection.

This document is intended to be somewhat generic. It is hoped that the ideas presented herein will lay a useful basis for detailed operational plans that will inevitably be specific to the CMAs for which they are developed.

EXECUTIVE SUMMARY

Background (Chapter 1)

Catchment management agencies (CMAs) exist to decentralise water resource management to regional and catchment levels. The nature and extent of responsibilities that can be delegated to CMAs under the National Water Act (No. 36 of 1998) mean that there is no equivalent local model from which any newly-formed CMA can learn. This and a series of complicating and complex realities associated with such management create very demanding circumstances. This report provides generic guidance to CMAs on how CMA management can facilitate learning and how individuals on the staff should approach learning. The Inkomati CMA (ICMA) is used as a specific case study. The research conducted in this project is described in the associated report,. WRC Report No. 1689/1/09.

Effective learning by individuals within the CMA essentially creates a learning organisation. Four specific learning-related abilities are essential:

- Acquiring knowledge from (i.e. learning from) external sources;
- Creating knowledge internally by effective processing of acquired knowledge;
- Transferring knowledge amongst staff members, to stakeholders in the water management area, and to other interested parties; and
- Adapting when necessary, based on the insights of sound new knowledge, to remain focussed on its vision.

The formal objectives of the study were:

- To further develop and refine a philosophy and set of principles that will enable the establishment of appropriate learning environments for good ecosystem governance;
- To develop a strategy that implements this philosophy in a chosen Catchment Management Agency; and
- To facilitate roll-out and initialise implementation of the strategy in the chosen Catchment Management Agency.

These objectives have as their ultimate aim the promotion of behavioural change in an organisation towards a conscious learning culture, characterised by active dialogue. This is particularly important for a public organisation like a CMA because it can contribute directly towards securing the legitimacy of the organisation in the eyes of its stakeholders.

The demanding water resource management environment of the CMA is a result of many factors:

- External realities include information overload, ever-increasing rate of knowledge production, increasing rate of knowledge availability, increasing ease of knowledge mobility, increasing interdependence between those with knowledge and those who need to apply it, limited resources for scientific development, and the general decline in the South African water sector.
- External uncertainties include regional and national politics, the quality of future tertiary graduates, future environmental attitudes and ethics, and the implementability of the National Water Act.
- Internal realities include the CMA's lack of history, continued dependence on DWAF, difficulties in attracting the right people, some operational system not yet being in place, yet inspirational staff.
- Internal uncertainties include the precise role of CMAs, the capacity to discharge mandates, and the nature of future learning partners.

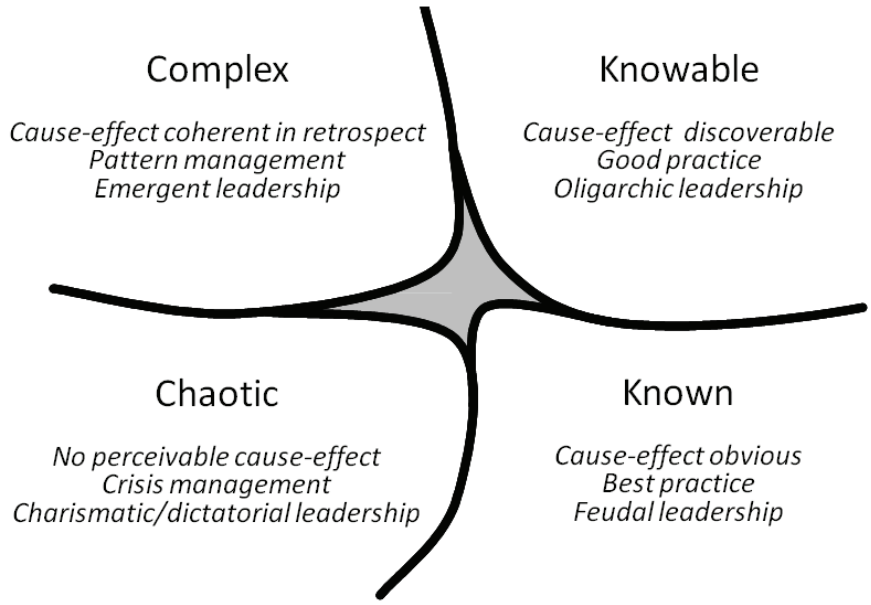
These create a situation of considerable complexity in the sense of being distinctly unpredictable.

Organisational learning (Chapter 2)

The early 1990s saw the first generation of the knowledge movement. This was characterised by technology-driven efficiency and emphasis on storing knowledge and intellectual property in explicit forms (manuals, databases, etc.). The second generation took place in the late 1990s and was a period of disillusionment and transition. Managers started to realise that their organisations might well have achieved efficiencies but it had been at the cost of effectiveness. This led to the third generation, still underway today, which acknowledged that people should be at the core of knowledge management.

Miller and Morris (1999) started by making a useful distinction between information and knowledge. They suggested that knowledge is created through the integration of information derived from data, plus theory that puts that information in a defensible context, plus experience of how things work in the real world. This model is used in this document.

Different kinds of appropriate knowledge were also recognised. For example, Snowden (2002) proposed the sense-making framework illustrated in the following figure. It suggests that different knowledge (theory, information and experience) may be required when operating in different decision-making domains. Each of the four domains contains a different model of community behaviour, each requiring a different form of management.



Snowden's (2002) four decision-making domains.

This document acknowledges learning (or equivalently, knowledge creation) as a distinctly social process. Social learning is a broad term that refers to processes of learning and change in individuals as well as in social systems. Communities of practice are particularly effective means of group learning characterised by voluntary participation and synergy driven by a shared passion.

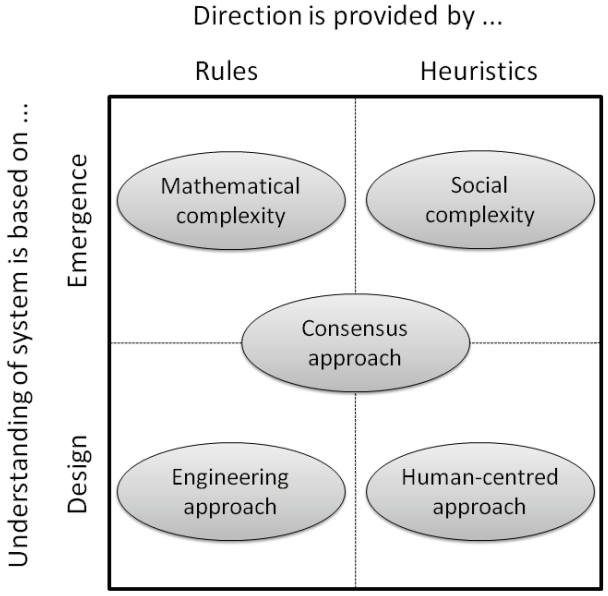
A pervasive learning culture is necessary for organisational learning to be effective. Nurturing such a culture involves shared visions and goals, establishing track records, finding the right people, and applying appropriate leadership. Learning is also intimately associated with change. Importantly, not fearing change allows one to be more receptive to new perspectives.

Knowledge-intensive organisations (like CMAs) rely heavily on their knowledge workers. These are people who, by the very interdependent nature of knowledge, must work in teams to be

effective. They work both with their hands (learning by doing) and with their theoretical knowledge. They analyse data and information and apply their specialised expertise to solve problems, generate ideas, anticipate trends, teach others, or create new products or services (Drucker, 1993). The organisation's knowledge workers comprise a critical component of its knowledge assets and intellectual capital.

A useful series of approaches to knowledge management was developed by IBM for the European Commission (European Commission, 2004). The axes comprise the following.

- **Design**. This refers to the ability of a leadership group or consultant to stand outside the system and design the system as a whole based on desired outcomes, a gap analysis, etc.
- **Emergence**. In this approach the system cannot be understood or managed as a whole, but only through the dynamic interactions of the agents (people, technology, government, etc.).
- **Rules**. These are based on prescriptive processes that remove ambiguity.
- **Heuristics**. These draw from values and allow a degree of ambiguity.



European Commission knowledge management scenarios for 2010.

Knowledge creation is now regarded as an active and dynamic process of relating, rather than a static one of storing what is known in a way abstracted from its use, typical of second generation knowledge management. Knowledge is now seen as volunteered rather than conscripted, to be characteristically spoken rather than written, and to be deeply contextual rather than abstract.

In the innovation chain from idea generation to full commercialisation or implementation of an idea, both creativity (out-of-box imaginative thinking) and commercialisation (in-the-box "concept into reality" thinking) play important roles. Emerging companies tend to emphasise creativity in their search for ideas that can potentially create competitive advantage. As they grow they balance the degree of creativity and commercialisation. Mature companies tend to focus more on commercialisation. Important in this innovation process is the absorptive capacity of the organisation. This is the ability to recognise the value of new, external information and knowledge, assimilate it and exploit it for benefit.

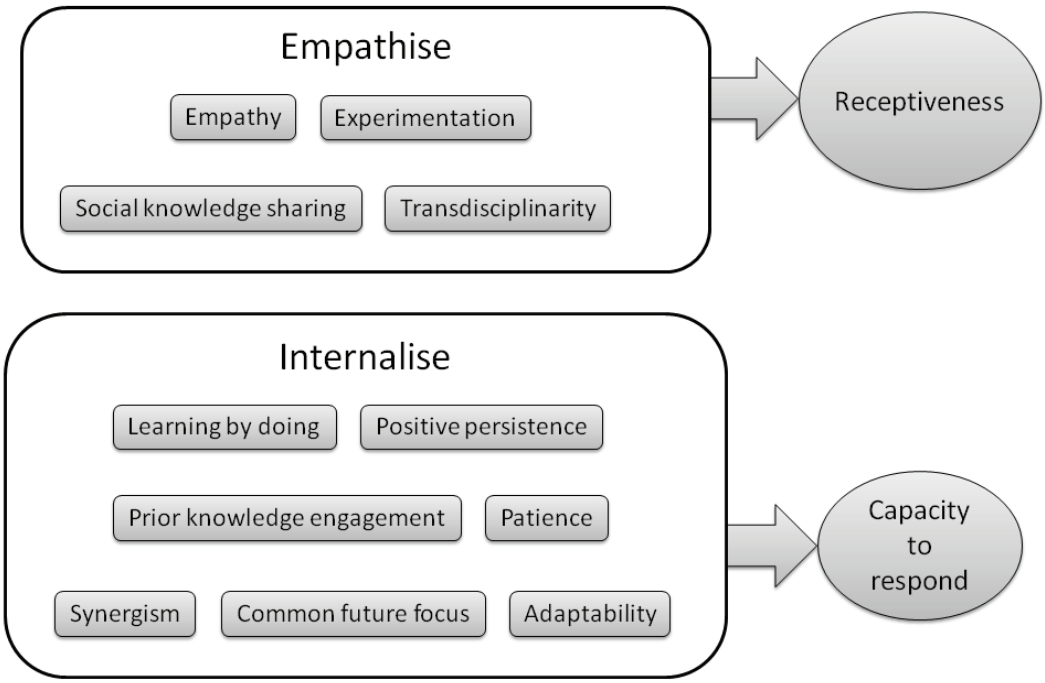
While much of the literature covering the above topics refers to typical commercial organisations, the concepts are as relevant to organisations with a mandate for social-ecological systems governance, like catchment management agencies.

Learning philosophy (Chapter 3)

It is important that any learning strategy can be soundly based on a well-considered philosophy. This philosophy is presented as a series of learning principles or what is preferably referred to as learning ideals. These ideals are in turn based on two important assumptions:

- **There's only one learning system**. All knowledge (scientific, local, traditional, practical, political, etc.) is acknowledged although scientific knowledge is regarded as indisputable. Social learning also inherently implies participation in this broader learning system.
- **Social-ecological systems (SESs) exhibit complexity**. SESs exhibit at least self-organisation (in a bottom-up sense) and unpredictability. Certain obvious pre-requisites need to be in place for a CMA to become a learning organisation. However, the exact path taken, and hence the precise nature of the ultimate learning organisation, will be determined by unpredictable events, properties and behaviours.

Learning is fundamentally about being empathetic to other points of view, in other words being receptive. However, the usefulness of learning only reaches its full potential value when it can be used to respond effectively to the messages being received. The learning ideals fall into these two categories, as indicated in the figure below. Effective receptiveness and response based on these ideals should contribute to the overall credibility, and hence legitimacy, of the organisation.



The empathy and internalisation categories of the basic learning ideals.

The learning ideals are:

- "**Common future focus**" strives to ensure that all stakeholders have agreed to a well-defined vision of the future and that this actively determines what is learned.

- "**Social knowledge sharing**" strives to facilitate freely interactive sharing, inquiry, debate and negotiation of new information between learners and those with the knowledge that should be shared.
- "**Empathy**" strives to stimulate co-creation of new knowledge by nurturing a culture in learners to interact and share with other knowledge systems (cultural, political, scientific, etc.) and knowledge levels (novice, expert) with understanding and an ethic of mutual respect for knowledge (in all its forms), wisdom, culture, language, abilities, concerns and inputs of all stakeholders.
- "**Learning by doing**" strives to ensure that knowledge is also created through hands-on practical experience.
- "**Prior knowledge engagement**" strives to ensure that knowledge creation acknowledges, monitors, adapts to, and builds on what learners already know.
- "**Patience**" strives to ensure that adequate time is allowed for absorbing appropriate knowledge and that the expectations during the learning process, of all concerned, are realistic.
- "**Experimentation**" strives to completely embrace (allow, plan for, and learn from) provisional or exploratory initiatives that are not necessarily guaranteed to succeed or produce short-term desirable results.
- "**Positive persistence**" strives to ensure that learners have determined yet positive and enthusiastic attitudes to acquiring new knowledge.
- "**Transdisciplinarity**" strives to ensure that the knowledge that is created (in individuals and in organisations) is appropriate and adequate at each level in a hierarchy of disciplines (e.g. from technical through political to ethical) and, where necessary, adequately detailed (i.e. based on deep understanding).
- "**Adaptability**" strives to ensure that individuals learn to manage their own resilience, that is, their capacity to react constructively to disturbance and to change when necessary.
- "**Synergism**" strives to ensure that teams are able to apply routine strategies that result in achievements greater than that attainable by the individuals operating separately ("the whole is greater than the sum of its parts").

To specifically address complexity, the following ideals are proposed.

- "**Sensitive persuasion**" acknowledges that self-organising natural and human systems are of such a nature that they cannot function optimally within formal "command and control" management approaches.
- "**Up close and personal**" acknowledges that the nature and extent of interpersonal relationships are core drivers of dominant social behaviours and so strives to make such relationships the focus of learning-related management actions.
- "**Expecting the unexpected**" strives to create and maintain an ever-present mindset of expecting to be surprised.

It is recommended that the above ideals be used as a guide to learning. They need to be adapted, slowly if necessary, to whatever the current organisational culture is. They must also be pragmatically implemented and reflectively tested to see whether or not they can incrementally improve the efficiency and effectiveness of learning.

Learning priorities (Chapter 4)

The demanding mandate of a CMA requires that the right people are nurtured in the right environment. Many issues are relevant to achieve this:

The right people

- **Attracting and retaining the best minds**.
  - ***Exploiting potential environmental attractiveness***;
  - ***Seeking and acquiring exceptional skills***;
  - ***Retaining critical expertise in feeder pool (i.e. DWAF regional office)***;
  - ***Creating enabling support systems***; and
  - ***Nurturing a network of strategic relationships***.
- **Anticipating "bad apples"**.
  - ***Acknowledge their possible existence***;
  - ***Don't underestimate them***;
  - ***Be receptive***;
  - ***Respond sensitively***; and
  - ***Sensitise new staff***.

The right environment

- **Building knowledge breadth and depth**.
  - ***Cover all bases***;
  - ***Cover core bases in depth***;
  - ***Fill gaps in depth from external network***;
  - ***Balance experts and novices***; and
  - ***Find some integrators***.
- **Learning and unlearning**.
  - ***Learn continuously***;
  - ***Capture learning in explicit form***;
  - ***Know when to unlearn***; and
  - ***Know how to unlearn***.
- **Responding rapidly but reflecting patiently**.
  - ***Build a supportive network***; and
  - ***Cultivate a reflective learning capacity***.
- **Facilitating individual and group learning**.
  - ***Acknowledge that both are important***;
  - ***Explicitly facilitate individual learning***;
  - ***Manage group learning***; and
  - ***Don't leave others behind***.
- **Using theory and practice**.
  - ***Learn by doing***;
  - ***Embrace theory***;
  - ***Acknowledge deeply embedded life interests***; and
  - ***Optimise your people portfolio***.
- **Building on prior knowledge but also experimenting**.
  - ***Acknowledge prior knowledge as a strength***; and
  - ***Periodically test the relevance of prior knowledge***.
- **Applying single-, double- and triple-loop learning**.
  - ***Continually improve***;
  - ***Get to the core***;
  - ***Apply adaptive management***; and
  - ***Share the learning***.

Learning strategy (Chapter 5)

The decision-making environment within the ICMA is such that it is dominated by challenging uncertainties. The associated unpredictability is typical of complex systems. Adaptive management, and in particular strategic adaptive management, is a framework designed for, and therefore well suited to, decision making in such an environment.

Accordingly, this is chosen as the framework within which the learning strategy is presented. The strategy is comprised of specific recommended actions. Many of these actions are aimed at raising awareness among the ICMA staff and selected stakeholders of the learning-related concepts presented in this document. Discussions, debates and even negotiation about the meaning and personal and organisational relevance of these issues are encouraged. In this way, a learning mindset and hopefully and more well-defined learning culture can begin to be nurtured.

The following summarises the proposed strategy:

Adaptive planning

- Phase 1: Decision-making environment.
  - Vision:
    - *Action*: The ICMA will undertake a series of engagements firstly with the ICMA Board, internal staff members and then with selected external stakeholders to establish a vision and high-level objective relating to learning and knowledge that supports the CMA's overall vision. This process will aim primarily to establish a common future focus and buy-in in respect of learning and knowledge management.
    - *Prototype*: The ICMA commits itself to "Learning for work excellence" in striving for its vision of "Water for all in the Inkomati". It also acknowledges that the very nature of learning is such that it pervades every aspect of water resource management in the Inkomati water management area.
  - Context:
    - *Action*: The context within which learning will take place will be discussed and understood by the ICMA Board, all staff members and selected external stakeholders.
    - *Prototype*: The discussion will include refinement and ultimate consensus on the underlying knowledge- and learning-related assumptions representing the global, national, and regional realities of water resource management. For example: There is one learning system; Social-ecological systems exhibit complexity; External knowledge-related realities; External knowledge-related uncertainties; Internal knowledge-related realities; and Internal knowledge-related uncertainties.
  - Operating principles:
    - *Action*: Operating principles that will guide learning-related management will be identified and discussed.
    - *Prototype*: The "learning ideals" presented in the Learning Philosophy Chapter, including those that acknowledge complexity, will be the basis for these discussions. In essence, these learning ideals acknowledge that, in the first place, learning is fundamentally about being empathetic to other points of view. This frame of mind increases the ICMA's capacity to be receptive and therefore acquire sound and relevant knowledge. Secondly, the learning ideals achieve their full potential by the depth of understanding created. This increases the capacity of the ICMA to be responsive, including adapting when necessary. The practical relevance of the learning ideals to the issues relating to "The right people" and "The right environment" (presented in the Learning Priorities Chapter) will also be discussed.

- Phase 2: Understanding the system.
  - *Action*: This phase will probe in greater depth the general nature of the ICMA itself and the Inkomati water management area. A critical input to this process is the current understanding of the status quo in the water management area, including all issues relating to water resource use and protection. The purpose of this phase will be to identify "vital attributes" which are core factors in the way the systems (ecological, social, etc.) in the water management area function. Once identified, these will be examined in depth and the factors that strengthen or weaken the vital attributes will be identified.

- Phase 3: Develop objectives.
  - *Action*: Specific and well-defined learning-related objectives will be developed and agreed to by all. These will be further broken down into achievable goals for management. Specific targets will be identified that describe the boundaries of the desired state (defined primarily by the learning vision above).
  - *Prototype*: Given the nature of learning and knowledge, the ICMA acknowledges the need for a nurturing management style rather than one that applies a quantitative "tick-box" mentality to monitoring progress and assessing staff performance. Accordingly, the ICMA management will not overemphasise quantifiable learning targets. Emphasis will be on job satisfaction and more qualitative assessments of the value of achievements. Specific objectives should relate to the above-mentioned contexts of the right people and the right environment and be appropriately based on the shared understanding developed within the ICMA of the above learning ideals.

Adaptive decision-making

- Management plan.
  - *Action*: Based on the above objectives, a detailed management plan will be developed and implemented. This will entail specific actions that will implement selected aspects of the learning philosophy. Their ultimate intention is to create an optimal learning culture.
  - *Prototype*: Specific actions are likely to relate to the following: Data management facilities; Information management facilities; Group learning facilities; Group learning and "learning by doing" opportunities; Capturing of reflective learning; Poster for learning ideals. For each of these actions, the consequences for learning and knowledge management will be predicted and documented.

- Monitoring.
  - *Action*: The ICMA management will periodically (at least every two years) reflect on the degree to which the installed overall learning-related systems have achieved the documented objectives. Some aspects may require more frequent reflection. Reflection will be heavily based on the personal inputs of staff members who will be asked to qualitatively assess the effectiveness of the systems in an open and honest manner.

    If the systems are falling short of the envisaged objectives or reaching levels of concern, specific management decisions will be taken based on the advice of staff members and the systems will be refined or replaced.

    Between such formal overall reviews monitoring of sub-processes will also take place at appropriate intervals. These sub-processes may include:
    - The attainment of individual high-level and low-level objectives.
    - The effectiveness of staff recruiting.
    - Progress in updating and maintaining data and information processes.
    - Effectiveness of group learning and "learning by doing" projects.

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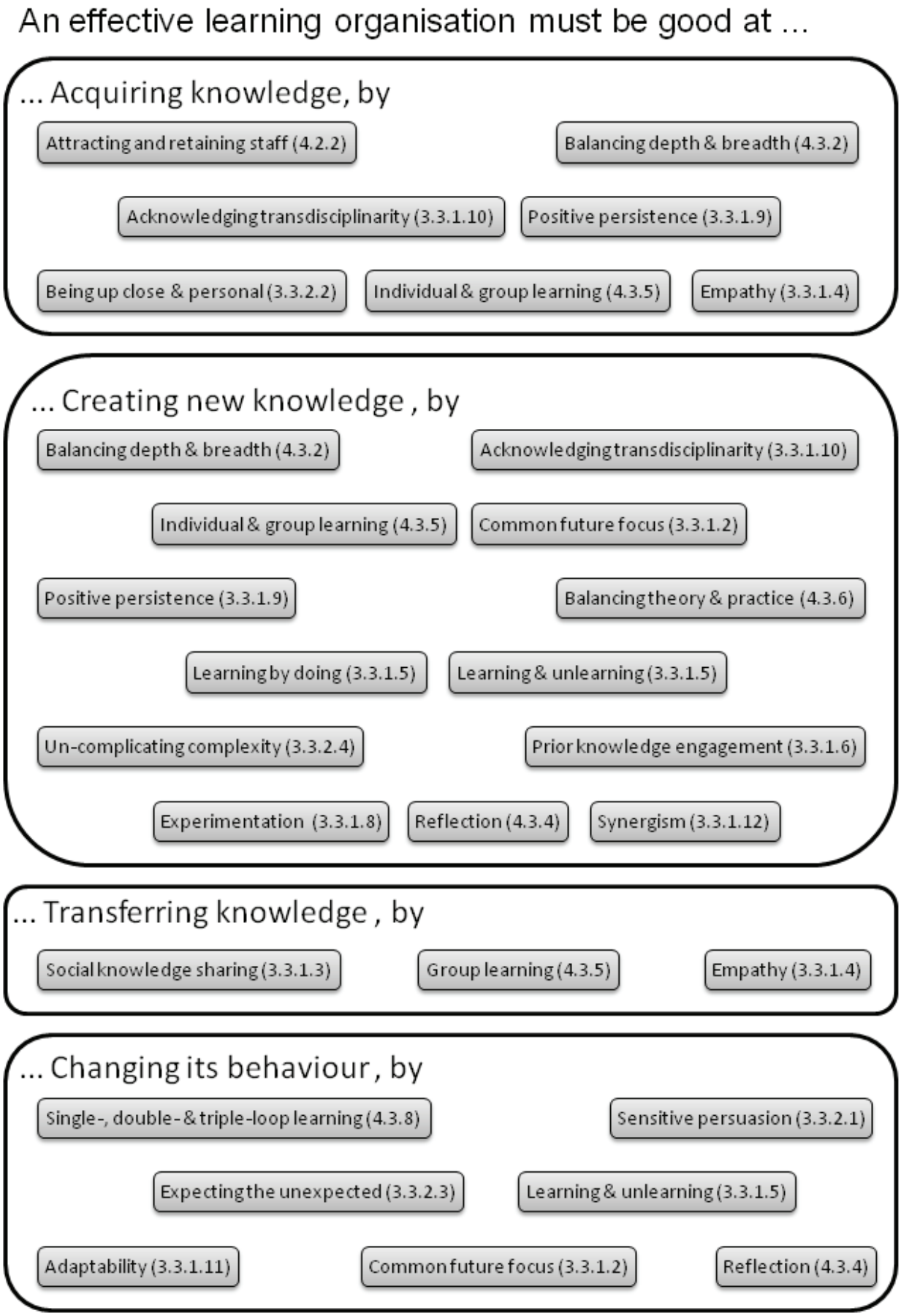
A GUIDE TO THIS DOCUMENT

The following figure illustrates how the concepts that guide organisational learning relate directly to the four fundamental properties of an effective learning organisation, namely:

- Acquiring knowledge;
- Creating new knowledge;
- Transferring that knowledge; and
- Changing its behaviour when necessary.

The section in which the concept is addressed is also given.


An effective learning organisation must be good at ...
... Acquiring knowledge, by
Attracting and retaining staff (4.2.2)
Balancing depth & breadth (4.3.2)
Acknowledging transdisciplinarity (3.3.1.10)
Positive persistence (3.3.1.9)
Being up close & personal (3.3.2.2)
Individual & group learning (4.3.5)
Empathy (3.3.1.4)
... Creating new knowledge , by
Balancing depth & breadth (4.3.2)
Acknowledging transdisciplinarity (3.3.1.10)
Individual & group learning (4.3.5)
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Learning & unlearning (3.3.1.5)
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Common future focus (3.3.1.2)
Reflection (4.3.4)

A fictitious CMA vision

2008	2018
3-Year backlogs at DWAF regional office	**CMA attracts international scientist**
DWAF officials confirmed today that applications for water use licences received as long as three years ago, remained unprocessed. Regional Director Mr Lesame blamed staff shortages. "Our staff turnover has been 28% in recent years," he said. "New staff members need to be trained every year. This is a considerable drain on our resources." A member of this regional office recently appeared before the Water Tribunal. Iron ore giant Nsimbi Holdings' CEO Mrs Swanepoel claimed DWAF had been "negligent" and had "not followed due process by refusing to make decisions regarding our application within reasonable time periods." As a result the company has been operating at half capacity, threatening the livelihoods of hundreds of workers and their families. The Tribunal found DWAF guilty. Mr Lesame said it was difficult to attract new staff of high quality. "We have lost a number of experienced staff members in recent years. We also cannot afford attractive salaries," he added. A tour through the drab office building in the city centre revealed paint peeling off walls, some toilets not functioning, and outdated computer equipment. Our guide, recently-appointed Ms Joyce Ngwenya, a hydrologist by training, looking at home among her books and plants in her office, said morale was "very low". The head of water resource management, Mr Naidoo expressed his concern about the current restructuring, the second in as many years. "The instability creates much stress," he said. "Many are now regarding their job simply as a stepping stone to another job with better pay." Mr Lesame blamed the transitional phase DWAF was in and was pessimistic about lessening work loads in the near future.	The head of the Inkomati catchment management agency, Ms Joyce Ngwenya, announced yesterday that Swedish scientist, Mrs Bergman, would be spending six months at the agency. "We are delighted to be sharing our successes in water resource governance with someone of Mrs Bergman's stature," said Ngwenya. "The Swedes pioneered much of the work in this field. Mrs Bergman's visit is a wonderful opportunity for us to learn from each other." Interviewed in the quiet gardens of the CMA's offices in spectacular bushveld surroundings, Mrs Bergman expressed her delight at the opportunity. "This visit follows a recent three-month visit by two CMA personnel to our offices in Sweden," she said. The CMA was recently praised by the president for its contributions to regional socio-economic development. "Our largely agricultural economy is booming, despite the recent drought," Ngwenya announced. "Our rivers are closely monitored and are currently all in the state desired by our water users." On a tour of their vibrant premises Mrs Ngwenya noted that "every day brings new challenges". "But the dedicated staff handle these well. No problem is too difficult for these people," she said proudly. While some worked feverishly at keyboards, laughter blended with high-spirited group discussions on details of their latest project, a multi-million dollar World Bank-funded groundwater sustainable utilisation plan. Mrs Bergman, also internationally renowned for her expertise on how organisations learn, told the group: "The adaptability, drive, and passion of this institution, coupled with their wealth of practical experience, are an inspiration to all of us."

CHAPTER 1: BACKGROUND

This chapter describes the purpose and scope of this report.

1.1 INTRODUCTION

This report arose out of a perceived need for newly-formed catchment management agencies (CMAs) to become highly effective learning organisations. Their decision making and implementation environment is demanding in many ways. Change, uncertainty and surprise are normal features of everyday life. Our capacity to learn therefore takes on special meaning and urgency (Roux et al., 2008). It is therefore imperative that the catchment management agencies are very successful at all of the following:

- Acquiring knowledge from (i.e. learning from) external sources;
- Creating knowledge internally by effective processing of acquired knowledge;
- Transferring knowledge amongst staff members, to stakeholders in the water management area, and to other interested parties; and
- Adapting when necessary, based on the insights of sound new knowledge, to remain focussed on its vision.

This report presents the following:

- The theoretical background to organisational learning;
- A learning philosophy (characterised by basic learning ideals);
- Some learning priorities (that begin to express how some of the ideals can be put into practice);
- A learning strategy (that can appear in the CMA's catchment management strategy); and
- An encyclopaedia of terms (that defines various commonly-used learning and knowledge management terms and concepts).

The research process and thinking upon which this report is based can be consulted for more in-depth information on some of the issues, particularly the learning ideals (Roux et al., 2009).

1.2 OBJECTIVES

The formal objectives of the project were as follows:

- To further develop and refine a philosophy and set of principles that will enable the establishment of appropriate learning environments for good ecosystem governance;
- To develop a strategy that implements this philosophy in a chosen Catchment Management Agency; and
- To facilitate roll out and initialise implementation of the strategy in the chosen Catchment Management Agency.

These objectives have as their ultimate aim the promotion of behavioural change in an organisation towards a sound learning culture, characterised by active dialogue. This is

particularly important for a public organisation like a CMA because it can contribute directly towards securing the legitimacy of the organisation in the eyes of its stakeholders.

It is explicitly assumed in this work that a learning organisation is an essential prerequisite for good ecosystem governance. The reasons for this are explored in more detail in the background section of WRC Report No. 1689/1/09. It might also be noted that the learning philosophy presented herein might be applicable more widely than ecosystem governance.

1.3 CURRENT REALITIES AND FUTURE UNCERTAINTIES

1.3.1 Introduction

The purpose of establishing catchment management agencies (CMAs) is the delegation of water resource management responsibilities from the Department of Water Affairs and Forestry (DWAF) to regional or catchment level. While the delegation of some responsibilities has occurred, the ICMA has not yet achieved the full degree of autonomy envisaged by the National Water Act (No. 36 of 1998). The ICMA also has a Board comprised of representatives of the various water user groups in the Inkomati water management area. A DWAF regional office also continues to operate in the area.

Any learning philosophy and strategy must be firmly grounded in these and other local, national and global realities otherwise its relevance is justifiably questionable. The following sub-sections list a series of important learning-related issues that are shaping current realities and that are likely to shape future trends. All the issues are implicit or explicit assumptions that justify and give context to the specifics of the learning philosophy (Chapter 3), learning priorities (Chapter 4) and learning strategy (Chapter 5).

The sub-sections distinguish between realities and uncertainties external to a catchment management agency and those currently within it. Most are considered to be quite generic. A few are specific to the Inkomati catchment management agency.

1.3.2 CMA external realities

- **Information overload**. Learners are burdened with data and information overload.
- **Increasing rate of knowledge production**. The amount of knowledge produced (explicit and tacit) is ever increasing (partly because the more mankind knows the faster it learns).
- **Increasing knowledge availability**. There is ever increasing availability of this knowledge (e.g. Google and associated tools like Google Scholar, Google Earth, Yahoo, etc.). International communication (e.g. using Skype and video-conferencing) and travel is now much more effective and efficient so it is now easier to access geographically-remote knowledge.
- **Increasing ease of knowledge mobility**. There is an increasing tendency for knowledge to move or be attracted to a particular locus (e.g. reflected in movement of people from public to private sectors and from less attractive countries to more attractive countries – the "brain drain").
- **Increasing interdependence**. There is increasing interdependence among those with knowledge and those targeted by the science and resulting technology. There are various perspective on this:
    - Interdependence inherently acknowledges Wenger's (2005) statement that "for individuals, learning increasingly requires learners to participate in learning systems". This is another fundamental premise upon which this work is based.

  - Interdependence is inherent in good governance which requires engagement with stakeholders.
  - The nature of priority problems in water resource management frequently requires input from multiple disciplines and therefore rely on more diverse and larger teams.
- **Limited resources for scientific development**. Apparently and paradoxically, South Africa's developing context can mean that developing and applying scientific knowledge can be hampered by either:
  - Actual limited financial resources (because other national needs have higher priority); or
  - Underutilisation of allocated resources (often due to inadequate capacity in government departments to effectively spend their budgets).
- **Decline in water sector**. The water sector in South Africa, guided by DWAF, has shown a steady decline (from a scientific, technical and co-learning perspective) over the past few decades. Evidence for this is the following:
  - Significant scientific and engineering expertise has left both DWAF and the country.
  - The previous vibrant and cohesive interface between science and government, specifically management and policy, that existed (De Coning and Sherwill, 2004) has greatly decreased.

1.3.3 CMA external uncertainties

- **Political**. There is currently considerable South African and regional political uncertainty.
- **Future tertiary graduate quality**. The quality of future tertiary graduates is uncertain.
- **Environmental attitudes**. The future environmental attitudes and ethics are uncertain, especially given South Africa's backlog of environmental consciousness (Steyn, 2005) and need for socio-economic development which some perceive as already happening at the expense of the natural environment upon which we all ultimately depend.
- **Implementability of the Water Act**. While the National Water Act (No. 36 of 1998) remains fundamentally sound, there are uncertainties emerging about DWAF's ability to implement it.

1.3.4 CMA internal realities

- **Lack of history**. Their very recent establishment as the first CMA means very little experience exists relating directly to their mandate. There are no other local catchment management precedents with similar management models from which to learn. Their short history also means they are likely to have little adverse "historical baggage" relating to integrated water resources management.
- **Continued dependence on DWAF**. The process of having all the necessary regulatory functions delegated to the CMA is slow.
- **Difficulty attracting the right people**. The Inkomati CMA is experiencing difficulties attracting and retaining the right people. This is partially due to:
  - The relatively small pool of appropriate human resources in South Africa;
  - The increasing ease of knowledge mobility meaning the CMA can easily lose good people to other organisations with perceived better conditions.
- **Inspirational staff**. The staff members currently comprising the Inkomati CMA are generally highly motivated, dynamic and positive.
- **Operational systems not yet in place**. In the Inkomati CMA it is taking time for human resource, finance, and information technology systems to be set up.

1.3.5 CMA internal uncertainties

- **Role of CMAs**. The precise model under which CMAs will function is still being debated.
- **Capacity to discharge mandate**. This may be partly dependent on being able to attract and retain the right kind of people in the right numbers. It may also relate to the difficulties in implementing the National Water Act.
- **Learning partners**. It is uncertain who will emerge as the CMA's learning partners.

1.4 REPORT STRUCTURE

This document is structured as follows:

- **Chapter 2: Organisation learning**. This chapter summarises the literature on organisational learning for ecosystem governance. It describes the evolution of the knowledge movement, the nature of a learning organisation and its learning culture. It also describes knowledge management and how this contributes to commercialisation. The importance of absorptive capacity is also stressed.

- **Chapter 3: Learning philosophy**. This chapter presents a general philosophy and a set of ideals relevant to learning organisations. Underlying assumptions are also presented and the importance of complexity is acknowledged.

- **Chapter 4: Learning priorities**. This chapter presents general priorities for facilitating catchment management agencies to become learning organisations. Based on the ideals presented in Chapter 3, it offers considerations for attracting the right people and for creating the right environment.

- **Chapter 5: Learning strategy for the ICMA**. This chapter presents a first draft of a proposed "learning strategy" that can appear in the Inkomati CMA's catchment management strategy. It is presented within the framework of strategic adaptive management, including adaptive planning and adaptive decision-making.

- **Chapter 6: Encyclopaedia of terms**. This chapter presents a compilation of simplified definitions and explanations of useful terms in alphabetical order. This addresses the need for developing a common understanding of the many terms and concepts in the field of learning and knowledge management.

- **Chapter 7: References**. This list the publications referred to in the text.

CHAPTER 2: ORGANISATIONAL LEARNING

This chapter summarises the literature on organisational learning for ecosystem governance.

2.1 INTRODUCTION

Learning or knowledge creation is a widely studied field with its own concepts and jargon. This chapter provides a summary of the associated literature focussing specifically on how organisations learn. This chapter is supplemented with an encyclopaedia of terms (Chapter 6) in which selected concepts and terms are defined.

2.2 KNOWLEDGE

2.2.1 Evolution of the knowledge movement

Tracing the learning associated with the evolution of the knowledge movement is one way of developing an understanding of how other scholars have viewed knowledge. Different authors have articulated this evolution in different ways, for example Karl-Erik Sveiby's three phases (Sveiby, 2001), Mark McElroy's two generations (McElroy, 2000), and David Snowden's three ages (Snowden, 2002). However, the core messages remain the same. The following is a summary of this evolution.

2.2.1.1 First Generation – Technology-driven efficiency

The 1st generation of the knowledge movement took shape between 1990 and 1995. The information technology (IT) revolution and the Internet started driving change in organisations. The IT solutions and management processes during this time were about reusing existing knowledge and how to avoid re-inventing the wheel. This era is characterised by a focus on information processing with issues such as data warehousing, groupware, document management, imaging, data mining, corporate intranets, and knowledge portals receiving most attention.

Technology enablement and the perceived efficiencies of business process reengineering lead to computerisation of major business applications. This generation is typified by the mantra of reengineering at the time: "*How people and companies did things yesterday doesn't matter to the business reengineer*" (Hammer and Champy, 1993, cited in Snowden, 2002).

The ultimate aims were to codify and store knowledge and to protect intellectual property. The idea that knowledge could be "managed" enthused managers and consultants around the world and the terms "Knowledge Management" and "Intellectual Capital" rapidly gained popularity. Both were seen primarily as means to increase efficiency. Knowledge management was "hijacked" by the IT vendors and intellectual capital was construed as a way of measuring intangibles and publishing information in Annual Reports.

2.2.1.2 Second Generation – Disillusionment and transition

During the second half of the 1990s a degree of disillusionment set in. Managers started to realise that their organisations might have achieved efficiencies at the cost of effectiveness. Many organisations had laid off people with experience or natural talents vital to their organisations but of which these organisations had been unaware. They started to recognise that experience, natural talents and certain skills were vital to sound business. However, these assets or capabilities could not be captured or stored. They resided only in humans.

Malhotra (1997) stated that most IT-enabled knowledge management approaches are based on a static notion of knowledge (i.e. knowledge in an explicit form) while disregarding how people actually go about acquiring, sharing and creating new knowledge. A techno-centric conceptualisation of knowledge gives little attention to the human aspects of knowledge creation, including:

- The dynamic and continuously evolving nature of knowledge which is largely a function of human imagination and creativity;
- The tacit dimensions of knowledge creation, which is deeply rooted in an individual's action and experience, ideals, values and emotions (after Nonaka and Takeuchi, 1995) – and its nature renders it highly personal and difficult to formalise and to communicate;
- The subjective, interpretative and meaning-making bases of knowledge creation, where the ability to share metaphors, analogies, and stories through multimedia technologies offer some representation and communication of meaning; and
- The processes of continuous learning and unlearning.

The work of Nonaka and Takeuchi (1995) played an important role in facilitating the transition between 2nd and 3rd generation knowledge paradigms. They distinguished between tacit and explicit knowledge and described four conversions that take place between these two knowledge forms. These conversions (socialisation, externalisation, combination and internalisation – referred to as the SECI model) are seen as critical to the knowledge creation process. These were defined as follows (Nonaka *et al.*, 2001):

- **Socialisation** (transferring tacit knowledge in one to tacit knowledge in another). Since tacit knowledge is context specific and difficult to formalise, transferring tacit knowledge requires sharing the same experience through joint activities such as being together, spending time or living in the same environment. A typical example of socialisation is traditional apprenticeship.
- **Externalisation** (articulating tacit knowledge into explicit knowledge). Through externalisation, tacit knowledge is translated and expressed in such forms as metaphors, concepts, hypotheses, diagrams, models, or prototypes so that it can be understood by others. These expressions are often inadequate and inconsistent leaving "gaps" between mental images and expressions.
- **Combination** (converging explicit knowledge into more complex and systematic explicit knowledge). Reconfiguration of existing explicit knowledge through sorting, adding, combining and categorisation can create new explicit knowledge.
- **Internalisation** (embodying explicit knowledge into tacit knowledge). Internalisation is closely related to learning by doing. When knowledge is internalised into individuals' tacit knowledge bases in the form of shared mental models or technical know-how, it becomes valuable assets. This tacit knowledge accumulated at the individual level is in turn shared with others through socialisation, setting off a new spiral of knowledge creation.

Nonaka and Takeuchi (1995) described how tacit knowledge is rendered explicit *to the degree necessary* to enable a manufacturing process to take place. Whether intended or not, popular interpretation of Nonaka and Takeuchi's conversion model was that tacit knowledge can be translated into explicit form (through externalisation) without loss. In reality, although some tacit knowledge can be captured in explicit form, the rich contexts of tacit knowledge remain tacit.

2.2.1.3 Third Generation – People are key

The 3rd generation of the knowledge movement is currently under way characterised by a move away from the notions of owning, storing or managing knowledge. The central theme that is emerging around effective "management" of knowledge is to understand the importance of people as organisational assets. There is a return to the human and social side of knowledge creation and innovation. Efficiency is not enough. The real value for corporations and society will be generated through creating environments that enable all people to create, absorb, share, transform and utilise knowledge.

A 3rd generation knowledge paradigm is people-centric. It emphasises the importance of informal communities for knowledge sharing and conversion processes. This generation draws extensively from the fields of organisational learning and learning theory (for increased learning performance) as well as complexity theory and in particular complex adaptive systems. These help to understand the relationship between creativity and order as well as complexity and chaos. They also help explore self-emergence of new capabilities and competencies. David Snowden provides three heuristics to illustrate the change in thinking required to shift from the 2nd to the 3rd generation (Snowden, 2002):

- **Knowledge can only be volunteered; it cannot be conscripted**. We can never truly know to what extent someone is using his or her knowledge. It depends on social relations in the group since imparting with knowledge cannot be forced.
- **We can always know more than we can tell, and we will always tell more than we can write down**. We are capable of knowing more than we have the conceptual ability to say; and the process of writing down involves both adding and taking away from the actual experience or original thought. The resulting "reflective knowledge" has high value but is time consuming and involves loss of control over its subsequent use.
- **We only know what we know when we need to know it**. Human knowledge is deeply contextual; it is triggered by circumstance.

Von Krogh et al. (2000) spell out an approach to "unlock the mystery of tacit knowledge and release the power of innovation". Implicit in this approach are the following principles (also see Von Krogh et al. (2001) on "bringing care into knowledge development"):

- Support knowledge creation, do not control it.
- Support knowledge enabling conditions, not Knowledge Management.
- Emphasise relationships and conversation building.
- Recognise a caring environment that accepts emotional knowledge and playfulness.
- Identify knowledge enablers and steps (activities) associated with facilitating knowledge enabling within an organisation.
- Recognise the importance of knowledge communities, which differ significantly from organisational teams.
- Have a set of specific principles or assumptions about what knowledge is and how it can be enabled.
- Have everyone in the organisation knowledge-focussed, not only management and the technical elite. This idea has important implications for organisational structure, management style and human resource planning.
- Management needs to understand what knowledge is and appreciate its various theoretical and philosophical underpinnings and allow these to inform their management behaviour.
- Recognise the idea of space in which knowledge enabling has its home in the people working in that space.

Quotations from Von Krogh et al. (2000)

"The fragility of knowledge creation means that it must be carefully supported by a number of activities that enable it to happen in spite of the obstacles."

"The creation of knowledge is not simply a compilation of facts but a uniquely human process that cannot be reduced or easily replicated."

"Good conversations are the cradle of social knowledge in any organisation."

"The whole process of knowledge creation depends on sensitive and aware managers who encourage a social setting in which knowledge continues to grow."

"Knowledge is globalized through re-creation—not mere imitation—at the local level."

2.2.2 Information and knowledge

In order to fully understand the context of 3rd generation knowledge management, we must discriminate between information and knowledge. There has been no shortage of authors providing their own definitions of these terms. In general, the definitions of information tend to be more uniform and less complex than the definitions of knowledge. Information is commonly defined as: organised data; data endowed with relevance and purpose; interpreted data (e.g. Drucker, 2001). These definitions are similar to many others which suggest that information includes human participation in the purposeful organisation of raw data.

Definitions of knowledge are generally more complex. For example Davenport and Prusak (1997) define knowledge as a mix of fluid experiences, values, contextual information and intuition that provides a structure to evaluate and incorporate new experiences and information. Knowledge originates and is applied in the minds of individuals. This is further enriched by definitions such as: true and justified belief (Nonaka and Takeuchi, 1995); a capacity to act (Sveiby, 1997); the capacity to act effectively (Dawson, 2000); an active process of relating (Stacy, 2001); a state of knowing (Allee, 2003); the capacity for informed action (Roy Page-Shipp, CSIR, personal communication, 2003).

The relationship between information and knowledge is aptly captured by Miller and Morris (1999). They state that knowledge comes about through the integration of information derived from data, plus theory that puts the information in context, plus experience of how things work in the real world. **Figure 1** illustrates this although feedback loops are also likely to exist.

This process of integration is also called learning. Learning theory suggests that to grasp the critical tacit dimensions in any domain of knowledge, one must have actual experience of practice in the field. New effective competencies cannot be developed simply by reading instruction manuals. Time must be invested to understand new technologies, and to improve our understanding and increase the clarity around new concepts (Miller and Morris, 1999).

Based on our experiences, we form internal representations of the world. These representations or mental models are critical to understanding our environment and guide how we think and act in order to achieve our objectives (Dawson, 2000). Johnson-Laird (1983) wrote:

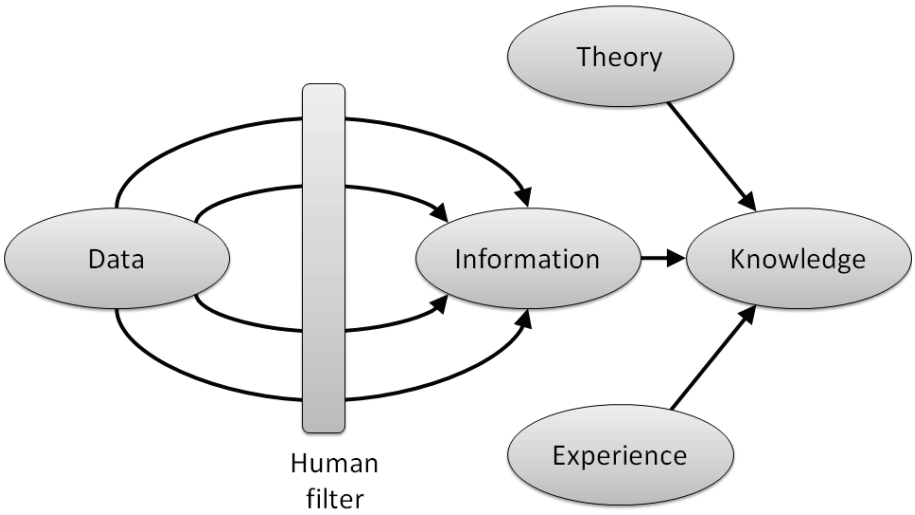


Figure 1 : The relationship between data, information and knowledge.

"*If you know what causes a phenomenon, what results from it, how to influence, control, initiate or prevent it, how it relates to others' states of affairs or how it resembles them, how to predict its onset and course, what it's internal or underlying 'structure' is, then to some extent you understand it. This psychological core of understanding, I shall assume, consists of your having a 'working model' of the phenomenon in your mind.*"

In knowledge management, the externalisation or writing down of knowledge is often referred to as codification. Knowledge which is tacitly possessed is codified or made explicit in the form of numbers, words and equations. In this form, knowledge can relatively easily become part of organisational artefacts (tools, documents, procedures, etc.), and can be transferred and "owned" by individuals and organisations. Strictly speaking, the written form does not represent knowledge but information. It becomes knowledge when an individual interprets and internalises the information. However, identical information will always provoke different meanings for different individuals since our interests, motivations, beliefs, attitudes, feelings, experience, and sense of relevance are always personal and changing.

We acknowledge that both information and knowledge are crucial organisational assets. Furthermore, due to the differences in their respective natures, these concepts require different strategies for leveraging them in an organisational context. For the purpose of this report, we view information and explicit knowledge as synonymous.

2.2.3 Knowledge for decision making

"*Quality of life depends on what happens in the space between stimulus and response*"
(Covey et al., 1994)

Snowden (2002) proposed the sense-making framework illustrated in **Figure 2**. It suggests that different knowledge (theory, information and experience) may be required when operating in different decision-making domains. Each of the four domains contains a different model of community behaviour, each requiring a different form of management and management style:

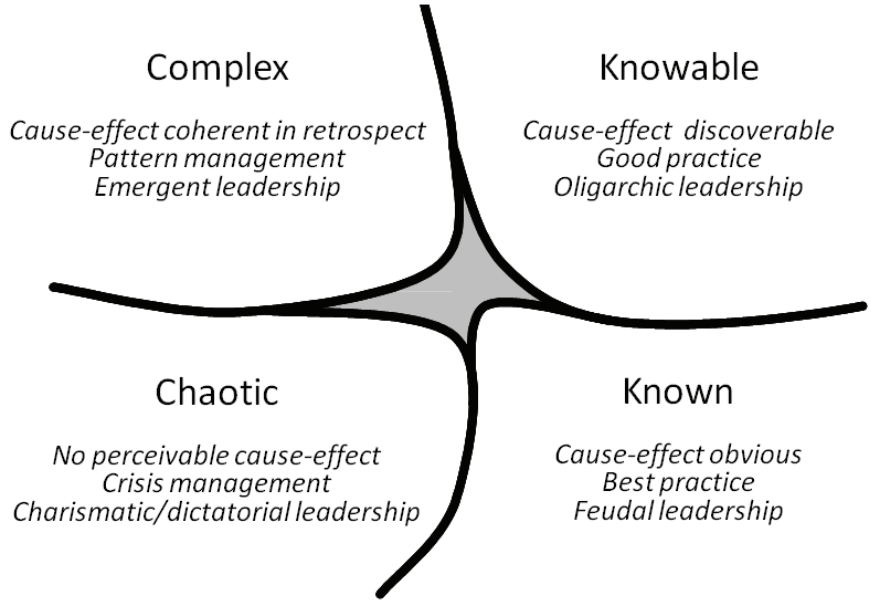


Figure 2 : Snowden's (2002) four decision-making domains.

2.2.3.1 Known domain

In the known domain, cause and effect relationships are generally predictable, linear and not open for dispute. Within known limits we can both predict and prescribe behaviour. A best practice approach can be applied to execute mostly routine functions, with a focus on incremental improvement of efficiency.

The appropriate decision model is to *categorise* incoming stimuli and then to *respond* in accordance with pre-determined practice. This is the domain of bureaucracies where structured techniques and routines are not only desirable but mandatory. Leadership tends to a feudal model, with budget having replaced land as the controlling mechanism.

2.2.3.2 Knowable domain

While relatively stable cause and effect relationships exist in the knowable domain, they may not be fully known or they may be known only by a limited group. Cause and effect are generally separated over time and space and therefore difficult to fully understand. However, with sufficient investment of time and effort, everything in this domain can potentially move to the known domain. In the absence of full understanding, we rely on good practice and expert judgement to advise decision makers.

The relevant decision model is to *sense* incoming data, *analyse* that data and then *respond* in accordance with expert advice or interpretation of the analysis. Entrained thinking patterns pose a risk since a simple error in an assumption may lead to a false conclusion. The leadership style is oligarchic (meaning lead by a small group), for example, requiring consent of the elders of the community.

2.2.3.3 Complex domain

In the complex domain, cause and effect relationships are only coherent in retrospect. The self organising patterns that emerge through the interactions of many agents can be perceived but not predicted. Surprise is the order of the day since expert opinion that is based on historically stable patterns of meaning is insufficient to prepare us to recognise and act upon unexpected patterns. A possible management strategy is to identify the early signs of patterns forming, both within and

beyond conventional conceptual boundaries, and then to disrupt undesirable patterns while stabilising desirable patterns.

The relevant decision model is to *probe* in order to make patterns or potential patterns more visible, to *sense* those patterns and to *respond* accordingly. Leadership cannot be imposed in this domain; it is emergent based on natural authority and respect. The leadership style is matriarchal or patriarchal rather than democratic.

2.2.3.4 Chaotic domain

No cause and effect relationships can be perceived in this highly turbulent domain. There is nothing to analyse and no time to wait for patterns to emerge. Crisis management is required.

The relevant decision model is to *act*, quickly and decisively, to reduce the turbulence; and then to *sense* the reaction to the action (intervention) so that we can *respond* accordingly. Leadership in this space is based on power that imposes order, either the power of tyranny or of charisma.

2.3 LEARNING

2.3.1 Learning as a social process

> *"The formalisation of organisational systems is successful to the extent that it enables informal systems"*
> (Etienne Wenger).

Although learning in a cognitive sense essentially takes place at the level of an individual, most learning takes place in a social context and is socially mediated (Brown, 1988; Kim, 1993). In fact, sustainable well-being within social systems (and especially within linked social-ecological systems) ultimately depends on our capacity to learn together about, and respond to, changing circumstances (Keen et al., 2005). Social learning is a broad term that refers to processes of learning and change in individuals as well as in social systems. This includes learning through observation of others, particularly role models (Bandura, 1977) and learning through participation (Wenger, 1998) involving active engagement within a group.

A rich type of knowledge-based relationship is one in which two or more parties create knowledge together. Knowledge co-creation is particularly relevant in situations where neither party has an answer or solution to the question or problem at stake, but by working together they are more likely to create the required knowledge (Dawson, 2000). Co-creation of knowledge with a partner depends on a high degree of trust, which is likely to be generated through previous interaction. Both parties allocate resources to the knowledge creation initiative or project, with the expectation that the initiative will generate valuable knowledge (although care should be taken to maintain a certain openness). At least one of the parties must have process knowledge of how to facilitate effective collaboration and both or all parties should ideally contribute content knowledge. Where both parties contribute content knowledge, the collaboration is characterised by a peer-level relationship as opposed to one partner being the knowledge "superior" as is often the case in a provider-purchaser relationship (Dawson, 2000; also see Nkhata et al., 2008).

The degree of knowledge equity between partners, existing power relations and levels of trust, as well as the prevailing culture regarding the free sharing of knowledge, are important considerations that should guide the nature and time frame of the venture. Ideally, one of the organisations should take primary responsibility for facilitation of the co-creation process. This facilitation is a very high-level skill, part of which is finding the delicate balance between directing the process and allowing (and even creating space for) spontaneous emergence of ideas, relationships and

knowledge combinations. Various tools and concepts, such as brainstorming (Sutton and Hargadon, 1996) and communities of practice (Wenger *et al*., 2002) can be used to facilitate the process of knowledge co-creation.

A "community of practice" is a form of group learning that relies on voluntary participation and synergy via a shared passion (Snyder and Wenger, 2004) and via the realisation of interdependence (Pahl-Wostl and Hare, 2004). These communities constitute networks of inclusive relationships in which people feel valued when they share their knowledge and are not bound by organisational affiliations (Wenger, 2000). A community of practice has three basic dimensions:

- The domain (the community's interest);
- The community (the people involved); and
- The practice (what the community does together) (Snyder and Wenger, 2004).

Communities of practice continuously create opportunities for enhanced innovation, for influencing their own mental models and making durable decisions. Although the strong self-regulating properties of communities of practice must be respected, much can be done by public sector organisations to enable their emergence and support their functioning (Wenger, 2004).

2.3.2 The learning organisation

Easterby-Smith (1997) distinguished between *organisational learning* and *learning organisations* by noting that the learning organisation represents an applied branch of the more empirical field of organisational learning. Organisational learning is shaped by a number of distinct disciplines and sub-disciplines, such as psychology, organisational development, management science, sociology and cultural anthropology. Whereas studies in organisational learning tend to focus on conceptual understanding of the learning process, writings on the learning organisation are mostly concerned with achievement of a desirable end state (Easterby-Smith, 1997).

This project has to consider contributions from both the above fields. However, since the project has an applied focus, it is important to define what is meant by a learning organisation. Peter Senge defined learning organisations as places "*where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together*" (Senge, 1990). More recently, Senge simply said that a learning organisation is "*an organisation that is continually expanding its capacity to create its future*" (Senge, 2006). Nonaka and Takeuchi (1995) use a third term, namely *the knowledge creating company*, to describe places where inventing new knowledge is not a specialised activity but a way of being and where everyone is a knowledge worker.

Garvin (1993) suggests that the above definitions are too abstract to guide practical application in organisations. He proposes that a learning organisation is "*an organisation skilled at creating, acquiring, and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insights*." These organisations actively manage the learning process to ensure that it occurs by design rather than by chance. Such management would include the measurement or auditing of the organisation's level of learning proficiency, as well as to develop operational interventions or a strategy for improving learning in practice. It is also important that appropriate new knowledge is learned, particularly in public service agencies.

According to Garvin (1993), learning in an organisation can be traced through three overlapping phases:

- **Phase 1 – Cognitive**: Members of the organisation are exposed to new ideas, expand their knowledge, and begin to think differently.

- **Phase 2 – Behavioural**: Employees begin to internalise new knowledge and alter their behaviour.
- **Phase 3 – Performance improvement**: Changes in behaviour lead to measurable improvements in results or outcomes.

2.3.3 Learning culture

> *"It is fashionable to talk about learning organisations, but it is less clear how such organisations should be structured to encourage communication, thinking and risk taking. It has been suggested that an organisation can be either efficient or innovative, but it is rare to find both characteristics in one organisation. This has to do with the isolation of knowledge within sub-units and with organisational attitudes to risk taking. Learning organisations need to be able to acquire and create new knowledge, to retain and transfer knowledge and to modify its own agendas and processes in the light of new knowledge. Innovation requires a culture that says there is always a better way if only we can find it."*
> (Cullen et al., 2001).

2.3.3.1 The nature of culture

Culture – the mere word brings a multitude of associations. A central concept in anthropology, it is endowed with a turbulent and divisional past. With the beginning of the nineties a new school of thought intimately linking cognitive processes and the negotiation of meaning in cultural groups started to enjoy popularity. With one foot treading on the traditional domain of psychology and the other one on anthropology, theories about culture united with theories about learning mechanisms to explain how meaning is negotiated within the limits of human cognition (see for example D'Andrade, 1995; Strauss and Quinn, 1997).

Based on such theories culture can be seen as systems and patterns of shared understandings; "unconscious agreements between members of social groups on how the world works and how to feel about it" (Drackner, 2004). It is "*the systems of signification by which we negotiate meaning and create local interpretations in various practices*" (Wenger, 2004). Culture conjures an illusion of stability, a reification (i.e. making an abstract concept real or concrete) of self-defining characteristics. In reality it is no such thing, "[it] …*is always undergoing maintenance work, repair, construction and reconstruction*" (Hannerz, 1982). Culture consists of *unquestioned knowledge*. As such culture represents the *natural way* of viewing, interpreting and classifying the world around us.

Cultural understandings establish, disappear and modify themselves through a process of negotiation with the outside world and the people in it. Cultural understandings in our heads are thus constantly tested and used on the wider context that surrounds us. The match, or the mismatch, between these two realms determines whether or not cultural understandings will be adapted, reconfirmed, discarded or simply remain untouched. The negotiation process works as a feedback loop; what belongs to the wider context is shaped by how understandings are externalised, and what people internalise in the form of understandings is duly determined by how and what is experienced in the surroundings (see for example Shore, 1996).

Cultural groups define themselves through their *identities*, which are highly fluid depending on the context in which they are embedded. "*Identity is about where one feels one belongs and develops in the interplay between the internal and external categorisation of the group and one's own feelings of connectedness. As such, identities are social constructions deriving their logic from the context in which they are embedded*" (Drackner, 2004). We enact different identities in different situations. As members of a group, "*individuals associate themselves with the group's social*

identity, which consists of a set of mutual understandings regarding the characteristics that distinguish them from non-members" (Rowley and Moldoveanu, 2003).

Culture manifests through norms (including conventions and customs), which are standard or ideal behaviours typical of a human group, often supported by legal or other sanctions. Individuals can either conform or not conform to these norms, and such heterogeneity in degree of conformance is important to how norms evolve (Ehrlich and Levin, 2005). Central to the evolution of norms is the question of how norms spread. It is thought that "*the spread (or not) of norms shares important characteristics with epidemic diseases*" and that "*norms spread through infectious transfer mediated by webs of contact and influence*" (Ehrlich and Levin, 2005).

2.3.3.2 The paradox of culture

It is clear that in order to understand cultural dynamics we must first understand what Lakomski (2001) calls the "paradox of culture"; a specific characteristic that makes cultural understandings highly resistant to change in certain contexts yet very changeable in others. Knowledge, based on experience, and in the form of cultural understandings provides us with a plan (capacity for action) for most unfamiliar situations we might encounter. Culture provides us with the tools to undertake complex tasks and situations that look unintelligible to an outsider (see Hollinshead, 2002); only the members of the cultural group can make sense of the signals, processes and vocabularies needed to complete the task effectively.

Once negotiated, little is needed to solve the next similar task unless the context in which it takes place is also changing. A situation where context and culture have been in a reaffirming relationship for a long time, a strong and shared understanding of how to make sense out of the world will have developed. Things are done routinely with little reflection as to why, even thinking and interpretation. The downside of such "safe operation" brings about certain "…*liabilities [which] include stereotypic thinking, poorly controlled information processing, inaccurate filling of data gaps, the rejection of apparently discrepant but important information, a refusal to disconfirm cherished hypotheses, and the inhibition of creative problem solving*" (Hodgkinson, 2003).

Stabilised and routinely undertaken production is all very well in the industrial mode of production, but rarely so in a knowledge organisation where the prime assets for creating a competitive advantage reside in the creativity of its people. Strongly guarded understandings might mean the loss of a competitive advantage, due to the lack of ability to change according to the circumstances. Such a culture of inadaptability should be highly discouraged in a knowledge organisation. The desired cultural traits are instead those which:

- Appreciate change as the order of the day,
- Represent it as a challenge, not a threat, and which
- Produce an air of naturalness over new experiences.

2.3.3.3 Facilitating a knowledge culture

Culture is neither managed nor controlled. In fact, there is so much uncertainty in dealing with cultural outcomes that it is neither worthwhile nor ethical to try. Cultural change must be *grown*, and it must be grown by introducing contextual space where it can grow. In such a culture, knowledge is shared, volunteered, and produced interactively. It also entails a will to discover new things and relationships and to not necessarily see change as a bad thing.

For Fichman (2003), trust is a relationship of both risk and interdependence. It has its basis in an expectation of positive responses from the one that enjoys trust to the trusting party. Trust is often a premise to overcome the vulnerability felt in uncomfortable situations, such as those typically needed in an innovation environment. Rosseau et al. (1998) (as quoted in Fichman, 2003) define trust as "*a psychological state compromising the intention to accept vulnerability based upon positive expectations of the intentions or behaviour of another*".

Trust is established when there is a transparency of rules – where cause and effect in the social environment are clearly visible. A work environment characterised by trust is an environment which exhibits low risks in times of personal exposure, making it cognitively and emotionally easier to adapt to changing circumstances or to commit to risky positions or actions.

Concepts related to the nurturing of a knowledge culture include:

- **Shared visions and goals**. In this case shared visions and goals do not entail concepts forced upon subordinates by management. Rather it is the expression of a collaborative will coming from inside the working group. The benefits of collaborative shaping of focus lie in each person's subsequent actions and behaviours. When employees themselves clarify the focus of the organisation, they gain more than a sense of direction and a means to define their code of conduct. The process helps them develop the appropriate will. This is because each person will be motivated to act in accordance with the role-related responsibilities they have defined for themselves. (Smith and Sharma, 2002).
- **Establishing a good track record**. If changing conditions in the past have largely turned out to have negative consequences for employees, it is likely that new initiatives will be battling with preconceived resistance. A community's ability to handle a changing environment then becomes strongly linked to their experience of uncertainty, either positive or negative. A long term knowledge management goal should therefore be to successively build on their track record of positive outcomes. In other words the success of knowledge practices will very much be dependent on the success of similar practices in the past.
- **The right people**. We often hear "people are our biggest asset" but this is seldom more than an empty phrase. This is unfortunate because it is very true. The right people forming the right groups are probably the most important factor in a knowledge-facilitating context. This shouldn't be mistaken for a call for homogeneity – quite the opposite. A knowledge environment, especially in innovation, will greatly benefit from diversity, as long as it can be harnessed. However if people are unable to negotiate a working reality they feel comfortable and secure within, the competitive advantage of having the right individuals will be lost. It is furthermore important to realise that the right people are not always those with the most technical skills (although this is certainly needed to achieve excellence). Consideration has also to be given to their personalities and how they fit within a larger group. Not all people are comfortable within a knowledge culture.
- **Appropriate leadership and guidance**. Knowledge leadership is described by Viitala (2004) as "*a process whereby an individual supports other group members in learning processes needed to attain group or organisational goals*". According to Viitala (2004), the roles of leaders in learning organisations have in the literature been characterised as coaches, facilitators, teachers, leaders of learning, and developers. Such roles are very different from the roles traditionally played by leaders in a command-and-control organisation. The knowledge leader should be facilitating a context where people can be allowed to discover and grow by themselves.

2.3.4 Learning for change

> *"It is important to remember that we cannot become what we need to be by remaining who we are" (*De Pree, 1989).

The following is taken largely from Schein (1995).

Organisations are traditionally designed for knowing and applying what they know rather than learning. The ability to develop the right new organisational capabilities is done through learning and changing our behaviour as a result. Human change, whether at the individual or group level, involves painful unlearning (without loss of ego or identity) and difficult relearning (as one cognitively attempts to restructure one's thoughts, feelings, perceptions and attitudes). Learning

and change is based on a continuous cycle of unfreezing, changing, and refreezing. The starting point of a new cycle is when there is some dissatisfaction or frustration, generated by data that disconfirm our expectations or hopes. The disconfirmation must arouse "survival anxiety" or the feeling that if we do not change we will fail to meet our needs or fail to achieve some goals or ideals that we have set for ourselves ("survival guilt").

In order to feel survival anxiety or guilt, we must accept the disconfirming data as valid and relevant. What typically prevents us from doing so, what causes us to react defensively, is a second kind of anxiety which we can call "learning anxiety". Learning anxiety is the feeling that if we allow ourselves to enter a learning or change process, if we admit to ourselves and others that something is wrong or imperfect, we will lose our effectiveness, our self-esteem and maybe even our identity. Learning anxiety is the fundamental restraining force which can increase in direct proportion to the amount of disconfirmation. This leads to the maintenance of the equilibrium by defensive avoidance of the disconfirming information. Therefore, the key to stimulating and navigating change is to deal with learning anxiety.

Unless sufficient *psychological safety* is created, the disconfirming information will be denied or refuted in other ways. No survival anxiety will be felt and, consequently, no change will take place. It follows that the key to effective change management is the ability to balance the amount of threat produced by disconfirming data with enough psychological safety to allow and assist people to acknowledge and internalize the credibility and relevance of new information, feel the survival anxiety, and become motivated to change.

If one is motivated to change, one may be able to "hear" or "see" something from a new perspective. This takes place through a process of cognitive restructuring that results in one or more of the following outcomes:

- **Semantic redefinition**. We learn that words can mean something different from what we had assumed.
- **Cognitive broadening**. We learn that a given concept can be much more broadly interpreted than that we had assumed.
- **New standards of judgement or evaluation**. We learn that the anchors we used for judgement and comparison are not absolute and if we use a different anchor or scale, our scale of judgement shifts.

While unfreezing creates a motivation to learn, it does not necessarily control or predict the direction of learning. A key element of a managed change process is the kind of role models one makes available to learners once they are unfrozen. When no good role models are available or when it is desirable to have genuinely creative learning, an option is to create the conditions for "scanning". Scanning is when the learner searches or scans by reading, travelling, talking to people, hiring consultants, or going back to school, to expose him or herself to a variety of new information that might reveal a solution to a problem or an insight in a new area of endeavour. Alternatively, when the learner feels psychologically safe, he or she may experience spontaneously an insight that spells out the solution. This is a most desirable outcome because of the assumption that the most stable solution will be the one that the learner has invented for him or herself.

For change to remain stable it must be refrozen. New behaviour of the learner must to some degree be congruent with the rest of the behaviour and personality of the learner or it will simply set off new rounds of disconfirmation that may lead to unlearning the very thing that one has just learned. An example where refreezing will be futile is when a supervisory programme teaches individual supervisors how to empower employees and then sends them back to an organisation where the culture supports only autocratic supervisory behaviour. In fact, for personal refreezing to occur, it is best to avoid role model identification and encourage scanning so that the learner will pick solutions that will fit him or her. For relational refreezing to occur, it is best to train an entire group that holds the norms that support the old behaviour. The group must collectively arrive at a new set of standards or norms that would guide their future behaviour.

2.4 KNOWLEDGE MANAGEMENT

2.4.1 The knowledge worker

Knowledge work refers to non-repetitive and non-routine work that entails substantial levels of cognitive activity. It involves analysing information and applying specialised expertise to solve problems, generate ideas, anticipate trends, teach others, or create new products or services (Drucker, 1993). Knowledge work frequently results in the creation of new information and knowledge. Thinking, reflection and learning are integral to knowledge work.

The knowledge worker is someone who works both practically and with theoretical knowledge. Knowledge workers acquire and use theoretical and analytical knowledge in highly sophisticated ways, as well as develop significant physical or manual skills. The training of the knowledge worker often involves formal education and cannot always solely be obtained through on-the-job training or apprenticeship. Due to the rapidly changing nature of information and knowledge, knowledge workers must be committed to and skilled in the habit of continuous learning (Sorrells-Jones and Weaver, 1999).

The interdependent nature of knowledge work implies that knowledge workers can only be successful through working together. This gave rise to the concept of a knowledge work team, which comprises a small number of people with complementary knowledge and skills, who recognise their interdependency, are committed to a common purpose, and hold each other and themselves mutually accountable (Sorrells-Jones and Weaver, 1999).

Knowledge workers with technical backgrounds (e.g. science and engineering) share a number of general characteristics. These technical professionals join a company because it provides an environment in which they can practice their vocation together. They are likely to adhere to standards of conduct set by their profession rather than by the company. They may aspire to recognition in their technical field rather than by the company directors. These professional people publish in the scientific literature, appear at conferences and can win Nobel prizes. They can potentially determine the futures of their companies (Lock, 1998).

Scientists and engineers are trained in their technical disciplines but almost never in the management of their own professional activities. A high proportion of these technical professionals have post graduate degrees, which implies a deep understanding of a particular technical field. They usually have little managerial training and often have an antipathy to management (Lock, 1998).

Technical professionals can vary markedly in their innovative ability. A very small proportion is highly creative and greatly outperforms their colleagues in discoveries and inventions made. For some reason, these people often have personalities that antagonise their less able peers and their managers. Directing talent provides management's greatest challenge in a technically-based company (Lock, 1998).

It is a myth that scientists become exhausted from overwork at an early age. It is more likely that they need to be mature before they can advance to work on the most significant problems. There is a trend for people to start in research and development (R&D) when young and then either move out to other functions or move up to an R&D management function, at which point they cease to be productive in an R&D context.

A perception is that it is rare for individuals in R&D to be very well paid, in the way that individual lawyers or managers can be. For this reason even very good R&D people tend to become dissatisfied and move towards other work. Some companies provide a dual career structure that allows the technically able to advance without assuming management responsibilities, but this is rarely implemented effectively.

2.4.2 Knowledge-intensive organisations

Within a knowledge paradigm, people are the only true agents in business. All assets and structures – whether tangible or intangible – are the result of human actions based on intellectual innovation. All depend ultimately on human ingenuity for their continued existence. Knowledge workers are the currency of knowledge intensive organisations. Through working in teams, knowledge, information and data that individuals transmit to each other become shared routines; that is, they are stored in the form of culture, social structure, organisational procedures, traditions, habits and group norms. This constitutes a level above that of the individual, which forms the social context within which individuals live, act and relate to each other. Effective learning and knowledge creation require a critical extent of shared values relating to openness, trust, affirmation, dialogue and empowerment. The effectiveness of these processes, in turn, require particular forms of leadership that establish values and provide a central vision to guide the learning and knowledge creation process.

Knowledge assets or intellectual capital are terms used to describe an organisation's knowledge worker employees. Intellectual capital has been defined as the sum of everything that everybody in an organisation knows that gives the organisation a competitive edge (Stewart, 1997). This concept provides a basis for accounting employees as assets and not as costs. This is of particular relevance for knowledge-intensive organisations, where knowledge has relatively more importance than tangible assets such as property, equipment and capital. The most important assets for knowledge-intensive organisations are knowledgeable people and applied brainpower (Sorrells-Jones and Weaver, 1999).

The personalisation of capital reframes some of the principles of labour theory. In the industrial or traditional economy, fixed capital, processes and technology owned by organisations provides the basis for value creation and employees are hired as operators. In the knowledge economy, the picture is more complex since knowledge cannot be fully owned by organisations. Knowledge workers view their talents and expertise as personal characteristics and take personal responsibility for developing these to further their professional trajectories. Increasingly, this trajectory is shaped in terms of personal identity and allegiance to their discipline rather than allegiance to the organisation. These workers "own" most of the abilities required for innovation (knowledge creation and conversion, creativity, social integration, relationships). When a knowledge worker leaves an organisation, the organisation loses some of its core abilities.

Sveiby (2001) recognised that management approaches that work in industrial settings are not necessarily appropriate for knowledge-intensive organisations, as illustrated in **Table 1**.

Accordingly, Sveiby (2001) listed the following challenges for knowledge-focussed managers:

- How do you stay in control when the primary production factor, namely creativity of staff, flourishes best when you do not control it?
- How do you exercise power when your hierarchical position in the organisation becomes irrelevant and the Internet and peer networks dictate the flow of information – the relative level of knowledge becomes the only power base?
- How do you motivate your people when the knowledge workers value the accord of their professional peers more than the approval of their leaders?
- How do you know that you are on the right track when the management information system does not report knowledge flows?

Table 1 : Contrasting perspectives under industrial and knowledge paradigms.

Item	Industrial paradigm	Knowledge paradigm
People	Cost generators or resources	Revenue generators
Managers' power base	Relative level in organisation's hierarchy	Relative level of knowledge
Power struggle	Physical labourers versus capitalists	Knowledge workers versus managers
Main task of management	Supervising subordinates	Supporting colleagues
Information	Control instrument	Tool for communication, resource
Production	Physical labourers processing physical resources to create tangible products	Knowledge workers converting knowledge into intangible structures
Information flow	Via organisational hierarchy	Via collegial networks
Primary form of revenues	Tangible (money)	Intangible (learning, new ideas, new customers, R&D)
Production bottlenecks	Financial capital and human skills	Time and knowledge
Manifestation of production	Tangible products (hardware)	Intangible structures (concepts and software)
Production flow	Machine-driven, sequential	Idea-driven, chaotic
Effect of size	Economy of scale in production process	Economy of scope of networks
Customer relations	One way via markets	Interactive via personal networks
Knowledge	A tool or resource among others	The focus of business
Purpose of learning	Application of new tools	Creation of new assets
Stock market values	Driven by tangible assets	Driven by intangible assets
Economy	Of diminishing returns	Of both increasing and diminishing returns

In most knowledge-intensive organisations, a misalignment commonly exists between representatives from two broad knowledge cultures, namely the "knowledge professional" and the "company worker or organisational bureaucrat". Within this context, the organisation employs four major players: the professional (or knowledge worker), the manager, the support staff, and the leader; where (Sveiby, 1997):

- A leader changes, a manager preserves.
- Some managers are leaders, but most probably are not.
- Leaders are important people in a knowledge organisation, and there are often more than one.
- The most highly skilled professionals – the experts – are the genuine income generators.
- Experts are characterised by a dedication to their jobs and their professions, a love of solving problems, and a dislike of routine.
- Leaders are the people whom others want to follow. They are informally appointed by their followers. Leadership involves two tasks: deciding where the organisation should go and persuading others to follow. The most successful leaders of knowledge organisations are usually former experts, but they are rarely the most outstanding experts.
- Professionals work hard and are often plagued by anxiety. They have to turn in first-rate creative performances year after year. They often lack employment security, they find it

hard to develop well-rounded personalities, they expose themselves to public criticism, they compete fiercely with one another and are simultaneously required to work in cooperative transdisciplinary knowledge teams, they work in constantly changing organisations, and their worth is judged only by what they produce.

2.4.3 Knowledge management approaches

The following statements reflect general perceptions of knowledge management:

- "… it forms a basis for innovation and underpins effective decision making within modern society" (European Commission, 2004).
- "the ability of an enterprise to capture knowledge and its ability to reuse, re-invent and innovate using that knowledge will become the key determinant and predictor of value" (Gartner Group).
- "We can demonstrate that more successful firms generally have a firmer understanding of knowledge management. They grasp that it requires a holistic approach that goes beyond changes in infrastructure and touches every aspect of a business, transcending divisions, functions, and hierarchies" (Knowledge Unplugged, McKinsey & Company global survey on knowledge management, 2001).

The term knowledge management covers different schools highly divergent in their focus and activities, ranging from university research in philosophy, sociology, psychology and technology to business consulting and industry practice. This means that knowledge management is difficult to define since there are many interpretations. Verna Allee provides a broad definition of knowledge management as "*the facilitation and support of processes for creating, sustaining, sharing, and renewing of organisational knowledge in order to generate economic wealth, create value, or improve performance*" (Allee, 2003).

The goal of knowledge management systems is typically to maximise organisational efficiency. Criteria that are set for successful knowledge management systems include:

- Everyone in the organisation knows where to go to find the organisation's knowledge.
- All individuals are able to use the knowledge in the context that is right for them.
- All knowledge is available and accessible and independent of physical location.
- All knowledge is relevant, current and directed (European Commission, 2004).

Based on a scenario building exercise that IBM undertook for the European Commission, five broad scenarios were identified for knowledge management by 2010, namely (European Commission, 2004; **Figure 3**):

1. Engineering approach;
2. Human-centred approach;
3. Consensus approach;
4. Mathematical complexity; and
5. Social complexity;

The axes in **Figure 3** comprise the following.

- **Design**. This refers to the ability of a leadership group or consultant to stand outside the system and design the system as a whole based on desired outcomes, a gap analysis, etc.
- **Emergence**. In this approach the system cannot be understood or managed as a whole, but only through the dynamic interactions of the agents (people, technology, government, etc.).
- **Rules**. These are based on prescriptive processes that remove ambiguity.

- **Heuristics**. These draw from values and allow a degree of ambiguity.

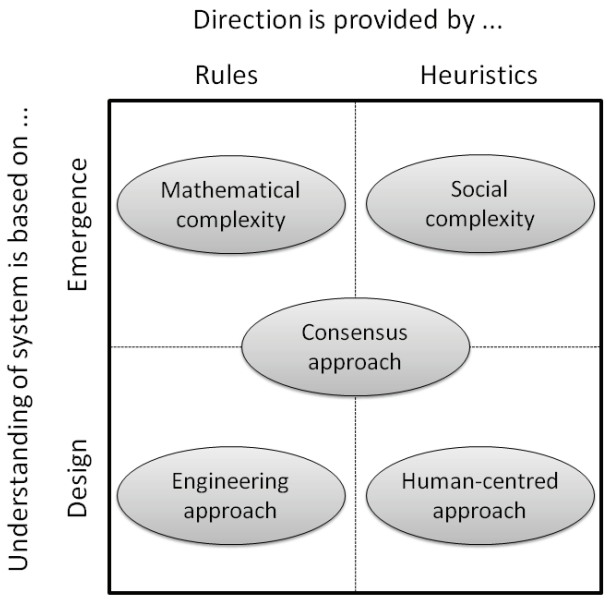


Figure 3 : European Commission knowledge management scenarios for 2010.

The above five scenarios are summarised in the following sub-sections, as developed by IBM for Europe (European Commission, 2004).

2.4.3.1 Engineering approach

The engineering or scientific approach is dominated by technology and modelling. Key words are "predictable" and "simulated". It is based on a strong representational understanding of the world. Everything has a cause or a reason that, given continual scientific development, will be known. Complex issues are interpreted as combinations of the simple. Humans are often viewed as barriers to system success due to their resistance to uncertainty represented by a technological system and to behavioural changes required by the system. Training programmes are used to "homogenise" users – single language, single processes, and single set of standards – to a one system fits all approach.

The Engineering Approach developed rapidly in the United States during the late 80s and early 90s. Development in Europe was much slower due to a perceived risk to innovation, flexibility, and individual freedoms. The Engineering Approach appears to be the dominant paradigm at present. Whilst it will continue to have a central role in knowledge management efforts, it will most likely at least be modified to take more account of human factors.

The first scenario is that, by 2010, the Engineering Approach will have established itself as a hygiene factor in good business management practice, especially in large multi-nationals. Technology will continue to stimulate change by continuously extending the range of possibility and introducing numerous unintended consequences into the system.

2.4.3.2 Human-centred approach

The social system does not accept universality of the engineering approach since the system cannot be conceived as a machine. There is a strong human element which values creativity and inspiration. Humans are part of the system to the core and individual leadership is propagated, representing a form of post-managerialism. People and social interactions form the basis, means and ends of knowledge management programmes within this scenario.

Under this scenario, organisations become more extroverted. Rather than working on internal control mechanisms, organisations are realising the benefits of effective global relationship building. More effort goes into the qualitative aspects of relationships and knowledge creation in support of innovation. Large conglomerate organisations are taking on extremely large global projects to create and disseminate science-based innovations across the spectrum from pharmaceuticals and defence to urban-rural development. Smaller organisations foster international collaboration projects to remain competitive and relevant. In the not-for-profit sector (by 2010 considerably larger than the manufacturing sector in Europe), knowledge management is used for the restoration of meaning and identity in embattled communities ravaged by poverty, disease, war, drugs and other ills. Networks of networks and communities of communities are so well linked that the dominant metaphor by 2010 has become international social integration based on inter-agency collaboration informed by up-to-date intelligence.

2.4.3.3 Consensus approach

The Consensus Approach represents a popularity position on knowledge management. It is characterised by a middle-of-the-road risk-averse strategy that has been adopted by the majority of business organisations and widely documented and taught over the past five years. The label of knowledge management creates enthusiasm (especially among first-time users). However, the largely best-practice methodologies that are being followed (used by most knowledge management vendors) are unlikely to provide competitive advantage largely due to their lack of research background and conceptual robustness.

Products and methods used within this scenario are developed for, and aimed at, large enterprises and as a result are frequently dependent on enterprise-level IT infrastructure operating within organisational firewalls. They frequently prevent inter-organisational networking and do not take cultural diversity and multilingualism into account. They are largely irrelevant to small and medium sized organisations. Due to its tendency to fluctuate between different fashions and the lack of a distinctive conceptual foundation, the Consensus Approach is likely to follow the traditional fad curve of decline.

2.4.3.4 Mathematical complexity

Similar to the engineering or scientific approach, Mathematical Complexity is dominated by a belief in the ultimate success of a predominantly technical approach in predicting and modelling complex situations. By 2010, interdisciplinary contributions from mathematics, language, computing and social science represent a significant intellectual asset. Artificial intelligence and intelligent agent software have found relatively everyday application in business. However, the use of artificial intelligence and agent technology faces specific problems in terms of confidentiality and privacy in Europe. Increasing automation as a result of agent-based tools creates increasing levels of unemployment and becomes a social issue.

2.4.3.5 Social complexity

Similar to the human-centred school, social complexity does not accept the universality of reason and predictability. This provides a contrast with the ordered universe of management science, with its reliance on certainty, rationality, control and linearity. Two important features of this scenario are:

- To understand the role of culture and value of learning, and
- To achieve both inner stability and adaptability. In this sense, organisations are not frantically reacting to environmental changes but become faster in adapting and absorbing changes without it being necessary to change the whole organisation.

By 2010, most organisations have mastered the basics of the engineering and social approaches, and many have incorporated the scientific and technical advances of the mathematical approach.

Some have been able to achieve yet higher results by recognising that purpose develops over time and by exploiting the full potential of the organisation through nurturing the emergence of patterns. This renders the strategy indeterminate in the short term, as it can only be validated in retrospect.

At this time, all strategies contain unknowns and in turn produce unknowns to others. Practitioners have developed noticeable skills in working with emergent phenomena. Knowledge creation is regarded as an active and dynamic process of relating, rather than a static one of storing what is known and abstracted from its use. Knowledge is now seen as volunteered rather than conscripted, to be characteristically spoken rather than written, and to be deeply contextual rather than abstract.

2.5 INNOVATION

2.5.1 Balancing creativity and commercialisation

As companies grow from emerging to mature, there is a natural evolution in the relationship between creativity and commercialisation (Shelton, 2001):

- **Tilt towards the creative**. Emerging companies typically place a higher premium on creativity. Their internal markets are biased towards the radical ideas and breakthroughs that can come from the creative process which can then be used to leverage the young company into a competitive advantage.
- **Balance creative and commercial**. As companies grow and mature, they learn to balance their creative processes with solid commercialisation skills. This is necessary for survival.
- **Focus on the commercial**. As companies continue to mature, the emphasis on commercialisation surpasses the attention to creative markets. The management mantra becomes profitability, asset utilisation, capital management, efficiency, benchmarking, all of which place more value on the commercialisation process.

An ideal balance would involve both excellence in creativity (involving experimentation) and excellence in business (commercial skills) driving organisational planning and strategy processes.

Shelton (2001) lists six steps for balancing creativity and commercialisation in the innovation process:

- **Develop innovation platforms**. This should be done for the different types of innovation the company wants to pursue. Platforms cut across the business unit silos and provide a balanced perspective on the value of an innovation, rather than one limited by the perception of a single business unit. Virtual platforms can cut across existing organisational elements and business units.
- **Create portfolios of the projects in each platform**. Review portfolios to ensure that creative and commercial markets are aligned and balanced. A portfolio that is overly rich in incremental projects signals a weak (internal) market for creative ideas. Companies that persist with this imbalance are likely to die a slow death by using their resources to commercialise improvements that the marketplace does not value. A portfolio that has an overabundance of radical and breakthrough innovations signals a hyperactive creative process and an internal market that discounts commercialisation. Some dot-coms have suffered from overactive creativity and too little commercialisation. This type of unbalanced company typically fails quickly because it never gets enough products into the marketplace and has little market relevance.
- **Form internal and external partnerships**. Internal partners from business and functional units are essential to success. However, top-notch innovations require more “bandwidth” than any one company can supply internally. Therefore, external partnerships with suppliers, strategic partners and customers are equally important.

- **Ensure that markets for creativity and commercialisation are open and transparent**. Closed markets create an air of mistrust and can hide inefficiencies and inequities. Create semi-annual innovation events that provide visibility and total transparency. Make the events open to everybody and highly publicised. Send the signal that value creation via innovation is a vital part of the culture.
- **Guard against organisational antibodies**. These may limit or destroy rejuvenated creative markets and processes. High-level senior executives should be part of an Innovation Board in charge of rejuvenating the creative market. Such visible support is necessary to offset the inherent resistance to change in the established commercialisation market.
- **Create a class of "entrepreneurs"**. They must embrace a full range of creative and commercialisation talents. This class should include venture investors, creative innovators, commercialisation gurus and individuals that function well in both commercialisation and creative markets.

Shelton (2001) also noted various creative (imaginative) and commercialisation ("concept into reality") contexts in the innovation process (**Table 2**).

Table 2 : Balancing of creativity and commercialisation processes in innovation.

Creativity processes	Commercialisation processes
▪ Out-of-box thinking	▪ In-the-box thinking
▪ Raw and refined ideas	▪ Engineering & manufacturing
▪ Experimentation	▪ Precision
▪ Ambiguity / uncertainty	▪ Well-calculated trade-offs
▪ Research	▪ Buying / selling of ideas
▪ Find the right things	▪ Do things right
▪ Ask questions and explore the unknown	▪ Answer questions and verify solutions
▪ Seize opportunities	▪ Avoid major risks
▪ Visualise the future and consider all options	▪ Get the product into the marketplace
▪ Include incremental and radical innovations	▪ Bias for incremental innovation

2.5.2 Absorptive capacity for innovation

Absorptive capacity is the ability of a social or organisational grouping to recognise the value of new, external information and knowledge, assimilate it and exploit it for benefit. It refers to a limit to the rate or quantity of information that can be absorbed and is largely a function of the level of prior related knowledge. This prior knowledge may include basic skills, a shared language or knowledge of the most recent scientific or technical developments in a given field – all of which permit effective communication across boundaries (Cohen and Levinthal, 1990).

In their re-conceptualisation of absorptive capacity, Zahra and George (2002) distinguish between two subsets of related capabilities:

- **Potential absorptive capacity (PAC)**.
  - ***Knowledge acquisition***. This includes an organisation's capability to identify and acquire externally generated knowledge that is critical to a firm's operations.
  - ***Knowledge assimilation***. This includes an organisation's routines and processes that allow it to analyse, process, interpret and understand information obtained from external sources (Szulanski, 1996). This capability incorporates *knowledge dissemination*, or the communication of acquired knowledge to all relevant individuals and departments.

- **Realised absorptive capacity (RAC)**.
  - ***Knowledge transformation***. This includes an organisation's capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge.
  - ***Knowledge exploitation***. This includes an organisation's ability to harvest and incorporate knowledge into its operations and to leverage knowledge to create new competencies or convert knowledge into new products or services. This may happen serendipitously or by means of systematic routines.

Each contributes uniquely to an organisation's competitive advantage. Zahra and George (2002) suggest that the efficiency of innovative organisations relate to the ratio of RAC (knowledge transformation and exploitation) to PAC (knowledge acquisition and assimilation). When RAC approaches PAC, the organisation has high innovation efficiency.

Well-developed capabilities of acquisition and assimilation are necessary to continually revamp an organisation's knowledge stock by spotting trends in the external environment and internalising associated knowledge. PAC makes an organisation *receptive* to external knowledge and provides an organisation with the *strategic flexibility* and degree of freedom to adapt and evolve in high-velocity environments.

Some firms may possess a strong ingenuity to understand complex technical problems but may not necessarily be as effective in translating such knowledge into product innovation strategies. Well-developed capabilities to transform and exploit knowledge (RAC) improve an organisation's capacity to leverage the knowledge that has been absorbed through product and process innovation, i.e. these capabilities improve an organisation's *responsiveness*.

Both subsets of absorptive capacity coexist at all times and each fulfils a necessary but insufficient condition to improve the innovative performance of an organisation. For example, an organisation cannot possibly exploit knowledge before first acquiring it. Similarly, capabilities to acquire and assimilate knowledge are of little use without a capability to exploit the knowledge to generate value (which may be in the form of profit) for the organisation.

Figure 4 presents a model of absorptive capacity comprised of the following concepts:

- **Knowledge sources**. These significantly influence PAC. External knowledge sources include acquisitions, purchasing through licensing and contractual agreements and inter-organisational relationships (including R&D consortia, alliances and joint ventures).

- **Complementarity**. Knowledge complementarity is the extent to which knowledge is related to and at the same time different from the knowledge in the existing system or networks – is positively related to a firm's learning (Lofstrom, 2000 as cited in Zahra and George, 2002). This suggests that the diversity of exposure and the degree of overlap between the knowledge bases of the external source and the organisation can enhance PAC.

- **Experience**. Past experience defines the locus of a firm's technological search, i.e. firms search for information in areas where they have had past successes. Experience is also closely connected to organisational memory – the sum or depository of knowledge in a system at a given time. Thus, a firm's absorptive capacity is a path-dependent capability that is influenced by its past experiences that are internalised as organisational memory. Also, "*experience significantly influences managerial cognition, which determines a firm's ability to manage knowledge*" (Gavetti, 2000 as cited in Zahra and George, 2002).

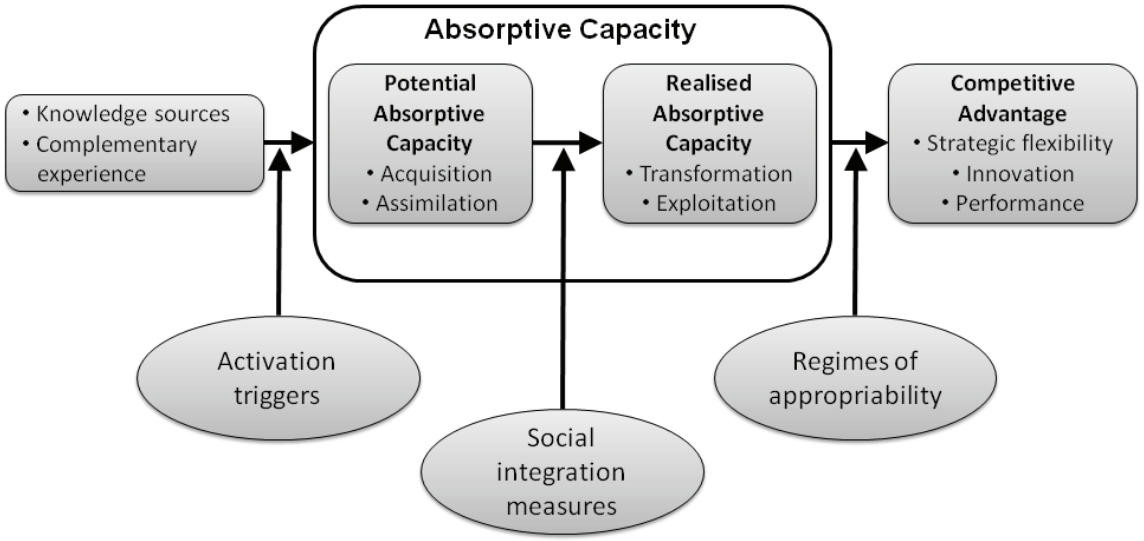


Figure 4 : A model of absorptive capacity.

- **Activation triggers**. These are events that encourage or compel a firm to respond to specific internal or external stimuli.
  - Internal triggers could be in the form of a new CEO with associated changes to internal policies and management styles, or an organisation's strategic re-alignment with its external markets.
  - External triggers are events that may influence the future of the business, industry or sector of concern and may include radical innovations, technological shifts and changes in government policy. Internal and external triggers induce or intensify a firm's efforts to seek external knowledge (Zahra and George, 2002).

- **Exploitation**. Knowledge exploitation requires the sharing of relevant knowledge among members of an organisation to promote mutual understanding and comprehension.

- **Social integration mechanisms**. These can facilitate the sharing and eventual exploitation of knowledge. Such mechanisms may occur informally (e.g. social networks or communities) or formally (e.g. project teams). Effective social integration mechanisms would reduce the gap between PAC and RAC and the overall innovation efficiency. Nahapiet and Ghoshal (1998) (cited in Zahra and George, 2002) suggest that structural, cognitive and relational dimensions of social integration also influence the creation of intellectual capital.

- **Regimes of appropriation**. These reflect the ability to protect the advantages of new products and processes and may affect a firm's sustained competitive advantage. When regimes are strong, returns from RAC will be high as firms can protect their knowledge assets and continue to generate profits from specific assets. Under low regimes of appropriation, performance may be sustained through an organisation's perceived superior value proposition, quality of service, network linkages or technical credibility.

As a collection of knowledge-based capabilities, AC is a source of *competitive advantage*. This advantage manifests in *strategic flexibility*, *innovation* efficiency and overall *performance*.

Essentially three groups of people can be identified that are critical to enhancing absorptive capacity in an organisation:

- Seekers of fundamental truths;
- Knowledge vendors; and
- Social integrators.

Each has a different peer network (external knowledge structure), which adds to the organisational knowledge assets. Knowledge created or absorbed by a partner organisation may well serve to improve its own performance and, consequently, competitiveness. While most people have a natural inclination to be more comfortable in one of the groups, a minority can migrate upstream and downstream along these functional groupings. Individuals from this minority commonly become the social integrators of an innovation system.

CHAPTER 3: LEARNING PHILOSOPHY

"Empathise to be receptive; Internalise to be responsive"

This chapter presents a general philosophy and a set of ideals relevant to learning organisations.

This chapter presents a comprehensive philosophy that is intended to guide learning in a demanding natural resource governance environment. Be pragmatic in its implementation. Use those aspects that seem most relevant and easiest to apply. Adapt them to current culture and don't try any quantum leaps. Learn from what worked and what did not work. Be patient. Persist in exploring different ways of applying the ideas.

3.1 INTRODUCTION

This chapter serves two primary purposes. First, it presents a consolidation of the learning (and other) theories tempered by the realities faced by organisations such as catchment management agencies (CMAs) in present-day South Africa (see Section 1.3: Current realities and future uncertainties). Secondly, it acts as a "bridge" between this theory, the current reality and the forthcoming strategy (Chapter 5). It does this by presenting a generic guiding framework upon which the strategy is developed. The ultimate objective is to promote behavioural change in the organisation towards a sound learning culture.

This chapter does the above both explicitly (to some extent) and implicitly (to a greater extent) by embedding the theory, current reality, and a way forward in a single, easily readable, accessible guiding philosophy.

One measure of its ultimate success will be the number of times it is specifically referred to when guidance is required in any specific scenario. Two general circumstances in which this could occur can be envisaged:

First, the CMA is specifically focussed on developing a strategy for improving its ability to learn as an organisation. The philosophy should provide a general framework within which an organisation-specific learning strategy can be developed.

Secondly, the CMA might be focussed on non-learning operational issues and wish to ensure that whatever course of action they adopt also takes account of their desire to create, maintain, or further develop themselves as a learning organisation. The philosophy must therefore be sufficiently generic and able to be integrated with other guidelines such that sound "learning" guidance is provided. These other guidelines might include those for public participation, water quality management, Reserve determination, resource classification, monitoring, and so on.

3.2 ASSUMPTIONS

3.2.1 Introduction

Before the philosophy is formally described, it is necessary to make clear certain basic assumptions upon which the philosophy depends. These are described in the following sub-sections.

3.2.2 There's only one learning system

3.2.2.1 All knowledge must be acknowledged

Many different forms of knowledge (scientific, local, traditional, practical, political, etc.) are continuously being produced. They co-exist in a single global learning system. Each has a distinct set of justifying criteria (Van Kerkhoff and Lebel, 2006), for example:

- **Scientific knowledge** follows accepted scientific practice and peer review.
- **Local knowledge** claims connection with a particular place.
- **Traditional knowledge** is justified by long-standing customs.
- **Practical knowledge** relies on first-hand experience.
- **Political knowledge** aligns with political processes.

All have a role to play in learning required for an organisation with a mandate for ecosystem governance.

3.2.2.2 The scientific process must be embraced

Science has been immensely beneficial to society. It is generally accepted that societies that embrace scientific knowledge creation enjoy proportionately greater production and service benefits than those that don't (Sagasti, 2004). Wilson (1999) also suggests that the chasm between scientific and pre-scientific cultures is the most significant divide within humanity, more so than race, religion, or between literacy and illiteracy. He further suggests that science "has yielded the most effective way of learning about the real world ever conceived".

While acknowledging the role of all knowledge forms, this philosophy specifically assumes that scientific knowledge is ultimately indisputable. This does not imply that ideas not subjected to the scientific process are unacceptable. Rather it implies that when an idea has been subjected to the scientific process, the scientific outcome is the result of choice if it conflicts with any other interpretation.

3.2.2.3 Knowledge forms in the innovation chain must be linked

Knowledge potential is realised through its effective application. These applications must link to production and service activities. To generate, transform and then incorporate scientific knowledge into applications it is critical to nurture and link many capabilities (Sagasti, 2004). This is done through a system of innovation (**Figure 5**). An innovation system is often conceived at a national scale although basic scientific knowledge knows no borders. Application of scientific knowledge must therefore interface with local knowledge (all forms) and therefore may be geographically bounded. The knowledge innovation chain requires that strong alliances exist between sites of basic research, those that transform new knowledge for application and those that apply knowledge in development of new products, processes and services. There are also delays in diffusion, adoption and use of knowledge moving in both directions (Breen et al., 2004).

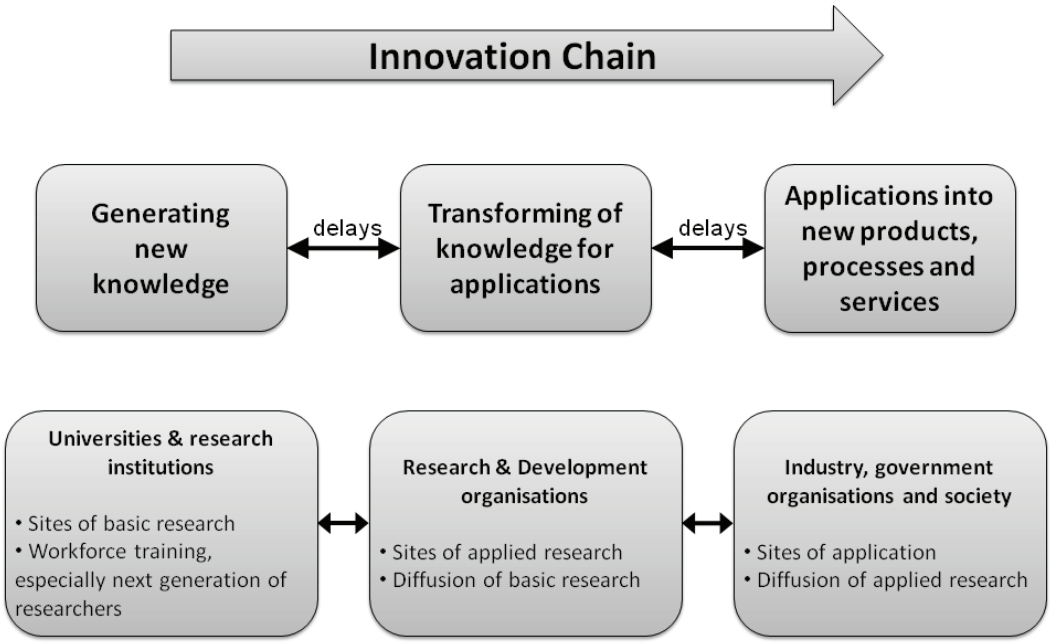


Figure 5 : The knowledge innovation chain.

3.2.2.4 The new social contract must be implemented

Notwithstanding its benefits, through enabling modern technologies, science has also been responsible indirectly for the current human domination of our planet and widespread deterioration of ecological systems. Human health, economies, social justice, national security, and so on, are also inter-linked and depend on the integrity of ecological systems (structure, function, and resilience). Science is currently being called upon to respond to one of the most pressing issues of our time: this interdependent relationship between human well-being and these ecological systems (Lubchenco, 1998).

A new social contract for science has therefore been proposed, with which any learning system must align:

- **Greater sustainability.** Science must urgently create new knowledge and communicate it to facilitate an evolution towards greater sustainability.
- **Contextualisation.** Science must place itself in context and provide workable solutions (see Section 3.2.2.3) while simultaneously searching for truth and producing "reliable knowledge".
- **Multi-scale transdisciplinarity.** Associated research must be transdisciplinary and take account of multiple spatial and temporal scales.
- **Cooperation.** There must be improved interagency and international research cooperation, more effective bridges between management, policy and science, and effective communication of findings to multiple audiences.
- **Reciprocity.** The public must better understand how science works and science must better understand its role in society.

3.2.2.5 Participation in the system is key

Social learning means participating in the broad learning system. One knowledge form should engage with another with knowledge flowing in both directions. The nature and degree of connectedness to the "one learning system" is the key factor determining the extent of individual, organisation and national participation and the degree to which they can realise benefits. In this

social network the number and the nature of nodes are important, as is the quality of those connections.

Integrated solutions for sustainable development are essential. These must be developed by interfacing multiple knowledge systems across a wide spectrum of disciplines. While information may be a "thing" that can be transferred, knowledge creation must be a "process of relating" (Stacy, 2001) involving careful negotiation of meaning (Wenger, 1998). Learning together, sharing both content and context, fosters much-needed shared understanding of the concepts, principles, and approaches (Roux et al., 2006). Social learning must be a core competence of an organisation responsible for governance of natural resources.

3.2.3 Social ecological systems exhibit complexity

An issue that is at the core of this philosophy is the degree to which the system in question (i.e. the social ecological system, SES) acts as a complex system. It is explicitly assumed here that the SES will inevitably act to some extent as a complex system. This specifically means the SES will exhibit at least the following properties:

- **Self-organisation**. This may manifest either in the system as a whole or in its constituent parts (of which the CMA is one). Self-organisation is the unprompted, unforced, natural bottom-up emergence of behaviour or properties, either in natural ecosystems or social, economic, cultural (or other) systems.
- **Unpredictability**. The very nature of complex systems is that causes and effects are not always predictable *a priori* before the event. (However, they may sometimes be at least partially understandable in retrospect.) Complex systems will behave in unexpected ways that are also possibly unprecedented. Surprise is inevitable.

Notwithstanding this acknowledgement of complexity, this philosophy explicitly assumes that learning organisations also have a degree of predictability. Past experience with organisations (and for that matter, SESs) does provide us with the means of predicting, often with some confidence, that doing something will have certain well known effects. For example, introducing fundamental organisational change causes staff uncertainty and results in various associated challenges.

Accordingly, the philosophy assumes the following:

The creation, maintenance, and growth of an organisation (in this instance the CMA) as a "learning organisation" involve predictable cause and effects relationships between:

1. A series of well-defined infrastructural pre-requisites and learning-related activities (the "causes"), and
2. The organisation's ultimate ability to perform as a "learning organisation" (the "effect").

In essence this says certain well-defined things have to be in place before learning can happen.

However, the precise path taken to become a learning organisation, and hence the precise nature of that ultimate ability, will be determined by unpredictable emergent events, properties and behaviours (either directly or indirectly related to learning) typical of a complex system. This is particularly so in one based on a natural resource that is scarce and variable in time and space.

This says that while organisations may be predictable to a significant extent, the detailed evolutionary paths and states at given points in time (and perhaps space, i.e. around the country or globally) will be occasionally unpredictably disrupted, possibly significantly (i.e. to the point of collapse).

3.3 PHILOSOPHY

3.3.1 Basic learning ideals

3.3.1.1 Summary

The ideals presented in the following sub-sections can be placed in two general categories, empathy and internalisation (**Figure 6**).

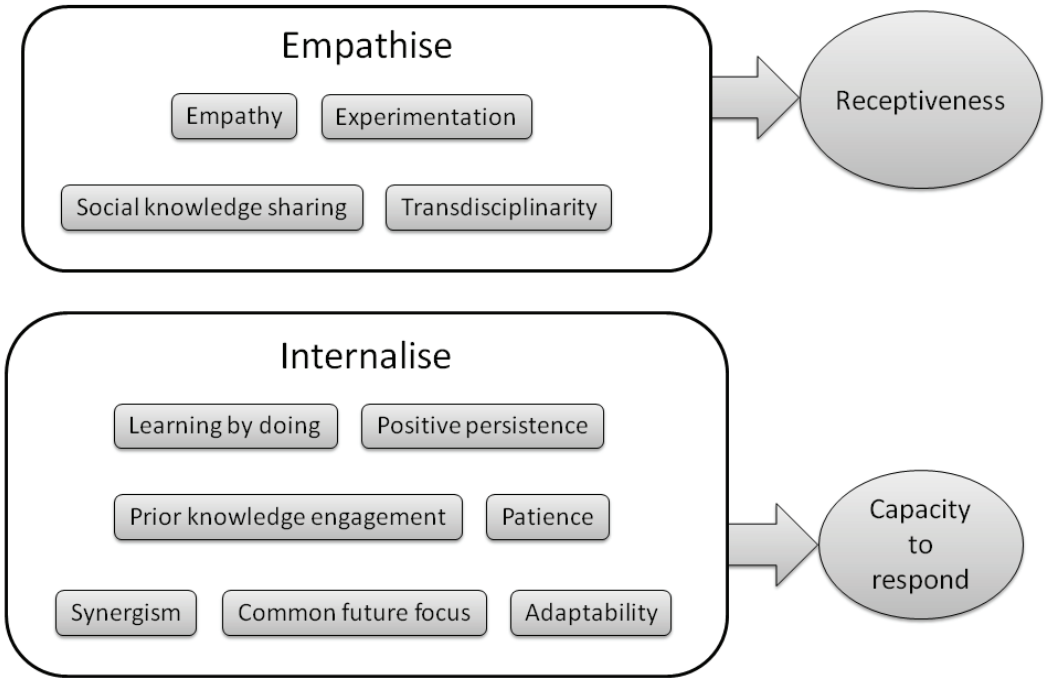


Figure 6 : The empathy and internalisation categories of the basic learning ideals.

Learning is fundamentally about being empathetic to other points of view, in other words being receptive. However, the usefulness of learning only reaches its full potential value when it can be used to respond effectively to the messages being received. Effective receptiveness and response based on these ideals should contribute to the overall credibility, and hence legitimacy, of the organisation. See the associated research report (WRC Report No. 1689/1/09) for the more detailed systems analysis upon which the following is based.

3.3.1.2 Common future focus

Ideal: *"Common future focus" strives to ensure that all stakeholders have agreed to a well-defined vision of the future and that this actively determines what is learned*.

Philosophy: Given active and frequent attention to our *raison d'etre*, our “reason for being”, and more specifically in the current context, our “reason for learning”. Encourage debate. Encourage everyone to have a forward-looking perspective. This includes all stakeholders in the SES for which the CMA has responsibility. No-one should be continuously “locked” into the present or past (unless one or the other has been identified as the future desired state). Learning-related actions can be justified on the basis of the shared vision.

Organisations may have a functional purpose. Individuals have personal purposes. However, ensure there is also a common moral purpose.

Justification: This Ideal improves overall learning efficiency and increases potential for synergistic interactions between learners (i.e. stakeholders).

Tensions: Since adaptability is also essential (Section 3.3.1.11: Adaptability), the vision must also be flexible. Visions should not be changed lightly. They should only be changed after intensive double- or triple-loop reflection (see Section 4.3.8: Apply single-, double- and triple-loop learning).

3.3.1.3 Social knowledge sharing

"Why does the group exist? Why does the animal not live alone, if not all year at least for much of it? There are many reasons but the principal one is learning. The group is the locus of knowledge and experience far exceeding that of the individual member. It is in the group that experience is pooled and the generations linked."
(Washburn and Hamburg (1965b). The Implications of Primate Research.)

Ideal: *"Social knowledge sharing" strives to facilitate freely interactive sharing, inquiry, debate and negotiation of new information between learners and those with the knowledge that should be shared*.

Philosophy: Acknowledge that learning is fundamentally and intimately a social experience. Provides infrastructure for, and allow for, expert-expert, novice-novice and especially expert-novice interaction and debate. Get them face-to-face in the office and especially in the field. Nurture networks on all scales. Don't try to do it alone. Someone out there has probably already solved your problem or knows how to solve it.

Justification: Social knowledge sharing improves learning efficiency and its effectiveness. These improve the ability to deal with information overload and extend knowledge depth. Knowledge breadth is also expanded. These improve the abilities to deal with significant decision making and complexity. Knowledge continuity is facilitated which improves the ability to deal with change. Synergism can be allowed to develop and better account can be taken of prior knowledge.

Tensions: Also allow for a degree of individual isolation for deep reflection when necessary. Acknowledge that different individuals will require different degrees of social interaction for optimal learning. Ensure that there are opportunities for information flow from individual to group and *vice versa*.

3.3.1.4 Empathy

"To enter into the space of another without permission, be it the land, the sea or that of an animal, is to violate that space. How do you ask permission of the land? You do it in the same way that you ask permission to enter the space of a patient, a friend, a lover or stranger. You take care. You "listen" to the intelligence of the other. You pay attention. You listen – feelingly."
(McCallum (2005). Ecological Intelligence: Rediscovering Ourselves in Nature.)

Ideal: *"Empathy" strives to stimulate co-creation of new knowledge by nurturing a culture in learners to interact and share with other knowledge systems (cultural, political, scientific, etc.) and knowledge levels (novice, expert) with understanding and an ethic of mutual respect for knowledge (in all its forms), wisdom, culture, language, abilities, concerns and inputs of all stakeholders*.

Philosophy: Acknowledge the rainbow nation, scientific and indigenous, radical and traditional. Listen feelingly. Negotiate meaning. Co-manage problems. Also have the courage to say where you are coming from, and importantly, why. However, beware of assuming you alone have the moral (or whatever) high ground. Acknowledge there may be uncomfortable clashes between mental models. If the social capital does not yet exist to cope with this, work towards creating it.

Be patient yet persistent. Have empathetic attitudes. Discomfort can ultimately be turned into a mutually enriching experience.

Justification: Empathy is at the core of effective engagement with an individual's prior knowledge. It smoothes identification of a common future focus and the social knowledge sharing needed to move towards it. It improves interpersonal relationships and hence allows for synergism to develop. The receptiveness associated with empathy can also increase the breadth of knowledge.

Tensions: Being empathetic does not mean that all have equal standing. Context and negotiation will determine relevance.

3.3.1.5 Learning by doing

Ideal: *"Learning by doing" strives to ensure that knowledge is also created through hands-on practical experience*.

Philosophy: Get your hands and feet wet and dirty. Never miss an opportunity to have a first-hand sensory experience. Smell it. Feel it. Hear it. See it. Do it yourself for a change. Learn by doing then do it again (and again if necessary). Acknowledge that deep knowledge is embedded in practice and that it cannot easily be detached from the person who had the experience.

Justification: Learning by doing improves knowledge depth and self-confidence and propensity of people to be positive and persistent. Also improved is the ability to deal with significant decision making and complexity. It also naturally facilitates healthy experimentation.

Tensions: While doing can provide experiences that can have long-lasting and deep impacts, the resources allocated to it must be appropriately balanced with theory. Theory provides a sense-making framework that can convert experience (and data and information obtained in other ways) to a more sound knowledge.

3.3.1.6 Prior knowledge engagement

Ideal: *"Prior knowledge engagement" strives to ensure that knowledge creation acknowledges, monitors, adapts to, and builds on what learners already know*.

Philosophy: What stakeholders already know, whether gained through experience or theoretical study, whether rational or otherwise, whether scientifically justified or based on traditional or indigenous knowledge, is explicitly taken into account in interactions with them. Knowledge of their context moulds the nature of engagement with them. Treat each knowledge system with empathy and acknowledged it as an integral part of the SES. Closely align any learning philosophy with prevailing culture.

Justification: Prior knowledge engagement encourages learning efficiency, learning effectiveness and knowledge depth. It can also improve self-confidence and hence encourage an attitude of positive persistence. These in turn facilitate dealing with information overload, the ability to deal with significant decision making and deal with complexity.

Tensions: To avoid becoming overly self-referential, have a pragmatic regard for experimentation (see below) especially in the sense of being receptive to new ideas and adventurously testing them. Encourage constructive mavericks to challenge the status quo. Acknowledge that while it is more comfortable to be inward focussed, subjecting one's ideas to peer review is an important component of scientific process.

3.3.1.7 Patience

Ideal: *"Patience" strives to ensure that adequate time is allowed for absorbing appropriate knowledge and that the expectations during the learning process, of all concerned, are realistic.*

Philosophy: Acknowledge that notwithstanding the fast pace of modern life, patience remains an essential virtue. Make time for reflection. Endeavour whenever possible to understand in depth. Consciously slow down whenever it is not essential to rush. Be realistic about the time required to master something; to gain "expert status" in a scientific field or establish trust and social capital in a multi-stakeholder community.

Justification: Patience allows for deepening knowledge in specific areas. This facilitates significant decision making and dealing with complexity. It is important for effective social knowledge sharing and the often time-consuming nature of learning by doing.

Tensions: The nature of governance organisations is that a job needs to be done, and often it needs to be done fast. Be continuously aware of this tension. Avoid becoming trapped in a mindset that automatically assumes everything is important and urgent. Make deliberate and thoughtful trade-offs, particularly between efficiency and effectiveness. Understand which issues will significantly affect the SES as a whole. Distinguish between slow variables (those controlling variables that change slowly over long time periods) and fast variables (those changing quickly). Understand their feedbacks and how they might affect issues determining the integrity of the SES as a whole. Use this to decide on what is immediately important and what can wait.

3.3.1.8 Experimentation

"Neither individual monkeys nor the social group can wait until confronted by needs and situations (danger, thirst, hunger, sex) to respond to them; the social system must be adapted to anticipate both daily needs and occasional crises. A system that could meet only day-to-day problems would not survive long, and evolution, through natural selection, builds a substantial margin of safety into the individual animals and into their way of life. The group moves more, is more exploratory, is more playful than there is any need for on an average day, but by so doing it is preparing for crises. The individual animals appear stronger and more intelligent than is necessary for normal activity, but survival requires coping with the rare event."

(Washburn and Hamburg (1965a). The Implications of Primate Research.)

Ideal: *"Experimentation" strives to completely embrace (allow, plan for, and learn from) provisional or exploratory initiatives that are not necessarily guaranteed to succeed or produce short-term desirable results.*

Philosophy: Actively invest in an experimental culture. Encourage open and free debate on costs and benefits of specific experiments. Avoid a culture that forces staff and stakeholders into ineffective action, or inaction, because there is fear of failure. Acknowledge that many "failures" (i.e. experiments) may be necessary before success is achieved. Actively encourage considered action even though there is uncertainty. Manage the uncertainty. Understand its nature and likely extent.

Justification: Experimentation is an essential prerequisite of adaptability. An experimental mindset also facilitates more effective learning by doing because individuals are less threatened by possible failure.

Tensions: Careless experimentation without due consideration being given to past experience and existing knowledge should be avoided (see Prior knowledge engagement above). Uncertainties should be quantified whenever possible and appropriately informed actions taken.

3.3.1.9 Positive persistence

Ideal: *"Positive persistence" strives to ensure that learners have determined yet positive and enthusiastic attitudes to acquiring new knowledge*.

Philosophy: Acknowledge that persistence is necessary and that those with inherently positive attitudes are more likely to be persistent. Employ people with the right stuff in the first place. Look for "self-starters" and those with a naturally enquiring nature.

Justification: Positive persistence, like patience, is essential for attaining deep knowledge. Positive attitudes rub off on colleagues, facilitating better interpersonal relationships and therefore possibly synergism. Such attitudes are especially constructive in times of change and dealing with significant decision making.

Tensions: Existing staff members or stakeholder who do not possess the right stuff present a particular challenge. It may not be easy to change a naturally pessimistic person into one that is positive and optimistic.

3.3.1.10 Transdisciplinarity

Ideal: *"Transdisciplinarity" strives to ensure that the knowledge that is created (in individuals and in organisations) is appropriate and adequate at each level in a hierarchy of disciplines (*e.g. *from technical through political to ethical) and, where necessary, adequately detailed (*i.e. *based on deep understanding)*.

Philosophy: Acknowledge the inevitable multi-dimensional nature of typical resource management problems. Encourage people to step outside their comfort zones, be empathetic, and consider other points of view. Have champions in multiple disciplines, especially vertically through the hierarchy. For example, ensure technocrats understand politics, politicians understand some science, and that scientists understand ethics.

Justification: Transdisciplinarity improves knowledge depth and the ability of an organisation to deal with complexity and the multi-dimensionality of typical problems.

Tensions: Transdisciplinarity is inherently about working in the space between disciplines and comfort zones. This is uncomfortable. Create an environment that minimises the discomfort. Transdisciplinarity is also inherently about breadth, which itself can be in tension with depth (see Section 4.3.2: Build knowledge breadth and depth). Also use the fact that depth in one discipline often makes it easier to work between disciplines.

3.3.1.11 Adaptability

Ideal: *"Adaptability" strives to ensure that individuals learn to manage their own resilience, that is, their capacity to react constructively to disturbance and to change when necessary.*

Philosophy: Apply the ideal of "expecting the unexpected" particularly in the sense of the unpredictability of a complex system (see Section 3.3.2.3: Expect the unexpected). Understand the basics of change management.

Justification: By its very nature, adaptability improves the individual's, and hence the organisation's, capacity to deal with change and other threats to sustainability. Learning can be more effective and therefore the ability to deal with significant decisions is improved.

Tensions: Excessive change, or perception of change, can be disruptive to the point that the basic job does not get done.

3.3.1.12 Synergism

Ideal: *"Synergism" strives to ensure that teams are able to apply routine strategies that result in achievements greater than that attainable by the individuals operating separately ("the whole is greater than the sum of its parts").*

Philosophy: Acknowledge the complicated and complex nature of SESs and that problem solving in this environment can be very challenging. Optimal solutions are seldom obvious at first sight. Acknowledge that two heads are better than one, and better than two heads working separately. Innovative solutions are likely to come from effective interactions between individuals in different disciplines. Encourage social knowledge sharing across disparate disciplines. Engage prior knowledge. Within the nestedness of social learning actively search for and nurture special relationships.

Justification: Synergism facilitates effective problem solving in a way that is likely to be impossible by individuals working alone.

3.3.2 Acknowledging complexity

3.3.2.1 Sensitive persuasion

Ideal: *"Sensitive persuasion" acknowledges that self-organising natural and human systems are of such a nature that they cannot function optimally within formal "command and control" management approaches.*

Philosophy: A natural system exhibiting emergent properties can be very sensitive to the underlying core factors that determine its nature. Disturbing these variables can be devastating. Similarly, a nuanced, softly-softly, empathetic approach is necessary when a functioning community of practice needs to be influenced or encouraged to change in some way. Hard-handed methods will be disruptive.

Justification: A complex system that is inherently self-organising can't be controlled without changing its very nature.

Tensions: Unacceptable communities of practice (i.e. those with detrimental effects on the integrity of the SES) may respond to heavy-handed techniques though there is no guarantee that the underlying causes will disappear. They may simply emerge in another form.

3.3.2.2 Up close and personal

Ideal: *"Up close and personal" acknowledges that the nature and extent of interpersonal relationships are core drivers of dominant social behaviours and so strives to make such relationships the focus of learning-related management actions.*

Philosophy: Strive for the above ideal of social knowledge sharing. Create infrastructure that enables a variety of group learning opportunities. Allow optimal mechanisms that work well in specific contexts to develop naturally. Further nurture their development. Although there may be many conceivable ways of interacting, probably only a select few will be relevant in any one context. Group learning is not only about talking. Even if little is said, be sensitive to the body language.

Justification: Emergent system-wide properties in complex systems are largely a result of short-range interactions between agents. Also, only a few such rules of interaction may be operating to cause the system behaviour.

3.3.2.3 Expect the unexpected

Ideal: *"Expecting the unexpected" strives to create and maintain an ever-present mindset of expecting to be surprised*.

Philosophy: Without being alarmist, managers and stakeholders alike should be conditioned on a continual basis to expect surprise. Change should be the expected order of the day. Monitor the integrity of the SES regularly. Search for signs of change that might develop, or worse, suddenly transform into surprise.

There should also not be despondency when the surprise manifests.

Importantly, acknowledge the difficulty that such surprises may be rare and therefore that maintaining heightened awareness requires a conscious effort. Out of sight should never be allowed to be out of mind.

There is no place for complacency. A continuous degree of some discomfort that creates a constructive manageable tension is necessary to maximise adaptability.

Justification: Complex systems are, by their very nature, unpredictable. Also, to maintain high levels of adaptability in times of crisis it is best that the system is "on the edge of chaos".

Tensions: Too much focus on rare events can detract from the everyday task of just getting the job done.

3.3.2.4 Un-complicate complexity

Ideal: *"Un-complicate complexity" stresses that emergent properties or behaviours, in both natural ecosystems and human systems, are likely to depend on only a few core variables, issues or rules.*

Philosophy: A complex system is not necessarily as bad as it first seems. Behaviour may not be predictable before the event. However, in retrospect causes and effects may be generally discernible. This presents a learning opportunity. Furthermore, there is likely to be only a few critical issues that determine the behaviour. It may not initially be easy to identify them though. So study the natural system in depth. If it is a community of practice, get to know it better than it knows itself. Understand what drives it. In particular, understand its history. Know its sensitivities and strengths. Study it from the inside. Ask yourself which one or two core issues are those without which the property or behaviour will cease to exist.

Justification: In complex systems only a few rules are necessary for the system to self-organise and for associated properties to emerge. Also, in a self-organising system the present depends intimately on the past.

Tensions: Systems may be complicated (that is, have many interconnecting components). However, although everything is seemingly connected, there is only likely to be a few critical connections that determine overall system behaviour. The complicated nature of systems may make their study time-consuming and costly.

CHAPTER 4: LEARNING PRIORITIES

"Nurture the Right Team in the Right Environment"

This chapter presents general priorities for facilitating catchment management agencies to become learning organisations.

4.1 INTRODUCTION

The Inkomati Catchment Management Agency (ICMA) is tasked with devolved planning and management of water resources across multiple scales (temporal and spatial) in its water management area (WMA). It is a public service agency. It therefore affects, and is affected by the state of its water resources and the dynamic use patterns of diverse resource users.

Any organisation with a mandate for social-ecological system (SES) governance faces a demanding array of internal and external challenges (Section 1.3). They must attract the right staff from a limited national human resource base. These staff members must make difficult trade-offs on behalf of society. They must realise that the social-ecological system will function as a complex system in which constructive self-organisation should be nurtured. They must deal with information overload, expect the unexpected (Section 3.2.3) and deal with change at many scales.

Many of these challenges can potentially debilitate learning. These and the sound application of the learning philosophy (Chapter 3) demand exceptional people. Even for such people learning will be a critical determining factor for the resilience, and therefore sustainability, of the ICMA (and potentially for the SES as a whole).

Effective and efficient learning must not only occur within the organisation. Learning must also happen with knowledge and learning partners within the broader WMA, as well as beyond the geographical boundary of its responsibility. Accordingly, any learning strategy must stress the essential role of a broad-based learning network. The ICMA needs to find a balance between its centralised governance and encouraging (as well as capitalising on) the creativity and agility associated with learning happening outside its organisational boundaries.

The recommendations made in this chapter are aimed primarily at the catchment management agency top management although all staff members will benefit from the ideas presented. Management should also give attention to a reward system that provides at least organisational recognition to those who exemplify a learning culture, characterised by the learning ideals in Chapter 3 and the concepts presented below.

4.2 THE RIGHT PEOPLE

4.2.1 Introduction

The nature of the mandate of a catchment management agency requires that it be a knowledge-intensive organisation. This means that knowledge is relatively more important than its intangible assets such as property and equipment. The most important assets are therefore its knowledgeable people and applied brainpower. Indeed, the knowledge workers "own" most of the abilities (e.g. knowledge creation, creativity and inter-disciplinary decision making) required for effectively executing the mandate of knowledge-intensive organisations.

These people should also be able to work together in effective teams in the complementary, interdependent and mutually accountable sense implied by Sorrells-Jones and Weaver (1999). Importantly, it is also not intended that such teams be elitist or exclusive in any way.

The following sub-sections address some of the issues relating to these intangible knowledge assets, i.e. the people.

4.2.2 Attract and retain the best minds

How can the ICMA ensure that they attract and retain key knowledge assets? How do they build and maintain professional relationships with those that do not formally work for the organisation or that have left the organisation? Consider the following:

- **Exploit potential environmental attractiveness**. The best professionals tend to have options and will choose a workplace based on perceived attractiveness. Geographic location and physical appearance contribute to such perceptions. For example, the Inkomati CMA has offices in Nelspruit. Marketable factors associated with a move to the "Slowveld" include a higher quality of life and an escape from the rat race.
- **Seek and acquire exceptional skills**. Remember that bright minds attract bright minds. Technical professionals love to work with and learn from acknowledged leaders in their field. A recognised and respected expert that is appointed will serve as a source of organisational credibility and a magnet to new talent. The opposite is also true: The loss of a highly valued employee may result in other employees questioning whether they should stay.
- **Retain critical expertise in feeder pool**. Don't lose critical expertise from the DWAF Regional Office (currently the primary feeder organisation). Remove some of the uncertainty regarding their potential roles in the CMA through frequent communication.
- **Create enabling support systems**. Knowledge professionals should be able to focus on their primary responsibilities and not be constrained by system shortcomings and distracted by unnecessary administrative duties.
- **Nurture a network of strategic relationships**. Don't try to own all the knowledge needed for executing your mandate. Rather create and nurture a strategic knowledge network. Nodes in the network should include stakeholders, academics, consultants and previous employees with valuable contextual knowledge.

4.2.3 Anticipate "bad apples"

The principles proposed for learning organisations paint an idealistic picture of the organisation consisting of a synergistic team of special people rising to any challenge. However, a reality is that an organisation can contain "bad apples" whose agendas are not aligned with the learning ideals of the organisation. For example, they may be solely concerned with personal advancement, even

act illegally or be deliberately or inadvertently destructive in many other ways. Such people can significantly undermine the efforts of the majority dedicated to effective and efficient learning. Accordingly, the following are proposed:

- **Acknowledge their possible existence**. Don't ignore the possible existence of "bad apples" (now or in the future).
- **Don't underestimate them**. Don't underestimate the potential negative effects of their actions.
- **Be receptive**. Be alert for signs of emerging unacceptable behaviour.
- **Respond sensitively**. Respond sensitively and with empathy when unacceptable behaviour does emerge. Get to the core of the causes and address them.
- **Sensitise new staff**. Make new staff aware that certain learning standards are expected. Emphasise in particular the need for the following: Common future focus; Social knowledge sharing; Empathy; Adaptability (see Chapter 3).

4.3 THE RIGHT ENVIRONMENT

4.3.1 Introduction

Emphasis has been given above to the fundamental importance of having the right people in the CMA. However, a fully-functioning CMA needs to ensure that these people are provided with an optimum learning environment. Of course, having the right people and having the right environment are interdependent. The very presence of the right people helps to create the right environment. Equivalently, the right environment helps to attract and retain the right people.

This section addresses a number of focus areas relating to such an environment. They are characterised by what might be referred to as "paired strategy options". They are based on the idea that, while a given ideal may be important to strive for, it is seldom the case that it should be applied in the extreme. Typically, it needs to be balanced with another ideal. Indeed, some ideals will be in direct tension with other ideals. This section therefore inherently recognises and explicitly addresses some of the balancing acts typically required by institutions tasked with management and governance of complex social-ecological systems.

Many of the concepts presented here have been expanded on in the following publication:

Roux DJ, Murray K and van Wyk E (2008). Learning to learn for social-ecological resilience: Balancing strategy options in public sector organisations. In: Burns M and Weaver A (Editors). *Exploring sustainability science – a southern African perspective*. African Sun Media, Stellenbosch, South Africa.

The interested reader is encouraged to explore this article for a more in-depth discussion of some of the issues.

4.3.2 Build knowledge breadth and depth

To become a Jack of all trades you must first be Master of at least one.

The concept of a catchment management agency is new to South Africa. Early investment in acquiring the breadth and depth of knowledge required to adequately discharge its mandate is of utmost importance. The start-up phase presents a once-off opportunity to start with a clean slate. The type and level of skills that the CMA will acquire through recruitment and appointment will determine its ability to deliver on its mandate.

- **Cover all bases**
  - ***Have some in-house capacity in all necessary disciplines:*** The following disciplines are critical: Aquatic ecology (at least two specialisations from botany, ichthyology and entomology), botany, water quality (including chemistry, microbiology and toxicology), hydrology, geohydrology, geomorphology, GIS, water resource planning and operations, administrative, legal and financial management support, stakeholder engagement (including the functions of ecosystem governance and strategic adaptive management) and communications. A combination of social facilitation skills and technical background is required.
  - ***Leverage external knowledge through internal depth:*** The CMA needs a certain minimum, "critical mass" of in-house depth of relevant knowledge to be able to identify, absorb and exploit knowledge that exists outside the CMA.
  - ***Perform a formal capacity needs analysis***.

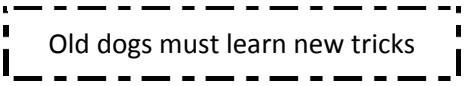
- **Cover core bases in depth**
  - ***Appoint some recognised experts:*** Significant depth of understanding and experience is required in the critical disciplines, namely, aquatic ecology, water quality (including chemistry, microbiology and toxicology), hydrology and geohydrology, water resource planning, management, and stakeholder engagement.

- **Fill gaps in depth from external network**
  - ***Develop strategic relationships:*** Knowledge flows across organisational boundaries are enabled by inter-personal relationships and networking which require time to establish.

- **Balance experts and novices*:*** Appoint staff to reflect a balance between seasoned professionals and novices to facilitate mentoring and succession. Attract experts first. Quality experts will tend to attract quality novices.

- **Find some integrators*:*** Ensure there are some individuals with depth of knowledge and breadth of experience who also have the skills for integrating across disciplines and knowledge forms. Create a post called, for example, "project integration manager" with a job description that is explicitly cross-cutting and multi-disciplinary.

4.3.3 Learn and unlearn



The complex nature of organisations and social-ecological systems and the unprecedented nature of CMAs will inevitably require new learning. Although each individual in a CMA will have a history, the CMA has no collective organisational history or memory specific to its identity. The ex-DWAF staff will bring a collective DWAF history to the CMA. However, the unique nature of CMAs will necessitate continual learning of new concepts and require suppressing and discarding outdated habits.

- **Learn continuously*:*** The intellectual capital within the organisation should be nurtured and grown continuously:
  - ***Build both individual and group skills***. See Section 4.3.5: Facilitate individual and group learning.
  - ***Provide learning opportunities***: Support attendance of, and especially participation in, relevant conferences, workshops, symposia and training courses. Promote ongoing formal education and actively encourage exposure to fieldwork.
  - ***Build confidence:*** Use mentors and allow for making mistakes. Allow especially for reflective learning from mistakes.

- **Capture learning in explicit form:** Tacit and implicit knowledge needs to be made explicit (e.g. by writing a report) so that it can be shared, stored as part of the organisational memory, and be available for future reference. Capturing learning in this way should be firmly institutionalised.

- **Know when to unlearn:** Encourage the self-confidence and humility required for exposure to new ideas and mental models.
  - ***Value mavericks:*** Use them to test prevailing paradigms.
  - ***Use double- and triple-loop thinking:*** This will quickly expose when unlearning is necessary. See Section 4.3.8.
  - ***Reinforce newly adopted ideas:*** Ensure there is sufficient reinforcement of new concepts to discourage falling back on old inappropriate habits.
  - ***Give it time:*** Create enough reflective time and appropriate physical space to enable disconnection from old mental models (like in a sabbatical or retreat).

- **Know how to unlearn:**
  - ***Manage with sensitivity:*** Unlearning requires people to move out of comfort zones. Imposed unlearning can therefore have emotional costs.
  - ***Do succession planning:*** Minimise the adverse effects of unlearning occurring through unplanned, and in some cases, even planned staff losses. Design innovative strategies to retain good staff.
  - ***Nurture relationships:*** Implement sensitive exit strategies with staff leaving the organisation. Create opportunities to subsequently engage with them to retain their critical knowledge within the learning network by focussing on the special interests (especially “deeply embedded life interests”).

4.3.4 Respond rapidly but reflect patiently

> "*Quality of life depends on what happens in the space between stimulus and response.*"
> (Covey et al., 1994)

A CMA environment is complex and surprise is inevitable. A stark reality is the need to respond efficiently and effectively to new situations as they arise. While some "fire fighting" is almost inevitable, there is also a critical need for ensuring that this does not occur at the cost of careful and reflective thought.

- **Build a supportive network**
  - ***Build knowledge breadth and especially depth (Section 4.3.2)***: Experience (which creates knowledge depth) will often be essential to effective response. However, both breadth and depth are important.
  - ***Nurture allies***: Create strategic alliances with organisations such as NGOs, universities, parastatals and government departments. Know the capabilities of individuals and develop deep relationships with them, sufficient to be comfortable calling them in an emergency and to involve them seamlessly in projects of interest to both parties.
  - ***Rely on experience***: Look to the experienced people in your organisation and in the wider learning network for guidance. But don't abuse them.
  - ***Take turns***. Consider taking turns to fight the fires.

- **Cultivate a reflective learning capacity**
  - ***Nurture role models***: Support, empower and learn from role models that may emerge who are able to practice reflective learning amidst the chaos.
  - ***Make the time***: Use occasional undisturbed retreats that deliberately create space for both general learning and reflective learning (e.g. capturing lessons learnt, double- and triple-loop thinking). These can improve the way things are done in future. See Section 4.3.8: Single-, double- and triple-loop learning.

4.3.5 Facilitate individual and group learning

"*Interdependence is and ought to be as much the ideal of man as self-sufficiency. Man is a social being*"
(Gandhi)

Learning, in essence, takes place at the level of an individual. However, most learning takes place in and is influenced by a social context (i.e. it is socially mediated). The CMA staff learning and broader extended learning network must grow in both size and quality. In particular, opportunities for learning in diverse social contexts should increase. Each individual, and the organisation as a whole, must find the right balance between the degree of individual learning and social learning.

- **Acknowledge that both are important.**

- **Explicitly facilitate individual learning.**
  - ***Create the space:*** Make physical space available and allow the time. Ensure the impression is created that learning takes place "on duty" and "off duty".
  - ***Cater for individual preferences:*** Allow for preferred modes of learning (for example, see Section 4.3.6: Use theory and practice).

- **Manage group learning.**
  - ***Create the space:*** Use anything from the tea room to stakeholder meetings.
    - Encourage the sharing of mental models.
    - Promote the use of role models, secondments and apprenticeships.
    - Support participation by allowing attendance at relevant events.
    - Acknowledge that effective group learning takes time.
  - ***Employ team players.***
  - ***Employ connectors:*** Find people who have networks and who can create them.
  - ***Facilitate connectedness:*** Use appropriate technology to connect, like cell phones, and email. Make adequate provision for subsistence and travel costs.
  - ***Know the brain profiles:*** Use this knowledge to encourage self-awareness and knowledge of the personalities and styles of others to optimise group learning.
  - ***Nurture effective communities of practice:*** (See Chapter 6: Encyclopeadia of Terms.) Support and influence (but don't command and control) their identity, engagement, alignment, and impact (see Section 3.3.2.1: Sensitive persuasion). Nurture good inter-personal relationships that emerge.
  - ***Engage, don't try to own:*** Don't try to acquire all knowledge. Engage your knowledge with the network. Learn how to effectively participate in broader learning systems – to be one part of a larger process where the benefit is mutual.
  - ***Sensitively expose and rectify:*** Use group learning opportunities to sensitively expose and rectify incorrect knowledge (factual or interpretive) that may be held by an individual or sub-group.
  - ***Learn with empathy:*** To fully understand and appreciate the contexts of your learning partners it may be necessary to spend time with key learning partners, e.g. through a temporary secondment to an irrigation board.

- **Don't leave others behind:** Beware of fragmented "ivory tower" learning when the link between an individual's or group's mental model and the shared mental model is broken or weakened. This can result in isolation. On the other hand, in some instances it may be beneficial for the organisation to allow a group to make optimal use of a specific learning opportunity (e.g. a new technology) without waiting for the rest of the organisation. However, at some point care should be taken to actively share such small-group mental models to expand the base of organisational shared meaning.

4.3.6 Use theory and practice

"There is nothing as practical as a good theory."

Most problems require a combination of both theory and practice in order to be tackled effectively. Optimal learning also requires data, information, experience (often deepened through learning by doing) and theory (that provides the context for interpreting the information and experience). A balanced portfolio of theorists and those who are more practically inclined, and an environment that gets them communicating, can be a powerful basis for highly constructive synergism.

- **Learn by doing**: Create opportunities for staff members to do things themselves.
  - ***Get feet wet***: Physically seeing, smelling, and feeling your water resources can provide deep everlasting perceptions and perspectives.
  - ***DIY***: Let junior staff do things themselves, like write reports or engage with stakeholders. This creates confidence and builds experience.

- **Embrace theory**: Don't shy away from it.
  - ***Understand the role of theory***: Theories and good models (especially simple conceptual models) help put data, information, observations, etc. in a broader context.
  - ***Tackle tough concepts***: Understand the basics of theories such as complexity, resilience, systems thinking, etc. They create perspectives that will not only help you understand the world around you, but also help you cope with its demands.
  - ***Combine theory and practice through own research***: Constantly formulate research questions to facilitate systematic probing, investigation, sense-making and learning.

- **Acknowledge deeply embedded life interests**:
  - ***Know your colleagues***: Bosses should know their staff better than they know themselves. Know what they are passionate about (e.g. are they natural theorists or natural field practitioners?).
  - ***Align tasks accordingly***: Align job descriptions with these interests. Don't simply use job description templates.

- **Optimise your people portfolio**:
  - ***Acknowledge a range***: Some naturally theorise while the field-work junky samples and analyses everything in sight. Be tolerant of both.
  - ***Get the right balance***: The "right" balance for your organisation will emerge over time and will be dynamic.
  - ***Viva la difference***: Encourage diversity in the approaches of people. However, always nurture an effective social knowledge sharing environment.

4.3.7 Build on prior knowledge but also experiment

> "*The group [of monkeys] moves more, is more exploratory, is more playful than there is any need for on an average day, but by so doing it is preparing for crises. The individual animals appear stronger and more intelligent than is necessary for normal activity, but survival requires coping with the rare event*" (Washburn and Hamburg, 1965).

Related prior knowledge is necessary to respond effectively to a new challenge. Therefore, the collective prior knowledge of the CMA's staff will determine how effectively the CMA can respond to everyday responsibilities and challenges. Indeed, it will also determine which challenges the CMA cannot respond to. Appropriate prior knowledge also enables the CMA to follow due process and accept accountability knowing that due process was followed to the best of their ability. The early growth phase of a CMA also offers a unique degree of freedom to explore options before standardising procedures.

Structured experimentation presents a mechanism for systematically exploring and choosing future options. In addition, when there is only limited understanding of a problem (i.e. when a theory is not available) experimental learning is the only way forward. Because the CMA operates in a complex system, the Water Act, associated policies and strategies, as well water use license conditions should not be viewed as "cast in stone". Rather, the social and ecological feedbacks from implementing these mechanisms should be monitored and studied to facilitate adaptive improvement over time.

- **Acknowledge prior knowledge as a strength.**
  - ***Align knowledge and responsibility:*** Ensure alignment between the prior knowledge (based on previous experience and training) and the functional responsibility of individuals. Equivalently, don't put the wrong people in the post.

- **Periodically test the relevance of prior knowledge.** (See also Section 4.3: Learn and unlearn.)
  - ***Allow experimentation***: Create some space for deliberate experimentation beyond immediately relevant boundaries of current needs and abilities. As active experimentation becomes an integral part of the culture, experimental learning will naturally help to modify beliefs and mental models that reside in the organisation.
  - ***Encourage social knowledge sharing (Section 3.3.1.3)***: Networking and active knowledge sharing (on an equal power base) within the extended learning network will help to prevent the organisation becoming self-referential. See also Section 4.6: Facilitate individual and group learning.
  - ***Learn with humility***: Learners need to be sufficiently self-confident and have sufficient humility to be open to alternative mental models when learning with stakeholders and colleagues.

4.3.8 Apply single-, double- and triple-loop learning

> "*An unreflective fastness always returns you to the same place*"
> (Cilliers, 2006)

When you have created time for reflection, what kind of thinking can we use to help us reflect in a structured and meaningful way? One useful framework involves thinking at various, and ever-deepening, levels varying from single- through to triple-loop thinking. Each has its place. Each has its time. However, each also has its ramifications.

- **Continually improve:** It is important that agreed procedures are implemented correctly. Apply single-loop learning (in effect, quality control) to ensure you not only maintain high standards but improve on them when necessary. This is critical for a CMA environment in which "due process" is an essential, if not legal, requirement.

- **Get to core:** Reflect on core assumptions (double-loop thinking) and even underlying values (triple-loop thinking) that underpinned an action or strategy (either successful or otherwise).
  - ***Prepare for and respond to unpredictability:*** Apply double- and triple-loop thinking more frequently in systems that are unpredictable, particularly when you have perhaps been caught off guard. Why did it happen? What should be done in future?
  - ***Encourage open non-threatening debate*:** Negotiate meaning and compare and analyse mental models to get to grips with underlying assumptions and governing values. Both double- and triple-loop thinking are useful when developing a common vision in a multi-stakeholder environment. The core assumptions and values of stakeholders can be identified and hence be better understood by others.
  - ***Prioritise relevance:*** Double- and triple-loop thinking help prioritise the relevance of incoming knowledge (and hence manage information overload more effectively).

- **Apply adaptive management.**
  - ***Do things better next time:*** Understand that single-, double- and triple-loop thinking and learning are the critical stages that result in doing things differently in future, i.e. adapting.
  - ***Have well-defined thresholds of potential concern (TPCs):*** Associate the TPCs with real actions (like "Have a management meeting to decide on how to respond. Document the decisions. Monitor follow-up actions and their effects.").

- **Share the learning.**
  - ***Capture the lessons:*** Make time to capture new experiential learning. (See Section 4.3.4: Respond rapidly but reflect patiently.)
  - ***Avoid fragmentation:*** Share the learning widely to avoid mental models becoming fragmented from the organisation and hence preventing the organisation from benefiting. (See Section 4.3.5: Facilitate individual and group learning.)

CHAPTER 5: LEARNING STRATEGY FOR THE ICMA

"In strategic terms, a company's knowledge vision gives its business plans a heart and soul."
(Von Krogh et al., 2000)

This chapter presents a first draft of a proposed "learning strategy" that can appear in the Inkomati CMA's catchment management strategy.

Because this chapter presents the strategy for the Inkomati catchment management agency as it could appear in their formal catchment management strategy, it is deliberately written largely as a stand-alone chapter which could reference this report for further detail.

5.1 INTRODUCTION

The decision making environment within the ICMA is such that it is dominated by challenging uncertainties. The following are some reasons for this:

- Far-reaching management decisions often have to be based on limited data and information.
- There are readily identifiable uncertainties, like the future political situation in the region, the general implementability of the Water Act, and the precise model under which CMAs will ultimately function.
- Social-ecological systems are complex systems which have an inherent capacity to surprise.

The ICMA itself and the social-ecological system (e.g. the Inkomati water management area) within which it operates are complex systems. For example, there a number of internal and external uncertainties (some of which are noted below in Section 5.2.1.2) and potentially high levels of disagreement among its stakeholders.

Accordingly, adaptive management, an approach eminently suited to deal with the unpredictability of complex systems, is acknowledged as a most appropriate management framework. It is a framework in which learning can be become firmly and sensibly entrenched in everything from day-to-day operations to long-term strategic planning.

Strategic adaptive management in particular provides a management framework particularly relevant to these early stages of establishment of the ICMA. It is strategic in the sense that it involves decisive action with foresight and purpose, adaptive in the sense that while acting, learning is also taking place, and it is participatory.

Adaptive management entails an initial adaptive planning process iteratively followed by an adaptive decision-making process. The process starts with all stakeholders deciding on a "desired

state". The reason for this is to focus decision-making on identifying and influencing factors (many of which are behavioural) that can contribute to a desired future condition (in this case a sound learning culture) rather than decision-making that focuses on a choice between immediate alternatives. This is then ultimately made operational by a set of objectives with well-defined measures and targets. Monitoring of these measures takes place. Monitoring results then prompt well-defined actions in response, if necessary. This may require adapting, i.e. changing, the ways things are done.

The essence of the strategy described here is the implementation of strategic adaptive management process specifically in the context of learning. It is strongly recommended that the process is undertaken with patience and attention to achieving a depth in debate and hence understanding on the meaning of the learning ideals and the many other concepts in this document. Only in this way will the strategy stand a chance of promoting the behavioural change necessary to embed a sound learning culture, characterised by ongoing active dialogue.

5.2 ADAPTIVE PLANNING

5.2.1 Phase 1: Decision making environment

5.2.1.1 Vision

Action: The ICMA will undertake a series of engagements firstly with the ICMA Board, internal staff members and then with selected external stakeholders to establish a vision and high-level objective relating to learning and knowledge that supports the CMA's overall vision. This process will aim primarily to establish a common future focus and buy-in in respect of learning and knowledge management.

Prototype: A prototype vision upon which to base the process will be the following:

The Inkomati catchment management agency (ICMA) commits itself to "Learning for work excellence" in striving for its vision of "Water for all in the Inkomati". It also acknowledges that the very nature of learning is such that it pervades every aspect of water resource management in the Inkomati water management area. Accordingly, there is a need for the following:

- A strategy that mainstreams a philosophy that ensures the optimal learning practices are thoroughly institutionalised, and
- Specific actions that facilitate implementation of selected enabling aspects of the learning philosophy.

The ICMA specifically commits itself to becoming a highly-effective learning organisation. This entails becoming very successful at the following:

- Acquiring knowledge from (i.e. learning from) external sources.
- Creating knowledge internally by effective processing of acquired knowledge.
- Transferring knowledge amongst staff members, to stakeholders in the water management area, and to other interested parties.
- Adapting when necessary, based on the insights of sound new knowledge, to remain focussed on its learning vision and associated objective.

5.2.1.2 Context

Action: The context within which learning will take place will be discussed and understood by the ICMA Board, all staff members and selected external stakeholders.

Prototype: The discussion will include refinement and ultimate consensus on the underlying knowledge- and learning-related assumptions representing the global, national, and regional realities of water resource management. For example:

- **There is one learning system**. In this system, all knowledge (e.g. scientific, local, traditional, practical, political, etc.) is acknowledged. However, scientific knowledge is specifically regarded as ultimately indisputable. The ICMA acknowledges that genuine participation in the broad learning system is critical.
- **Social-ecological systems exhibit complexity**. The ICMA acknowledges the relevance of complex systems in their water management area and within the ICMA itself. In effect, this acknowledges that a degree of bottom-up self-organisation will play a significant role in the functioning of the system for which the ICMA is responsible. Importantly, the ICMA also acknowledges that unpredictability goes hand-in-hand with complexity. Both self-organisation and unpredictability have profound implications for the ICMA's management approach.
- **External knowledge-related realities**. Globally there is ever-increasing potential for data and information overload and an increasing rate of knowledge production, availability and mobility. These all increase the interdependence between those with knowledge and those without it (the "haves and the have nots"). South Africa is also faced with limited resources for scientific development and a general decline in the water sector.
- **External knowledge-related uncertainties**. A variety of uncertainties exist relating to the future political situation, future tertiary graduate quality, attitudes towards the environment, and the implementability of the Water Act.
- **Internal knowledge-related realities**. Being the first CMA to be established, there are no other local water resource management models from which to learn directly. Dependence on DWAF remains high and difficulties are being experienced attracting highly qualified staff to the ICMA. A number of operational systems are also not yet fully functional.
- **Internal knowledge-related uncertainties**. Uncertainties exist relating to the exact model under which CMAs will function, the capacity of the ICMA to discharge its mandate, and who might emerge as the ICMA's future learning partners.

5.2.1.3 Operating principles

Action: Operating principles that will guide learning-related management will be identified and discussed.

Prototype: The following "learning ideals" will be the basis for these discussions:

- "**Common future focus**" strives to ensure that all stakeholders have agreed to a well-defined vision of the future and that this actively determines what is learned.
- "**Social knowledge sharing**" strives to facilitate freely interactive sharing, inquiry, debate and negotiation of new information between learners and those with the knowledge that should be shared.
- "**Empathy**" strives to stimulate co-creation of new knowledge by nurturing a culture in learners to interact and share with other knowledge systems (cultural, political, scientific, etc.) and knowledge levels (novice, expert) with understanding and an ethic of mutual respect for knowledge (in all its forms), wisdom, culture, language, abilities, concerns and inputs of all stakeholders.
- "**Learning by doing**" strives to ensure that knowledge is also created through hands-on practical experience.
- "**Prior knowledge engagement**" strives to ensure that knowledge creation acknowledges, monitors, adapts to, and builds on what learners already know.
- "**Patience**" strives to ensure that adequate time is allowed for absorbing appropriate knowledge and that the expectations during the learning process, of all concerned, are realistic.

- "**Experimentation**" strives to completely embrace (allow, plan for, and learn from) provisional or exploratory initiatives that are not necessarily guaranteed to succeed or produce short-term desirable results.
- "**Positive persistence**" strives to ensure that learners have determined yet positive and enthusiastic attitudes to acquiring new knowledge.
- "**Transdisciplinarity**" strives to ensure that the knowledge that is created (in individuals and in organisations) is appropriate and adequate at each level in a hierarchy of disciplines (e.g. from technical through political to ethical) and, where necessary, adequately detailed (i.e. based on deep understanding).
- "**Adaptability**" strives to ensure that individuals learn to manage their own resilience, that is, their capacity to react constructively to disturbance and to change when necessary.
- "**Synergism**" strives to ensure that teams are able to apply routine strategies that result in achievements greater than that attainable by the individuals operating separately ("the whole is greater than the sum of its parts").

In essence, these learning ideals acknowledge that, in the first place, learning is fundamentally about being empathetic to other points of view. This frame of mind increases the ICMA's capacity to be receptive and therefore acquire sound and relevant knowledge. Secondly, the learning ideals achieve their full potential by the depth of understanding created. This increases the capacity of the ICMA to be responsive, including adapting when necessary.

In order to specifically acknowledge complexity, the following ideals will also be discussed.

- "**Sensitive persuasion**" acknowledges that self-organising natural and human systems are of such a nature that they cannot function optimally within formal "command and control" management approaches.
- "**Up close and personal**" acknowledges that the nature and extent of interpersonal relationships are core drivers of dominant social behaviours and so strives to make such relationships the focus of learning-related management actions.
- "**Expecting the unexpected**" strives to create and maintain an ever-present mindset of expecting to be surprised.

The practical relevance of the above ideals to various issues in the following critical contexts will also be discussed:

The right people

- **Attracting and retaining the best minds**.
  - ***Exploiting potential environmental attractiveness***.
  - ***Seeking and acquiring exceptional skills***.
  - ***Retaining critical expertise in feeder pool (***i.e. ***DWAF regional office)***.
  - ***Creating enabling support systems***.
  - ***Nurturing a network of strategic relationships***.
- **Anticipating "bad apples"**.
  - ***Acknowledge their possible existence***.
  - ***Don't underestimate them***.
  - ***Be receptive***.
  - ***Respond sensitively***.
  - ***Sensitise new staff***.

The right environment

- **Building knowledge breadth and depth**.
- **Learning and unlearning**.
- **Responding rapidly but reflecting patiently**.
- **Facilitating individual and group learning**.

- **Using theory and practice**.
- **Building on prior knowledge but also experimenting**.
- **Applying single-, double- and triple-loop learning**.

5.2.2 Phase 2: Understanding the system

Action: This phase will probe in greater depth the general nature of the ICMA itself and the Inkomati water management area. A critical input to this process is the current understanding of the status quo in the water management area, including all issues relating to water resource use and protection. The purpose of this phase will be to identify "vital attributes" which are core factors in the way the systems (social, ecological, etc.) in the water management area function.

Once identified, these will be examined in depth and the factors that strengthen or weaken the vital attributes will be identified.

5.2.3 Phase 3: Develop objectives

Action: Specific and well-defined learning-related objectives will be developed and agreed to by all. These will be further broken down into achievable goals for management. Specific targets will be identified that describe the boundaries of the desired state (defined primarily by the learning vision above).

Prototype: Given the nature of learning and knowledge, the ICMA acknowledges the need for a nurturing management style rather than one that applies a quantitative "tick-box" mentality to monitoring progress and assessing staff performance. Accordingly, the ICMA management will not overemphasise quantifiable learning targets. Emphasis will be on job satisfaction and more qualitative assessments of the value of achievements.

Specific objectives should relate to the above-mentioned contexts of the right people and the right environment and be appropriately based on the shared understanding developed within the ICMA of the above learning ideals.

5.3 ADAPTIVE DECISION-MAKING

5.3.1 Management plan

Action: Based on the above objectives, a detailed management plan will be developed and implemented. This will entail specific actions that will implement selected aspects of the learning philosophy. Their ultimate intention is to create an optimal learning culture.

Prototype: Specific actions are likely to relate to the following:

- **Data management facilities**. This is based on the assumption that information management cannot function effectively without an underlying sound data management system. Accordingly, all aspects of data management (especially relating to important external stakeholders and critical components of the natural ecosystems in the water management area) will be carefully considered and database systems put in place in a manner that ensures robustness and effectiveness. Data acquisition, storage, and retrieval will be critical components.
- **Information management facilities**. This is based on the assumption that knowledge management cannot function effectively without an underlying sound information

management system. This will entail careful examination of the information requirements of staff members. Responses may include the establishment and maintenance of a library of relevant publications. Both data and information management facilities address the ICMA's vision of an effective learning organisation being able to acquire knowledge effectively.

- **Group learning facilities**. Specific attention will be given to allocating pleasing and practical locations for groups to come together, either at a moment's notice or with more foresight, possibly at more remote locations for more in-depth interactions and social knowledge sharing.
- **Group learning and "learning by doing" opportunities**. Opportunities for the ICMA staff to work and learn together in an integrated manner on real water management issues of importance in the Imkomati water management area will be identified. These should be issues which (a) require a multi-disciplinary approach and (b) result in a well-defined final product (like a report) with which staff members can clearly associate themselves with pride.
- **Capturing of reflective learning**. A system will be devised that facilitates learning based deep reflection on successes and failures. Consideration will be given to both how the outputs of such sessions will be captured and how the learning will subsequently be made available. This issue directly addresses the ICMA's vision of an effective learning organisation being able to create and transfer new knowledge. The ICMA also acknowledges that this is one mechanism that will facilitate the passing on of lessons learned by the ICMA to other fledgling CMAs.
- **Poster of learning ideals**. A poster (or series of posters) will be developed that capture the basic learning ideals in a simple, pleasing and communicative manner. These will be displayed in the ICMA building especially including locations frequented by visitors and external stakeholders. The intention is to instil these ideals to such a degree that they become mainstreamed into every day actions and terminology. The ultimate intention is enable the sound creation of knowledge within the ICMA, a critical aspect of the ICMA's knowledge vision.

For each of the above specific actions, the consequences for learning and knowledge management will be predicted and documented.

5.3.2 Monitoring

Action: The ICMA management will periodically (at least every two years) reflect on the degree to which the installed overall learning-related systems have achieved the documented objectives. Some aspects may require more frequent reflection. Reflection will be heavily based on the personal inputs of staff members who will be asked to qualitatively assess the effectiveness of the systems in an open and honest manner. Consideration will also be given to a reward system for outstanding contributions to learning and facilitating an organisational learning culture. Rewards will at least entail recognition within the organisation.

If the systems are falling short of the envisaged objectives or reaching levels of concern, specific management decisions will be taken based on the advice of staff members and the systems will be refined or replaced.

Between such formal overall reviews monitoring of sub-processes will also take place at appropriate intervals. These sub-processes may include:

- The attainment of individual high-level and low-level objectives.
- The effectiveness of staff recruiting.
- Progress in updating and maintaining data and information processes.
- Effectiveness of group learning and "learning by doing" projects.

CHAPTER 6: ENCYCLOPAEDIA OF TERMS

This chapter presents a compilation of definitions and explanations of useful terms in alphabetical order. See the associated research report (WRC Report No. 1689/1/09) for a more detailed discussion of many of these terms.

Absorptive capacity

Absorptive capacity is the ability to (a) recognise the value of new knowledge, (b) assimilate it and (c) exploit it for benefit.

Adaptability

Adaptability is the capacity to influence the resilience of a system (Walker *et al*., 2004).

Benchmarking

Benchmarking is the process of measuring and assessing products, services and practices of recognised leaders in the field to determine the extent to which they might be used and adapted (TBCS, 1996, quoted in DNRE, 1997).

Cognitive

Cognitive means relating to the mental process by which knowledge is acquired. Cognitive processes include perception, intuition and reasoning.

Community of practice

A community of practice is a group of people who (a) share a passion and (b) meet regularly and informally to learn and practice how to do things better (Wenger, 2004).

Complexity

Complexity is relevant to a learning organisation context because organisations are complex systems (Seel, 1999) or, equivalently, one property of organisations is complexity (Fioretti and Visser, 2004). Similarly, ecological systems, social systems, and overall "social-ecological systems" can also be regarded as complex systems (Levin, 1998).

Being able to recognise a system as being complex allows one to better understand that system. For example, suspecting that a system is complex encourages one to explore the system specifically looking for the variety of characteristics that typically occur (like the interacting agents, the rules of their interaction and the feedback mechanisms). This exploration increases understanding. Importantly, identifying a system as complex immediately defines its likely future as, for example, unpredictable. This has fundamental implications for managing such systems.

Complex systems are systems with specific characteristics or properties, some of which are described below.

The two most important characteristics are:

Self-organisation and emergent properties. System-wide patterns, behaviours or properties, that are not properties of individual agents, emerge over time in a bottom-up manner as the system organises itself.

Unpredictability. The behaviour of complex systems is inherently unpredictable.

More technical characteristics are:

Near-neighbour interactions. The rules governing the interactions between agents are usually such that only near-neighbour (short- and medium-range) interactions are relevant. It is these interactions that ultimately result in the emergence of the above-mentioned system characteristics. High-level (system-wide) order is therefore conferred on the system in a bottom-up manner. These interactions are also typically "non-linear". This means that cause and effect relationships are not necessarily simple.

Feedback. There can be many top-down feedback mechanisms. These mechanisms feed back the effects of the actions of agents (namely the emergent property or behaviour) to those agents, affecting the way the agents act in future. The interactions between agents, and in particular the rules governing the interactions, can therefore be constantly adapting as a result of such feedbacks.

Nesting. Organisations consist of people, who have brains comprising cells, all of which are complex systems in themselves. Therefore, the agents depicted in **Figure 7** below can also be complex systems (i.e. with their own agents, emergent properties, feedback loops, history, etc.) (**Figure 7** left). Similarly, the organisation exists within a social system which in turn exists in the broader social-ecological system (**Figure 7** right).

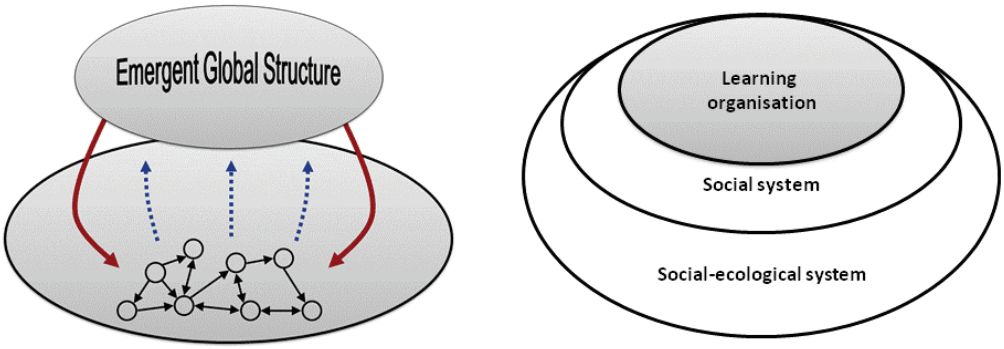


Figure 7 : Nested complex systems.

Both mathematical and social complex systems exist. Mathematical complex systems have emergent properties that arise from simple well-defined rules of agent interaction. Social complexity, on the other hand, acknowledges the uniqueness of human systems compared to natural ones. For example, humans make decisions based on patterns, humans create and maintain multiple identities, and humans can be intuitive and irrational. These all create a richness of connections that greatly increase the degree of unpredictability of social systems.

Examples of mathematical complex systems:

Bird flocking. Introduced by Reynolds (2001), bird flocking is a prime example of a mathematical complex system. The reader is strongly encouraged to examine this system further. The rules of agent (i.e. bird) interaction are: *Separation*: Steer to avoid crowding local flockmates; *Alignment*: Steer towards the average heading of local flockmates; *Cohesion*: Steer to move towards the average position of local flockmates. These simple rules, followed by each individual bird, can explain the movement of the whole flock.

Fish shoaling. The reader is also encouraged to obtain a software package "Cool School" (free of charge) from http://www.kewlschool.com/. It simulates a school of fish and predators. Playing with the parameters in the software gives one a good feel for how simple rules of local interaction can have big effects on system behaviour (in this case, the way fish shoal).

Complicated

Complicated means consisting of many interconnecting elements. A *complicated* system differs from a *complex* system (see Complexity) in that the behaviour of a complicated system can be deduced from the understandable interactions of its individual component parts. Complex systems are inherently unpredictable.

Deeply embedded life interests

Deeply embedded life interests are subjects or activities about which people are profoundly passionate.

Double-loop learning

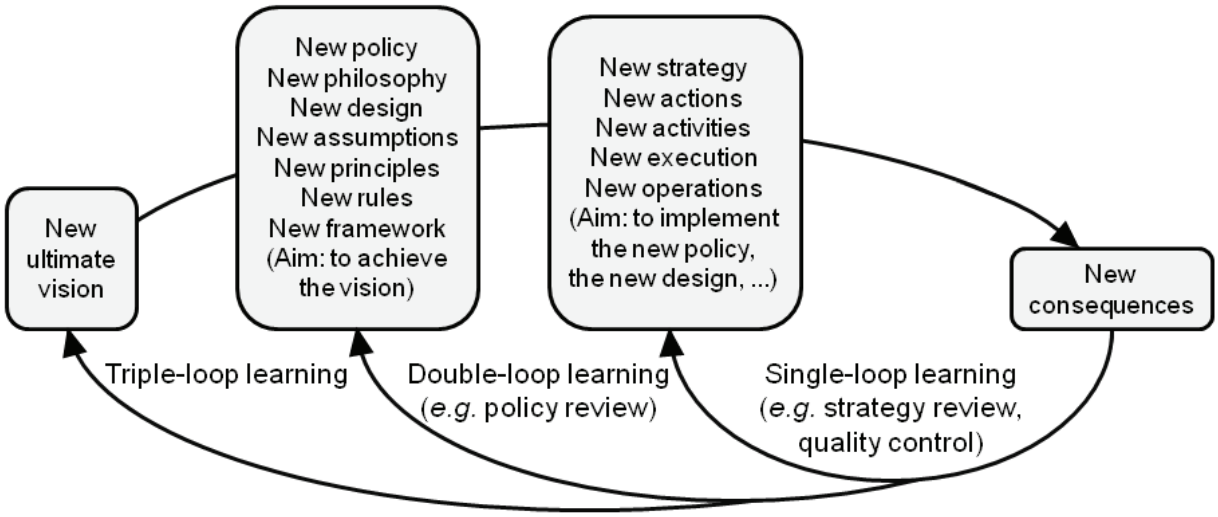


Figure 8 : Single-, double- and triple loop learning.

The general framework within which single-, double-, and triple-loop learning can be understood is as follows: An ultimate vision leads to a policy (design, assumptions, principles etc.) to achieve it, which in turn requires a strategy (actions, activities, etc.) to implement, which leads to consequences from which learning takes place.

In essence, single-loop learning changes what or how something is done. Double- and triple-loop learning changes why things are done.

Single-loop learning involves detection and correction of errors relating to everyday operations, much like in quality control. It typically results in incremental change (Smith, 2005).

Double loop learning involves questioning (reviewing), and revising if necessary, the policy, design, assumptions, principles, etc. for which an original strategy was developed. This can result in extensive revision of operational strategies (Smith, 2005).

Triple-loop learning occurs when the original premise behind the policy, design, assumptions, etc. is questioned (reviewed) and revised if necessary (Raelin, 2001). Radical reorganisation can result.

Ecological memory

See Memory, ecological

Governance

Governance is a political process of participative government in which society shapes the general rules of the game, one outcome of which is policy.

Governance, adaptive

Adaptive governance is governance that specifically caters for change because outcomes of some rules of the game (like policies) or associated management actions are uncertain or unpredictable. (Compare with Management, adaptive.)

Governance, cooperative

Cooperative governance is governance specifically aimed at facilitating individuals and organisations working together for mutual benefit.

Governance, ecosystem

Ecosystem governance is cooperative governance of social-ecological systems.

Heuristic learning

Heuristic learning is self-education using a combination of experimentation, trial and error, experience, and self-discovery (as opposed to being taught directly).

Heuristic rule

Heuristic rules are rules that permit a degree of ambiguity of interpretation. They provide general guidance in which extremes of tolerable and intolerable behaviour or interpretation may be clear, but for which there is a large grey area where personal interpretation is key (adapted from Snowden & Stanbridge, 2004).

Information

Information is data to which value has been added by interpreting that data in some context. An example is a water quality measurement (the datum) that has been assessed against a water quality guideline.

Knowledge

Knowledge is that which is known, or knowable by a person that can contribute to their capacity to act effectively (partly based on Dawson 2000). It can be explicit or tacit. It can be information that has been deeply contextualised using theory or experience (or both). An example is a water quality measurement (the datum) that has been assessed against a water quality guideline where (a) the theory of origin of the guideline is well understood or (b) there is long experience of the historical trend of this variable and its management. In either case, this extra contextualization can significantly contribute to a greater capacity to act effectively in the management of that variable.

Knowledge, explicit

Explicit knowledge is information in explicit form (e.g. stored in written form, equations, in databases, specifications, guidelines, etc.).

Knowledge, tacit

Tacit knowledge is knowledge that exists only in a person's head. It is often highly personal, context specific and difficult to codify and share (Nonaka et al., 2001).

Knowledge depth

Knowledge depth refers to the acute factual and contextual understanding of the subject to the extent that tacit knowledge becomes an integral part of communicating that understanding.

Knowledge-intensive organisations

Knowledge-intensive organisations are organisations in which knowledge has significant importance compared to tangible assets such as property, equipment and capital. The most important assets are the knowledgeable people in that organisation.

Learning

Learning is the creation of knowledge.

Learning organisation

A learning organisation is one skilled at (a) creating, (b) acquiring and (c) transferring knowledge, and (d) at modifying its behaviour to reflect new knowledge and insights (Garvin, 1993).

Management, adaptive

Adaptive management is the process of practically moving towards the vision created by adaptive governance. It relies heavily on monitoring that provides feedback and enables informed adaptation of both the governance and management processes (adapted from Boyle *et al*., 2001, cited in Folke *et al*., 2005).

Memory, ecological

Ecological memory comprises the species, processes and learning that persist in an ecosystem after a disturbance event (adapted from Berkes et al., 2003).

Memory, organisational

Organisational memory refers to how organisations encode, store, and retrieve the lessons of history despite the turnover of personnel and the passage of time (Levitt and March 1988). It provides a means to retain and transmit information from past to future members" (Stein 1995).

Memory, social

Social memory is the long-term communal understanding of their experience of the dynamics of environmental change and the associated successful and unsuccessful adaptations.

Paradigm

A paradigm is a philosophical or theoretical framework of any kind, a habit of reasoning or the box in the commonly-used phrase "thinking outside the box" (Wikipedia).

Reflection

Reflection is the practice of stepping back to ponder the meaning to self and to others in one's immediate environment about what has recently transpired (Raelin, 2001).

Resilience

Resilience is the capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same functions, structure, identity, and feedbacks (Walker et al., 2004).

Self-referential

Self-referential refers to being internally focussed, based on the individual's or group's own experience and lacking in external peer review.

Single-loop learning

See double-loop learning.

Social capital

Social capital refers to the degree to which the following exist: (a) trust, (b) reciprocity, (c) common rules, norms, and sanctions and (d) general connectedness in networks and groups (Pretty and Ward, 2001).

Social-ecological system

A social-ecological system is a linked system of people and nature.

Social memory

See Memory, social

Transdisciplinary hierarchy

A transdisciplinary hierarchy was proposed by Max-Neef (2005) as a combination of (a) natural social, economic, science and engineering disciplines, (b) sector disciplines (water, agriculture, industry, etc.), (c) country and international disciplines (political, legal, etc.), and (d) human value disciplines (ethics, etc.).

Triple-loop learning

See double-loop learning.

Unlearning

Unlearning means abandoning the application of previous knowledge in favour of newer knowledge considered to be more appropriate (Nystrom and Starbuck, 1984).

CHAPTER 7: REFERENCES

Allee V (2003). *The Future of Knowledge – Increasing Prosperity through Value Networks*. Butterworth-Heinemann, Boston.

Bandura A. 1977. *Social Learning Theory*. Prentice-Hall, Englewood Cliffs, New Jersey.

Berkes F, ColdingJ , and Folke C (2003). Building Capacity to Adapt to Change: The Context. In: *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. BerkesF , Colding J, and Folke C (Eds.) Cambridge University Press. Cambridge. 1-29.

Breen CM, Jaganyi JJ, Van Wilgen BW and Van Wyk E 2004. Research projects and capacity building. Water SA 30(4): 1-6.

Brown GP 1988. Observations on the use of symbolic interactionism in leisure, recreation and tourism. *Annals of Tourism Research*. 15(4): 550-552.

Cilliers P (2006). On the importance of a certain slowness. *Emergence, Complexity & Organization* 8(3): 106-113.

Cohen WM and Levinthal DA (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*. 35: 128-152.

Covey SR, Merrill AR and Merrill RR (1994). *First Things Thirst: Coping with the Ever-increasing Demands of the Workplace*. Simon & Schuster , London.

Cullen P, Cottingham P, Doolan J, Edgar B, Ellis C, Fisher M et al. (2001). *Knowledge seeking strategies of natural resource professionals*. Synthesis of a workshop held in Bungendore, New South Wales, June 5–7, (2001) Technical Report 2/2001, Cooperative Research Centre for Freshwater Ecology, Australia.

Dawson R (2000). *Developing Knowledge-Based Client Relationships – The Future of Professional Services*. Butterworth-Heinemann, Boston.

D'Andrade RG (1995). *The Development of Cognitive Anthropology*. Cambridge University Press. Cambridge.

De Coning C and Sherwill T (2004). *An assessment of the water policy process in South Africa (1994 to 2003)*. Water Research Commission Report No. TT232/04. Pretoria, South Africa.

De Pree M (1998). *Leadership is an Art*. Doubleday/Currency, New York.

DNRE (1997). *Best Practice in Performance Reporting in Natural Resource Management. A Report to the ANZECC Working Group on National Park and Protected Area Management*. Department of Natural Resources and Environment, Victoria.

Drackner M (2004). Culture and Change; a Knowledge Management Perspective. CSIR Environmentek Report No. ENV-P-I 2004-082. Pretoria, South Africa.

Drucker PF (1993). *Post Capitalist Society*. Harper Business Publishers, New York.

Drucker P (2001). *Management Challenges for the 21st Century*. Harper Business Press, New York.

Easterby-Smith M (1997). Disciplines of organizational learning: Contributions and Critiques. *Human Relations*. 50(9): 1085-1113.

Ehrlich PR and Levin SA (2005). The evolution of norms. *PLoS Biol* 3(6): e194.

European Commission (2004). *Business Knowledge Management: A study on market prospects, business needs and technological trends*. IBM United Kingdom, Basingstoke.

Fichmann M (2003). Straining towards trust: Some constraints on studying trust in organisations. *Journal of Organisational Behavior* 24: 133-157.

Fioretti G and Visser B (2004). A cognitive interpretation of organizational complexity. *Emergence, Complexity & Organization* 6(1-2): 11-23.

Folke C, Hahn T, Olsson P and Norberg J (2005). Adaptive governance of social-ecological systems. *Annual Review of Environmental Resources*. 30:441-473.

Garvin DA (1993). Building a Learning Organisation. *Harvard Business Review*, July-August, pp.78-91.

Hannerz U (1982). Comparative culture theory: The production of culture in contemporary complex societies. An outline of research, Socialantropologiska Institutionen, Stockholms Universitet, Stockholm.

Hodgkinson GP (2003). The interface of cognitive and industrial, work and organisational psychology. *Journal of Occupational and Organisational Psychology* 76: 1-25.

Hollinshead M (2002). The brain, the mind, and societal and cultural learning: the emergence of a new paradigm of future research. *Futures* 34:509–521.

Johnson-Laird PN (1983). *Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness*. Cambridge University Press, Cambridge, UK.

Keen M, Brown VA and Dyball R (2005). Social Learning: A New Approach to Environmental Management, in: M Keen, VA Brown and R Dyball (Eds), *Social Learning in Environmental Management: Towards a Sustainable Future* (London, Earthscan), pp. 1-21.

Kim DH (1993). The link between individual and organizational learning. *Sloan Management Review* 35(4): 37-50.

Lakomski G (2001). Organizational change, leadership and learning: Culture as cognitive process. *The International Journal of Educational Management* 15: 68-77.

Levin SA (1998). Ecosystems and the biosphere as complex adaptive systems. *Ecosystems* 1: 431-436.

Levitt B and March JG (1988). Organizational learning. *Annual Review of Sociology* 14: 319-410.

Lock D (ed.) (1998). *The Gower Handbook of Management*. Gower Publishing, Hampshire.

Lubchenco J (1998). Entering the century of the environment: a new social contract for science. Science 279: 491-497.

Malhotra Y (1997). Knowledge Management in Inquiring Organizations. In: Proceedings of the 3rd America's Conference on Information Systems (Philosophy of Information Systems Minitrack) Indianapolis, August 15-17, 1997, pp. 293-295.

Max-Neef MA (2005). Foundations of Transdisciplinarity. *Ecological Economics*. 53: 5-16.

McCallum I (2005). *Ecological Intelligence: Rediscovering Ourselves in Nature*. Africa Geographic. Cape Town.

McElroy MW (2003). *The New Knowledge Management: Complexity, Learning, and Sustainable Innovation*. Butterworth-Heinemann, Boston.

Miller WL and Morris L (1999). *4th Generation R&D – Managing Knowledge, Technology, and Innovation*. John Wiley & Sons, Inc. New York.

Nkhata AB, Breen CM and Freimund WA (2008). Resilient social relationships and collaboration in the management of social-ecological systems. *Ecology and Society* 13(1): 2.

Nonaka I, Konno N and Toyama R (2001). Emergence of "Ba". In: Nonaka I and Nishiguchi T (Eds.). *Knowledge Emergence: Social, Technical and Evolutionary Dimensions of Knowledge Creation*. Oxford University Press. New York.

Nonaka I and Takeuchi H (1995). *The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation*. Oxford University Press.

Nystrom PC and Starbuck WH (Eds.) (1984). 'To Avoid Organizational Crises, Unlearn'. *Organizational Dynamics* 12(4): 53.

Pahl-Wostl C and Hare M (2004). Processes of social learning in integrated resources management. *Journal of Community and Applied Social Psychology*. 14: 193-206.

Pretty J and Ward H (2001). Social Capital and the Environment. *World Development* 29(2): 209-227.

Raelin JA (2001). Public Reflection as the Basis of Learning. *Management Learning* 32(1): 11-30.

Reynolds C (2001). *Boids: Background and Update*. http://www.red3d.com/cwr/boids/.

Roux DJ, Murray K and van Wyk E (2008). Learning to learn for social-ecological resilience: Balancing strategy options in public sector organisations. In: Burns M and Weaver A (Eds.). *Exploring sustainability science – a southern African perspective*. African Sun Media, Stellenbosch, South Africa.

Roux DJ, Murray K, van Wyk E and Hill L (2009). *Enabling effective learning in catchment management agencies: Research report*. Water Research Commission Project K5/1689. Pretoria, South Africa.

Roux DJ, Rogers KH, Biggs HC, Ashton PJ and Sergeant A (2006). Bridging the science-management divide: Moving from unidirectional knowledge transfer to knowledge interfacing and sharing. Ecology and Society 11(1).
Online: http://www.ecologyandsociety.org/vol11/iss1/art4/.

Rowley TJ, Moldoveanu M (2003). When will stakeholder groups act? An interest- and identity-based model of stakeholder group mobilization. *Academy of Management Review* 28: 204-219.

Sagasti F (2004). Knowledge and Innovation for Development: The Sisyphus Challenge of the 21st Century. Edward Elgar, Cheltenham, UK.

Schein EH (1995). Kurt Levin's Change Theory in the Field and in the Classroom: Notes Toward a Model of Managed Learning.
Online: http://www.solonline.org/static/research/workingpapers/10006.html .

Seel R (1999). *Complexity & Organisational Development – An Introduction*. http://www.new-paradigm.co.uk/complex-od.htm.

Senge PM (1990). *The Fifth Discipline*. Doubleday, New York.

Senge PM (2006). *The Fifth Discipline: The Art and Practice of the Learning Organisation*. Random House, London.

Shelton RD (2001). Developing an internal marketplace for innovation – balancing creativity and commercialisation. Arthur D. Little Prism, Issue 1.

Shore B (1996). *Culture in Mind: Cognition, Culture, and the Problem of Meaning*. Oxford University Press, Oxford.

Smith MK (2005). Learning in organizations. Infed (the informal education homepage). Online: http://www.infed.org/biblio/organizational-learning.htm

Smith PAC and Sharma M (2002). Developing personal responsibility and leadership traits in all your employees: Part 1 – Shaping and harmonizing the high-performance drivers. *Management Decision* 40: 764-774.

Sorrels-Jones J and Weaver D (1999). Knowledge workers and knowledge-intense organizations, Part 1: A promising framework for nursing and healthcare. *Journal of Nursing Administration* 29: 12-18.

Snowden D (2002). Complex acts of knowing: paradox and descriptive self-awareness. *Journal of Knowledge Management* 6(2): 100-111.

Snowden D and Stanbridge P (2004). The landscape of management: Creating the context for understanding social complexity. *Emergence: Complexity and Organizations* 6(1-2): 140-148.

Snyder WM and Wenger E (2004). Our world as a learning system: a communities of practice approach. In: Conner ML and Clawson JG (Eds), *Creating a Learning Culture: Strategy, Technology and Practice*. Cambridge University Press, Cambridge.

Stacy R (2001). *Complex Responsive Processes in Organizations: Learning and Knowledge Creation*. Routledge, London.

Stein EW (1995). Organizational memory: review of concepts and recommendations for management. *International Journal of Information Management* 15(1): 17– 32.

Stewart TA (1997). *Intellectual Capital: The New Wealth of Organizations*. Bantam Doubleday Dell Publishing Group, New York.

Steyn P (2005). The lingering environmental impact of repressive governance: the environmental legacy of the apartheid era for the new South Africa. *Globalizations* 2(3): 391-402.

Strauss C and Quinn N (1997). *A Cognitive Theory of Cultural Meaning*. Cambridge University Press, Cambridge.

Sutton RI and Hargadon A. (1996). Brainstorming groups in context: Effectiveness in a product design firm. *Administrative Science Quarterly* 41: 685-718.

Sveiby KE (1997). *The New Organizational Wealth – Managing and Measuring Knowledge-Based Assets*. Berett-Koehler Publishers, Inc. San Francisco.

Sveiby KE (2001). Knowledge Management –The Viking Way.
Online: http://www.sveiby.com/articles/vikings.html.

Szulanski G (1996). Exploring internal stickiness impediments to the transfer of best practice within the firm. *Strategic Management Journal* 17: 27– 44.

TBCS (1996). *Quality Services Guide VII – Benchmarking and Best Practices*. Treasury Board of Canada Secretariat.
Online: www.tbs-sct.gc.ca/tb/pubs/qual-mgt/ENG/8qgl-1e.html.

Van Kerkhoff L and Lebel L (2006). Linking knowledge and action for sustainable development. Annual Review of Environmental Resources. 31: 445–77.

Viitala R (2004). Towards knowledge leadership. *The Leadership & Organization Development Journal* 25: 528-544.

Von Krogh G, Ichijo K and Nonaka I (2000). *Enabling Knowledge Creation: How to Unlock the Mystery of Tacit Knowledge and Release the Power of Innovation*. Oxford University Press. New York.

Von Krogh G, Ichijo K and Nonaka I (2001). Bringing Care into Knowledge Development of Business Organizations. In: *Knowledge Emergence: Social, Technical and Evolutionary Dimensions of Knowledge Creation*. Nonaka I and Nishiguchi T (Eds). Oxford University Press. New York.

Walker B, Holling CS, Carpenter SR and Kinzig A (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society*. 9(2): 5.
Online: http://www.ecologyandsociety.org/vol9/iss2/art5/

Washburn SL and Hamburg DA (1965a). The Study of Primate Behavior. In: *Primate Behavior: Field Studies of Monkeys and Apes*. DeVore I (Ed.). Holt, Rinehart and Winston, New York.

Washburn SL and Hamburg DA (1965b). The Implications of Primate Research. In: *Primate Behavior: Field Studies of Monkeys and Apes*. DeVore I (Ed.). Holt, Rinehart and Winston, New York.

Wenger E (1998). *Communities of Practice: Learning, Meaning, and Identity*. Cambridge University Press, Cambridge.

Wenger E (2000). *Communities of practice and social learning systems*. Organization 7(2): 225-246.

Wenger E (2004). *Knowledge management as a doughnut: Shaping your knowledge strategy through communities of practice*. Ivey Business Journal. January/February 2004: 1-8.

Wenger E (2005). Learning for a small planet: a research agenda. Available online at http://www.ewenger.com/research/index.htm

Wenger E, McDermott R and Snyder WM (2002). *Cultivating Communities of Practice: A Guide to Managing Knowledge*. Harvard Business School Press, Boston.

Wikipedia. http://en.wikipedia.org.

Wilson EO (1999). *Consilience: The Unity of Knowledge*. Vintage Books, New York.

Zahra S and George G (2002). Absorptive Capacity: A Review, Reconceptualisation, and Extension. *Academy of Management Review*. 27 (2): 185-203.