INDIVIDUAL AND ORGANISATIONAL LEARNING AND THE ECOLOGY

FACTORS THAT INFLUENCE THE DIRECTION OF LEARNING

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Declaration

By submitting this thesis electronically, I declare that the entirety of the work contained herein is my own original work, that I am the owner of the copyright hereof (unless to the extent explicitly or otherwise stated) and that I have not previously in its entirety or in part submitted it for obtaining my qualification.

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Abstract

Organisations are required to change their internal structures and configuration at a rapid rate as the external environment changes. The external environment comprises of a number of actors and agents that make up society. This includes social movements and government. The influence that industry has over the actions of government is significant. The question is how society, via social movements and NGO's, influence government and thereby policy and how this leads to change in business organisations. How does learning take place in business organisations when it comes to ecological matters? What is the effect of social norms, expressed in public policy and social movements, on organisations? How can these processes be enhanced for the sake of the ecological agenda?

The aim of the research is to present a case for directing the learning process. Organisations will generally develop new products based on existing knowledge and grow this knowledge base. It is argued by some theorists that social movements and NGO's influence the process of innovation and development. To cater for the ecological elements in an innovation process, it must be part of the organisational objectives. It means that it must be catered for from the outset to direct and influence the process.

Chapter 1 outlines the problem statement and the argument that social norms influence the learning process of individuals and groups in organisation to achieve an ecologically friendly outcome in a variety of ways.

To determine if the hypothesis is true, Chapter 2 researched the subject of organisational learning. It examines the attributes that organisations must have to promote a learning agenda. This includes the role that the external organisational environment plays through feedback loops, and how these influence the direction of the learning process.

To understand issues regarding the ecology, I present in Chapter 3 a high level synopsis based on existing knowledge of economics, environmental economics and ecological modernisation.

Both Chapters 2 and 3 take a view on policy and the role it plays in shaping the learning process. It is important that the process of policy development is influenced from the outset. Through the networks of the social movements, alternatives may be presented to society. These alternatives are aimed at influencing the innovation process of organisations either

directly through the market or indirectly through policy. When society subscribes to the position presented, a social movement gives them the means to engage with industry and government.

Chapter 4 is a case study on carbon capture and storage. The purpose of the case study is to demonstrate the interaction of the various actors in a technology development process and the factors that have to be taken into account when making decisions. It is a demonstration of a directed learning process with the aim of developing an ecologically friendly technology.

Chapter 5 is the concluding chapter and provides a summary of learning organisations and ecological modernisation. I provide a brief summary of the main points in the argument and draw a conclusion on the relationship between organisational learning and how this learning is directed from the outset.

Opsomming

Organisasies moet hul interne strukture en verstellings te verander teen 'n vinnige tempo as die eksterne omgewing verander. Die eksterne omgewing bestaan uit 'n aantal van die akteurs en agente wat die die samelewing op maak. Dit sluit sosiale bewegings en die regering in. Die invloed wat die bedryf het oor die optrede van die regering is betekenisvol. Die vraag is hoe die samelewing , deur middel van sosiale bewegings en nie-regeringsorganisasies , die invloed van die regering en sodoende beleid en hoe dit lei tot verandering in die sake-organisasies . Hoe leer sake-organisasies wanneer dit kom by die ekologiese sake? Wat is die effek van sosiale norme , uitgedruk in openbare beleid en sosiale bewegings , op organisasies? Hoe kan hierdie prosesse verbeter word ter wille van die ekologiese agenda?

Die doel van die navorsing is om 'n saak te stel vir die regie van die leerproses. Organisasies sal oor die algemeen die ontwikkeling van nuwe produkte wat gebaseer is op bestaande kennis en groei van hierdie kennis basis. Daar word aangevoer deur sommige teoretici dat sosiale bewegings en NGO se invloed op die proses van innovasie en ontwikkeling. Om voorsiening te maak vir die ekologiese elemente in 'n innovasie proses , moet dit deel van die organisasie se doelwitte wees. Dit beteken dat voorsiening gemaak moet word vir dit van die begin af om die proses te beïnvloed.

Hoofstuk 1 omskryf die probleemstelling en die argument dat die sosiale norme beïnvloed die leerproses van individue en groepe in die organisasie 'n ekologies vriendelike uitkoms te bereik in 'n verskeidenheid van maniere.

Om te bepaal of die hipotese korrek is , Hoofstuk 2 ondersoek die onderwerp van organisatoriese leer . Dit ondersoek die eienskappe wat organisasies moet leer om die agenda te bevorder. Dit sluit in die rol wat die eksterne organisatoriese omgewing speel deur middel van terugvoer, en hoe hierdie invloed op die rigting van die leerproses is.

Kwessies rakende die ekologie te verstaan, het ek in Hoofstuk 3 'n hoë vlak opsomming gebaseer op die bestaande kennis van die ekonomiese , omgewings- ekonomie en ekologiese modernisering.

Beide hoofstukke 2 en 3 is 'n uitsig oor die beleid en die rol wat dit speel in die vorming van die leerproses. Dit is belangrik dat die proses van die ontwikkeling van beleid beïnvloed word van die begin af . Deur die netwerke van die sosiale bewegings , kan alternatiewe aangebied word aan die samelewing. Hierdie alternatiewe is gemik op die beïnvloeding van die

innovasie proses van organisasies , hetsy direk deur die mark of indirek deur beleid. Wanneer die samelewing onderskryf die posisie wat aangebied word, 'n sosiale beweging gee hulle die middele om betrokke te raak met die bedryf en die regering.

Hoofstuk 4 is 'n gevallestudie oor koolstof vang en stoor . Die doel van die gevallestudie is om die interaksie van die verskillende rolspelers in 'n tegnologie-ontwikkeling proses en die faktore wat in ag geneem word wanneer besluite geneem moet word. Dit is 'n demonstrasie van 'n leerproses met die doel van die ontwikkeling van 'n ekologies vriendelike tegnologie.

Hoofstuk 5 is die afsluiting hoofstuk en gee 'n opsomming van leer organisasies en ekologiese modernisering. Ek gee 'n kort opsomming van die belangrikste punte in die argument en 'n gevolgtrekking oor die verhouding tussen organisatoriese leer en hoe hierdie leer word gerig van die begin af.

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Chapter 1
Research Problem

1.1 Introduction

Organisations must change on a continuous basis to cater for the requirements of the external organisational environment due to one or more actors influence creating market shifts. These changes can be iterative and incremental, building on existing knowledge or radical and discontinuous based on new knowledge.   Change has an impact on the internal functioning of the organisation and will require adjustment in terms of processes or product. In order to deal with these changes, an organisation must have the internal structures and capability to adjust its internal architecture to accommodate the shift[1]. Effecting change to processes and products imply that the knowledge is resident or will be obtained through a process of learning.

The direction of the organisational change will be determined by strategic management in conjunction with individuals. If an organisations innovation was directed towards economic gain irrespective of the ecological impact,, directing the change towards an ecologically friendly outcome would require that actors and agents promoting the ecology influence the external and internal environments of the organisation. Organisational change requires individuals to learn and change how they filter information[2]. In organisations and society, individuals are members of groups or have access to groups that have influence and are able to influence agendas. Accessing a group that has influence will allow an individual to influence the strategic direction of an organisation if the individual's assessment of the environment is considered plausible by the group[3]. The organisation is viewed as a system and thus the individuals and groups operate within this system to achieve its goals and objectives. The assumption is that the group has influence over the setting of objectives and

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[1] Tushman, LT, Andersen, P. (eds) 2004. Innovation Streams, Organisation Designs, and Organisational Evolution in Managing Strategic Innovation and Change A Collection of Readings. 2-7.

[2] Weick KE, 1995, Sensemaking in Organizations, 112

[3] Kleiner, A. 2003. Core Groups: A theory of Power and Influence for "learning" organizations

the strategic direction and if agreement is reached, they will work together in achieving the organisation's objectives[4].

Using the above as a basis for implementing strategies to deal with change, consideration is given to the rate of change necessary to remain sustainable and grow market share. Organisations developing technology, as well as the organisations that take up new technology, are exposed to the environment that they operate in. Continuous development is critical if a technology company wishes to be a market leader. Organisations adopting a technology must find a way to also adopt the changes that is associated with introducing the new technology, i.e. modifying its existing internal architecture. The interaction of internal and external environmental factors gives rise to complexity. The manner in which these interactions occur must be assessed and modified to ensure a successful change.

In directing the change process, the issue of ecology and the ecological impact of new technologies must be considered if ecological and economic sustainability is to be achieved. This would require that individuals and groups in the organisation learn from the external environment through mechanisms such as feedback loops[5]. The ecological impact and the loss of use of the ecology has become an important issue that organisations must deal with. Nations, in conjunction with social groups are continuously exerting pressure on organisations to reduce the impact of technologies on the environment, as well as the use of materials. A primary argument in the literature reviewed is that economic benefit is the only consideration for investment by industry. Economic factors require that fewer resources are used, and the process of research and development instituted yield an increase in the profitability to the organisation. Ecological modernisation uses these principles looking at the development of technology with the aim of reducing the environmental impact and being economically feasible[6].

An organisation must have the internal capability and structures to deal with ecological innovation requirements if it is to produce products that meet the consumer's expectation. The fact that an organisation has to adapt to external and internal environmental conditions suggests change is necessary.   Individual and group mental models, through their

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[4] Kim, DH. 1993. The Link between Individual and Organizational Learning 44-45

[5] Hyland, PW, Gieskes, JFB, Sloan, TR. 2001. Occupational clusters as determinants of organisational learning in the product innovation process 198

[6] Jamison A. 2000. On Ambiguities of Greening, 251

interpretation, influence the organisation and the creation of a new shared model is a critical success factor for the adoption of a change initiative[7]. This implies change is introduced and driven through individuals who in turn influence a group through their association resulting in the acceptance thereof. It also suggests that the dynamic in initiating a "new" organisational process is complex and must be cognisant of the elements that could lead to the failure, i.e. not achieving the objective.

The research will demonstrate that a relationship exists between organisational learning through the individuals and groups that are influential and the direction that an organisation takes. Through the establishment of boundaries, the learning process is directed to achieve these objectives. If the objectives include an ecological aspect, the learning process will be directed to achieve an ecologically friendly outcome.

1.2   Organisational Learning Background

An organisation dealing with change in environments where knowledge creation is an imperative and product development is the focus requires internal organisational structures that promote idea generation. Organisational learning requires internal structures and an internal environment that will promote learning and idea generation. The underlying philosophy is that learning has to take place at an individual and group/team level. The complexity of creating an environment conducive to learning will be discussed.

In this regard the creation of a learning organisation is itself a complex task that deals with internal and external organisational environments. Individuals and their interpretations of data and environment as well as roles in groups are reviewed. This is aimed at building the argument that individuals and groups, while forming part of a learning organisation, are influenced partly by the external environment and in turn aims to effect internal changes in the philosophy of the organisation. These agents and actors of change set the tone for the next phase of technology development and innovation. Boisot and his work around knowledge assets is explored in great detail. The concept of knowledge assets is used in subsequent chapters to demonstrate that learning cycles are necessary for the evolution of data and information, which will correctly or incorrectly result in discarding certain data elements[8].

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[7] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 286

[8] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 96

The literature reviewed highlights various attributes, amongst others, that exert influence in the organisation and aids or blocks the change. The concept of the learning organisation does not in itself demonstrate a change in favour of the ecology, but represents the ability of the organisation to respond to environmental feedback.

1.3   *Ecological Modernisation Background*

Exploitation of the environment/ecology[9] has become an issue and society has become more active in protecting it. The internet provides a platform to create virtual communities and blogs, using it as a communication medium, increasing the reach of social movements. Social actors that recognise the adverse ecological impacts and promote the idea that more ecologically friendly innovation and technology developments are necessary could lead to change that starts to address ecological challenges. Governments are policy making institutions and their role in effecting ecological change in innovation processes is reviewed and considered in this research. Innovation together with social movement support in the development of ecologically friendly technologies creates conditions that could support change[10]. The organisation must consider the requirements for the development of new technologies and evaluate these requirements to determine whether a radical or incremental development philosophy will provide the desired solution. Regulation can be considered as catalyst for developing ecologically friendly technologies and products[11]. Compliance with the regulatory requirements also has to be considered and is an important dimension of the innovation process. This suggests that trade-offs must be considered in determining if the solution is economically viable and sustainable, and whether the market is ready. Organisations also have to consider a number of scenarios, including how competing organisations will respond to the external environment. Ecological modernisation is reviewed in the context of a win-win scenario, promoting both technological development and ecologically friendly products.

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[9] Exploitation of the environment/ecology makes reference to the excessive use of raw materials and the by-products created in manufacturing the product of through the use of the product.

[10] Sonnenfeld DA. 2002, Social Movements and Ecological Modernization: The transformation of Pulp and Paper Manufacturing, 2

[11] Murphy J. Gouldson A. 2000. Environmental policy and industrial innovation: integrating environment and economy through ecological modernization, , 35

1.4 *Research Methodology*

This is primarily theoretical research with the aim of reviewing research on learning organisations and ecological modernisation and whether conceptually it is possible that a relationship between learning organisations and ecological modernisation exists. It is by no means an all encompassing attempt and does not cover the entire scope of learning organisations nor does it deal with all the challenges in creating a learning organisation. It is an extract of key concepts that provides the basis to create an argument that individuals are influenced by social actors, who in turn sets a direction that the organisation takes in developing new technologies. Therefore for the innovation to be ecologically relevant, it must be part of the objective setting process.

Some of the key areas within the domain of ecological modernisation is reviewed and discussed, however this is also done in a selective manner. The concepts are extracted to provide sufficient insight into formulating an argument that demonstrates the relationship between learning and the ecological technological developments that take place in organisations.

The argument is crystallized and applied using carbon capture and storage as a case study to demonstrate the relationship. The primary source of information for the theoretical argument was extracted from articles published. The case study on carbon capture and storage was built on two primary information sources. These are the report drafted by the Intergovernmental Panel for Climate Change (IPCC) which was established as a joint initiative between the World Meteorological Organisation and the United Nations Environment Programme; and an MIT commissioned study to ascertain the Future of Coal as a fossil fuel in generating power. The IPCC report was compiled based on contributions from hundreds of experts, from different countries supported by their governments and from various disciplines all contributing to the study to combat climate change through carbon capture and storage. The MIT study was interdisciplinary in nature and combined the study of technology options and policy options. Supporting articles are reviewed to provide detail to the argument that social norms influence and will continue to influence individuals and groups in the process of learning and direct the development of ecologically friendlier technology.

1.5   Purpose of the Study

Organisational objectives are set by the strategic management team. They will initiate a process for research and development and develop and implement a strategy that with the aim of achieving the desired outcome. Organisations comprise of individuals which, through alliances, are actors that form part of a group in within the informal structures. . Once the objectives have been set, it establishes a data/information boundary and organisations in most instances will select data/information that promotes their goal. An assessment of the environment provides insight into existing "knowledge assets"[12] and the strategy is aimed at leveraging these assets in the research and development process. The objective of this research is to demonstrate that society has an influence in directing research and development with the aim of ecological protection through social movements, legislation and market actors. . Each of the preceding categories of actors must have an understanding in the particular discipline from an ecological perspective, promoting the need for an intervention. This in turn requires ecological actors to have certain level of knowledge to engage with the industry and government. The hypothesis is that an individual, having undergone a learning process shares the learning with a group that he/she is affiliated with. If the knowledge shared is convincing and complies with the purpose of the group, a new or revised shared mental model is adopted. Individuals may form part of multiple groups, which are internal and external to an organisation. If the individual has access to or is part of a group within an organisation that has influence, the individuals mental model is shared in an attempt to create a revised or new shared model. This influence can shift the information boundary of an organisation and redirect organisational resources to develop new technologies aimed at protecting the ecology. Actors representing industry will be well versed in their technology and the reasons to maintain current research and development trajectories.   External organisational groups wishing to influence to direction of research and development must therefore be well versed in the current and alternatives to existing technologies if they are to participate meaningfully in the debate. .

This study will present a perspective on the role that external organisational actors play in influencing an individual's cognitive processes in terms of the ecology. These individuals, having a shared model with groups in organisations are considered and the role they play or can play in directing the research and development trajectories in favour is both economic

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[12] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 4

and ecological outcomes. The individual may not be part of the formal hierarchy but generates power through the informal networks that exist within the organisation, thus making individual agency a key to influencing the direction of change.

1.6   Outline of Thesis

Chapter 1 presents the two key concepts, namely organisational learning and ecological modernisation, which is fundamental in forming the argument. It also outlines the purpose of the study including the research methodology that is applied.

Chapter 2 reviews research pertaining to learning organisations and some of the qualities and attributes that are necessary to create a learning organisation. An assessment of the role of individuals and the various roles that an individual can play within the organisation is explored with a view to obtain some insight into the mechanics of the circle of influence. The field of organisational learning is diverse and the concepts under discussion within the chapter are aimed at promoting the argument pertaining to learning and directing learning initiatives in favour of economic as well as ecological gains. Innovation, be it product or process, is a key outcome of the organisational learning process.

Chapter 3 reviews the field of ecological modernisation. This paper focuses on how research and development of technology and innovation can be, and in instances are directed to achieve an ecologically friendly and economically viable outcome for the organisation. In this chapter, a link is made between learning, innovation and the ecology. Interest groups, industry and Government structures including supra-structures such as the EU are discussed with a view to understanding the drivers of ecological change. Mechanisms such as regulation are analysed to gain insight into the level of incentives and protection as catalysts, and is required when Governments are promoting an ecological agenda.

Chapter 4 is a desktop case study of the carbon capture and storage (CCS) proposal that is recommended and endorsed by most governments as a carbon emission reduction strategy. Research articles are the primary source of information with two documents forming the foundation of the knowledge base, the Intergovernmental Panel on Climate Change (IPCC) report on CCS which is endorsed by all countries that form part of COP; and the MIT case study on the Future of Coal. The chapter reviews the processes and the technology as well as the experience and learning that has occurred and in still required in the process of developing the technology for implementation. It draws on the previous two chapters to

strengthen the argument that individuals are critical in technology development but the endorsement of the technology requires the buy-in of actors from the different segments, i.e. industry, society and government.

Chapter 5 is the concluding chapter and notes the influence that each group has in accepting a technology like carbon capture and storage, especially as it is still under development. The case of learning and innovation, starting with the individual, is highlighted as critical elements in promoting ecologically friendly technologies. The chapter concludes by drawing a correlation between society, individuals, interest groups and government in the quest to develop ecologically friendly technologies.

Chapter 2
Individual and Organisational Learning

2.1　　　*Introduction*

The purpose of this chapter is to explore the topic of learning from both an individual and organisational level. To understand some of the organisational environmental requirements of the organisational learning process, I will explore relevant elements of organisational dynamics in terms of the influence that these have in setting the direction an organisation takes. The subject of knowledge assets[13] is discussed with a view to explore learning cycles in subsequent chapters. An attempt is made to determine the role of the various actors, such as individual, internal and external groups, and the manner in which their knowledge, mental models, shared vision and learning influence the direction of the organisation. The research material studied was for the purpose of obtaining an understanding of the environmental factors that individuals and groups encounter in executing their respective function which influences the learning process. This is also not the "silver bullet" in creating a learning organisation, but rather to understand and assess actors, agents and process, amongst others, that are relevant and influences the direction that an organisation takes. These are viewed as important elements as they will "push" an organisation down a particular development path. This path is especially important when an organisation adopts a technology development path for its research and development phase, which is further discussed and elaborated on in Chapter 3 and Chapter 4.

Understand the learning process and the path that is traversed to get to decisions, directing learning through the setting of boundaries and some of the organisation's environmental elements that will determine or impact the learning process are important in developing the argument. To gain insight into learning, I start with a review of individual learning. Elements that contribute to individual learning are identified and reviewed and the impact that it has on

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[13] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy

the process. In the context of organisational learning, organisations are considered to be the primary influence on the individual learning process with the aim of achieving the organisations objectives. The internal environment and configuration thereof will direct the learning process. As mental models shape the learning process on an individual level and shared models on a group level, the concept of interpretation is explored. Arguments developed by Daft and Weick[14] regarding interpretation as well as Kim[15] regarding individual learning provide insight into interpretation with the aim of improving our understanding of directed learning. The decision making process for the development and adoption of a strategy also involves interpretation and requires knowledge of the environment. Leadership and leadership style are explored to determine the impact that it has on learning and creating a learning environment.

With the exploration of the topic on leadership it is deemed necessary to address the issue of power and the role that it has in defining boundaries and creating an environment. Power in its various forms is considered a key element in the learning process and discussed with a view to assessing, at a high level of abstraction, the impact that it has in setting a strategic direction. This sets the platform for the organisational culture and whether the culture that develops will promote learning and innovation. On the point of leadership and culture, the research aims to demonstrate that leadership style influences culture. It can either promote of stifle change depending on the belief system and the extent to which the group can make sense of the external environment in relation to the internal environment[16].

Knowledge creation and learning require a discussion of tacit and explicit knowledge. Nonaka and Takeuchi's viewpoint on the subject is presented with the aim of demonstrating the process of learning, including experiential learning. Another perspective presented is the work done by Boissot, which is especially important since knowledge exploitation in the learning process requires the organisation to sweat assets. With reference to learning, this asset is knowledge. Knowledge creation takes place within boundaries and setting these boundaries determines the extent of coverage of the research and development. Exploring the I-Space[17] provides some clarity on directing the learning process.

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[14] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 284 – 295

[15] Kim, DH. 1993. The Link between Individual and Organizational Learning, 37 – 50

[16] Bass, BM. 1990. From transactional to transformational leadership: learning to share the vision, 9 – 32

[17] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy

2.2   Learning

Learning is something that is continuous and associated with both successes and failures, i.e. something is learnt irrespective of whether the goal that was set at the outset was achieved or not. Failures however create the environment to change and improve and are often a source of inspiration for the learning process as it inspires the team or individual to push ahead[18]. As is the case with learning, organisational learning always takes place whether it is an objective of an organisational initiative or not. The key to organisational learning is linked to individual learning since organisations as entities must have a medium to learn through. The medium in this instance are the individuals that make up the organisation. The method and tools of transfer of learning from the individual to the organisation determines the effectiveness and quality of the learning process.[19] Another factor that must be considered is the internal environment. The internal environment will determine the rate at which the learning is necessary or required for sustainability or progress. Schein[20] points out that environmental instability has increased significantly and with this increase the rate at which individuals and organisations have to learn has become an imperative. He also points out that learning is not a unitary concept considering that organisations comprises of individuals with different culture, belief systems and values. The individual learning ability and process is therefore a critical element in the organisational learning process.

Boisot argues that the learning takes place through a process of reducing data. This s achive when one extracts information from data and then discards the data once the objective is achieved. The figure below is used to describe the process of learning, and distinguishes between two different learning processes. One is continuous learning as a result of doing things over time. Second is discontinuous learning which comes about due to insight. The data processing agent derives patterns from the data which modifies the ability to act on the information. This modification is the act of creating new knowledge as a result of the data processing agent interrogating the data. In the figure below, knowledge application and knowledge creation are two distinct areas.   However new knowledge cannot be created without knowledge being applied. The application of knowledge provides data processing agents with the ability to apply newly created knowledge. This results in a cumulative

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[18] Martensen, A, Dahlgaard, JJ. 1999. Strategy and Planning for innovation management – supported by creative and learning organisations, 881

[19] Kim, DH. 1993. The Link between Individual and Organizational Learning, 37

[20] Schein, EH, 1993. How can organisations learn faster? The challenge of entering the green room. 85+

collection of data. The learning that takes place as a result of experience is tacit knowledge. For the purpose of sharing this information within organisations, they require the knowledge to be shared internally, i.e. it must be codified[21].

Figure 1 – Evolutionary Production Function
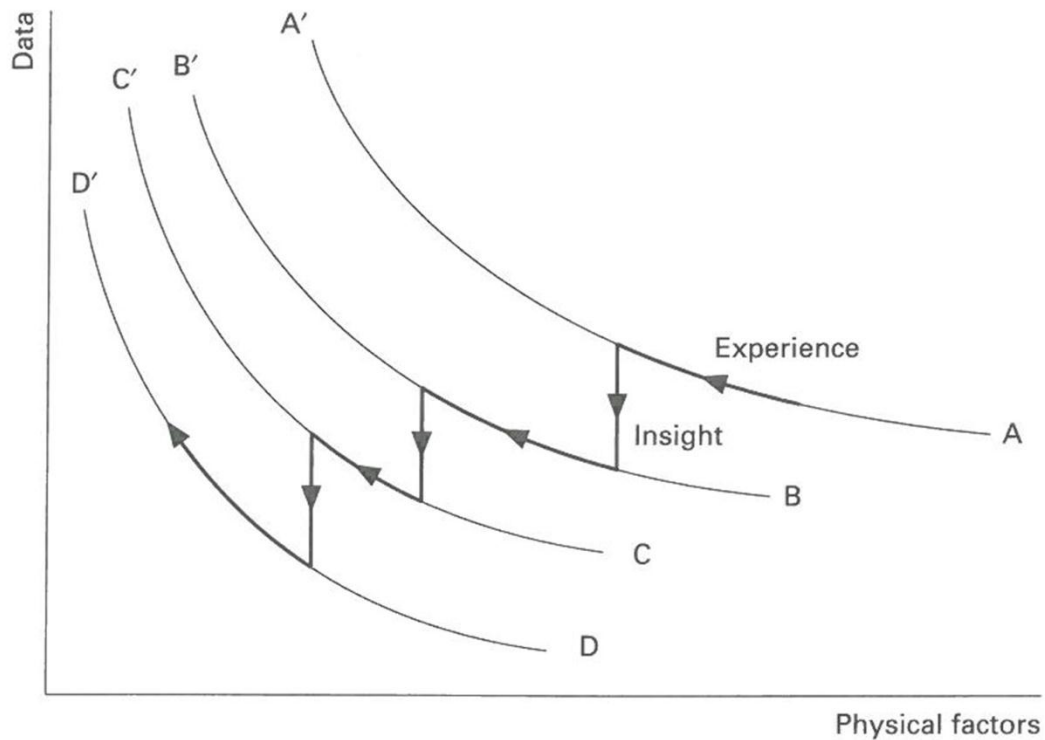
Experience and Insight in the Evolutionary Production Function

 Source – Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 37

2.2.1 Individual Learning

In literature that has been reviewed for this chapter, a distinction is made between individual and organisation learning, i.e. an individual can learn without an organisation but organisations cannot learn without an individual. Kim supports the learning arguments made by Argyris and Schön , Piaget and Kolb   All the authors agree that learning refers to "what people learn (know how) and how they understand and apply that learning (know why)"[22]

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[21] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 28-39

[22] Kim, DH. 1993. The Link between Individual and Organizational Learning. 38

Kim makes reference to the work of 4 authors in terms of learning – (1). Argyris and Schon argue that learning is translated into different behaviour that is replicable. (2). Kolb states "Learning is the process whereby knowledge is created through the transformation of

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Boisot asserts that a firm's knowledge is found in the individuals that work for the organisations, i.e. the tacit knowledge. This is further supported as significant parts of the tacit knowledge gained through experience by the individual cannot be codified. It will remain with the individual and influence future learning cycles[23].

Kim provides us with a definition of learning which is, "increasing one's capacity to take effective action"[24]. It is experiencing an event, the assessment of the event in terms of the mental model of the individual doing the learning, adjusting that mental model and changing actions in the world based on the new mental model and the process starts all over again. There is a continuous cycle of learning that occurs on an individual level[25].

Kim also suggests that in the process of learning, memory is a key factor that links individual and organisational learning. Memory and learning are very much integrated in that memory is the storage of what has been learnt. Learning is about acquiring through experience or observation and processing them against the backdrop of previous learning. Based on this it is evident that what is learnt is based on the existing memory but also what is learnt will influence and impact memory of previous learning thus creating a new memory. Kim elaborates further and states that within memory there are active structures that will impact on the way we process and mental models is a good way of understanding these structures. Mental models play a crucial role in the ability of how an individual sees and does things as these models are the individual's representation of the world. In essence it is the view of the world of a particular individual and how that individual experiences the world, but also what the individual takes from the world through observation and participation. Learning has two parts, operational and conceptual, which is related to two parts of mental models. Operational learning has to do with doing things that are routine. Conceptual learning involves analysing and understanding the reasons for things being done in the first place. The two types are required to work together for effective learning.[26]

Individuals participate in decision-making processes, which require a "data shedding" process. This process can result in potentially useful data being shed, albeit unknown at the

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experience". (3). "For Piaget, the key element to learning lies in the mutual interaction of accommodation (adapting our mental concepts based on our experience in the world) and assimilation (integrating our experience into existing mental concepts)."

[23] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 86

[24] Kim, DH. 1993. The Link between Individual and Organizational Learning, 38

[25] Kim, DH. 1993. The Link between Individual and Organizational Learning 39

[26] Kim, DH. 1993. The Link between Individual and Organizational Learning 38 - 40

time. Individuals that were part of the decision making process will have some of the data committed to memory. It becomes part of their tacit knowledge base. If these individuals are still will the organisation in later years, the commitment to memory could become useful to the organisation during later learning cycles[27].

DeChurch and Mesmer-Magnus introduces the concept of team mental models and does a comparison of team transactive memory with that of individual memory post training. Team mental models are visible in expert teams that must perform and co-ordination of execution takes place without having to communicate. The transactive memory model is based on the explanation that teams that were trained together do perform much better than teams that were individually trained[28].

Schein distinguishes between three types of learning, (1) Knowledge acquisition and learning, (2) Habit and skill learning, (3) Emotional conditioning and learned anxiety[29]. Information acquisition is a necessary and critical component for building a knowledge base. The knowledge base is not in itself a learning tool as insight into the information using existing knowledge is necessary. Only once there is insight can a new direction or approach be determined. The second kind of learning is one that affects the behavioural traits of individuals. During the learning process, individuals make errors which are ignored with the aim of the individual focusing on their improvement through the demonstration of correct and desirable behavioural traits, i.e. ignore what is not within the existing boundary that has been set. The psychological aspect of this kind of training is based on the fact that the individual experiences a type of *anxiety*. In this case, the individual experiences a level of frustration and the individual is anxious due to their inability to achieve the correct or desired behaviour. A driving force that pushes the individual is the fact that there is a desire to overcome the level of incompetence being experienced to achieve a stable, correct and desirable set of habits. Error tolerance is viewed as a necessary element and plays an invaluable role in the learning process, and this is not always available in the environments that individuals operate in. Environments in a traditional organisational structure are usually hostile and offer little support for learning through mistakes. The third kind of learning is emotional conditioning and learned anxiety. This is a very effective learning method, in fact it is deemed to be more

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[27] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 44-45

[28] DEChurch, LA, Mesmer-Magnus, JR, 2010, The Cognitive Underpinnings of Effective Teamwork, A meta-analysis, 33

[29] Schein, EH, 1993. How can organisations learn faster? The challenge of entering the green room 85+

effective than learning through reward which is associated with traditional organisational structures and leadership. It is however not a positive learning tool as it punishes for incorrect or inappropriate behaviour but does not guide the learning processes in getting to the correct or desired behaviour or outcome. This implies that the individual is not encouraged to learn or to step outside of what is considered to be normal and acceptable behaviour. Once this type of conditioning is set, it narrows the range of the individual and the organisation. No new learning or behaviour will occur due to the internal environment being intolerant to mistakes.[30]

Boisot, like Schein, also asserts that new knowledge is generated through experience and memory of individuals. In a system and over time, data is accumulated. This data can only be reduced through acts of insight, shifting the knowledge base to a new level and the cycle starts all over again[31].

From the above, it is evident that process of individual learning is a complex path to traverse as the methods and manner of learning are determined not only by the individual's mental models, but also by what the internal environment allows through policies and procedures, amongst others. It is necessary to provide a definition of individual learning and for this purpose, I have used the definition of Kim, i.e. individual learning can be viewed as "*a cycle of conceptual and operational learning that informs and is informed by mental models.*"[32]

2.2.2   Organisational Learning

Organisational learning is far more complex than individual learning since it involves a number of individuals. Learning at this level is significantly different from individual learning due to the fact that a number of people are involved in developing and effecting processes which results in *moving*[33] the organisation. This creates the situation of dealing with multiple perspectives (mental models) of the same situation[34]. The complexity of the engagement of multiple individuals is clear in the model presented by Beer, in which he uses an example of 40 individuals trying to communicate with each other. Should there be no

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[30] Schein, EH, 1993. How can organisations learn faster? The challenge of entering the green room 85+

[31] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 31-32

[32] Kim, DH. 1993. The Link between Individual and Organizational Learning. 40

[33] This movement can be either negative or positive as learning can be both productive and counterproductive to the organisation.

[34] Kim, DH. 1993. The Link between Individual and Organizational Learning 40

constraints or rules governing the communication, the formula n(n-1) provides one with the number of channels that will be available. This would result in 40 people being able to communicate using 1560 different permutations. It is a completely undesirable state and a state that must have some form of boundary if the organisation is to achieve anything[35].

Organisations are made up of individuals and therefore their learning ability has a significant impact and influence on the organisational learning process. Kim supports Argyris and Schön[36] stating that organisations have a shared model[37] with shared assumptions that helps to maintain the balance in the organisation.   The argument presented suggests that organisational learning has to develop shared models. This will govern the behaviour of individuals in so far as people being unnecessarily argumentative or unruly, i.e. managing interactions that are potentially counterproductive to the goals of the organisation. Later in the chapter power is introduced which provides Kleiner's view on promoting learning and maintaining order in an organisation. The learning of an organisation is represented in the routines that are developed, such as standard operating procedures which play a role in the governance of the organisation. Implementation of standard operating procedures can be attributed to past learning and has therefore become part of the organisations memory. It is critical that the organisation is able to emphasise the context of the routines that have been implemented so that it still allows progressive goals to be set. Organisational learning is a process, as is the case with individual learning. Therefore there has to be a measure on whether changing routines, which has been implemented based on previous learning, is necessary to cater for a new environment[38].

Organisations continuously change their behaviour and these behavioural changes are guided by the feedback from the environment. Short-term feedback is governed by a well defined set of rules since the information of the external environment is analyzable. When information from the external environment is believed to be vague at best, more general rules apply giving the individuals more latitude in the determining the behavioural change.[39]

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[35] Beer, S. 1974. Designing Freedom. House of Anansi Press Limited 15

[36] Kim, DH. 1993. The Link between Individual and Organizational Learning 41,

Kim states that "Argyris and Schön present a theory whereby organisational learning takes place through individual actors whose actions are based on a set of shared models."

[37] There are other models and theories that have been developed and demonstrate the influence it has on organisational stability, however for the purposes of this paper the theory of Argyris and Schon is presented.

[38] Kim, DH. 1993. The Link between Individual and Organizational Learning 41

[39] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 288-289

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There is a change that occurs in organisational behaviour which is influenced by the change that occurs on an individual's belief system. This behavioural change is influenced by the external environment which in turn requires that the internal environment responds to this change. This change will have an influence on the individual's belief system which will reinforce it in either a positive or negative way. This suggests a strong link between the external environment, the individual and the organisation. A number of scenarios may also present itself in which learning does not take place in the learning cycle discussed above. There must be a balance between conceptual and operational learning for organisational learning to be effective. It is also necessary that the complexities involved in organisational learning be acknowledged and understood as it impacts the process of design. An organisation must and will learn from its external environment, however learning also takes place internally based on the learning of the individuals and groups that make up the organisation. The perception that the individuals and organisation has of the external environment influences and plays a role in determining what they learn and look for and thus the analysis of information is dependent on their interpretations.[40]

In the learning process, codification and abstraction of tacit knowledge provides a basis to exploit the knowledge asset. The exploitation thereof implies that interpretation takes place which is a subjective process. The level of variety increases as the size of the population increases. Should the learning result in a paradigm shift from an organisational perspective, it may require the destruction of existing knowledge in favour of new knowledge. However, the tacit knowledge will remain in the people of the organisation, and play a role in the interpretation of future learning cycles.[41] Interpretation is a subjective process, however it plays a significant role in determining the path that an organisation takes in terms of its internal structure as well as the manner it engages the external environment. Depending on the context, the content of codification may change. The subject of interpretation must be explored to obtain a greater understanding of how it can influence organisations.

2.2.3   Learning and the I-Space

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[40] Kim, DH. 1993. The Link between Individual and Organizational Learning 42-43

[41] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 94-100

2.2.3.1   Codification, Abstraction and Diffusion

Experiential learning is the gradual accumulation of data over time which at some stage during the data accumulation and shedding process leads to discontinuous learning as a result of gaining insight. The accumulation process is also called experiential learning whilst discontinuous learning shreds data. For effective learning to occur, the act of codification and abstraction is crucial in reducing the data volume. It is a process of categorising data to take on general properties which reduces the volume of data. This process is essential if the organisation is to communicate effectively. The I-Space brings these elements together into a "single conceptual framework". This framework is a representation of codification, abstraction and diffusion of data and information. It depicts information flows that are necessary for the creation and diffusion of knowledge. Codification is the process of "assigning phenomena to categories". The more complex the phenomena, the more difficult it is to codify. Codification is a process that is undertaken to reduce data processing resources, however the more categories that require codification in the data set, the more complex and time consuming the exercise. To select something that will be included in codification implies that something has been rejected, i.e. data has been shed. Another way of putting it is that only data that fits into the model of the data processing agent is selected; i.e the data has been interpreted in a particular way[42].

Abstraction and codification work together. Codification is about giving "form to phenomena" whilst abstraction gives the phenomena structure. It is a process undertaken to keep the number of categories at a minimum for a specific task of codification. As a result, the process of abstraction reduces the number of attributes that must be codified per category. Abstraction can be viewed as reductionist.[43]

Diffusion refers to that proportion of a population for which the information would be meaningful to varying degrees if there was an interest. The population in this instance can refer to organisations, industries and countries. It is however a requirement that each member of the population has the capacity to receive, process and transmit data. Boisot supports Shannon and Weaver who identified three problem areas that arise in any communication:-

> 1. Is the message received the same as the message sent?

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[42] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 41-47

[43] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 48-52

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2. Is the message received understood?

3. Is the message received acted upon as intended?

This highlights the fundamental issues that are experienced in the diffusion of a message in the target population.[44]

2.2.3.2   I-Space – an integrated conceptual framework

The I- Space is a conceptual framework that is used to understand how information flows work. It conceptually brings together the acts of codification, abstraction and diffusion. Using this framework, one can better understand the process for creating and diffusing knowledge within a specific population. Availability of information does not imply that it will be used within a particular population. Information reach within a given data processing agent population will be higher when the level of codification and abstraction is high, but it does not mean that the information is taken up by the target population. The process of codification and abstraction is undertaken to share knowledge. However during this process, knowingly or unknowingly there is an asymmetry between senders and receivers. Senders, as a result of learning through either experience or creating new knowledge will invariably have a substantial bank of tacit knowledge which will not be part of the receiver's memory. The success of sending the knowledge will be dependent on the ability of the sender to capture the relevant dimensions of the data, i.e. the codification and abstraction strategy. Strategies designed to structure data with the aim of improving the reach do so at the expense of information depth.[45]

Figure 2 – The Diffusion Curve

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[44] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 52-53

[45] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 55-57
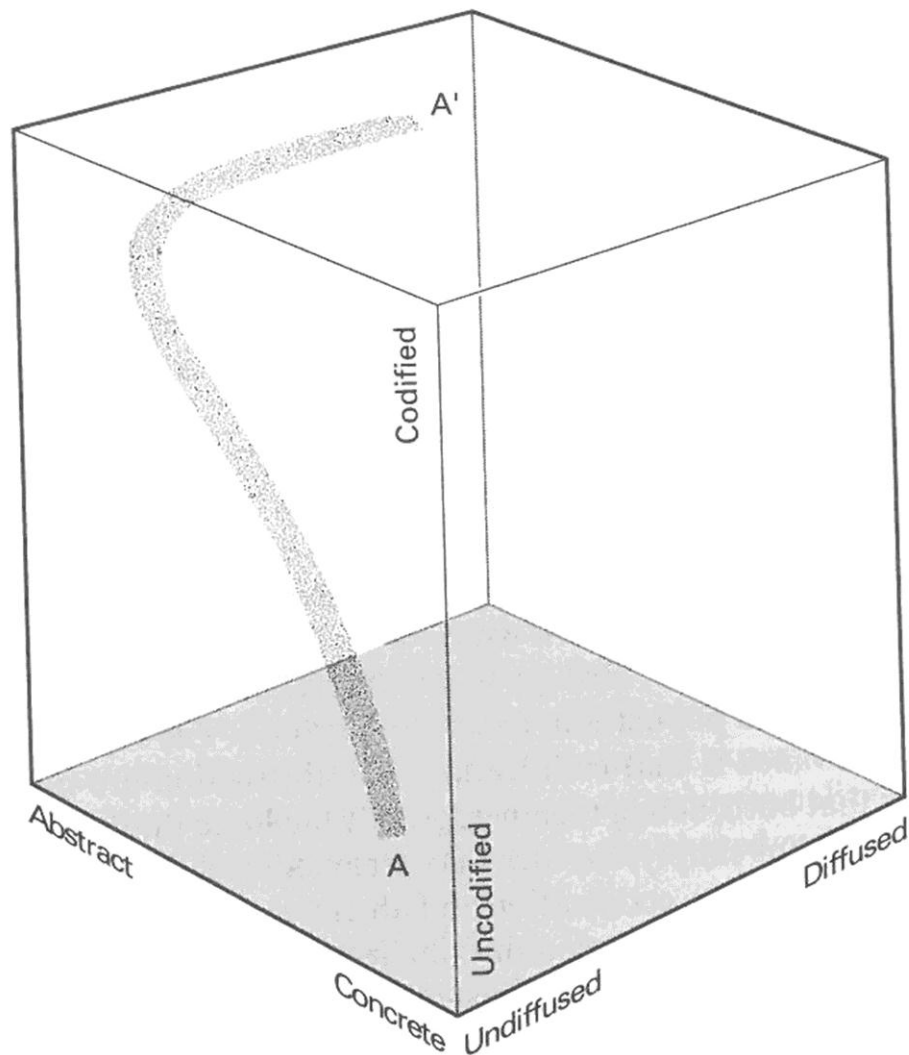
The Diffusion Curve in the I-Space

Source - Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 56

The process of codification, abstraction and diffusion and the ability of the sender to effectively communicate with the target population highlight an importance of data shedding. Making information explicit does not imply that the intended message of the sender will received by the receiver as outlined above. Interpretation of the message is a crucial part of the learning process as individual experiences of the information received is subjective.

2.2.4 Interpretation

Earlier in the chapter, Schön's view on organisational cohesion was presented which requires the adoption of a shared model. Daft and Weick argue along a similar line that shared meaning internal to the organisation establishes the platform for strategy formulation and direction of learning. Elaborating on this view, the internal environment has numerous

sources of information and data. The act of interpretation requires managers to review and assess and try and make sense of the information (Daft and Weick call information events "*events*"). Daft and Weick define interpretation as "... the process of translating these events, of developing models for understanding, of bringing out meaning, and of assembling conceptual schemes among key managers.[46]" The interpretation process can be allocated into three general categories, scanning, interpretation and learning. Scanning is the process of data collection. Interpretation is the process of giving meaning to the data that has been collected. This part requires the interaction of the individuals in the organisation and would require people to share their mental models, making it explicit.[47] It will lead to organisational interpretation in which new shared models and understanding is developed amongst the top management members responsible for interpretation. Learning takes place when the interpretation leads to action. Daft and Weick quote the definition of Argyris and Schön, "learning is the process of putting cognitive theories into action."[48]

Interpretation is the way that an individual or organisation view the internal and external environment based on their own belief system. It is a key element of the learning process, the manner in which the information from both the internal and the external environment is viewed and interpreted. Kim supports the view of Daft and Weick[49] on interpretation which is relevant and necessary to explore to gain a deeper level of insight into the learning process.

Daft and Weick have done extensive work in the area of interpretation systems which influences the manner in which information is selected and this interpretation process is carried out by the individuals and collectively by the organisations. Organisations are complex multidimensional entities which, through previous learning, have developed their own set of rules of engagement. Daft and Weick present the model for organisational interpretation[50], and outline the following four assumptions:

> First, organisation action is based on information that is derived from an uncertain external environment. It must be analysed within the context of the organisational requirements and what they perceive to be necessary for their survival.

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[46] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 286

[47] Kim, DH. 1993. The Link between Individual and Organizational Learning 44

[48] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 286

[49] Kim, DH. 1993. The Link between Individual and Organizational Learning 43

[50] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 285-286

Second, interpretation on behalf of the organisation is carried out by individuals who send and receive information into and from the external environment however the organisation has memories which will influence the interpretation process. Therefore the interpretation is bigger than that of the individual as the organisation memories, in whatever form, will guide the individual interpretation process.

Third, strategic management is responsible and performs the function of interpretation from the aggregated information received. This is compiled by various groups or functions within the organisation which reports to them. A convergence of interpreted information from within the organisation takes place at the top level which is then further interpreted.

Fourth, the manner in which the external environment is interpreted by different organisations differs, either in the way they process or the method they apply. Each organisation will define its own approach to assessing the external environment and this in turn could lead to different interpretations which influence the organisation's approach to strategy and decision making[51].

This demonstrates the complexity in developing an action plan in an uncertain environment in which internal and external interpretations can vary.

The concept of individual learning is very complex and when this concept is extended to an organisation in which multiple people or various groups impact on the organisational learning process, the complexity grows exponentially. The Daft and Weick model points to the dimensions of the complexity internally in the form of individuals and groups and externally on an uncertain environment which is interpreted differently by different organisations. The learning process must be directed by an overarching set of objectives and a strategy to achieve this. This is where leadership steps in to play a key role in the process of transformation. The organisational strategy therefore plays an important role in mapping the way into the future.

The organisation's view of the environment plays a role in determining what is relevant and what should be discarded. A concrete and fixed view thereof with the assumption that it is linear and determinant suggests that it will search for the "*correct interpretation*"[52].

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[51] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 285-286

[52] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 287

Everything that the organisation does will be based on its assumption that a logical rational process can be followed to get to *the answer*. Organisations that assume the external environment cannot be analysed to some extent shape the external environment that they operate in, i.e. the interpretation of the environment may result in the organisation shaping the environment as opposed to the environment influencing the interpretation. This could result in an environment being invented that is beneficial to the organisation[53].

Ambidextrous organisations on the other hand seem to have the ability to operate within the different spheres, interpreting information for each of the knowledge creating areas, i.e. incremental, architectural, and discontinuous and market innovations. Each of these areas will serve the customer base that it is intended to satisfy and this may include the creation of an environment (market) for the take up of the products[54]. An organisation that actively searches the external environment, including "testing" the environment uses an intrusive approach to determine the path it should take. The level of intrusiveness of an organisation may also impact the process of interpretation and what is interpreted. This will include a trial and error process in which the feedback from the external environment and the interpretation of that feedback will be used to adjust the boundary accordingly, if it fits into the strategy of the organisation. Daft and Weick make reference to an earlier publication of theirs in which organisations that adopt this approach are called "test makers". In contrast to these organisations, there are those that operate within a set of boundaries or rules, and do not exceed those boundaries unless it is absolutely necessary. The external environment is accepted as is. They are called "passive organisations". Only during a time of crisis will these organisations extend the boundaries. The level of intrusiveness is also dependent and determined by how hostile the external environment is. The more hostile the external environment is perceived to be, the greater the level and degree of searching for information to aid in the process of interpretation. These are classified as adopting an active approach. Organisations that operate within a captive external environment do not expend the level of energy and resources. Once an organisation has settled, there is less of a need to find, seek or invent opportunities.[55]

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[53] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 287

[54] Tushman, LT, Andersen, P. (eds) 2004. Innovation Streams, Organisation Designs, and Organisational Evolution in Managing Strategic Innovation and Change A Collection of Readings 2nd Edition. 8.

[55] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 288

Daft and Weick provide us with four methods that can be used in analysing the external environment and the strategies that can be adopted by organisations for external environmental assessments. The first is enactment which assumes the external environment cannot be analysed and by virtue of this has an active intrusive strategy, constructing their external environments. Second is a discovering mode in which organisation searches for the correct answer in the external environment but the organisation still remains intrusive. External environmental data in this case can be analysed. Third, "conditioned viewing"[56] describes an organisation that does not have an intrusive strategy and works from the premise that the external environment can be analysed. These organisations operate within traditional boundaries and assume a captive external environment. Fourth, is "undirected viewing"[57] which assumes that an organisation is operating in an external environment that cannot be analysed and still adopts a non-intrusive strategy.

Each of the methods introduced by Daft and Weick can be used to make predictions that relate to other organisational characteristics that can be linked to the interpretation modes. "The predictions pertain to 1) Scanning and data characteristics; 2) The interpretation process within organisations; and 3) The strategy and decision process that characterize each mode".[58] Scanning is the act of gathering data. The method used to obtain the data is dependent on the method of interpretation of the organisation. Daft and Weick highlight data sources and data acquisition as methods of obtaining data. Managers have access to data from different sources and these sources can be internal or external to the organisation. When an external environment is less analysable, managers will place reliance on external data sources, i.e. they will be more dependent on the network to check the validity of existing data obtained. Should the organisation work from the premise that the external environment can be analysed, a more formal and structured approach will be adopted using traditional systems to provide data. Data acquisition involves using various means of getting data depending on which mode of interpretation is in use. Organisations that apply conditioned viewing will use formal information systems to obtain data. When organisations are in discovery mode,

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[56] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 289 - a term from Aguilar, 1967 referenced by Weick and Daft

[57] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 289 - a term from Aguilar, 1967 referenced by Weick and Daft

[58] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems. 290,
(1) scanning and data characteristics;
 (2) the interpretation process within the organisation;
(3) the strategy and decision process

structured surveys and studies of the external environment will be executed. Organisations using undirected viewing will be less dependent on formal management information. Enacting organisations will use feedback mechanisms from the external environment for analysis and other irregular methods of obtaining data.[59]

Current knowledge of the organisation can be viewed as using probabilities on events to determine the outcome. Using the feedback from the environment modifies the probabilities associated with these events. As a result, the knowledge base is modified. Boisot asserts that the interpretation of the data and information is dependent on the paradigm of the data processing agent prior to receipt of the new information. Different managers may vary in their interpretation due to "cognitive style, computational capacity or individual circumstances". These differences should be viewed as a source of new insight.[60]

The interpretation process is performed by managers based on the aggregated data received from the various sources. An understanding of the environment is obtained by converting this data to information and then into knowledge. Daft and Weick describe two methods in the conversion of data into knowledge, namely "equivocality reduction and assembly rules". "Equivocality is the extent to which data are unclear and suggest multiple interpretations about the environment."[61] When the multiple interpretations of the cues from the environment exist, the interpreters will discuss them at length which in turn will alter their individual mental models, to arrive at a common interpretation resulting in a shared model[62]. The net result of this common interpretation is that the organisation can initiate a course of action. "Assembly rules are the procedures or guides that organisations use to process data into collective interpretations."[63] Data that is unambiguous and can be analysed with ease will be subject to the application of more rules. With a greater degree of uncertainty about the data, the managers require more flexibility in the interpretation process. This also results in processes of refinement in which the data can be processed by these individuals a few times.

One can ascribe the processes outlined above to the organisation making sense of the external environment. The interpretations could impact the process of strategy design and the

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[59] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 290

[60] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 102

[61] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 291 Weick and Daft make reference to two pieces of work, one by Daft and Macintosh, 1981; and the second by Weick, 1979.

[62] Kim, DH. 1993. The Link between Individual and Organizational Learning 46

[63] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 291

decision-making process. In the strategy formulation process, Daft and Weick supports the view held by Miles and Snow who suggest that strategy can be organised into four types, "prospector, analyser, defender and reactor." The application of the strategy formulation process is dependent on the view that the organisation has of the environment. Prospector strategy is when the organisation views the environment as continuously changing and therefore opportunities continuously arising. The analyser approach is used by organisations that view the external environment as analysable and will only proceed once the correct answer has been found. Defender strategy development approach is when an organisation wishes to protect its market. Daft and Weick do not view the reactor method as a development method at all as these types of approaches accepts whatever comes along[64].

Decision making processes is very much dependent on the manner and the outcome of an analysis of data and information and therefore must be subject to the interpretation process. This includes the process of making sense of the data and information through sharing comparing and adjusting the perspectives of the data processing agents involved[65]. Therefore the decision making process will be influenced by the view that the organisation has of the external environment and how it is interpreted. Interpretation is very much a part of learning as it influences how the environment is viewed internally and externally and what individuals see as part of the organisation. The individual, in their role as management will determine a strategy that is an appropriate one to move the organisation to the next cycle.

2.2.5   The Social Learning Cycle

The concept of the I-Space, developed by Max Boisot, which comprises of three dimensions viz. codification, abstraction and diffusion, was introduced earlier in the chapter. The I-Space is a representation of these elements that integrates these dimensions. When this framework is adapted to represented data and information flows over time, the I-Space can be adapted to show the various states of knowledge viz. Personal knowledge, Proprietary Knowledge, Text Book Knowledge and finally what is referred to as Common Sense. For this flow of new

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[64] Daft, RL, Weick, KE. 1984. Toward a Model of Organisations as Interpretation Systems, 292

[65] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 102

knowledge and transformation to occur, the three dimensions have to occur in a particular sequence. This sequence is referred to as the "social learning cycle" (SLC).

Figure 3 – Social Learning Cycle
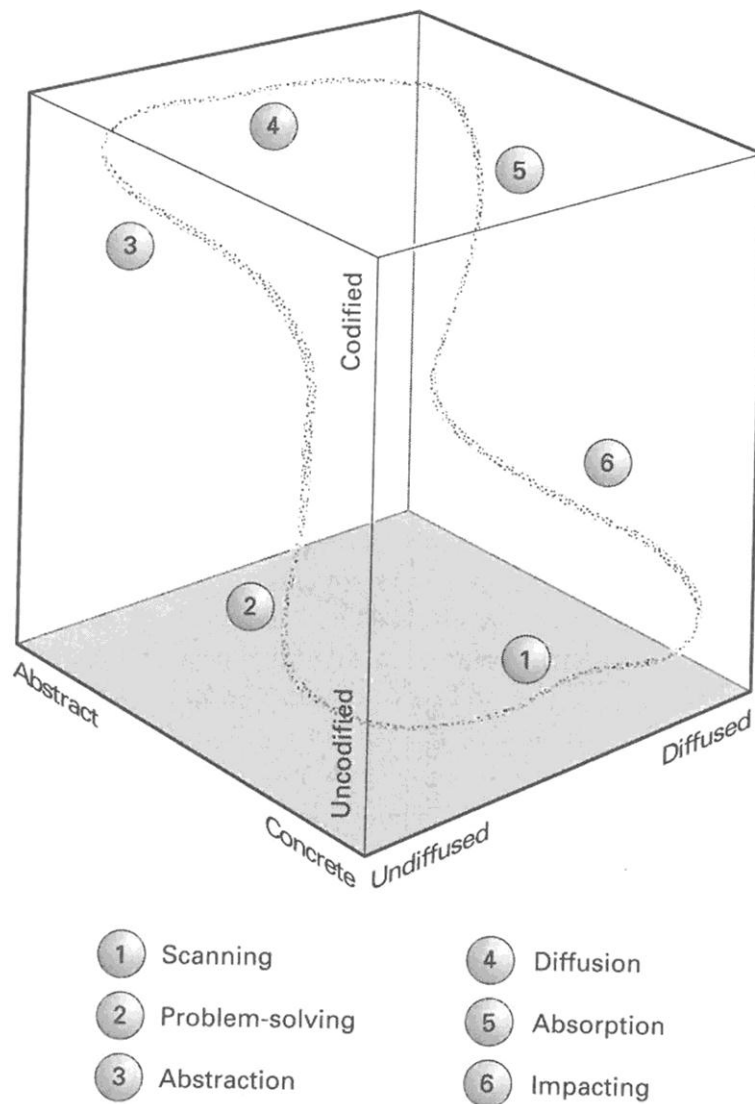
The Social Learning Cycle (SLC)

Source – Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 60

Boisot breaks down the SLC into six distinct phases viz.

1. Scanning which is the process of identifying opportunities and threats. Patterning data into unique insights that then becomes the possession of individuals or small groups;

2. Problem Solving is the process of structuring these insights through codifying them giving them shape and eliminating uncertainty;

3. Abstraction is the process of generalisation of the codified insights so that it can more widely applied;

4. Diffusion is a process of making available the insights with the targeted population;

5. Absorption is when these codified insights are applied in different situations in which learning takes place by doing;

6. Impacting – this occurs when abstract knowledge is embedded in "concrete practices".

The SLC may take on a different shape depending on the target population, i.e. in the case of patents; the creator of the knowledge will want to ensure that it is not widely diffused irrespective of whether it is an individual or organisation. The figure below depicts this limited diffusion.

Extracting value from the organisation requires planning if the organisation is going to be able to leverage the assets that it has at its disposal. The assets could be in the form of embedded knowledge such as a product or codified knowledge that can be traded. An organisations strategy will provide a roadmap that outlines how the particular asset will be leveraged. It will also provide a guideline that will direct the data processing agent in what to codify and what data to shed. The next section is aimed at getting a better understanding of strategy and the learning process.

Figure 4 – Blockages to Diffusion
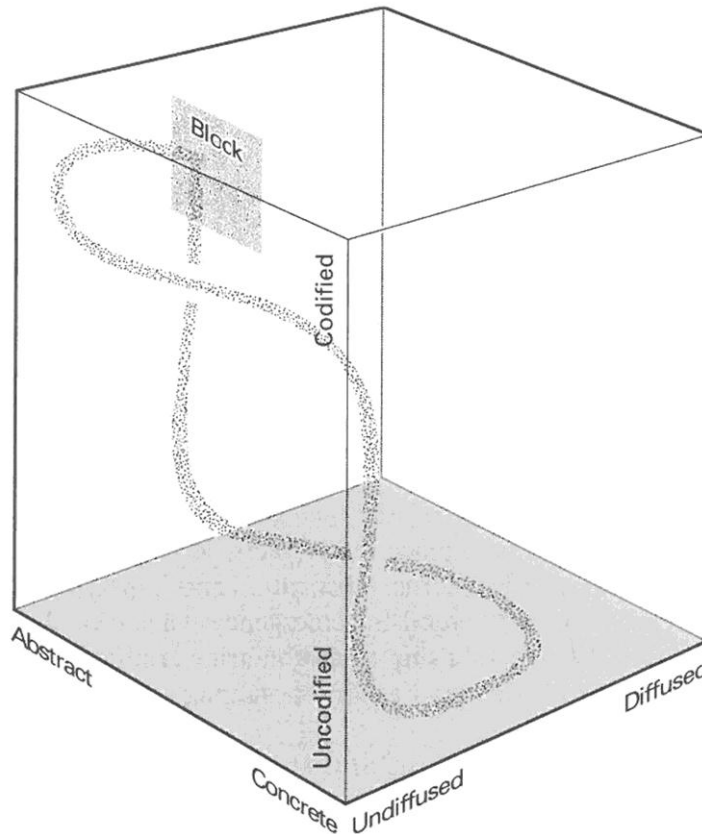
Cycle 1: Blockages to Diffusion

Source – Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 62

2.3   Strategy

Planning is an integral part of the traditional rational approach to strategic development and as such has been instrumental in shaping and developing sophisticated tools to assist in the process. The actual process of strategy formulation and the implementation thereof is not given as much consideration as the process of planning in the traditional strategy approach. There is a sense that the literature in strategy focuses on and continues to view strategy in the context of top management being the dominant role player[66]. In the context of organisational

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[66] Voronov M, Yorks L. 2005. Taking power seriously in strategic organizational learning, 10 – the authors make reference to the work of (Palmer and Hardy, 2000), (Mintzberg and Waters, 1895; Raimond and Eden, 1990), (Hardy 1996; Mintzberg and Wesley, 2001), (Eden and Ackerman, 1998), (Reynolds, 1998)

learning, the socialising of the strategy development and learning process has been recognised.[67]

Organisational strategy is a key element in the development process and path to achieve an organisation's stated objectives. Within the context of knowledge creation, strategy development essentially plots the path and determines the knowledge and resources required to achieve these objectives. This is guided by the organisational intention, which provides the basis for determining the value and applicability or truthfulness of the knowledge. The organisational intention is important in fostering employee commitment.[68] Within the ambit of strategy development, the proponents of the generative thinking perspective advocate that change must be continuous and incremental. This allows for a gradual and long term view on organisational change with a constant view of the external environment, which will initiate the development or learning cycle.[69] Knowledge creation requires the interaction of multi-disciplinary self-managing teams. This establishment model is necessary to deal with the complexity of product innovation and development, and therefore a strategy development process of an organisation must take into account that market problems are "organised complexity"[70].

Irrespective of whether an organisation is based on Western philosophy or Japanese culture, the key imperative is to maintain its competitive advantage. When devising a new product, innovation strategies are necessary in staying ahead of the marketplace. Development of the new product line is essential to maintain the competitive edge. Understanding and pre-empting the shift of the market and customer requirements and making provision for these shifts prior to its occurrence will allow for a continued and improved market share. Strategies that are designed to integrate, build and reconfigure existing competencies will be able to cater for the fast changing environment.[71]

This would require that the organisation's distinguishing feature is based on internal capability, something that cannot be easily replicated by its competitors. Its strategy must

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[67] Voronov M, Yorks L. 2005. Taking power seriously in strategic organizational learning, 11 – authors reference the work of (Eden and Ackerman, 1998; Mintzberg, 1991; Mintzberg and Waters, 1985; Hedberg and Wolff, 2001)

[68] I Nonaka, H Takeuchi, 1995, The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation74-75

[69] De Wit B, Meyer R. 2001. Strategy Synthesis – resolving strategy paradoxes to create competitive advantage 145

[70] De Wit B, Meyer R. 2001. Strategy Synthesis – resolving strategy paradoxes to create competitive advantage 30

[71] Tushman, LT, Andersen, P. (eds) 2004. Section IV Innovation and Business Strategy in Managing Strategic Innovation and Change A Collection of Readings 2nd Edition. 307

therefore be designed around its internal competence and capability.[72] This demonstrates the importance of the social aspects within with organisation coupled with the coordination function and organisational politics, all three playing a very key role in the success of initiatives undertaken. Within learning organisation structures, strategists are deemed to play a lesser role in the success or failure of initiatives[73].

Within strategy development and learning, strategy must be viewed as part of the organisational learning process, a continuous process of review and redefinition based on the outcome of the implementation, and emergent strategy.[74]

2.4 Integrated view of Individual and Organisational Learning

As an extension to the definition of individual learning, Kim defines organisational learning as "*increasing an organisations capacity to take effective action.*"[75] Individual learning takes place when the beliefs of the individual changes and is *imprinted* in the mental model of the individual. This affects the learning process of organisations as the learning of the individuals influence the shared model of the organisation, i.e. each of the members within the group make some or all of their mental models explicit and in the process a shared mental model is developed. Organisations cannot learn without the individuals and all individuals are not necessary for organisational learning. Although this is case, it does not imply that all learning on an individual level is translated into a direct benefit for the organisation from a learning perspective. Indirectly, it may and probably will influence to a certain extent what is made explicit and therefore have an interpretation implication. As is the case with the individual, organisational memory plays a vital role in organisational learning and individual and shared mental models. It is a matter of finding ways of making the individual mental models explicit that will initiate the process for the development of new shared models. Individual mental models must surface as it is invisible to the organisation and it serves as a potential source of

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[72] Tushman, LT, Andersen, P. (eds) 2004. Dynamic Capabilities and Strategic Management in Managing Strategic Innovation and Change A Collection of Readings 2nd Edition. 312, Reprinted from Strategic Management Journal

[73] Voronov M, Yorks L. 2005. Taking power seriously in strategic organizational learning, 12

[74] Voronov M, Yorks L. 2005. Taking power seriously in strategic organizational learning, 14 – authors reference (Mintzberg 1991) as an example that supports the assertion.

[75] Kim, DH. 1993. The Link between Individual and Organizational Learning 43

knowledge. To what extent the organisation will be influenced by the individuals mental model is dependent on the influence the individual has on the group or the organisation.

Sharing the individual mental model is critical in the process of transformation of the shared model as it may impact on the way the environment is interpreted. One would assume that the individual is in a position of influence in the organisation for this to occur as it is not everyone that can have a transformative impact on the organisation[76]. This prompts a discussion on the nature of leadership in organisations and specifically it's role in interpretation of the environment as part of the learning process.

2.5 Leadership

Zaleznik argues that a distinction exists between managers and leaders in terms of their personality and behaviour as well as the way they interact with people in the organisation. Conventional organisations develop a succession plan through the development of managers as opposed to looking at individual leaders and putting mechanism in place to develop them. Leaders, in their behaviour and approach seem to operate outside of acceptable norms of a bureaucratic structure, favouring high risk initiatives as opposed to managers who typically prefer to work within boundaries of structure[77].

Kotter argues that a distinction between managing and leading exists, however his argument is different to the one made by Zalzenik. He contends that managers and leadership each have a place in the organisation as they perform different roles and functions. Good managers are said to bring order in what would be a chaotic environment because they are good at reducing complexity. Managers are good in environments that are created by large organisations. Leaders on the other hand are able to deal with change especially in external environments that are volatile. Due to the fact that external environments shift continuously and in some cases to the extreme, more and more the organisation has to deal with change. Complexity and change thus requires approaches from managers and leaders and therefore characterises each role differently. [78]

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[76] Kim, DH. 1993. The Link between Individual and Organizational Learning 44-45

[77] Zaleznik, A, 1986. Excerpts from Managers and leaders: Are they Different, 54

[78] Kotter, JP. 1990. What Leaders Really Do, 104

Transformational leaders are charismatic leaders that are inspiring, intellectually stimulate them and may be emotionally supportive[79]. Transformational leaders have a high expectation of performance from the teams that are led by them. They are able to articulate the direction and organisation goals very clearly, setting optimistic realistic targets for the team to achieve. It is important in this style of leadership that subordinates develop. The rationale is that if the individual develops, the organisation too develops[80]. However, there are leaders that enter into agreements between themselves and the sub-ordinate on performance requirements and expectations. Work is performed based on the commitment of the leader to improve the status of the individual and is used as a motivating factor. Bass calls this the transactional leader[81], which can be equated to a manager. A transactional leader motivates the team via performance measures which in turn is used to determine the reward. The leader determines the level of reward as well as design the structure within which the individuals will operate. This type of leadership occurs within a stable external environment and therefore little initiative is taken to change[82]. There is no need for change, new knowledge creation or innovation leading to new product development.

A study by Ohio State University revealed that two dimensions were a dominant feature in leadership behaviour, initiating structure and consideration. Initiating structure makes reference to the manner and extent that the leader will structure his/her role and the team in pursuit of the defined gaols. A leader that demonstrates 'consideration behaviour' is one that has respect for the ideas generated by the subordinates, where a level of mutual trust exists and has an appreciation for the feelings of the subordinates[83].

Weick uses an example of soldiers finding their way in mountainous terrain using a map from another terrain as a guide and plotting the existing terrain on the map, i.e. correcting the map. This demonstrates the ability of the leader to make decisions based on the outcome of action

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[79] Bass, BM. 1990. From transactional to transformational leadership: learning to share the vision, 22 - Superior leadership performance – transformational leadership – occurs when leaders broaden and elevate the interest of the employees, when they generate awareness and acceptance of the purposes and mission of the group, and when they stir their employees to look beyond their own self-interest for the good of the group.

Tickle, EL, Brownlee, J, Nailon, D. 2005. Personal and epistemological beliefs and transformational leadership behaviours 708

[81] Bass, BM. 1990. From transactional to transformational leadership: learning to share the vision, 21 – Leadership that is based on a transaction between employee and leadership is called "transactional leadership".

[82] Tickle, EL, Brownlee, J, Nailon, D. 2005. Personal and epistemological beliefs and transformational leadership behaviours 708 - 709

[83] Robbins, SP, 1998, Organisational Behaviour. 350

and adjust the next steps based on the outcome. There was a set goal to achieve and the leader of the group kept the vision of the goal in mind when interpreting and making decisions[84].

Schein suggests that for learning to occur, there has to be psychological safety for the individuals and group to learn, thus the environment and structure that are created foster learning. In doing so, it is necessary for the charismatic leader not only to develop a long-term direction but also to design and articulate the immediate and next achievable steps. The establishment of this type of learning environment forces people to step outside of their learnt behaviour and journey on the path of learning and exploring new ideas. Leaders couple this with a reward system pointing out innovations that they have come up with and not recognised and then associating this with a reward. Leaders play a very crucial role in the learning process. The ability of the leaders to continuously learn is necessary if the organisation is to follow. This implies that the leader has to extend beyond the limits of the organisational boundary through the interaction and engagement with the external environment. It also shows a willingness of the organisation to change[85]. A discussion of leadership would be incomplete without taking account of power and the influence that individuals and groups with power have in the organisation.

2.6   Power

There are various views on power and decision-making but for the purposes of this research, Kleiner has been selected[86]. Power in organisations can be categorised in two ways, legitimate power and power through authority. Power through authority is achieved due to the position of the person and it is maintained through the structures, boundaries and rules of the organisation. People that are given legitimate power due to their relationship with their co-workers may accelerate their level in the hierarchy. In instances where legitimate power does not allow for this progress, the individuals with legitimate power may "outrank" the individuals in the hierarchy simply because of the support that they enjoy, i.e. people follow them willingly. This would be the case with labour movement organisations. This scenario suggests that it is possible for people to have authority and no legitimacy and therefore

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[84] Weick KE, 1995, Sensemaking in Organizations, 55

[85] Schein, EH, 1993. How can organisations learn faster? The challenge of entering the green room.1993, 85+

[86] Kleiner, A. 2003. Core Groups: A theory of Power and Influence for "learning" organizations

Kleiner provides valuable insight on the argument of power and influence of core groups in organisations. It also reinforces the viewpoints of Daft and Weick, and Kim pertaining to shared models and shared meaning to promote learning.

limited influence in the organisation.[87] It is this type of influence that plays a role in the development and creation of new and existing shared mental models.

There is a close relationship between leadership and power. A commonly accepted view of leadership suggests that it requires that a common goal exists between leader and subordinate. This would require both parties to work towards the achievement of these goals, including mentoring and development of the subordinate. This can be equated to legitimate power. Authoritative power on the other hand does not require any such relationship as instructions flow from top down and there is little if any participation by the subordinates in setting goals. The distinction between power and leadership is that leadership requires a relationship between the leader and the subordinate whereas the concept of power requires no relationship.[88]

Power plays a significant role in terms of influence in an organisation. However, the power of an organisation does not necessarily lie in top management. Kleiner asserts that power resides within a core group and for them to be effective in the learning process; the core group must have a shared mental model. The influence and power that the core group has can shift the organisation, thus if their mental model changes, they are able to initiate change through the power and influence they have within the organisation.[89] The core group operating, due to their power will have the ability to influence the organisations direction and select a particular development path. This path will have specific learning and information requirements.

The power of the core group also extends to the development and management of an "integrated learning base"[90] which is the base that encapsulates the core business of the organisation. Kleiner asserts that each organisation will rise or fall based on the level of the integrated learning base, due to the fact that the core differentiator and knowledge generating ability is based on the tacit knowledge of this core group. Even though explicit codified knowledge does exist, it is insufficient and does not contain the experiential elements that are

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[87] Kleiner, A. 2003. Core Groups: A theory of Power and Influence for "learning" organizations 675

[88] Robbins, SP, 1998, Organisational Behaviour. 397

[89] Kleiner, A. 2003. Core Groups: A theory of Power and Influence for "learning" organizations 672

[90] Kleiner, A. 2003. Core Groups: A theory of Power and Influence for "learning" organizations
Kleiner makes reference to Professor Alfred D Chandler, author of the Invisible Hand (Chandler, 1977) and Inventing the Electronic Century (Chandler, 2001). Chandler used the term "integrated learning base".

able to carry the organisation through the development and innovation process.[91] It is therefore argued that the power of the core group is significant and has the ability to enable or disable learning and change initiatives and value.[92]

Another view on power and organisational influence is also presented by Voronov and Yorks. They assert that power has two faces, "*primary power* and *secondary power*"[93]. With regard to primary power, it defines the boundary and is therefore an enabling and limiting factor to our world view. It influences the organisations view of knowledge, how the organisation makes sense of data and information and impacts on the process of analysis. This view again lends itself to the work done by Daft and Weick with regard to interpretation and its role in making sense of data and information. Secondary power is power in the conventional sense, i.e. through the position that is held by the manager[94]. Since primary power focuses on the establishment boundaries, domain experts would by default be in a position of power due to their knowledge. As secondary power is about predefined boundaries and managers can use this power to exert influence. Primary power can therefore play a crucial role in reducing the amount of secondary power that a manager may have as the domain definition resides in the former.[95]

2.7   *Knowledge*

Learning, knowledge and knowledge creation are integral in the process of innovation, product development and understanding the external environment. None of these elements must be viewed as a once-off exercise. Knowledge creation, based on the work of Nonaka Takeuchi, is a continuous development process that "goes" through a number of stages until it becomes useful knowledge that can be applied in the product development process.[96] It ultimately leads to new products being released in the market place. In the knowledge creation process, information plays a key role, as information is manipulated and analysed to provide insight into a particular aspect, i.e. the information is used to create knowledge.

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[91] Kleiner, A. 2003. Core Groups: A theory of Power and Influence for "learning" organizations 277-279

[92] Kleiner, A. 2003. Core Groups: A theory of Power and Influence for "learning" organizations 281

[93] Voronov M, Yorks L. 2005. Taking power seriously in strategic organizational learning, 16

[94] Voronov M, Yorks L. 2005. Taking power seriously in strategic organizational learning, As defined by Voronov and Yorks – ability to get ones goals met.

[95] Voronov M, Yorks L. 2005. Taking power seriously in strategic organizational learning, 17

[96] I Nonaka, H Takeuchi,1995. The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, 71

Knowledge is the use of the information within the context of the individual's beliefs which will ultimately influence the behaviour and actions.[97] There are two distinct knowledge categories, tacit and explicit.[98] The exchange between the two categories together with experiential learning within the organisation is an imperative in the knowledge creation process.

The level of success of organisations is directly linked to the manner in which they "treat" these two elements. It is argued by Nonaka and Takeuchi that these elements are the primary differentiator between Western and Japanese companies and the culture of learning and knowledge creation. Japanese companies have been used as a benchmark in terms of knowledge management and knowledge creation for many years. This is coupled with their ability to continuously develop new products through innovation.[99] The structure of their teams and the manner of engagement between leadership and team members is viewed as a key component that steers the creation and development process[100]. Nonaka and Takeuchi assert that Japanese companies, in the face of a crisis always resort to the "organisational knowledge creation" process to carry them through. They make a clear distinction between the American giants IBM, Sears and General Motors and large Japanese companies that use the knowledge creation process, the former having been the "monarch" of the American economy. Due to the American companies dominating the market, they were blind to the changes taking place in the external environment. Their interpretation of the external environment was limited to the values and shared models of their respective organisations. Japanese companies through continuous engagement and monitoring of the external environment "look outside" and anticipated change unlike the three American companies. Nonaka and Takeuchi suggest that they ignored the outside market and by implication believe that they were the trend setters.[101]

In the knowledge economy an organisation is always transforming as it can ill afford to be static. The rationale is that new knowledge in a knowledge economy is always being

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[97] I Nonaka, H Takeuchi, 1995. The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, 58

[98] I Nonaka, H Takeuchi, 1995. The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, 8 "Tacit – something not easily visible and expressible. Tacit knowledge is highly personal and hard to formalise, making it difficult to communicate or share with others. Explicit – something formal and systematic. Explicit knowledge can be expressed in words and numbers". Pg 8 these definitions guide the argument on the differences between Western and Japanese companies.

[99] I Nonaka, H Takeuchi, 1995, The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, 4

[100] I Nonaka, H Takeuchi, 1995, The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, 11

[101] I Nonaka, H Takeuchi, 1995, The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, 4

generated and this changes the external environment. To cater for these changes in the external environment the knowledge must be internalised so that it can be factored into the products being offered to the market.[102]

To get an organisation to a state in which it has the ability to learn and create knowledge, the organisation must be transformational and the leadership must have the ability to guide the knowledge and the knowledge worker appropriately. That would include giving them a sense of freedom.[103] Leaders must have the ability to allow a degree of latitude to the sub-ordinates that will ensure that they perform beyond what is required.[104] The boundary within which they operate must be flexible to adjustment.

Innovation and organisational sustainability have a very strong link. Flynn and Chatman quote Amabile[105] "[i]nnovation is absolutely vital for long-term corporate success... [N]o firm that continues to deliver the same products and services in the same way can long survive. By contrast, firms that prepare for the future by implementing new ideas oriented toward this changing world are likely to thrive." Innovation is fundamental in ensuring that a company retains its competitive advantage. Knowledge creation and innovation can be viewed as two side of the same coin. Knowledge from the external environment is gathered and shared within the organisation specifically with the teams working with new product development. In working with the knowledge gathered, it undergoes a conversion of sorts and is then released to the environment in the form of products and services. This is the process of innovation and the Japanese companies have been able to continuously be innovative.[106]

The structure of an organisation influences the ability of the people to be creative and innovative. Even though creativity resides within individuals, it has been argued that groups may have a higher yield for producing new products.[107]

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[102] I Nonaka, H Takeuchi, 1995, The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, 6

[103] I Nonaka, H Takeuchi, 1995, The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, 15

[104] Tickle, EL, Brownlee, J, Nailon, D. 2005. Personal and epistemological beliefs and transformational leadership behaviours, 708 Transformational leaders communicate a clear, optimistic and attainable picture of the organisations future, encouraging subordinates to develop "beyond the norm" so that the organisation can also grow and develop.

[105] Tushman, LT, Andersen, (eds) 2004. Strong Cultures and Innovation Oxymoron or Opportunity? in Managing Strategic Innovation and Change A Collection of Readings, 234 , reprint

[106] I Nonaka, H Takeuchi, 1995, The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, 6

[107] Tushman, LT, Andersen, P. (eds) 2004. Strong Cultures and Innovation Oxymoron or Opportunity? in Managing Strategic Innovation and Change A Collection of Readings 2nd Edition. 235, reprint

What has been outlined above demonstrates that the process of creating knowledge is fairly complex and requires a base of existing knowledge. The existing knowledge is used to create new knowledge. Boisot makes reference to the fact that existing knowledge must be codified for diffusion to occur. The process of diffusion provides the basis for new knowledge creation. Nonaka and Takeuchi suggest that the exchange between tacit and explicit creates the platform for new knowledge creation. Innovation is not possible without the process of creating new knowledge.

2.8   *Innovation and Environment*

There is a definite relationship between learning, knowledge creation and innovation and it is the combination and application of all these elements that will provide the platform for an organisation to have an edge over its competitors. For incremental innovation to take place there must be a large degree of intra-organisational and/or inter-organisational co-operation, each function providing its input to the process[108].

Innovation requires that a firm extracts value from its knowledge assets or acquires the knowledge to produce new knowledge. It is understood that firms that invest in research and development either formally or informally will perform better than those that follow. In order to create new knowledge, existing knowledge with the organisation has to be transformed. This implies that knowledge which is tacit must e made explicit, i.e. it must be codified and abstracted.[109]

The type of incremental innovation will be determined by the market as well as the ability to improve on the existing technology. Both radical discontinuous and incremental approaches to innovation can only take place in organisations that have a learning culture and have the ability to continuously change. These organisations are able to muster the support of staff across the organisation to provide insight into product requirements based on environmental requirements, i.e. feedback loops[110]. A highly innovative organisation is therefore extremely

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[108] Westerlund, M, Rajala, R, 2010, Learning and innovation in inter-organizational network collaboration, 437

[109] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 42-44

[110] Hyland, PW, Gieskes, JFB, Sloan, TR. 2001. Occupational clusters as determinants of organisational learning in the product innovation process 198

dynamic and the people have the ability to adjust to the change fairly quickly[111]. For learning to be of value to the organisation, it is imperative that diversity exists, not only in people and process but also in strategy[112]. New product development is a result of incremental innovation but may consist of multiple developments in other areas/categories. Complex products are made up of a number of subsystems, i.e. they are made up of independent components that each has their own product or technology life cycle[113].

Innovation in technology follows a particular life cycle that influence the next generation of product innovation as well as new product development. The process of innovation can result in competing products being launched, as was the case VHS and Beta[114]. This would require that the organisations through its engagement with the external environment will push to become the dominant player, but the choice is now ultimately influenced by the external environment. Depending on the technology category, the external environment and actors will influence the outcome of the selection which may include government, social bodies, consumers and alliance partners. Once the "decision" has been made and the design has been adopted as an industry standard, the innovation that will subsequently take place is incremental, continuously improving the product options[115]. Existing technologies and processes that are continuously and incrementally improved can be viewed as exploitative innovation. It is the process of analysis and development of existing knowledge, producing product enhancements to satisfy the market segment. Process innovation would be using current knowledge to build on to improve the process efficiency[116].

Tushman and Andersen discuss another form of innovation that involves a shift within the component technology of a product. This innovation leads to the creation of new markets and expands the reach of the organisation, however they point out that it is different to

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[111] Hyland, PW, Gieskes, JFB, Sloan, TR. 2001. Occupational clusters as determinants of organisational learning in the product innovation process 199

[112] Hyland, PW, Gieskes, JFB, Sloan, TR. 2001. Occupational clusters as determinants of organisational learning in the product innovation process 203

[113] Tushman, LT, Andersen, P. (eds) 2004. Innovation Streams, Organisation Designs, and Orgnisational Evolution in Managing Strategic Innovation and Change A Collection of Readings 2nd Edition. 3, Adapted from Chapter 17 "Organizational Technology" by ML Tushman and WK Smith

[114] Tushman, LT, Andersen, P. (eds) 2004. Innovation Streams, Organisation Designs, and Orgnisational Evolution in Managing Strategic Innovation and Change A Collection of Readings 2nd Edition. 6, "Beta was more technologically advanced (e.g. the tapes held greater amount of information with higher resolution) and initially captured more of the market, JVC was able to beat Sony through proactive alliances with strong producers and distributors.

[115] Tushman, LT, Andersen, P. (eds) 2004. Innovation Streams, Organisation Designs and Organisational Strategy in Managing Strategic Innovation and Change A Collection of Readings 2nd Edition. 5-6, Adapted from Chapter 17 "Organizational Technology" by ML Tushman and WK Smith

[116] Westerlund, M, Rajala, R, 2010, Learning and innovation in inter-organizational network collaboration, 436

incremental innovation. Even though there is a difference, there is reluctance on the part of the innovators to treat it as an "architectural innovation" which seems to have a debilitating impact on the future of the organisation, as the organisation is unwilling to adjust its internal functioning. Reference is also made to a "discontinuous innovation", one that changes a current technology to the extent that the core of the "old" technology becomes redundant. A market-based innovation is one that uses incremental innovation to cater and pander to the market requirements. These incremental innovation changes are usually introduced by the competitors who ultimately displace the position of the innovator and become more successful in the market. The primary reason for this is the fact that the innovating organisation's structures were not able to deal with the "disruption" and consequently were not able to retain their position in the market[117].

Innovation is also viewed as a result of using internal and external environmental knowledge to develop new knowledge leading to the development of new products in which the demand is unknown and the tested technology uses is innovation and adopts a process of exploration[118].

Innovation and the ability to develop new knowledge are influenced by organisational culture. The internal environment in which the boundaries are set and the rules of engagement which governs the internal environment influences the behaviour of individuals and teams. The following section will take a closer look at organisational culture.

2.9   *Organisational Culture*

Morgan suggests that another key differentiator exist between Japanese companies and Western companies, and identifies the differentiator as the social and organisational culture. Since the 1970s the Japanese have gained the respect of the Western world as they were able to introduce successful turnaround strategies producing reliable high quality products. There is consensus amongst most theorists that the success can be attributed to the Japanese culture and way of life.[119] Culture is viewed as the systems of knowledge, values, laws, ideology and daily rituals within a society. Western culture is based on a dire need to fulfil individualistic

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[117] Tushman, LT, Andersen, P. (eds) 2004. Innovation Streams, Organisation Designs and Organisational Strategy in Managing Strategic Innovation and Change A Collection of Readings 2nd Edition. 6-7, Adapted from Chapter 17 "Organizational Technology" by ML Tushman and WK Smith

[118] Westerlund, M, Rajala, R, 2010, Learning and innovation in inter-organizational network collaboration, 436

[119] Morgan, G 1997, Images of Organisation, 119

needs which work against the larger system. In Japanese culture acknowledgement and respect is achieved by working within and in service of the larger system.[120] Corporate culture therefore influences the approach and engagement model of employees in the development of new knowledge. Nonaka and Takeuchi state Schein's position that there has to be "shared experience" which results in a "shared view". This integrates and becomes part of the fabric of the organisation when people are not aware of these elements any longer. Culture from this perspective is a "group experience". They further state that organisational culture is made up of beliefs and knowledge of the individuals that make up the organisation.[121]

De Wit and Meyer define culture as "the collective programming of the mind which distinguishes one group or category of people from another"[122], and in this instance culture specifically makes reference to a country or nation. Context is therefore also important in determining and understanding the culture issues that impact the perspective and learning ability of the population.[123] Culture changes when deep beliefs and its associated assumptions change as experience changes.[124] This reinforces the role of culture in the knowledge creation process.

Boisot has defined culture as the "sharing of information within a population distributed across space and time"[125], which fits in with the notion of culture as defined by De Wit and Meyer. Choo interprets Schein's definition to mean simultaneous organisation adaptation to the external environment whilst the internal integration also takes place.[126] These definitions all share something in common with regard to knowledge creation but none of them make a direct reference to knowledge or the creation thereof. This position is affirmed by Nonaka and Takeuchi. They argue that although significant research has been done and continues to be done there is not sufficient recognition given to the knowledge creation process of the

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[120] Morgan, G 1997, Images of Organisation, 125

[121] I Nonaka, H Takeuchi, H, 1995, The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, 42

[122] De Wit B, Meyer R. 2001. Strategy Synthesis – resolving strategy paradoxes to create competitive advantage.,

[123] De Wit B, Meyer R. 2001. Strategy Synthesis – resolving strategy paradoxes to create competitive advantage. pg 45 – reference is made to the leadership theories of Americans being ill suited for Japanese managers

[124] Senge, P, Kleiner, A, Roberts, C, Ross, R,Smith B, 1994, The Fifth Discipline Field book, pg 20

[125] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 122

[126] Schein's definition from CW Choo, pg 98 2006 – "Culture is: A pattern of shared assumptions, invented, discovered or developed by a given group, as it learns to cope with its problems of external adaption and internal integration, that has worked well enough to be considered valid, and, therefore, is to be taught to new members of the group as the as the correct way to perceive, think, and feel in relation to those problems"

individuals.[127] Choo also states that shared assumptions become part of the organisational culture once learning and validation of these assumptions have occurred. It is a continuous and recurring sense-making process between the external environment and the internalising thereof.[128] In instances, using Boisots I-Space, there are a number of discontinuities that can arise in the information flows within a culture. Where these discontinuities are detected, it can result in distinct groupings within the population. These distinct groupings tend to communicate easier within the group than across the groups within the population. Groupings exist within each population category which includes organisations.[129] This argument supports the discussion on power and the influence that groups may have on the organisation.

The culture of the organisation plays a significant role in the success or failure of the organisation. A key element that influences the behaviour of the employees is the leadership style and manner of engaging with the team. In the examples cited by Morgan, an insurance company president preferred a non-confrontational approach and in essence the issue around team dynamics was never resolved. The corporate culture was based on superficial behaviour creating an image of harmony. This resulted in the company being taken over by the parent company due to its inability to perform. In the case of a successful company, viz. ITT, the leadership style result in the development of a corporate style based on fear. Although the growth of the company was phenomenal during the 20 year period, it was at great expense to culture and people of the organisation and the company reputation.[130] This leadership style is in conflict with that described by Nonaka and Takeuchi.

For an organisation to develop a learning culture an environment must exist, or be created, which allows them to unlearn the old culture in favour of the new. An organisation that has a history of past successes which is embedded in the behaviour, attitude and mannerisms of the organisation makes culture a powerful force to deal with. Culture, according to Schein, "is the accumulation of past learning" which implies it is a history of the past successes of the

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[127] I Nonaka, H Takeuchi, 1995, The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, pg 42, they assert that there are three areas of focus that are not taken into account. 1. Most studies do not pay attention to the potential and creativity of human beings. 2. Human beings are seen as information processors not information creators, and 3. The organisation is portrayed as passive in its relation to the environment, neglecting its potential to change and create. These are important points as it discards the learning ability of individuals, which in turn impacts on the organisational learning.

[128] Choo, CW, 2006, The Knowing Organisation How Organisations Use Information to Construct Meaning, Create Knowledge, and Make Decisions, 99

[129] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 120-121

[130] Morgan, G 1997, Images of Organisation, 130-135

organisation. Due to the fact that the old way of doing things has previously been successful, unlearning that behaviour is difficult to say the least[131].

Groups can be viewed as mini-organisations. Within the group structure, cultural norms play a role through the social approval of activities which play a powerful role in stimulating the innovation process[132]. Tushman and Andersen present the argument made by Flynn and Chatman stating that in a strong culture, there are certain conditions which will stifle innovation. This is aligned to the previous notion that a strong belief system in a core group could retard the process of change. In situations like this it is expected that the individual will not speak out as they would be going against the consensus approach. This type of culture does not favour innovation even though organisation performance may be enhanced through other means. Based on the argument that "culture and innovation are opposing forces", a distinction is drawn between conformity and uniformity. The distinguishing factor between the two is that conformity ensures group harmony whereas uniformity occurs when members are identical in "interests, attitude and behaviours". Norm strength of the group is determined by the fact that there is conformity and not uniformity. Cultural content which is defined as the behaviour and attitude of the group, it is argued, adversely influences innovation. It is suggested that the norm content must be viewed in the context of the behaviours being supported and the fact that they vary widely.[133]

Hyland *et al* suggests a different view from that of Nonaka and Takauechi, viz. that within the organisation, one finds a number of groups that are structured on a formal and a social basis. Each of the groups will have an associated culture. Hyland *et al* use a report from Adler in which the findings revealed that some "heterogeneous teams were more productive than homogeneous team" when looking at cultural diversity.[134]

Culture has an influence on how individuals perform, especially from the knowledge creation and innovation perspective. It is accepted that organisational learning is captured in the policies, processes and procedures of an organisation. If the culture of the organisation is restrictive and bureaucratic, it will stifle the learning process. Boundaries will be defined and

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[131] Schein, EH, 1993. How can organisations learn faster? The challenge of entering the green room.1993, 85+

[132] Tushman, LT, Andersen, (eds) 2004. Strong Cultures and Innovation Oxymoron or Opportunity? in Managing Strategic Innovation and Change A Collection of Readings, 236 - 238

[133] Tushman, LT, Andersen, (eds) 2004. Strong Cultures and Innovation Oxymoron or Opportunity? In Managing Strategic Innovation and Change A Collection of Readings 236 - 238, reprint

[134] Hyland, PW, Gieskes, JFB, Sloan, TR. 2001. Occupational clusters as determinants of organisational learning in the product innovation process 200 – Reference is also made study done by UCLA and reported by Adler 1986.

tightly managed. Introducing anything new will require endorsement by multiple levels or groups making change extremely difficult. For and organisation to have the ability to innovate and learn, it must have the ability and a culture that lends itself to change. Being able to change allows it to respond and structure its internal environment to accommodate the requirements of the external environment.

2.10   Change

Environmental factors that influence organisations, be it internal or external, are continuously at play within an organisation irrespective of whether the organisation plays a dominant role amongst competitors. Some of these influencers will require a radical shift in the organisation or a mild shift, but it is dependent on the position that organisation has adopted and the organisational culture. Ultimately, the change that the organisation will undergo is necessary for their survival. The extent of the change initiative will be influenced by the knowledge base resident in the organisation versus the new knowledge base that is required, the value system, the current vision versus the new vision and the attitude towards learning. The further apart the current versus the new is, the greater the organisational shift will be, i.e. radical change versus and incremental change[135].

Learning is a key requirement for a successful change to take effect and become embedded. To ensure a sustainable edge over the competition, a company has to develop the ability to learn faster and create new knowledge quicker than the competitors. As highlighted above, creating a common platform and using the internal resource base effectively is critical for the success of the initiative[136].

Learning organisations work from the premise that change is a constant as it will always require a review of the boundaries of the organisation. This would imply that change takes place in incremental steps making it routine. However should the change initiative require expansion or reinvention during the course of the implementation, it could result in a radical change initiative. As the level of change being experienced is subjective, it is the individuals

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[135] Kofoed, LB, Gertsen, F, Jorgensen F. 2002. The Role of CI and learning in an organisational change process: experience from a longitudinal study of organisational change 165-166

[136] Karp, T, 2004, Learning the steps of the dance of change: improving change capabilities by integrating futures studies and positive organisational scholarships 350

that will determine the degree of change in terms of the experience of the change initiative[137]. Since the change occurs at an individual level and it has an impact on their behaviour, buy-in from the people will make the task of the internal environmental change easier especially if the implications of the change has been communicated successfully and people understand their role in the initiative.[138] Change in effect is about learning and the participation and buy-in from the individuals ensure that the learning process will be successful.

Of primary concern during a change initiative, involving many individuals in an organisation is the fact that the change will impact on their values, beliefs, behaviour and rules by changing it on an organisational level.[139] It therefore requires a change in organisational culture that is extremely difficult to effect especially where it is entrenched. For the organisation to make an effort to change, i.e. the individuals to participate willingly in the process, it is imperative that they be made aware of the environmental challenges and consequently the crisis that faces the organisation[140]. This is a barrier to learning as pointed out above.

In preparation for change, an organisation has to undergo and "unfreezing"[141] process, i.e. a process in which the organisation shifts from the maintenance position that it is in. The "unfreezing" process gives the organisation a shake up and allows for new thinking to be introduced, it is an attempt to break into the existing culture of the organisation. Culture change is about getting to the core of the individuals belief system, his values, skills and knowledge[142]. The change that is being introduced initiates the learning process. According to Schein learning can be achieved through the introduction of a specific kind of anxiety[143], however when preparing for change, it is of more value to create a sense of enthusiasm within the organisation that will provide a platform for sharing the new vision. Leaders thus play an important role in creating the platform for the introduction of change and for the impending cultural change that is planned.

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[137] Guangming, CAO, G, Clarke, C, Lehaney, B. 2000. A systemic view of organisational change and TQM 187

[138] Karp, T, 2004, Learning the steps of the dance of change: improving change capabilities by integrating futures studies and positive organisational scholarships 351

[139] Guangming, CAO, G, Clarke, C, Lehaney, B. 2000. A systemic view of organisational change and TQM 188

[140] Robbins, SP, 1998, Organisational Behaviour. (eds) 615,

[141] Smith, I. 2005. Achieving Readiness for Organisational Change 409 - Smith makes reference the concept of unfreezing coined by Kurt Lewis.

[142] Smith, I. 2005. Achieving Readiness for Organisational Change 409

[143] Schein, EH, 1993. How can organisations learn faster? The challenge of entering the green room.1993, 85+

Organisations or industries that adopt a change philosophy do so to gain the edge by getting the product first to market. It is about ensuring a good return on investment. The profitability of the initiative will be linked to the manner in which the organisation's resources is used and configured internally. This assumes that the organisation has the ability to leverage its assets, primarily its knowledge assets, to reorganise so that it may capitalise on the opportunity.

2.11   Summary

Individual and organisational learning is a complex domain and there are a number of categories that has been selected for discussion that impact on the ability of an organisation to learn. These categories are identified amongst others as:-

1. Interpretation;

2. Organisation Strategy;

3. Leadership Style;

4. Power;

5. Innovation;

6. Culture; and

7. Change.

The discussion pertaining to individual learning outlines the interplay between organisational structures and the limits that are set internally which create the boundaries to the individual learning process. Learning organisations set these boundaries based on the existing knowledge base or knowledge assets as termed by Boisot. In as much as it guides the organisation, it also limits the organisation as any learning that takes place outside of the anticipated outcome can be discarded. Learning is therefore directed towards an outcome.

Mental models and the shifting of these mental models are crucial in the individual learning process. To shift the organisation requires that the individual influences the shared model of the organisation. An individual wishing to influence the organisation at this level has to make their mental model explicit if changing the internal environment is their desired outcome. Organisations comprise of core groups which exert a significant level of influence on the direction that an organisation takes. In the case of learning organisations, the proposed shift

may impact the organisations belief system and this shift cannot occur without the endorsement of the core group. The core group would interpret on an individual level, but with a shared model, would also be guided by organisational memory. Interpretation of the information presented, using organisation memory, individual mental models and shared vision, will be viewed in the context of organisational survival.

To be guided by on overarching set of objectives with a strategy developed to achieve this implies that the learning process is directed towards a particular outcome. In selecting the path to achieve the organisational objectives, an understanding of the knowledge requirements and organisational assets is necessary and essential. Taking this into account, the strategy outlines the method of learning necessary to bring about the change that is required. Learning is therefore about changing or improving the organisation internally to comply with the demands of the external environment. It is about configuring the organisational assets to cater for the needs of the external environment.

For changes to be effected in this manner, one must assume that the style of leadership allows a certain degree of flexibility. In an authoritarian environment, the relationship is based on a hierarchy and compliance determines reward. This stifles the ability of individuals in the process of knowledge creation and therefore learning. An organisation that promotes learning will adopt a transformational style of leadership. With culture being the accumulation of past learning, it will require that assumptions be adopted and a process of continuous sense-making takes place. This will be part of the learning process.

Change requires the shifting of boundaries. Leaders therefore have to continuously interact with the external environment, pushing their individual boundaries that will provide the foundation for pushing the organisation boundaries. Continuous and incremental change is necessary if an organisation is to have the ability to respond to the requirements of the external environment. Leadership must therefore have the ability to change and adapt the internal structures of the organisations in a manner that will promote the new shared model, and create the necessary value.

The learning process is directed by a core group within organisations to achieve a particular outcome. For an organisation to promote an ecological agenda, the learning must be directed to achieve this outcome. This internal reconfiguration will be in response to changes in the external environment.

Chapter 3 explores the topic of ecological modernisation. The aim is to demonstrate the changes that have been introduced in products and technology as a result of the learning that takes place. The content of Chapter 2 is used to argue that change which has been introduced is due to learning that occurred, which resulted in paradigm shifts. It essentially requires discontinuous innovation in areas where significant technological advances have occurred. In areas where changes have occurred that have a smaller impact, the innovation used the philosophy of iterative and incremental. However both approaches require a learning process.

Chapter 3

Environment, Economics, Ecology, and Ecological Modernization

3.1 Introduction

In this chapter, ecological modernisation is explored and the actors and agents that play a role setting an ecological agenda. The concept of modernity[144] as defined by Giddens provides a foundation that explains the shift in belief systems through a process of knowledge creation and learning. The technology and innovation in terms of ecological challenges continues to have different views. Environmental economists view the ecology as another factor of production[145] whilst ecological economist as presented by Booth views the ecology from a moral and ethical perspective.

To provide some perspective, a short history on environmental and ecological economics is introduced and the complexities that existed from a policy perspective. It required consideration of the ethical and moral dilemmas that face regulators when developing new policy. Both are key issues in creating the argument and both require one to consider the knowledge creation and learning occurs. It suggests that the perspective must extend beyond utility and that consideration must be given to the future generation's experience of the environment. The environment in itself has value and this value is not determined by the value that individuals or society derives from it.

Mol is a well known author in the field of ecological modernisation and has explored the subject from a number of perspectives. These include areas such as social impact[146] and transformation as well as politics[147] and organisational structures. These perspectives are

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[144] Giddens A. 1990. The Consequences of Modernity

[145] Booth, DE. 1994, Ethics and the limits of environmental economics

[146] MOL, APJ. 2000, The environmental movement in an era of ecological modernisation

[147] Mol APJ. 2002, Ecological Modernisation and the Global Economy

presented as part of the argument that demonstrates the evolution and change on multiple levels.

Murphy and Gouldson provide insight into the policy development[148] arena and identify it as a key driver to bringing about change in the external environment that organisations operate in. The policy provides an instrument for governments to effect change in the external environment that organisations operate in and creates the shift towards an ecological agenda. As changes are incremental in nature, some ecological groups view technology development irrespective of the objective of the improvements, as a continuation of exploitation of the ecology. It promotes consumerism and the capitalist agenda and the innovation process is viewed as having a purely economic objective.

From an institutional and organisational perspective, changes within government and organisational structures are discussed and a view is presented that in order to effect ecological changes, it is necessary to work within the parameters or boundaries that exist. The aim is to continuously push to extend the boundary to promote an ecological agenda.

In terms of innovation from an ecologically motivated perspective, Jänicke outlines key aspects and differentiates between incremental and radical approaches to technological change. Ecological modernisation is viewed by its scholars as a mechanism to change to a concept of technological development to promote both an ecological and economic agenda. It is about channelling and directing the knowledge creation process to derive an ecologically beneficial outcome using technology differently, i.e. extending the boundary or establishing different boundaries within which organisations operate in[149].

The research will demonstrate that key authors such as Mol, Jänicke and Gouldson agree on the fact that there is a shift in interest from policy makers to protecting the ecology due in part to societal shifts. This requires evolution of the society, government and organisations. Social movements have in the past been viewed as confrontational and the evolution in their approach also had to take place. Social movements have become less confrontational and more participatory and even though the changes are slow, progress is being made.

Learning and the creation of new knowledge is evident throughout the chapter. Each section draws a relationship to learning using arguments presented in Chapter 2. Technological

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[148] Murphy J, Gouldson A. 2000. Environmental policy and industrial innovation: integrating environment and economy through ecological modernization

[149] Jänicke, M. 2008. Ecological Modernisation: new perspectives

modernisation cannot occur without innovation and innovation is a learning process describing the creation if new knowledge, either cumulatively or discontinuously. Throughout the chapter, the concept of Boisot's I-Space and Daft and Weicks view on interpretation will be used. The aim is to demonstrate a relationship in each section between ecological modernisation and learning, more specifically, to present the argument of technological development and directed learning.

This will enhance our understanding and will provide us with insight into the complexity of creating an environment that can adapt to the ecological changes required. A discussion on the evolution of society with new knowledge influencing behaviour as the basis of the evolution requires a brief discussion about modernity. The following section provides a brief introduction to modernity.

3.2 Modernity

Modernity has been defined differently by different authors. Ulrich Beck used an equation as a means of defining modernity. The equation is that a new modernity is a result of the desired and the familiar, which means that the introduction of a new modernity is based on incremental changes of things that are familiar[150]. Giddens definition of modernity is "modes of social life or organisation which emerged in Europe from about the seventeenth century onwards and which subsequently became more or less worldwide in their influence"[151]. Modernity is viewed as dynamic due to the fact that time and space can be separated and recombined. There is a continuous reordering of the relationships in society as existing and new knowledge influences the behaviour of people, both in individuals and groups. Time and space is therefore important if we are to understand modernity. Modernity influences and transforms time and space and this is evident looking at the pre-modern world. As an example, time of day could not be accurately gauged and referenced. To this extent, an event occurring at a particular time "was almost universally either connected with 'where' or identified by regular natural occurrences". For society to have the ability to function in an integrated or interconnected manner on a global scale, it was necessary not only to be able to determine time (in terms of measurement) but also for society to transform and adopt the 'standard' of time and organise using time as a standard. Space too is closely linked with time

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[150] Beck U, Giddens A, Lash S. 1994. *Reflexive Modernisation*, 4

[151] Giddens A. 1990. The Consequences of Modernity, 1

and plays a role in the shaping of society. Social influences are not bounded by location, i.e. distance is not an obstacle in shaping social structures. The ability to split time and space is a critical aspect to the dynamic nature of modernity. As Giddens explains, there are 3 reasons for this:-

- It is a necessary requirement for disembedding;

- In modern societies, there is an interconnection in local and global societies which was not possible in pre-modern societies and therefore influences people on a global scale.

- History requires that a date and time stamp be used, which provides society with a worldview of events and experience.

The term disembedding used by Giddens is the aggregation of 'social relations' in the context of local engagements and the application of these attributes across time and space. In discussing the modern social institutions, two mechanisms for disembedding are identified and discussed i.e. symbolic tokens and expert systems. An example of a token is money, which does not take on a characteristic of any group but has meaning to each group. Expert systems are expertise that are responsible for or influence social environments through their knowledge and expertise. This influences what individuals and groups do on a continuous basis although there is not constant interaction and engagement with these professionals[152]. It demonstrates that modernity is about the process of change, learning and creating new knowledge based on existing knowledge. Modernity is characterised by, amongst other attributes, change and the pace that it occurs at, the scope involved in bringing about that change and the structure and nature of institutions associated with modernity such as political structures[153].

Transformation of organisational structures is influenced by existing knowledge. The knowledge base changes over time as learning occurs. The SLC depicts the movement of data through the I-Space, showing the flow from concrete, undiffused to abstract and diffused. This suggests that uncodified data is codified, methods of abstraction are applied to concrete data sets and eventually within a given target population knowledge becomes common. The methods of communication influence reach. Technology has lifted spatio-

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[152] Giddens A. 1990. The Consequences of Modernity, 17 - 27

[153] Giddens A. 1990. The Consequences of Modernity, 5-6

temporal limitations and as a result access to data and information has increased. Society has benefited from technology and its use in communication. This reinforces and supports the fact that modernity is about change and pace. As more knowledge is created and diffused, interest groups will review what is available with the aim of building on the base. Modernity is very relevant to the discussion of technology and the ecology.

It is necessary to point out that not all data in the I-Space is for the purpose of diffusion to general population. The opposite is possible in which well placed individuals or organisations gain unique insights which creates the potential for proprietary knowledge.[154] Different groups will view the information flow in the I-Space differently and as a result can be represented differently in the I-Space.

These will be addressed later in chapter and the influence that it has in shaping environments within which the ecological agenda is negotiated.

3.3 Ecological and Environmental Economics

3.3.1 A Brief History – Institutionalising ecological economics

Research is directed by the objectives of an organisation as well as the discipline within which it falls. The aim of the research is to produce a product that is marketable. Ropke makes a comparison in terms of the economic factors of production for the purpose of the demonstrating value of research from a product perspective, viz. "research is the production of new knowledge"[155]. Ecological economics, which was institutionalised in 1998, was a case of interdisciplinary cooperation comprising of various strands of economics, general systems theory, systems ecology and energy studies. As the initiating disciplines involved in the institutionalisation process, it was viewed as an imperative to understand the "ecological and economic systems and their interactions in terms of flows of energy and matter"[156].

In the mainstream disciplines, each stream focused on core issues without taking into account or considering the benefits of a cooperative approach. Economists focus on the requirements for economic growth and view this growth as necessary to provide the resources to deal with

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[154] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 58

[155] Ropke, I. 2005, Trends in the development of ecological economics from the late 1980's to the early 2000's, 264

[156] Ropke, I. 2005, Trends in the development of ecological economics from the late 1980s to the early 2000s, 267

pollution and the ecological problem. Ecologists on the other hand were viewed as having the sole aim of reducing pollution and ignoring economic challenges. Political issues such as distribution in the current generation were ignored by both economists and ecologists and with fundamental differences that was this evident, the non-conventional researchers believed it was necessary to establish a new organisation.[157]

Environmental issues became more visible and subsequently were institutionalised within the political domain. With this institutionalisation, legislation was developed in the interest of protecting the natural environment, however assessments in the late 1980s determined that implementation had been lacking. Due to the unsatisfactory results, politicians deemed it necessary to become more stringent in the application and the requirements. This is viewed as the first steps towards ecological modernisation[158], which is discussed in great detail later in this chapter. At this juncture, a convergence between ecological concerns and economic growth started to develop in which a cooperative approach would result in a win-win situation.

Development of the theories and expanding on the body of knowledge of each discipline, i.e. economics and ecology, would make sense to its own target population. They have a share model and learning and knowledge that is created and made explicit will have undergone a data shedding process. The data shedding process eliminates all data that is deemed not relevant to the specific disciplines objectives. During the process of codification and abstraction, language use will use terms that are unique to each discipline, the "phenomena" used to contextualise the message will be based on the theoretical foundation of the specific discipline. Boisots evolutionary production function suggests that data accumulation and therefore the learning and knowledge creation through experience and insight will be unique to each discipline. A paradigm shift occurred and resulted in the creation of a new target population. The convergence of the theories into a unifying theory occurred as a result of a discontinuous learning process. Further data accumulation and data shedding will be determined by the new target population and results will be interpreted based on this paradigm.

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[157] Ropke, I. 2005, Trends in the development of ecological economics from the late 1980s to the early 2000s, 268

[158] Ropke, I. 2005, Trends in the development of ecological economics from the late 1980s to the early 2000s, 268

3.3.2 Ethics and the Environment

Booth, a development theorist who became an influential ecological economist, argues that human beings are constantly searching for happiness and the natural environment plays a role in achieving that happiness[159]. Nature is able to provide happiness to people without having depleted any of the available natural resources, i.e. it remains in an unaltered state, which implies that it does not involve the excessive use of materials in determining utility. The outcome should not lead to extinction and at least maintain the level of the resource. In utilising the material from nature, utility should not negatively impact on the ability to provide other services to human beings, nor should it lead to by-products that are harmful to the environment and human beings.

Uses that result in destruction must be regulated through the regulatory and legislative environment. However in the context of economics, a cost-benefit determination is always part of the evaluation process. In this case, should it be determined that the damaged parties are appropriately and sufficiently compensated for the loss to be incurred, the damaging party may continue with the destructive activities. In this process of evaluation, the damaging party will make every effort to externalise the cost of the damage so that it maximises the gain. Whatever processes can be utilised in the disposing of by-products at a lesser cost, albeit at the expense of society and the environment, it will be utilised[160].

3.3.3 Morals and the Environment

Environmental economics, in Booth's view, involves the study and evaluation to determine the "maximum net benefit" in the process of resource allocation. From a perspective that human beings are willing to protect and defend the natural environment irrespective of the instrumental value suggests that the natural environment is "morally considerable"[161]. This changes the perspective on compensation as bringing ethics into the evaluation equation in the process of destruction which makes this impossible if what is being destroyed is viewed as morally considerable by at least one individual. In evaluating this argument, further analysis is required when viewed in the context of the greater good, using or exploiting the natural resources that are owned by the public. This requires an evaluation of the elements

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[159] Booth, DE. 1994, Ethics and the limits of environmental economics, 244

[160] Booth, DE. 1994, Ethics and the limits of environmental economics, 245

[161] Booth, DE. 1994, Ethics and the limits of environmental economics, 247

involved in doing a cost-benefit analysis, i.e. willingness-to-pay and willingness-to-be-compensated in comparison to the value of the resources in the marketplace[162].

> Willingness-to-pay is the maximum payment the public is willing to make for the reservation of a resource and assumes that the public has no prior right to use of the resource.

> Willingness-to-be-compensated is the minimum amount the public is willing to accept for giving up the resource in a preserved state and presumes a prior right of use.

Booth further suggests that when evaluation takes place on a cost-benefit analysis method, a further level of complexity is introduced in the evaluation and analysis process when taking into account preservation. This implies that no compensation will adequately suffice or justify the use or exploitation of the resource and the preservation imperative can only be replaced by other moral considerations that are of higher importance such as survival or self preservation. Therefore if one analyses the cost-benefits in the normal process of determining the economic benefit and utility, exploiting resources will always be "morally considerable" since someone will always be worse off. Environmental economists assert that the natural environmental resources should be viewed as property and therefore put all interested parties on an equal footing to bid for the property. This should remove the natural environmental problem as all parties now have a right to bid for the property. Environmental economists believe that in this manner the Pareto principle will come into play, however when viewing this from a moral perspective, for losses incurred due to natural environmental destruction, adequate compensation is never possible except when higher order "morally considerable" issues take precedent[163].

Azqueta and Delacamara[164] argue that the main issue is managing the access to resources and the ranking of the needs and wants giving it a priority. If one takes a purely anthropocentric[165] ethical view, then it is only the value of human beings that must be factored into the morally considerable notion. With this being the position, then every person in the present and future has the right to enjoy the natural environment. It is an issue of use of resources, whilst

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[162] Booth, DE. 1994, Ethics and the limits of environmental economics, 9 248

[163] Booth, DE. 1994, Ethics and the limits of environmental economics, *Ecological Economics*, 9 249

[164] Azqueta, D, Delacamara, G. 2006, Ethics, economics and environmental management, 525-526

[165] Anthropocentrism is the notion that human beings are the dominant species on earth and that the environment can be used in service of human beings wants and needs without consideration of moral issues.

ensuring that ecological sustainability is maintained and through the use of this approach, protect the right of future generations.

3.4 Ecological Modernization

3.4.1   History and theoretical bases of Ecological Modernisation

Ecological modernisation emerged as a theory in the early 1980's and the development of the theory is attributed in part to the work undertaken by Joseph Huber, who published the first book on the subject "Die verlorene Unschuld der Ökologie". The theory was initially presented in German only, but based on the discussions that have been presented in English from the late 1980's, technological innovation is a focal point of the theory. Fisher and Freudenberg present the argument that there are theorists within the ambit of sociology who view technological development and progress as a contributor to natural environmental issues.   However, this perspective of the argument is based on the fact that industrial development is the best option available to industry and society to "escape from the ecological crises"[166]. Gouldson and Murphy essentially view ecological modernisation as the use of economic actors in a manner that will be mutually beneficial to the process of economic growth as well as ecologically friendly[167].

Aligned to this thought process Jamison presents the fact that influential actors in business and government have come to appreciate and understand the contribution of the environmental lobbyist in the development of economically feasible technologies. Innovation and technological development is seen as a major contributor to the process of economic recovery of a nation-state and in cases even furthering the aims of capitalism, i.e. profit generation. There has been an evolution of the thought process around the use and development of technology. Instead of focusing the development of new knowledge and the refinement of existing knowledge on prevention in the research and development of new technologies, a shift has occurred to integration of these technologies from a social and

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[166] Fisher DR, Freudenberg WR. 2001 Ecological Modernization and Its Critics:Assessing the Past and Looking Toward the Future, 701-709

[167] Gouldson, A, Murphy, J. 1996, Ecological Modernisation and the European Union, 11

economic perspective[168]. This is a paradigm shift and influences the manner in which the data and knowledge will be interpreted. Once the paradigm shift occurs, i.e. the learning process is discontinuous and radical, learning will follow the iterative and incremental pattern for the development of new products.

Ecological modernisation is therefore viewed as a means of responding to existing ecological challenges as well as focusing on new and emergent issues. This does not detract from the fact that most developmental programmes   require a catalyst. Regulation regarding development based on ecological challenges is necessary to motivate industry to have a longer term view on their product development life cycle. It does require the organisation to change its view and internal structures to comply with the regulatory changes. Instead of viewing policy changes as an obstacle, the opportunity that is presented by these requirements should be explored and in so doing organisations can overcome their short term barriers. Instead of focusing on incremental innovation, organisations can and will focus on radical innovation, which can also lead to a scenario of first to market advantage. An organisation that follows will not necessarily have the internal structures to effectively deal with the radical organisation change required to manage the introduction of the innovation.[169]

According to Mol, ecological modernisation theorists view the transformation of institutions and the behaviour of society as a fundamental part of the shift to a mutually beneficial relationship between economic growth and the protection of the natural environment[170].

Central to the establishment of ecological modernisation is the creation of a new body knowledge which has to be made explicit if a new shared model is to be created amongst stakeholders. Joseph Huber provided has the insight that established a foundation, i.e. the knowledge base, for subsequent cumulative knowledge creation. Policy makers influence and determine the behaviour of organisations by making their learning, the shared model, explicit. From an organisation perspective, a core group exercise their influence and promote their shared model. A compelling argument must be presented to the core group by a member if a paradigm shift is to occur. Regulation and the interpretation thereof can create the opportunity if the existing knowledge, either product or expertise, can be leveraged. With

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[168] Jamison A. 2000. On Ambiguities of Greening, 251

[169] Murphy J. Gouldson A. 2000. Environmental policy and industrial innovation: integrating environment and economy through ecological modernization, , 35

[170] Mol, APJ. 2000, The environmental movement in an era of ecological modernisation, 45

referencing to the learning process, building on existing knowledge will be the least disruptive path with a more favourable economic outcome in the short-term than establishing new structures, practices and knowledge. Organisations will prefer to keep the development of new knowledge in the region of the I-Space that favours maximum value.

3.4.2   Ecological modernisation – theory and critics

In the development of the theory, Fisher and Freudenberg accept and is recognise that there are two primary differences with regard to the expectations of ecological modernisation when compared with other theories pertaining to the society-environment relationships. First and foremost it views technological improvements with the aim of being environmentally friendly as being economically feasible. Secondly it views the actors within the political landscape changing the relationships and nature of engagements with industry and other political actors to an extent where it becomes politically acceptable to promote environmental protection.[171] Even in the political domain it is necessary to ensure that the values and shared vision of the core group is maintained.

Toke defines ecological modernisation as "the relationship between the ecological crisis and the mechanisms through which society confronts the implications of crisis"[172]. From a policy perspective, the question that remains unanswered is whether ecological modernisation can work in the interest of preserving the natural environment for future generations. It is the answer to this question that will determine whether a more radical approach is necessary in the preservation of the natural environment. What is noticeable and has become more visible is the fact that consumption and production processes are being scrutinised and analysed constantly and subsequently re-designed on both an economic and an ecological perspective.[173]

Ecological modernisation can be compared with the concept of sustainable development however this concept too is being contested but there are also differences that exist. One of the differences is the fact that ecological modernisation does not deal with the social equity

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[171] Fisher DR, Freudenberg WR. 2001 Ecological Modernization and Its Critics : Assessing the Past and Looking Toward the Future, 702

There are a number of differing perspectives on the theory of ecological modernisation ranging from acceptable to critical and many scholars and theorist also have views that are between the two extremes. The most critical and negative sentiments have been expressed by scholars who believe that concept of ecological modernisation is not achievable and therefore bound to fail 702.

[172] Toke D. 2001. Ecological Modernisation: A Reformist View, 281 The notion of social engagement is a key element in the development of ecologically accepted practices and the development of new and the incremental evolution of existing knowledge through the process of codification and diffusion plays a significant role in the changes being applied, by both government and business. 281

[173] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 94

aspect, which is catered for although not in its entirety in sustainable development. It is however evident that the survival or sustainability of companies is dependent on the support of the consumer. Government is dependent on the citizens of the nation-state and therefore have to factor into their policy development not only economic development but ecologically friendly directives. The emphasis of the argument for ecological modernisation and the developmental process is striking a balance between natural environment and economic development[174].

Murphy and Gouldson supports the view of Mol which is that environmental challenges "can be addressed within the framework of modernity"[175] through a collaborative process between business and state, which will yield positive results for economic development. To achieve this, it is necessary to initiate structural change at a macro level, utilising methods that will reduce the negative impact on the natural environment. From a policy perspective, it will be necessary to find innovative methods and instruments that will provide incentives to business in the development of ecologically friendly technologies.

The argument being formulated in terms of regulation reinforces the view presented by Daft and Weick that more general rules of interpretation applies since the environmental feedback is vague. Two sets of feedback requires interpretation, one from an economic perspective and one from an ecological perspective. Ecological modernisation theory provides the individuals with a new foundation to interpret information and develop knowledge regarding regulation and policy that takes both these perspective into account. Neither view is discarded. It does however promote new knowledge creation to provide the policy makers with evidence that new innovation complies with the ecological agenda, whilst still providing the organisations with the economic benefits for sustainability.

3.4.2.1 Key Features of ecological modernisation theory

 Berger *et al* make supports Christoff and Mol and identifies and summarises the key features that distinguish ecological modernisation from other theories.[176]

- Ecological Modernisation as technical adjustment

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[174] Toke D. 2001. Ecological Modernisation: A Reformist View, *New Political Economy*. 6 (2), 279 – 291.

[175] Murphy J. Gouldson A. 2000. Environmental policy and industrial innovation: integrating environment and economy through ecological modernization

[176] Berger, G. Flynn, A. Hines, F. Johns, R. 2001, Ecological Modernization as a Basis for Environmental Policy: Current Environmental Discourse and Policy and the Implications on Environmental Supply Chain Management, *58*

- Ecological modernisation promotes competition along the lines of technological improvements or changes to achieve a state of market competiveness in which the product has environmental benefits. Cost cutting is achieved through improving resource usage and this is primarily due to pressure from the market and society.

- Ecological modernisation as a belief system

  - Ecological modernisation propagates that long-term sustainability can only be achieved through the effective utilisation of resources thereby protecting the environment from exploitation. This amongst others requires changing and improving consumer preference for environmentally friendly products.

- Ecological modernisation as policy discourse

  - In the production and consumption process, a change of focus to the environment and the impact of wasteful resource usage must be considered from a policy perspective. The main focus of the discourse is about the economic impact of environmentally friendly production means, i.e. development along resource efficiency.

- Ecological modernisation and environmental policy making

  - There are a number of questions that are pertinent to the role ecological modernisation plays in the process of development of environmental policy. Consideration must be given to the various actors within society that play a role in the development of these policies.

  - The approach to policy making and policy development is one that is not based on the conventional autocratic style of command and control but requires a process of negotiations and reaching consensus on approach and industry regulation. Societal problems cannot be solved through state intervention only and requires a collaborative approach to be adopted between state and industry. This is an iterative approach adopted that is promoted in the policy-making arena with the aim of adopting pragmatic principles in the development of environmentally friendly initiatives and products.

  - As a consequence of these changes, there is also a rise in the market of various actor and agents as a result of the environmental policy requirements.

It must be noted that even though it is a consequence of the environmental policy requirements, the rise in numbers are attributed not only to the desire to make a positive change but also to economic incentives.

- ▪ Transnationalisation and globalisation also have an impact on environmental policy development. This is visible in bodies such as the EU that sets policy frameworks for member nation-states as guidelines in the development of their policies.

Ecological modernisation requires an evolution of technology, society and government the extent of change that is required is outlined above. This demonstrates the complexity involved especially since there are numerous actors with varying views on an environmental issue. Reviewing the key features of ecological modernisation, Berger *et al* makes a comparison to sustainable development and identifies that in the development of environmental policy, societal elements are largely excluded.[177]

Ecological modernisation has its own tensions from a theoretical perspective. To further exacerbate the matter, the promotion of research and development on an ecologically friendly basis whilst still achieving the economic growth requirements of governments adds to the level of learning complexity. The tenure of the leadership will be threatened if government is unable or unwillingly to adjust structurally based on the environmental feedback. When the structural modifications are implemented, if requires interpretive models to guide and direct the knowledge generation process. Daft and Weick provide insight into the relevance of the sender and receiver transmission. This is supported by Boisot who elaborates on the importance of the codification, abstraction and diffusion of the message and the influence that it has on the interpretive model of the population. A consideration in improving the communication is whether the sender and receiver of the message are from the same target population. Context and memory of the receiver will influence how message is in interpreted.

3.4.3   Economics and Innovation

Innovation is a process that is initiated which views the various stages of economic activity in the determination of the level of evolution that a product can undergo. This includes the

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[177] Berger, G. Flynn, A. Hines, F. Johns, R. 2001, Ecological Modernization as a Basis for Environmental Policy: Current Environmental Discourse and Policy and the Implications on Environmental Supply Chain Management, 60

search for a new product, adoption of the product developed, modifications or enhancements to existing products and new processes developed in the production of the product, including new organisational structures. The stage of innovation is dependent on whether it is a radical discontinuous change or incremental continuous change. They are however inter-related in that a radical, discontinuous change is necessary for and an absolute pre-requisite for incremental, continuous innovation. A necessary ingredient in making the innovation process a success irrespective of whether it is incremental or radical is an existing network of relationships that will, through a process of diffusion, adopt the new innovations. That implies the existence of existing knowledge upon which the new innovation can leverage allowing for the successful take up thereof[178].

Gouldson mentions a number of changes that have been initiated on an organisational level as a result of a joint perspective on innovation and development, i.e. from an economic and ecological development perspective. Innovation around recycling, development of waste management systems and regulation around this has resulted in organisational/institutional transformations that can be considered as a semi-permanent state[179]. Changes in some instances can have a significant impact on existing systems. It will require the development of new skill sets and knowledge to replace the existing knowledge base and in the case of developments that are discontinuous, this shift is more radical. The fact that the continuous change requires knowledge that builds on the existing knowledge makes diffusion and adoption of the changes easier. During the implementation of a new technology, as experience and knowledge are acquired the rate of uptake increases and the quality improves along with it. The cost benefit also improves as knowledge of the new product filters through the organisation which allows for a more effective and efficient structure to support the innovation. Without the learning effects and the potential to grow to a technology that is adopted by a broader base, the technology becomes expensive and inefficient, and therefore will not be economically feasible. Due to the nature of innovation and the fact that a technology that is not adopted is a very expensive product to maintain, it is apparent that in a self-regulating environment incremental change will be favoured[180].

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[178] Murphy J. Gouldson A. 2000. Environmental policy and industrial innovation: integrating environment and economy through ecological modernization, 35

[179] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 94

[180] Murphy J. Gouldson A. 2000. Environmental policy and industrial innovation: integrating environment and economy through ecological modernization, , 35-36

Innovation that introduces a new technology can be as a result of an end-of-pipe scenario, and this does not necessarily equate to ecological modernisation. Ecological modernisation is a concerted effort made by the innovators to reduce the consumption of materials directly or indirectly and to assist in the creation of an environment for the diffusion of the product. The theory is based on the premise that the developed nations will promote through the industry innovation processes with a more environmentally friendly paradigm in the development of new technologies. A sound economic model is essential and government's role is crucial in creating the climate that will allow for and promote the development of eco-friendly products. Policy is therefore another critical element in setting the pace and at which eco-friendly initiatives are launched by industry actors. From an economic perspective, modernisation is viewed as method of improving processes and products. With an increase in competition in the market it has influenced the speed at which innovation takes place. It is the direction of the innovation that can and must be influenced by other actors such as government. This ensures that the innovation processes include the objective of eco-friendly design. This can be achieved in one of two ways, either cleaner technology which is a result of incremental change or clean technology which is a result of radical change[181].

From an economic perspective, industry has adopted the approach to develop green markets based on established markets which makes the process of diffusion easier.[182] In specific sectors of the industry, these markets evolved due to the fact that consumer knowledge was improved significantly over a period of time, with a greater understanding of the harmful effects on both the environment and people.[183]

In the case of the paper and pulp industry, actions groups circulated information and knowledge about chlorine and dioxin used in the manufacture of in paper to women throughout the United States of America, UK, Canada and Australia. This put significant pressure on the producers of these products to start using more ecologically friendly technology to ensure that their existing products line sales continue to enjoy the levels of market support with respect to tampons, sanitary pads and diapers. This reinforced the notion

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[181] Jänicke, M. 2008, Ecological Modernisation: new perspectives, 558

[182] Jamison, A. 2000. On the Ambiguities of Greening, 254

[183] Sonnenfeld DA. 2002, Social Movements and Ecological Modernization: The transformation of Pulp and Paper Manufacturing, 2

that the costs for the conversion to environmentally friendly means of production were modest and that the market for the use of these products already existed[184].

Economies are viewed as nation-state domains. All challenges outside of the borders were previously viewed as playing no role in influencing "local" situations, but this is no longer applicable. The channels of distribution and marketing in the process of globalisation determines the global economy and is there not restricted by borders.[185]

Organisations with an established consumer base would want to continue to exploit them through the development and introduction in the market of product enhancements. This promotes a cumulative knowledge development strategy and as a result the development of the new products is directed to incremental modifications and change. The "correct" interpretations" of the individuals is based on this strategy and data that does not reinforce this interpretation will be discarded. In the case of the shifting of the wood, paper and pulp industry, the action groups were responsible for the codification, abstraction and diffusion of the information and knowledge. It is evident that the strategy adopted for this process was "correct" and that influenced the level of absorption and impacting. The level of influence of the consumer base was the trigger for manufacturers to implement a discontinuous learning and knowledge creation strategy. In this case, it was a paradigm shift that was necessary from both industry and government. The direction of the change was essentially forced on them due to new knowledge that was made available to the consumer population, the action group target population.

3.4.4   Technology, the technocratic project and Modernisation

Innovation and technology go hand in hand and as such within the ecological modernisation debate, technology and technological development has been a part of the discussion from the onset. Environmentalists during the earlier years held the view that the technology was a cause of deterioration of the natural environment. Another view held by environmentalists was the fact that technologists were merely shifting the environmental problem instead of tackling the issues and solving them. Mol and Jänicke supports Hajer's view that there are two distinct views of ecological modernisation, namely "techno-corporatist ecological

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[184] Sonnenfeld DA. 2002, Social Movements and Ecological Modernization: The transformation of Pulp and Paper Manufacturing, 5

[185] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 95

modernisation and reflexive ecological modernisation."[186] Whilst "techno-corporatist" makes reference to technology from an administrative perspective, reflexive modernisation makes reference and points to learning within a society, culture and associated politics and the revision or introduction of different structures within institutions as a result of the ecological modernisation initiative. Technology may not be the central element or the driver of the change. However in the transformation of the institution, technology does play a role.

There has been a definite shift from "end-of-pipe" technologies to a more integrated systemic change by looking at introduction of new technology as a "socio-technological system"[187]. The shift from the "end-of-pipe" modifications or enhancements to a preventative technology has been pursued by scholars from the ecological modernisation school of thought. To further this agenda, a significant shift has occurred to ensure that where applicable and relevant, individual technologies have become more complex and integrated into socio-technological systems. It is more visible in industrial type programmes such as renewable energy. This also demonstrates the reliance of multi-disciplinary initiatives to achieve the desired ecological outcome using technology.[188]

When interpreting ecological modernisation as being a technocratic initiative, Hajer states that the ecological problems cannot be solved through a process of social learning only as suggested by social institutions. Technology and the development thereof are deemed to be out of control. The driving force behind ecological modernisation is policy-makers, the scientific community and experts from various fields and disciplines that push its agenda. Through defining the problem and solutions, these actors take charge of and influence the direction of the debate. In understanding the impact that social movements had on the ecological debate, it must be viewed in the context of the system within which they operated. Members of these movements came from various disciplines, including the scientific community, and each of these groups of people had their own understanding or perceived the reality of the ecological problem differently, i.e. influenced by their situation or circumstances. The state dealt with these movements either through force or by inviting them to participate in the legal processes, i.e. inquiries and public debates, in which the message

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[186] Mol APJ, Jänicke M. 2009, 2010 The Origins and Theoretical Foundations of Ecological Modernisation Theory, in: *The Ecological Modernisation Reader – Environmental Reform in Theory and Practice*, 20

[187] Mol APJ, Jänicke M. 2009, 2010 The Origins and Theoretical Foundations of Ecological Modernisation Theory, 20 in: *The Ecological Modernisation Reader – Environmental Reform in Theory and Practice* 21

[188] Mol APJ, Jänicke M. 2009, 2010 The Origins and Theoretical Foundations of Ecological Modernisation Theory, 20 in: *The Ecological Modernisation Reader – Environmental Reform in Theory and Practice* 21-22

gets lost. Ecological modernisation is viewed as a means of repression and creates the diversion from the more radical views on environmentalism and the content and direction of the debate. It is suggested that key issues on the natural environment are conveniently left out such as the nuclear debate.[189] There are different perspectives that are presented and each one has merit in terms of learning as it promotes knowledge creation. The development of knowledge in the different disciplines ensures that a larger body of data is available for analysis. Subjectivity will influence the interpretation and data shedding process, however additional data and information provide the opportunity for insight to occur, i.e. a paradigm shift on an individual.

A key critique raised by Hajer is the fact that ecological modernisation promotes the agenda of development of newer and better technology which in turn promotes consumerism. Society is enslaved by technology and its development and the fabric of society as a consequence changes. Scientists and technicians develop technological solutions based on institutional bias and goals. Little attention is given to members of the scientific community or expertise that counters the mainstream.[190] This reinforces the argument that the interpretation of data and information that influences the knowledge creation process is subjective. It will be determined by the strategy adopted unless external parties are able to create sufficient environmental turbulence that dislodges or unsettles the existing structures. To achieve this, knowledge creation and innovation based on a different paradigm must exist and be available to use. Environmental feedback therefore also shifts and directs the knowledge creation process of organisations provided that an economic benefit can be realised.

3.4.5 Politics and Environment

Environmentally friendly initiatives have an economic implication and as a consequence will usually require an intervention from the state to promote the development and use of these types of technology. It is therefore necessary to assess and understand the political landscape and the evolution of politics in the knowledge diffusion process and the promotion of

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[189] Hajer, M , 2010, Ecological Modernisation as Cultural Politics in The Ecological Modernisation Reader – Environmental Reform in Theory and Practice 86-87

[190] Hajer, M , 2010, Ecological Modernisation as Cultural Politics in The Ecological Modernisation Reader – Environmental Reform in Theory and Practice 88

ecologically friendly innovations. Jänicke identifies three characteristics that make this ecological innovation different from conventional innovations processes, viz.

- Ecological innovations have a potential not to succeed in the market place and requires political support

- As ecological innovation has a global impact since it attempts to resolve global issues, the market is borderless and can be distributed globally

- The demand for innovations that are environmentally friendly is created as a result of the "global industrial growth" and therefore the use of the scarce resources is a consideration in the ecological innovation process.

This demonstrates a clear case for ecological innovation. However the market success is also a consideration. A necessary and integral part of a successful migration to new ecologically friendly technologies is the political landscape and the willingness of the state to introduce regulatory requirements as a mechanism for the promotion of these objectives. In as much as the impact on the environment is the objective of the introduction of new regulations and innovation, a country that has demonstrable policy also provides the opportunity to be more visible in the global political arena albeit mainly the smaller OECD countries[191].

The view of introducing regulation to promote ecological innovation is a revision of the perspective held during the 1980s in which time the argument was that regulation introduces high costs on firms and consequently "stifles innovation and competitiveness". Since the natural environment has featured high on the agenda in the 1990s this view has changed and demonstrated that a country's competiveness can be enhanced and promoted through environmental regulation. It is arguable that regulation can create impediments to companies, but companies and industries that are able to evolve have a number of advantages that can be capitalised on.

- Regulation creates support for companies and industries that comply with the requirements, e.g. renewable energy sector in Germany

- In an market environment that is uncertain and complex, regulation becomes more predictable and therefore companies are able to manage the innovation of existing and new products more easily

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[191] Jänicke, M. 2008, Ecological Modernisation: new perspectives, *Journal of Cleaner Production*, 16 559

- Regulation within the context of the natural environment also evens the playing field as companies need be concerned about whether the competitor will implement the same measures, it is almost a certainty

- A number of distinct advantages exist with regard to promoting an environmentally friendly technology within an organisation, the barriers a simply removed. Furthermore companies do not have to be too concerned about the fact that consumers may reject the product, there is simply no choice.

This demonstrates and underscores the importance of regulation. It must however be viewed in the correct context of environmental regulation. Knowledge creation and evolution is a key element in the innovation process, and more so in the environmentally friendly development process.[192]

This is a demonstration of the shift that has occurred from the 1980s to the 1990s. From a national perspective, the shift of creating knowledge to promote the natural environment was viewed as an opportunity to exploit a market. A paradigm shift occurred on a national level that forced industry to change its perspective. In the research undertaken, there was not direct reference to the role that an industry core played in changing the regulation. An organisation that shares its knowledge with regulators and makes it available also promotes the standards of their product. This is typically how an organisation can promote product "lock-in" and use it to their benefit.

3.4.6 Politics and Modernisation

The state and function it performs as well as the state structures are undergoing continuous transformation with the aim of ensuring that it can perform the role expected by the public. Irrespective of the extent of the modernisation of the state and the ability to transform, it is viewed to be running in parallel with the ecological modernisation initiative due to the fact that the same drivers are the motivation for the change. The question of whether the state changes would have occurred or at least be initiated without the pressure from the environmental groups and changes taking place must be considered and therefore the modernisation of the political structures should be viewed within this debate. Modernisation is influenced by innovation which in turn drives development in the long-term. Jänicke's

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[192] Janicke, M. 2008, Ecological Modernisation: new perspectives, *Journal of Cleaner Production*, 16 559

definition of modernisation by is "the institutionalisation and differentiation of a new technological, political-social, and scientific-cultural level of problem solving, based upon a fundamental paradigm shift."[193] This shift also has an impact on the political machinery and implies that a parallel shift or modernisation of the political system must occur. Simply put, the state machinery is responsible to produce, using the state resources, and distribute these resources with the aim of shaping and directing its citizens. The nation state, described by Van Tatenhove and Leroy, comprises of three subsystems, viz state, market and civil society, and the degree to which these subsystems are independent from each other would determine the extent of the "political domain"[194]. Independence also suggests that learning will take place on at least three different interpretations. Individuals wishing to promote a perspective will be required to make the information explicit with the aim of creating a shared model with the target population.

In the analysis of the political domain, a distinction is made between the "three phases"[195] of modernisation viz. 'early', 'anti-' and 'late'. Early modernisation is based on the premise of a 'responsible state' having the ability to effectively and efficiently plan and develop and implement policy. It presupposes that both the market and civil society demonstrates maturity and willing participate in the implementation of the policies giving effect to the policies which have been developed using proven scientific standards and subsequently adopted. Anti-modernisation however does not share in the optimism of the early modernisation scholars as it is deemed to be a linear, one dimensional view. Anti-modernisation scholars and authors are of the view that real problems are not addressed such as issues relating to equality and poverty amongst others. The relationship between market and state is viewed as one developed on the basis of not being necessarily in the interest of society with the potential of creating a dictatorship.

A more participatory form would result in more progressive policy instruments to influence the behaviour of the market such as undertaking environmental impact assessment before initiating large industrial projects. Late modernisation scholars and authors share the belief

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[193] Janicke, M 1993 On Ecological and Political Modernisation - Translation by Bettina Bluemling from Über okologische und politische Modernisierungen, Zeitschrift für Umweltpolitik und Umweltrecht, 2, 159-175, in: The Ecological Modernisation Reader – Environmental Reform in Theory and Practice, 29

[194] Van Tatenhove, JPM, Leroy, P 2009, Environment and Participation in a context of Political Modernisation in: The Ecological Modernisation Reader – Environmental Reform in Theory and Practice, 191

[195] Van Tatenhove, JPM, Leroy, P 2009, Environment and Participation in a context of Political Modernisation in: The Ecological Modernisation Reader – Environmental Reform in Theory and Practice, 192

that politics and society will be steered and structured based on the outcome of modernisation and its consequences. The risks will influence the political behaviour and therefore play a role in the development and modernisation of the political arena. Van Tatenhove and Leroy refer to the work of Beck who suggests that the state is responsible for not being able to provide and regulate the market in the first place. The nature of the risks in a globalised market has changed and cannot be effectively managed through the conventional structures of central state machinery.

Late modernisation therefore suggests that the roles of state, market and civil society has become more intertwined, resulting in a greater level of integration between the representative structures. This in turn provides the platform for an integrated approach to the development of the problem statement and solution which forms part of the policy formulation process[196]. This approach has been adopted by supra-national institutions in which member states use a co-operative and integrated development process to benefit the region.

Learning will take place within each of the three areas, i.e. "early", "anti" and "late" based on their interpretative model that provides guidance and direction. Pertinent data and information per area will be analysed for codification, abstraction and diffusion. Boisot refers to the structure that governs this type of knowledge creation as a "clan". Each of them will be responsible for setting the criteria that governs their behaviour and also how new knowledge must be structured for diffusion. This requires a process of negotiations with peers who reviews what is being presented and provides constructive criticism[197].

3.4.7   Politics and Policy Development

Economic development and ecological issues were always viewed as being at opposite ends of the scale and in fact in the developed countries, there has always been an antagonistic relationship between economic development and environmental protection[198]. Policy makers in favour of economic development considered ecological requirements as slowing down growth, i.e. putting the brake on economic development. During this period, the challenge was determining the trade-off between the environmentalist and the economist in developing

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[196] Van Tatenhove, JPM, Leroy, P 2009, Environment and Participation in a context of Political Modernisation in: The Ecological Modernisation Reader – Environmental Reform in Theory and Practice, 192-193

[197] Boisot, MH, 1998, Knowledge Assets Securing Competitive Advantage in the Information Economy, 132

[198] Gouldson, A, Murphy J. 1996, Ecological Modernisation and the European Union, 11

a feasible solution. This was generally the end-of-pipe scenario in which modifications were made to ensure compliance with the ecological requirements. Berger, *et al* shares the views of Gouldson, Murphy and Hajer who were deemed to have adopted a radical approach to ecological development and believed that a radical approach was necessary in the manner in which society viewed the natural environment. One has to be cognisant of the concept of sustainable development that shifted the discussion from an either or scenario to a collaborative scenario. This set the platform for a "mutually reinforcing" approach that would ensure economic development and ecological improvement and consequently have a positive impact on social equity.[199]

Notwithstanding these differences and similarities, the importance of natural environment and ecological issues came to light in countries that were experiencing environmental and ecological challenges, such as Germany with acid rain and the fact that the Green Party had gained representation at a federal level. Issues such as Chernobyl, global warming and the ozone depletion increased the importance of the ecological issues and challenges in the international arena[200].

Ecological issues have become increasingly more visible in a number of government institutions nationally and globally. The issues being addressed are limited however the number of agreements within the multilateral organisations is on the increase[201]. These agreements encapsulate a common set of principles in the policy and legislative domains. Supra-national institutions such as the European Parliament exercise a great deal of influence on member states and are therefore able to "counteract the side-effects of global capitalism"[202] caused by them.

Forums such as the World Commission on Environment and Development (WCED) as well as the Environmental Action Programme of the European Union have set the platform for environmental policy to play a more meaningful role in the debate around economic development. Member states have refocused its instruments for the "internalisation of

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[199] Berger, G. Flynn, A. Hines, F. Johns, R. 2001, Ecological Modernization as a Basis for Environmental Policy: Current Environmental Discourse and Policy and the Implications on Environmental Supply Chain Management, 56

[200] Toke D. 2001. Ecological Modernisation: A Reformist View, 280.

[201] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 99

[202] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 100

environmental costs"[203] and using strategies aimed at minimising waste as well as ensuring a longer product life-cycle. In achieving this objective, EU member states have adopted an approach of shared responsibility, dialogue and partnership with industry to the extent that industrial self-regulation and policing exists through instruments such as the eco-management and audit scheme. The sophistication in policy development and the shift to product life-cycle as opposed to specific segments in the product development has resulted in industry shifting to a more progressive approach in product development[204]. A shift away from end-of-pipe development by the various industrial players into a more proactive anticipatory scenario has created markets that are predictable which in turn has arrested the escalating costs of introducing reactive measure to ensure compliance[205].

Jänicke support the argument presented by Levi-Faur, *et al* and points out that regulation has made a comeback to the extent that it has lead to the development of the theory of "Regulatory Capitalism". Instruments used in the development and focus of regulation have shifted significantly in this period and is referred to as "smart" regulation[206].

Both cumulative and discontinuous learning results can result in structural change, however discontinuous change is far more disruptive and expensive. Government structures had to shift and undergo significant change due to the shift from the 1980s to the 1990, i.e. consideration of the natural environment. The learning process adopted was aimed at achieving economic benefit for local industry and to promote the development of industry expertise. A first-to-market scenario for a nation on a technology innovation would have significant economic growth benefits. Political leadership, and the structures or parties they belong, will not only derive the benefit of "grateful" citizens, but also ensure support from industry players. It will reinforce the legitimacy of the leadership. The development of instruments that promote this approach is another example of a learning cycle that is directed by the purpose of the establishment. The power of the core group in these establishments, be it Supranational or Multi-lateral organisations, will play a significant role in directing and

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[203] Berger, G. Flynn, A. Hines, F. Johns, R. 2001, Ecological Modernization as a Basis for Environmental Policy: Current Environmental Discourse and Policy and the Implications on Environmental Supply Chain Management, 57

[204] Berger, G. Flynn, A. Hines, F. Johns, R. 2001, Ecological Modernization as a Basis for Environmental Policy: Current Environmental Discourse and Policy and the Implications on Environmental Supply Chain Management, 57

[205] Janicke, M. 2008, Ecological Modernisation: new perspectives, 559

[206] Janicke, M. 2008, Ecological Modernisation: new perspectives, 560

promoting a particular learning agenda. This is will achieved through the development of appropriate regulation. One such tool is "smart" regulations.

The table below depicts the elements necessary for a successful "smart" and innovation-friendly framework of environmental regulation[207].

Table 1 Elements of a "smart" and innovation-friendly framework of environmental regulation

Instruments are innovation-friendly if they

- Provide economic incentives,

- Act in combination,

- Are based on strategic planning and goal formulation,

- Support innovation as a process and take account of the different phases of innovation/diffusion.

A policy style is innovation-friendly if it is

- Based on dialogue and consensus,

- Calculable, reliable, and has continuity,

- Decisive, proactive, and demanding,

- Open and flexible,

- Management-oriented.

A configuration of actors is innovation-friendly, if

- It favours horizontal and vertical policy integration,

- The various objective of the regulation are networked,

- The network between regulator and regulated is a tight one,

- The relevant stakeholders are included in the network.

Source Jänicke M. 2008, Ecological Modernisation: new perspectives

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[207] Janicke, M. 2008, Ecological Modernisation: new perspectives, 560

One such successful use of this type of framework was used in the Japanese "Top Runner" approach which demonstrates the fact that an "innovation-friendly"[208] climate can be established. This approach takes into account the different phases of a product life cycle from innovation to the diffusion of the product in both the international and national arenas. As a transnational organisation, the EU has also successfully created programmes that comply with the "innovation-friendly" concept in renewable energy, EU trading scheme and the EU Eco-design Directive. Ensuring economic viability is the key to the success of any policy and to this extent the EU regulations are flexible enough to take into account the investments cycles of organisations.

Determining the extent of applicability of certain knowledge and its value to the organisations is always dependent on the perspective of the organisation, i.e. the boundary that has been established. Through the development of "smart" regulation, governments have created a mechanism that requires organisations to extend the boundary. Organisations data shedding strategies must be reviewed and adjusted to cater to ensure firstly continued economic participation and secondly, benefiting from the creation of the new market. Organisations that identified the opportunity earlier in the development and adjusted their strategy accordingly may have created a product "lock-in" scenario through the adoption of their standard. First to market on intellectual property also provides a mechanism to further exploit the knowledge through iterative and incremental product improvements.   Essentially, "smart" regulation creates a market for the ecologically friendly product design, reducing the risk usually associated with a new product entering the market.

3.5 Policy, Politics and the Environment

3.5.1   Environmental Institutions

Globally there has been a shift in the structuring of supranational institutions to facilitate cross border economic activity on a regional level. "Political arrangements" to combat environmental issues have been around since the 1970s. Environmental issues have also been included in institutions such as the EU and North American Free Trade Agreement

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[208] Janicke, M. 2008, Ecological Modernisation: new perspectives, 560

(NAFTA). As environmental challenges have taken on a regional perspective within these economic arrangements, these supranational bodies and their "political institutions and arrangements"[209] to deal with the ecological issues within their regions have had to upgrade them to the same levels to have the ability to deal with it. Although the idea is good, there are a number of shortcomings in simply up-scaling to accommodate the regionalisation of the ecological issues.

1. Economic globalisation has altered the face the ecological deterioration as experience during the 1970s which extends beyond a change in the scale of the issues. Thus changing the scale of the political institutions and political arrangements to introduce and regulate environmental reform is an inadequate structure for real and sustainable change. Ecological issues that result from globalisation extends beyond borders and has no geographical limitation and therefore institutions and political arrangements based on nation-state principles are simply inadequate[210]. There must be a fundamental shift in the structures.

2. These global political institutions are viewed differently by the various member states as there are significant differences on an economic and political level. This ultimately impacts their ability with regard to viable approaches in terms of ecological reforms. Ultimately, the up-scaling of these institutions are dependent on the various nation-states, and therefore it may not be feasible for a unilateral application of these reforms due to variations in the level of global economic activity[211].

3. Governments have adopted different forms to cater for the local challenges, such as municipalities, and these actors are also playing a role in the management of ecological challenges. The localisation of structures outside of the traditional political structures and associated institutions are being considered by some scholars as an answer to the continuing ecological deterioration. Society and industry are becoming more powerful and play a more substantial role within the ambit of environmental politics. Traditional structures have been superseded as a result and it is assumed that this has taken place "against the background of a weakening system of sovereign

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[209] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 100

[210] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 101

[211] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 101

states"[212]. Ecological issues have become an integral element in the political and economic arena.

The above reinforces the view that the external environment plays a significant role in adjusting the view and boundaries of organisations including that of governments. Society through action groups, are presenting alternatives to those offered by industry, such as renewable energy as opposed to fossil fuel energy generation. These alternatives require policy adjustments and in many cases a total shift in policy. To effect this level of policy change requires government, like industry, to supplement its existing knowledge base with the new knowledge that is required to deal with the changes. The initial shift is radical and discontinuous, and subsequent steps in the learning cycle will be iterative and incremental. It does however require a complete shift or change in the internal environment structures.

3.5.2   Social Movements Network in Action

The development of ecological modernisation theory has influenced changes within organisations and institutions due to the evolution, internalisation and adoption of ecological practices. Social movements have been acknowledged for their role in this change but the extent of influence in the transformation process has not been determined. In his study of the pulp and paper manufacturing industry, Sonnenfeld found empirical evidence to support the notion that social movements play a significant and important role in the transformation of society. The harmful effects of dioxin, a by-product of chlorine used to bleach paper, became an area of interest especially as it was used in a variety of consumer products such as cartons, diapers, paper towels and female sanitary products. Greenpeace together with a number of other transnational NGO's used their networks, which had a global reach, to spread the word and inform members of the harmful effects of dioxin. In Tasmania, a paper mill was being planned even though there was strong opposition from the community. The community considered it an inappropriate use of agricultural land, however authorities and the proposed owners of the plant ignored the residents' concerns. Through the network of Greenpeace information regarding the by-product dioxin was diffused within the community, the argument shifted to include the use of technology that is dioxin free. The plant was not built and the requirement for implementing new chlorine free technology was never realised, however the environmental social movements used this lesson and initiated a country wide

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[212] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 102

campaign for the use of chlorine free technologies in the paper and pulp industry in Australia[213].

The theory of ecological modernisation has improved the level of co-operation between the ecological groups, industry and government. It provides a base for a pragmatic approach using technological innovation, i.e. alternatives are on offer. Economic cost benefits are still a requirement in determining the feasibility, however the fact that technological options exist makes it easier to promote the ecological agenda. Alternative knowledge streams which have less of ecological impact, does not only provide the theoretical base but also the technology. Regulators, through initiatives like "smart" regulation can promote the use and further innovation of these alternatives. As the installed base increases, knowledge and knowledge assets increase which reduces the cost of the technology and data processing agents.

3.5.3   Market and the Environment

Within the domain of ecological modernisation, one cannot discard the role that market dynamics and economic forces play in the ecological transformation process. It is the exchange and trade-off between the market, politicians and consumer groups shape and determine the extent of the ecological reforms that are introduced[214]. This transformative process and the associated innovation steadily change the institutional arrangements within the economic domain.   Each of these groups evolves and goes through its own data accumulation and data shedding process. This is learning associated with experience which increases the tacit knowledge of the individuals. It is evident that learning of individuals shapes the organisational learning process, however power and leadership does play a role in directing this learning.

There are typical capitalist organisations with the sole aim of maximising profits at the expense of the environment. Other than a few cases in which organisations embrace the ecological change requirements, one can generally expect to put these economic actors under pressure prior to them participating in an ecological reform process. This is achieved through interventions introduced by consumers/citizens, the political environment and organised groups. Once the ecological reform has been adopted by the economic agent, it becomes a

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[213] Sonnenfeld, DA, 2002, Social Movements and Ecological Modernization: The Transformation of Pulp and Paper Manufacturing, 2-5

[214] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 102

matter of integrating it into the operations of the organisation and the effect of this change creates its own external environment and tools for successful diffusion[215]. Through this process of innovation and diffusion, the transformation and ecological reforms are based on an integrated approach of economic and environmental goals. With a high rate of diffusion and the fact that social movements have access to a larger knowledge pool of alternative technologies, it has become easier to make a case for policy change. It still requires social actors to impart knowledge and create the shared model effectively creating a paradigm shift. Once this occurs, the interpretive model has changed and therefore this influences all future interpretation of information received by the policy makers.

Implementation of norms to manage the ecological issues has been on the increase and to this extent, has had both positive and negative consequences when viewed from an efficiency perspective. Taking from the example of tropical timber, boycotting tropical timber results in less of a demand and this in turn reduces the value that is placed on the rainforests. With insufficient demand, establishing a framework for a sustainable resource, i.e. tropical timber, becomes costly and the land use is re-prioritised. In this instance, reducing demand through boycotting the tropical timber can result in a counterproductive outcome. With regard to the diffusion of norms, the method of diffusion can and will determine the effectiveness of the norm. Mohr supports the view of Sugden and suggests that norms can be diffused through "analogy"[216]. It also demonstrates that there is no effective means for the diffusion of norms and more so if it was not deemed to be efficient in the first place. In evaluating the effectiveness of a norm, one must also view it in context. A norm for the protection of the environment will diffuse quicker amongst environmental groups and appropriate government institutions as opposed to the user group that exploits the resources and the natural environment. This reinforces the perspective of interpretation of information and the learning cycle. It also promotes the perspective presented by Boisot that organisations will make every attempt to keep their knowledge in the maximum value region of the I-Space.

Ecological reform and transformation is not guaranteed and must still be viewed as a process that unfolds slowly and steadily. With political, economic, consumer and civil society all playing a role in this agenda, the potential for regression to occur or the institutional arrangements to remain unchanged exists, especially in light of the fact that each actor has a

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[215] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 103

[216] Mohr, E. 1994, Environment, norms, society and economics, 235

specific power base.[217] As economic progress is ultimately the primary goal of all economic activity, the ecological issues will always be secondary and to this extent ecological reform will always require the efforts of the various bodies aimed at achieving ecological transformation.

Mol argues that economic interests are not equally distributed amongst economic players, and this distribution will be mimicked in the reforms and transformations that these players will subscribe to. A demonstration of the ecological reforms being subjected to the objectives of economic players is evident in the establishing of international standards. This is demonstrable in the ISO standard sanctioned by the WTO in which the design process excludes the developing nations, and thus the standards when imposed on them, cannot be necessarily complied with[218]. One therefore has to be cognisant of the interplay between the economic and ecological actors and the trade-offs, but cannot discard the fact that the natural environment will play a part of the institutional reform and transformation.

3.5.4 Economics and Politics

When addressing the issue of local, national or international markets, one invariably has to acknowledge that economic actors at play have political support. Production processes have been subjected to regulation and it is in these regulations that political support and or approval is required in order for the product to comply with ecological requirements. As markets are no longer restricted by nation-state boundaries, the legitimation of the production process and product requires "approval" from the various interested structures, and this would include the environmental groups with their global network[219]. This type of oversight by interested structures also ensures that the political structures and institutions are actively pursuing the ecological agenda. Economic actors are the dominant or core group and as a result can direct the policy development process. Through the creation of institutions and environmental groups that play oversight, the power relationship has shifted and provides action groups with access and opportunity to influence the policy development process. Once regulation has been changed, economic actors are forced to change their products and technologies to comply with the requirements.

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[217] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 102

[218] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 104

[219] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 105

Irrespective of the size and nature of the market and organisation, it is an absolute requirement that they have a physical presence, and therefore must have a geographical location"[220]. Based on physical location, there is also exposure to the local issues and influence such as the social, cultural and physical conditions that shape the behaviour of the organisation. Global organisations are under constant scrutiny which extends beyond their physical location and therefore have to be cognisant not only of the local issues but also the requirements of the global market they operate in. They are invariably held to account on the global environmental requirements. Political pressure is a necessary catalyst in creating movement within organisations to change their practices, and it is only post this pressure that requirements become entrenched in the behaviour of the organisation. The maturity of the developed countries in setting the global environmental priorities can be attributed to the fact that environmental exploitation of their resources has required immediate intervention. It can also be argued as the reason that developed countries and their governments are at the forefront of developing and politically institutionalising the ecological agenda. This is a distinguishing factor that is a setback for developing nations as they are always lagging in implementing and institutionalising ecological reforms[221]. This lag not only impacts on the ability to comply with standards, but also excludes developing nations from gaining economic benefit. The developing nations have insufficient knowledge assets and are not able to direct industry accordingly. As a result implementing new technologies produced by the developed nations comes at a high cost.   The economic and learning benefits of implementing policy to support new ecologically friendly technologies can be realised due to a lack of absorption and impacting thereof.

3.5.5   Global Environmental Reform

As discussed above, depending on the locality, the citizens have different needs and requirements as is the case between the developed and developing nations. Because of the different nature of the requirements, it is clear that ecological requirements differ and thus the potential for a single global framework is not possible, nor can a global frame of reference be

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[220] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 105

[221] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 106

universally applied in civil society. The globalisation of ecological issues can be discussed in the context of the following[222]:-

    i.   The ethics and principles of environmental behaviour as regards investments, production, and trade of transnational companies and investment banks are increasingly applied in a similar way to practices anywhere around the globe;

    ii.   The potential to monitor environmental (mis)behaviour of transnational corporations and institutions has moved far beyond the major centres of the global environmental movement in the developed world;

    iii.   Environmental misbehaviour and information are communicated around the globe; and

    iv.   Sanctions can transcend the boundaries on one state and are no longer limited to the localities of misbehaviour.

The extent to which the above is applicable is dependent on the investor profile, as local investors in a developing nation or economic region is less likely to be subjected to reprisals than a transnational investor. However in the case of developed nations and economic region institutions, a heightened awareness of the impact and power of civil society has created a new form of politics which can no longer be ignored by the "representatives of global capitalism"[223].

The use of fossil fuel for energy generation is an area that every nation has an interest in. Other than renewable energy, no new knowledge has been created that has the ability to produce the energy requirements of the world. Even if alternatives are available, the necessary knowledge on a global scale to implement and manage power generation would not be available. From the discussion in Chapter 2, technology becomes cheaper as the installed base increases. This can be attributed to the fact that knowledge and experience increases which also increases product usage. It also results in iterative and incremental improvements making it more efficient. Organisations promote individuals to pursue a particular agenda for product improvements which will improve market share, i.e. it directs the innovation process. In the next chapter, the carbon capture and storage initiative is reviewed to demonstrate how

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[222] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 108

[223] Mol APJ. 2002, Ecological Modernisation and the Global Economy, 108

learning strategies have changed to cater for the requirements of the ecology. It does not provide an opinion on whether the technology is ecology friendly or not.

3.6 Summary

Ecological issues have surfaced in last few decades of the 20th century and part of the reason that environmental groups have become more successful in raising the awareness is due to globalisation. Associated with Modernity is the fact that society is becoming more knowledgeable about issues regarding the natural environment. This is evident in the behaviour of markets and the innovation process being directed through setting objectives that are both ecologically friendly and have economic benefits.

Environmental groups, through the use of networks and technology extend beyond the borders of nation states. Awareness campaigns are aimed at changing the views of society and as a consequence the behaviour with the aim of influence governments and organisations. During the 1980s environmental policy was generally ineffective and environmental groups applied pressure to effect changes. With a greater level of social awareness the environmental groups applied pressure on governments and in the 1990s more effective policy and enforcement was introduced.

Markets have a complex structure and organisations aim to maximise market share. Green innovation is viewed as a costly exercise. A process of innovation is required to develop technology, using existing knowledge to create new knowledge. This implies a transformation of the organisation and is fairly costly. Some form of market protection is required that will level the playing field for the industry. This takes the form of policy, and the policy is developed based on changes in the political environment, i.e. pressure from society and social groups. Government structures had to be modified to cater for the changes required by society to deal with the ecological challenge. It required co-operation of governments at a higher level as the ecological challenge is not contained within the borders of a nation-state.

Ecological modernisation adopts the perspective that process of innovation aimed at achieving more with less. It therefore promotes knowledge creation from an ecologically friendly perspective, however in directing the learning organisational strategy is also a key element in ensuring success. The use of existing markets to promote a green agenda poses less of a risk to an industry. But it also requires catalysts such as government regulation and

policy. For an industry to adopt a more aggressive greening strategy alternative instruments are required and the concept of smart policies has been developed. This provides industry and governments to have a greater level of collaboration in finding technological solutions that are ecologically friendly.

There are theorists that oppose this view and suggest that a bias still exists to direct and develop technologies that are in the interest of the industry and purely for economic gain. This view is shared by environmental groups which also represent the interest of society. These groups also comprise of experts and scientists that are not aligned to the mainstream science. Opposing views present a platform for dialogue and negotiation and promotes the knowledge creation, innovation and learning process. Through a process of dialogue, continuous learning and transformation take place, shaping structures and influencing belief systems.

Formal structures have been influenced to the extent that supranational entities have been created to address issues relating to the environment. Supranational bodies comprise of many nation-states and have differing political views. As a result, they are responsible for developing frameworks and guidelines that will influence policy development of nation-states. These organisations also play a key role in sharing information and developing instruments to promote the ecological agenda. One challenge that is universally recognised as a serious ecological issue is the release of carbon into the atmosphere. It is such a serious issue that the World Metrological Organisation and the United Nations Environment Programme established the Intergovernmental Panel on Climate Change (IPCC) to assess and develop strategies for carbon abatement.

Ecology is a primary consideration in modern times. For organisations operating in environmentally sensitive industries to change their paradigm to focus on ecological issues, a policy intervention is required. Organisations that do not pursue an ecological agenda, especially with technology developments, face the possibility of attracting penalties of governments and the public, which will direct the research and development agenda set by the strategic management. The next chapter reviews the CCS concept, from a knowledge creation perspective and the factors that direct or guide it.

Chapter 4

Ecological Technological Change and Learning – Carbon Capture and Storage

4.1 Introduction

In this chapter, I aim to make explicit that ecologically friendly technological change either incremental or discontinuous is due to changes in the internal organisational environment. The internal shifts in organisational objectives occur as a result of changes in the external environment, viz. social and regulatory. In the context of the Carbon Capture and Storage, an overview of South Africa is presented and its participation in the industry and government learning cycles. The evolution of the power generation industry is presented to provide a background of the experiential learning that has occurred in the industry. Power generation globally uses primarily coal based technology.

From an ecological perspective, carbon emissions are viewed as a major contributor to global warming. Carbon capture and storage (CCS) which is in its initial stages in terms of a technology, has been identified by industry and governments as a carbon mitigation strategy. The relationship between ecological modernisation and learning has been established in Chapter 3. Factors that direct ecological technological development is identified and discussed, especially the role that government and policy makers play in this process.

Carbon capture and storage is reviewed to demonstrate how ecological modernisation and learning process is implemented on a global scale. It is not a technical paper on carbon capture and storage, nor is it an attempt to promote it as a solution to carbon abatement. Carbon capture and storage is presented as a specialist learning area, i.e. a niche target population. Even though there may be a high diffusion rate, absorption and impacting will be limited. It is argued below using the I-Space. Diffusion of CCS technology and technological change will take place to a select audience whose primary aim is to use the existing knowledge to create new knowledge, i.e. develop a solution that can be implemented on a large scale.

Policy makers and action groups are introduced in the form of supranational and environmental bodies that play an active role in the carbon abatement debate. These groups are expected to create the conditions in the external environment for the implementation of CCS and set the rules of engagement. The United Nations and the World Meteorological Organisation established the Intergovernmental Panel on Climate Change (IPCC) to "(i) assess available scientific and socio-economic information on climate change and its impacts and on the options for mitigating climate change and adapting to it and (ii) to provide, on request, scientific/technical/socio-economic advice to the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC).[224]"

The IPCC, agreed to produce a special report on carbon capture and storage. The report was drafted by the Working Group III of the IPCC who obtained input from hundreds of experts in different but related disciplines for the development and improvement of the CCS concept. This report is an output of the various learning that has occurred and also demonstrates the collaborative learning process when developing technology based on the theory of ecological modernisation.

The discussion on the carbon capture and storage in South Africa will focus on the role that organisations such as South African Centre for Carbon Capture & Storage, Council for Geoscience and Eskom are playing in the development of the technology, but more so, the potential for carbon storage. Without the potential for carbon storage, carbon capture does not make economic sense. South Africa plays a role in the international arena as well, both in terms of policy development and capacity building. This includes the establishment of a South African Centre for Carbon Capture and Storage, which together with various organisations is developing a demonstration project, and has identified in conjunction with the Council for Geoscience, potential storage areas in South Africa[225].

The research presented here shows that in certain situations, the will and commitment of technology organisations, governments, end-user organisations and NGO's exists as there is a great deal of collaboration between these actors from an iterative learning cycle perspective to develop the carbon mitigation solution. The required technology is not sufficiently mature to determine the final product design[226]. It therefore requires the industry to develop projects

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[224] Working Group III, 2005, IPCC Report on Carbon Dioxide Capture and Storage, Cambridge University Press, vii

[225] Council for Geoscience, 2010, Atlas on geological storage of carbon dioxide in South Africa, 9 - 17

[226] Markusson, N, Kern,F, Watson, J, 2011, Assessing CCs viability – A socio-technical framework, 5744

that will demonstrate the viability of the technology, which will also require that a number of pre-requisites are met. The learning cycle pertaining to this technology seems complex as it comprises of a number of different technologies, some proven and others in development phase. The complexity lies in the integration of these technologies with the aim of capturing the carbon, safe transportation and the storage thereof to the appropriate site and the subsequent transfer to a permanent, geologically suitable storage facility.

This technology for the purpose of and specific to the energy sector, i.e. use of fossil fuels, seems to be in the final stages of R&D and allowances have been made in the design and development of new projects for the use of this technology[227].

4.2 Learning and Technology Development

4.2.1   **Creating and Managing the Environment**

The research in Chapter 2 and Chapter 3 makes reference to innovation in the development of knowledge which is embedded in technology. The importance of innovation for continuous improvements in organisations is emphasised[228]. Innovation either leads to the creation of new knowledge which is either radical and disruptive from an organisational perspective, or incremental and iterative which requires minor modifications to existing products. The learning development cycle for carbon capture and storage is both incremental as well as discontinuous. This is due to the fact that it is an integration of a number of technologies, old and new, to achieve the objectives of carbon mitigation. In the energy sector, coal has and will continue to play a major role as it is widely available globally. As a result of its availability, it is also cheap unlike oil and gas which is available mainly in the Middle East and more expensive than coal. This has an influence in the pricing of the fossil fuel. Despite the contribution of coal to greenhouse gas (GHG) emissions and carbon dioxide when used as an energy source, it remains a "fuel of choice" globally.[229]

GHG has been identified and agreed to as a major contributor to climate change and the reduction of these emissions is necessary to reduce the effect on the atmosphere. To give

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[227] Gibbens, J, Chalmers, H, 2008, Preparing for global rollout: A 'developed country first' demonstration programme for rapid CCS deployment, 503

[228] Murphy J. Gouldson A. 2000. Environmental policy and industrial innovation: integrating environment and economy through ecological modernization, 35

[229] Ansolabehere, S. Beer, J. Detch, J. et al. 2007. The future of Coal, Options for A Carbon Constrained World, 1

effect to this, multilateral bodies have been established for the purpose of driving the agenda of reducing the emissions generated from source. The United Nations Framework Convention on Climate Change is one such body that has established the principles for countries to cooperate in the process of reducing GHG emissions from all identified sources. To this extent, part of the agreement pertains to making available information and technology options to members in developing and developed countries, pertaining to a "sink" or "reservoir". A "sink" is defined as "means any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere" and a "reservoir" is defined as "means a component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored."[230] Multinational bodies, together with their supporting technical teams are creating a new language. It is a process of codification and abstraction that is initiated for the purpose of diffusion to the target population.   This definition is critical especially since the message has global reach. The senders and receivers must create the common platform so that this information can be interpreted in the 'correct' manner.

The Framework also established the principles for the sharing of information and to provide assistance in the development of education and training programmes for both the public and bodies established by member states. Included in this "exchange programme" is the sharing of information regarding technological development with the aim of reducing the costs of the development cycle as this technology is aimed at resolving a global challenge, i.e. developing and introducing measures to reduce emissions of GHG. Also included in the requirements is the development of appropriate instruments to promote the implementation of mitigation measures.[231]

Organisations wish to keep knowledge in their maximum region, i.e. codified and abstracted with diffusion limited to the organisation. This allows them the opportunity to derive the maximum economic benefit, i.e. if the information is scarce it maintains or increases its value. The organisation is deriving value from its investment in their knowledge assets and further innovation uses an iterative and incremental strategy. The higher the level of diffusion, the more access the target population has. It is apparent that the United Nations is putting measures in place with the aim of increasing the learning rate and spreading the investment burden across organisations and nations.

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[230] 1992, United Nations Framework Convention on Climate Change, United Nations, 4

[231] 1992, United Nations Framework Convention on Climate Change, United Nations, 1-13

4.2.2 The learning framework

With a view to understand learning in the context of climate change and associated technologies, Boisot's model of learning[232] is used. Boisot describes a model for a learning cycle of specialised industries. Understanding this model requires one to assess learning triggers that that use existing knowledge to develop a product, i.e. a knowledge asset. It uses an intangible entity together with tangible material to produce a physical asset. In doing so, the process of evolution using the information to transform the physical asset is an attempt to use less physical resources, which also complies with the economic model in terms of the production function.[233] Information that becomes available in the process of learning can be viewed as a means of creating a saving from an economic perspective. It plays a role in using less material and results in the production cost of the physical asset being less, an iterative process in the learning and product development cycle.

A critical element in the learning process is reducing entropy and complexity. To achieve this data is analysed and selected based on the desired outcome, i.e. data that is perceived to be irrelevant or not reinforcing the purpose of the study is discarded. Boisot uses the term "selective acts of forgetting". This act of selecting data requires that the output be codified as part of the process of creating new knowledge. Abstraction is a critical part of the codification process as it simplifies what must be codified and removes unnecessary or unwanted complexity. The process of abstraction with codification provides the platform for diffusion in which the body of knowledge can now be distributed to various interested parties for absorption. Absorption is the physical act of taking in the knowledge, i.e. diffusion is making the knowledge available for "consumption" but does not necessarily result in the knowledge being taken up. Absorption is component in the process of the learning cycle in which the codified knowledge is applied in the real working environment and results in experiential learning.[234]

The learning process is not a simple linear process. It is a cumulative process in which learning and progress takes place through the eradication of errors within the body of knowledge. Gradually and incrementally it becomes part of the social and institutional memory. Any developments within the organisation are based on this institutional memory

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[232] Boisot, MH. 1998, Knowledge Assets – Securing Competitive Advantage in the Information Economy,

[233] Boisot, MH. 1998, Knowledge Assets – Securing Competitive Advantage in the Information Economy, 27

[234] Boisot, MH. 1998. Knowledge Assets – Securing Competitive Advantage in the Information Economy, 41-61

that resides within the social structures of the organisation. There are challenges with incremental changes continuously being effect. Should an error in the knowledge have gone undetected it will remain as part of the solid foundation, which result in "error lock-in". The later in the process of new knowledge creation the error in detected, the more difficult it is to fix the problem. When the rate of diffusion is such that it has become common knowledge there is no longer value in that knowledge and the utility is substantially less. In conventional models, organisations would slow down the rate at which the technology progresses beyond codification since its utility reduces beyond this point. It is necessary to retain as much of the knowledge internally in the organisation ensuring that value cannot be derived by another organisation. Boisot calls this "N Learning" as it conforms to the Neo-classical linear view of the world.[235]

Learning and knowledge creation in a nonlinear indeterministic world cannot guarantee the outcome. Small changes can result in a significantly large outcome, one that was not anticipated or expected and in complexity theory became known as the "butterfly effect".[236] This demonstrates the complexity in the development of new knowledge and also reinforces the notion in the previous of selective knowledge creation, i.e. discarding data that is believed to be irrelevant as it does not comply with the requirements of the intended outcome. New knowledge is created either as an incremental add-on or replaces the existing knowledge. The use of existing knowledge may have a spill-over effect in terms of the development of the current knowledge and therefore cannot be viewed as cumulative. To this extent the knowledge that is being created has the potential of displacing the existing knowledge. This implies that in the learning process, when data does not make sense, the outcome should be explored further to ascertain the value that can be derived from the data set. It sets the platform for radical change within the organisations and individuals. Diffusion and absorption is viewed as potential value-add. This knowledge can now be applied in different contexts and enhance the value of the knowledge. The creator of the knowledge would have been bounded by the context in which the knowledge was developed and would have interpreted the findings within this context only. Developing new superior knowledge that requires a radical change does not necessarily imply the old knowledge will automatically be displaced. It must be viewed in the context of the services and infrastructure that support the

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[235] Boisot, MH. 1998. Knowledge Assets – Securing Competitive Advantage in the Information Economy, 90-99

[236] Jackson, MC. Systems Thinking Creative Holism for Managers, 114

existing knowledge base and the extent of change that is required to displace the old. This is even more so when the learning takes place within a few individuals and organisations, and on face value would appear to resemble the N Learning cycle described above. It is however not the case, as learning continuously takes place but with a specific audience. In the Schumpetarian or S-Learning cycle, it is necessary to identity the target audience that can make use of the knowledge for further development as opposed to assuming that knowledge not made available to all is hoarding.[237]

Industry generates a significant volume of CCS. Since a carbon abatement plan is being developed, industry is forced to consider options in reducing their emissions. As a result of thereof, a much wider interest group has developed. It is still a very specific target audience. However instead of just ecological action groups using the knowledge aggressively to develop new knowledge, industry is looking at new alternatives to protect their investment in plant and equipment. The new knowledge and learning will comprise of both iterative and incremental as well as radical and discontinuous development cycles.

4.2.3   Learning and Technological Change

Technological change has always been recognised as a major contributor to economic growth, a decrease in the cost of producing a product and increasing productivity. A key phenomenon associated with the reduction in the cost of production is "learning-by-doing". Cost reductions in studies of this nature has been attributed to a number of variables including but not limited to expenditure on research and development, learning-by-doing and economies of scale. In the case of coal fired power, technical changes in terms of improvements in the technology to produce electricity is compared to the "cumulative installed capacity" which in turn is compared to the savings achieved due to economies of scale. [238]

There is agreement that the major source for the production of energy until 2030 is the use of fossil fuels, with the cheapest fossil fuel being coal. Demand for energy in 2030 is expected to be 40% more than the current energy requirements with the majority of the increase

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[237] Boisot, MH. 1998, Knowledge Assets – Securing Competitive Advantage in the Information Economy, 99-106

[238] Yeh, S. Rubin ES. 2006. A centurial history of technological change and learning curves for pulverized coal-fired utility boilers, *Energy*, 32 1996

expected from China and India. In the scenarios developed to forecast the demand for electricity, renewable energy sources was included, and despite the inclusion of these technologies, it is still estimated that fossil fuel will be used to produce 80% of the global demand. The graph below is a depiction of the Global energy demand[239.]

Figure 5 – Global Energy Demand
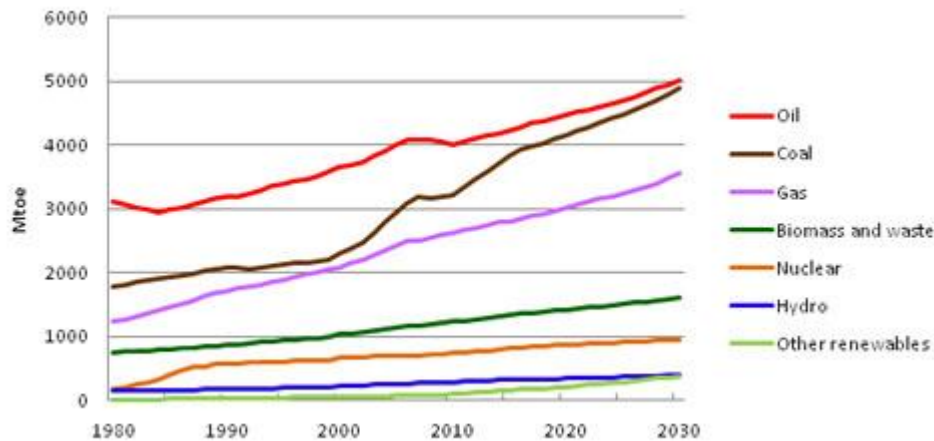
Source - http://www.co2crc.com.au/aboutccs/needccs - 05/2012

Globally, the use of fossil fuel for power generation increases the experience base as well as the investment in technology to improve efficiency. With a larger installed based, codification, abstraction and diffusion rates for the target population will increase. The experiential learning component will also increase, i.e. learning-by-doing.

The graph demonstrates the growth expected in the energy sector and the requirement for continued use of coal based technologies. Yeh and Rubin state that the Energy Information Administration anticipates that the total installed capacity globally for pulverised coal will be approximately 2000GW in 2030 in comparison to the total installed capacity of 1119GW in 2003. As a technology that has been in use for over a century, the pulverised coal boiler has undergone a number of technological improvements with the aim of improving reliability , efficiency and performance of the technology from an ecological perspective. Due to an

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[239] http://www.co2crc.com.au/aboutccs/needccs - 05/2012 Graph description - "World energy demand expands by 40% between now and 2030 –an average rate of increase of 1.5% per year – with coal accounting for more than a third of the overall rise (Data for graph obtained from World Energy Outlook - OECD/IEA 2009)". The exact detail of this kind of graph will be contentious as long as the issue at hand is as significant as it is.

increase in the installed capacity of the pulverised coal technology, economies of scale have also been achieved, reducing the overall cost of the plant technology[240].

In the research presented, ecological modernisation and organisational learning theorists agree that experience improves the resident knowledge in an organisation and will influence the innovation process. In support of the argument raised by Jamison in Chapter 3, development of technology in favour of reducing ecological impacts as opposed to prevention is view of ecological modernisation theorists. Innovation strategies adopted by organisations prefer an incremental approach which will yield greater economic benefit, as well as retain the existing organisation structure. This method is favoured above a discontinuous radical innovation.

The coal industry is an established industry. In the debate on ecological modernisation, an organisation will implement an innovation strategy more easily if it is based on existing knowledge as it is deemed to be less of an economic risk. Innovation in the coal industry follows the same rationale as argued in ecological modernisation which is using existing technology and evolving it as opposed to investing in development of prevention technologies. A history of the use of coal and the available knowledge in the industry follows.

4.2.3.1 Pulverised Coal Plant Development Cycle

In the years leading to 1970, the United States played a critical role in the development of pulverised coal technologies due to the fact that approximately 50% of the global installed capacity was in the United States. During this time, the global industry for equipment was dominated by two American companies, General Electric and Westinghouse. They were followed by the Japanese Groups Hitachi, Mitsubishi and Toshiba as well as the European Group ABB[241].

4.2.3.2 Thermal Efficiency

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[240] Yeh, S. Rubin ES. 2006. A centurial history of technological change and learning curves for pulverized coal-fired utility boilers, *Energy*, 32 1997

[241] Yeh, S. Rubin ES. 2006. A centurial history of technological change and learning curves for pulverized coal-fired utility boilers, *Energy*, 32 1997

In 1900, the thermal efficiency of the pulverised coal power plant was 8% and over the period up to 1960 improved to 40%. The increase in the efficiency is attributed to the advances made in boiler technology. Subsequent to this improvement, the efficiency dropped between 2% and 3% due to the fact that the improved technology, supercritical boilers, was abandoned. This was due to the fact that the demand for new power plants reduced and that the supercritical boiler technology was not as reliable as the older technology. The technology deployment strategy is dependent on the total cost of producing electricity. With coal prices higher in Europe and Asia, the technology development of the supercritical boiler technology continued as it was economic feasible. Plant efficiency increased to between 42% and 44%, and a number of other design changes have been effected to improve the technology. It is expected that improvement over the next few years will improve the technology that will yield even higher efficiencies. The installed base of technologies brings the discussion back to the experience or learning curve[242].

The drop in demand of the new technology was associated with reliability. The experience associated with this technology was limited and the learning and development process was prematurely stopped for economic reasons. Therefore the process of codification, abstraction and diffusion was limited, i.e. it was not at the level of the older technology. There were also no regulatory guidelines to promote the technology with the aim of achieving ecological benefits.

4.2.3.3   Technology Learning Curve

A measure of the global experience based on the world wide cumulative installed capacity was undertaken by Yeh and Rubin with the aim of determining the learning rate in terms of technological innovation between 1920 and 2002. The analysis of the data collected suggests that for every period that the installed capacity doubles, the efficiency of the technology improves by 3.3%.

At the rate that technology development takes place, it is anticipated that thermal efficiency will improve to 43.9% when the installed capacity reaches 2000GW globally. The scenario developed suggests that this capacity will be reached in 2030. As with any model, there are variances that must be factored in. Therefore on a best case scenario taking the plateau effect

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[242] Yeh, S, Rubin ES, 2006. A centurial history of technological change and learning curves for pulverized coal-fired utility boilers, *Energy*, 32 1997-1998

out of the equation, i.e. take the rate of improvement of the best technology only that is commercially viable, the efficiency achieved will be 46.4% when reaching a cumulative capacity of 2000GW globally. One must however exercise caution as the outcome of each of the scenarios that is modelled is dependent on the input data and as highlighted by Yeh and Rubin, studies have shown that efficiencies in excess of 50% can be achieved by 2020 due to progress in materials and other plant equipment.

It is evident that the technology improvement in the pulverised coal boiler technology is also influenced by external environmental conditions, such as the introduction of regulations to improve the emissions. Due to regulations new technology components were introduced into the pulverised coal plants resulting in further learning to reach previously achieved efficiencies[243].

The development of the carbon emission technologies demonstrates that as the installed capacity increased, efficiencies were achieved. The investment in knowledge creation to achieve improved efficiency can initially be attributed to achieving an improved yield. The natural environment was not the primary consideration. The shift on the learning and development boundary to include the natural environment occurred as a result of policy and regulation. In Chapter 3, Booth argument is presented that organisations will externalise the cost of its waste and will continue to do or seek the least cost option to ensure maximum gain, irrespective of the cost to society and the ecology. Regulations are a method of forcing a shift in the organisation boundary and initiate a path of knowledge creation. Organisations that are able to respond quickly can achieve market advantage through their new resident knowledge. It now also becomes a barrier to entry for organisations that do not invest in the creation of new knowledge.

Organisational learning is influenced by the external environment. The external environment boundaries are established through policy in the case of carbon mitigation strategies. Policy is influenced by the viewpoints of society and environmental bodies, which promotes the implementation of carbon mitigation strategies in the industry. Learning and development is directed to meet the objectives of the organisations and natural environment. As pointed out

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[243] Yeh, S. Rubin ES. 2006. A centurial history of technological change and learning curves for pulverized coal-fired utility boilers, *Energy*, 32 1998-1999

by Kim[244], a crisis can be very effective in effecting transformation. Kim also states that authors such as Nonaka, Weick, Shon and Pitt views a crisis as an opportunity to learn. Carbon mitigation and the natural environment is one such crisis.

4.3 Coal as a Primary Fuel Source

The energy market and associated technologies as well as coal mining are a well established industry. A shift in the requirements to a more ecologically friendly technology to reduce carbon emissions requires a change in strategy, but not necessarily core competencies. Tripsas and Gavetti[245] state that an organisation's behaviour is influenced by its history and future actions and behaviour will be based on past experience, but also on internal competencies. Technology development process will use existing competencies to develop products that will appeal to the market. Coal based technology is an established market and the technology is mature. Organisations that are established will use knowledge development strategies based on its internal competencies to minimise structural disruption and maximise economic benefit. Fossil fuel will continue to play a major role in the production of energy in the future, even though it has been identified as a major contributor to global warming through the emission of greenhouse gases. As a result, technology companies will continue to use strategies that will exploit the existing knowledge base through incremental changes. Coal based power generation cannot be ignored in the development of a carbon mitigation strategy, i.e. the technology cannot just be replaced. There are practical considerations such as experience, logistics, economic growth and social expectations regarding price and availability of power. A study conducted by MIT[246] on the use of coal in the future has identified five ways to reduce the carbon emissions being generated viz.

1. Efficiency gains must be realised in the use of energy;

2. Increase the usage of renewable energy sources;

3. Increase the usage of nuclear power in the production of electricity;

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[244] Kim, L, 1998, Crisis Construction and Organisational Learning Capability Building in Catching-Up at Hundia Motor in Managing Strategic Innovation – A Collection of Readings, (reprinted) 375

[245] Tripsas, M, Gavetti, G, 2000, Capabilities, Cognition, and Inertia – Evidence from Digital Imaging in Managing Strategic Innovation and Change – A collection of Readings (reprint), 18-19

[246] Ansolabehere, S. Beer, J. Detch, J. et al. 2007. The future of Coal, Options for A Carbon Constrained World

4. Changing to fossil fuels that are less carbon intensive; and

5. Continue using fossil fuels, primarily coal, and introduce carbon capture and storage.

The cost of producing electricity using coal is cheaper even though the cost of building the supercritical pulverised plant is more expensive when compared to the natural combined cycle gas turbine technology. Furthermore, natural gas is available in far fewer regions than coal. Due to this and the fact that coal is the cheapest fossil fuel available, coal will remain the primary fuel of choice in the future. A significant disadvantage of coal is that it produces higher CO_2 emissions when compared to oil and natural gas. Mapping the future use of coal requires consideration of the alternatives to ensure the management of CO_2 emissions either via the use of a carbon tax, or by using technologies that reduces the CO_2 emissions. In order to achieve emission reduction through the use of technology, various incentive models have to be developed and analysed to determine which model will facilitate the innovation process at the lowest possible cost in terms of overall cost of production.[247] The shared vision of the innovators is not based on the paradigm of saving the natural environment. Innovators are directed and influenced by the organisation objectives which are invariably associated with the profit motive. This includes the consumer, who will want to pay the cheapest price for the use of power. Since coal is more globally distributed, it makes economic sense to use a fossil fuel that will provide the cheapest energy. As a result, it promotes the development of the coal based technology, unless mechanisms are introduced that that has a negatively impacts the economic benefits derived. If the economic impact is sufficiently severe, it can create a shift in paradigm; the creation of a new shared model.

The primary fossil fuel used by existing power generation technologies is coal. In developing these technologies to improve the efficiency, consideration is given to the boundaries, since it directs the learning process. It allows the individuals to select data and information and "develop meaningful insight"[248]. To create a paradigm shift, the system must be defined and the relationship between ecological and economic performance assessed.

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[247] Ansolabehere, S. Beer, J. Detch, J. et al. 2007. The future of Coal, Options for A Carbon Constrained World, 5-14

[248] Boon, F, Wagner, M, 2009, Assessing the relationship between economic and ecological performance: Distinguishing system levels and the role of innovation, 1908
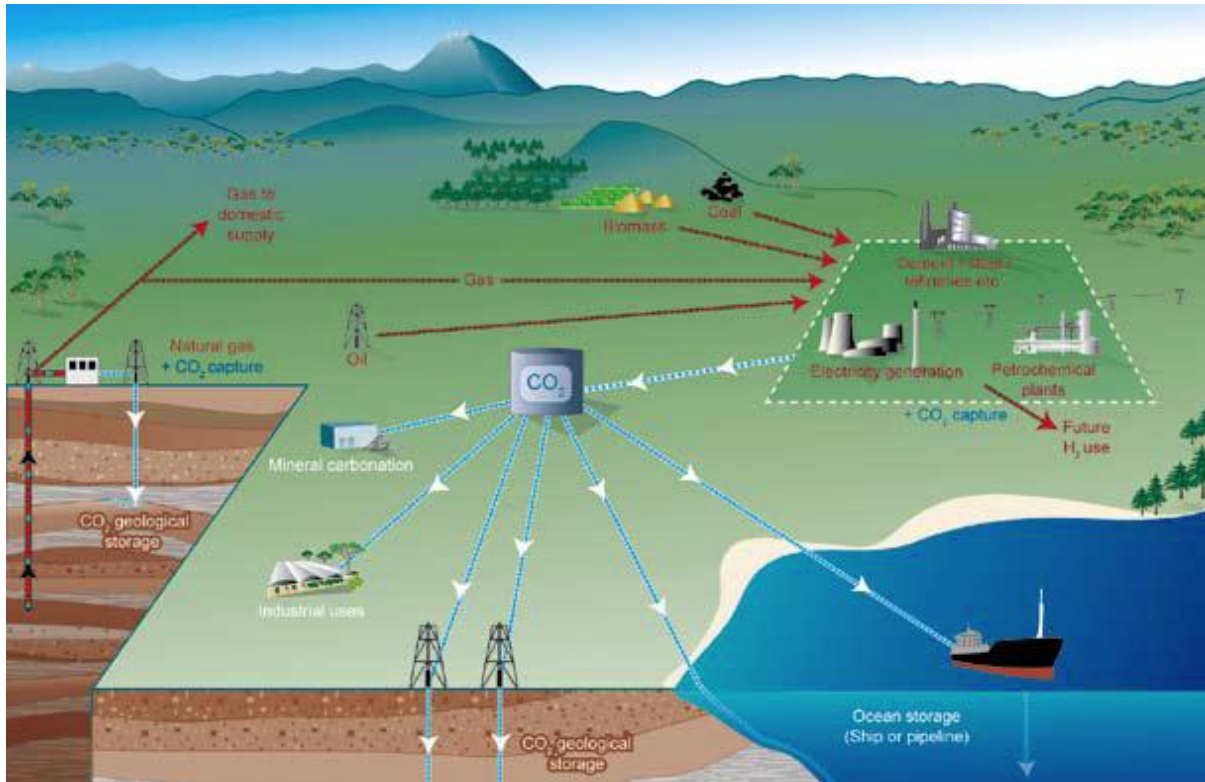
4.4 Carbon Capture and Storage (CCS)

This research is not evaluating the viability of CCS and what is being proposed as a carbon mitigation strategy. For the purpose of understanding learning in the context of the natural environment, an alternate case study could have been used to make the point.

CO_2 is a by-product of an energy generation process either from the physical combustion of the fossil fuel or from the preparation of the fossil fuel for the purposes of generating energy. The production of CO_2 and other greenhouse gases is a significant contributor to global warming. As part of the global initiative to curtail the emission of CO_2 and other greenhouse gases into the atmosphere, the United Nations Framework Convention on Climate Change (UNFCCC) was endorsed and ratified by 189 nations. Technology and the development or modification of existing technology are options that have been tabled to reduce carbon emissions, however these technologies are still being developed. One of these technologies that hold promise for reducing the release of CO_2 into the atmosphere is carbon capture and storage[249]. The diagram below is a schematic representation of various industries using a single CO_2 capture and storage facility[250]. Multinational and supranational organisations have been identified by ecological modernisation theorists as critical in setting regional regulatory frameworks. Member nations develop national regulations in compliance with the multinational organisations. This cooperative and integrated approach provides the platform for the entire region to benefit from. In the case of the UNFCCC, nations participating in the development and knowledge sharing initiatives will provide mechanisms for the establishment of local markets, i.e. create a demand. The regulatory environment is the catalyst for initiating ecologically friendly technology development.

Figure 6 – Concept Diagram for CO_2, Transport and Storage

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[249] Working Group III, 2005, IPCC Report on Carbon Dioxide Capture and Storage, Cambridge University Press, 54

[250] Working Group III, 2005, IPCC Report on Carbon Dioxide Capture and Storage, Cambridge University Press, 4

Source Working Group III, 2005, IPCC Report on Carbon Dioxide Capture and Storage

The capturing of CO_2 requires the separation of the gas from other flue gases, in a post combustion plant, prior to being released into the atmosphere. This process requires that energy from the plant be utilised for the extraction process and as a result reduces the output of the power plant. For the power plant to produce the same energy output with carbon capture, it would require a bigger boiler and increased quantities of coal. Therefore with carbon capture, the generating efficiency of the plant reduces[251]. In providing an ecologically friendly solution, efficiency is lost. No direct economic benefit is derived, unless consideration for the ecologically and society. The regulatory environment would have to force organisations to accept the "internalisation of environmental costs"[252]. To continue exploiting the existing knowledge, organisations have to look at new technological development that manages the waste which has been externalised. CCS is one such approach.

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[251] Ansolabehere, S. Beer, J. Deutch, J. et al. 2007. *The future of Coal, Options for A Carbon Constrained World*, 24-25

[252] Berger, G. Flynn, A. Hines, F. Johns, R. 2001, Ecological Modernization as a Basis for Environmental Policy: Current Environmental Discourse and Policy and the Implications on Environmental Supply Chain Management, *57*

4.4.1 Capture Technologies

The technology deployed is dependent on the process or the power station at which the capture process will be implemented. There are three approaches that can be used to capture the carbon:-

1. Pre-combustion

2. Post-combustion

3. Oxyfuel combustion

The rates of capture for pre and post combustion are typically between 85% and 95% of the CO_2 emitted, whilst the capture rate of oxyfuel combustion is approximately 95% of CO_2 emitted[253].

Capture processes have been in use for over 80 years, however due to the fact that there are no incentives for the storage and transportation it is release into the atmosphere. Examples cited that capture CO_2 is the purification of natural gas and the production of hydrogen[254]. The development of these technologies is due to the economic benefits that the organisation will realise in producing more concentrated fuel. Organisations use their tacit knowledge to promote the objectives set by the leadership. It is the context within which all new knowledge is created. A wealth of experience has built up in the capture technologies and the industry will continue its innovation programmes aimed at improving efficiency, however it is primarily for economic gain.

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4.4.2 Short History of CO_2 Capture

The process of capturing CO_2 from a gas in a commercial environment was first reported in 1941. This process is still in operation today and its primary purpose is the removal of CO_2 and H_2S for the purposes of reduced maintenance such as avoiding corrosion and freeze-out

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[253] Rochon, E, Bjureby, E, Jonhston, P, Oakley, R, et al, 2008, False Hope Why Carbon Capture and Storage won't save the Climate, Greenpeace, 11

[254] Working Group III, 2005, IPCC Report on Carbon Dioxide Capture and Storage, Cambridge University Press, 108

of equipment and increase plant efficiency with higher heating value of gas. The catalyst for the development of this technology was the increase in oil prices in the 1970's coupled with the introduction of environmental regulations. Technology evolved to selectively remove H2S from the gas stream due to the restrictions imposed by the regulations introduced. It was during this period that the MEA was used by the oil industry for the capture of CO_2 from the gas stream and used for Enhanced Oil Recovery. It was subsequently abandoned due to the oil prices reducing which made it economically unviable to "produce" CO_2. In the 1990's, with emission reduction being a priority, there was renewed interest in the technology[255].

4.4.3   Technology Strategy and its Challenges

Technology use in the climate change context forms an essential and fundamental component in any strategy. It is however unclear to determine which technologies to adopt especially since there are a number of options and none of these options are proven technologies[256]. In order for these technologies to be further developed, it is argued by Bowen as is the case with Van den Broek, Hoefnagels *et al*[257], that incentives are necessary. The determination on the type of incentive must be carefully considered by government to ensure that the appropriate technology is selected for development. Carbon capture and storage seems to be favoured as the technology to implement for climate mitigation strategy. Investment is required by both government and the private sector to promote this technology. The argument of incentives is also made by ecological modernisation theorists and the evidence of success of this type of government intervention can be seen in smart regulations. It creates an environment and a market for innovative companies and ecologically conscious consumers which reduce the risk that organisations face when an innovation results in a radical discontinuous shift. It also provides an incentive for codification, abstraction and diffusion of information. In instances where it is not proprietary, the increased diffusion provides a base for other disciplines to apply a different model to the same information.

Current trends show that much of the effort with regard to the development of the technology has been focused on lobbying governments for support in the innovation process instead of investing in the technology development process. The challenge that faces governments is

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[255] Van den Broek, M, Hoefnagels, R, et al, 2009, Effects of technological learning on future cost of performance of power plants with CO2 capture, 458-469

[256] Bowen, F, 2011, Carbon Capture and Storage as a corporate technology strategy challenge, 2256

[257] Van den Broek, M, Hoefnagels, R, et al, 2009, Effects of technological learning on future cost of performance of power plants with CO2 capture,

that waiting for carbon tax policies to provide the incentives to the industry would imply that the development process will be slow. The investment in carbon capture and storage technology is a strategic investment, and therefore will be linked to the climate mitigation strategy of the firm. Some of the key questions that organisations must ask is the valuation of an uncertain technology as well as when it would be considered appropriate in the development life cycle to participate. Different organisations will adopt different strategies which compliment their core business, for example a coal company will apply greater emphasis on carbon capture and storage technology as opposed to a company that operates in the broader spectrum of fossil fuels such as BP, which will promote other technologies as well[258].

Each of these companies has a different view of the information and therefore will interpret the information differently. Further codification, abstraction and diffusion will take place based on the knowledge assets within the organisation, both tacit and codified, and future learning will based on the strategy adopted by the organisation. The fact that technology is not "locked-in" allows for varying degrees of freedom in applying the information to the processes or product of the organisation. clearly the choice made by the organisation will influence what its knowledge creation strategy and will also identify what to discard and what should be retained.

4.4.4   Policy and Carbon Capture and Storage

Costs associated with the development of this technology are uncertain, and the economic viability is equally uncertain. To promote innovation and development of this technology governments have to develop policy as a means of incentives. The use of smart regulation as discussed in ecological modernisation is an instrument suggested to promote the innovation process.

Strategies adopted by governments must take the view that the process requires the focus to be on the innovation processes regarding the technology and subsequently need to shift to promote deployment of these technologies. Managing this change requires a "flexible" approach regarding the timing for the introduction of the amended policies. It is

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[258] Bowen, F, 2011, Carbon Capture and Storage as a corporate technology strategy challenge, 2256-2257

recommended by the IEA that the timeline be managed through "gateways", which will determine when the change in policy should be implemented.

Until such time that there is a financial incentive for a lager investment from the private sector in carbon mitigation technologies, the rate of innovation for developing the carbon abatement technologies will be slow. Currently the carbon trading prices are much lower than the cost per ton for carbon abatement. It is predicted that carbon prices will rise and eventually exceed the cost of abatement at which point it will make economical sense to invest in CO_2 mitigation technology. The graph below demonstrates carbon pricing versus carbon capture and storage costs per unit over time[259.]

These gateways suggest that milestones have been developed to achieve a certain knowledge level prior to proceeding to the next level. It is an internal SLC requiring that information be codified, abstracted and diffused to the rest of the population group. In the case of the UNFCCC agreement the population group would comprise of all disciplines and individuals associated with the development of the technology. The "black box" which contains the intellectual property of the organisation remains concrete and uncodified however the knowledge that can be shared is diffused.

4.4.5 Socio-technical aspects of Carbon Capture and Storage

Stephens and Juisto argues that there is no "silver bullet" to resolve the issues regarding society's need for energy, but that no consensus has been reached on how to allocate the resources against the various competing technologies. In the development of these alternatives, public policy plays an important role and the political and social mechanics must be taken into consideration. The evolution of large technical systems does so in conjunction with political, social and cultural structures. This leads to the technology becoming entrenched, and a transition will occur within this socio-technical framework when a new technology gains sufficient popularity to displace the older entrenched technology[260]. This is part of the process of modernity described by Giddens. The shift is a paradigm shift and requires a level of absorption and impacting of diffused information, which over time society will embed. A critical success factor that has been discussed throughout the paper is the influence of policy on the direction that an organisation takes. For the displacement of old

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[259] IEA, 2012, A policy Strategy for Carbon Capture and Storage, 8-9

[260] Stephens, JC, Jiusto, S, 2010, Assessing innovation in emerging energy technologies: Socio-technical dynamics of carbon capture and storage (CCS) and enhanced geothermal systems (EGS) in the USA, 2020

technology, a catalyst is necessary to promote not only the uptake of the technology but the development of the knowledge to create the technology.

Markusson, Kern and Watson assert that policy makers have to deal with a great deal of uncertainty as there is still no business case for the full scale implementation of carbon capture and storage technology. With carbon capture and storage and the lack of reliable data, the analysis was done based on learning curves of other technologies. The result of this study by Markusson, Kern and Watson shows that the academic knowledge creation and diffusion process is well developed. Furthermore, activities of the actors involved guide the innovation processes by ensuring that the vision is well developed. It is however not the case with the development of a market for these technologies which was found to be weak[261]. The market for these technologies is organisations that generate power. Using the example of the paper and pulp industry, an informed consumer can change the direction that an organisation takes. This is due to the influence that the consumer has with policy makers, provided that the policy makers act accordingly. The policy making environment also has an internal and external environment. The same SLC model can be used to depict the learning cycle of these institutions. Creating a change internally first requires that the information be made explicit and that the shared model is adjusted and adopted. Initiating the change will be based on the change in the external environment which comprises of industry and society.

CCS presents a bigger challenge since carbon generating plants are already established and the primary producer of energy globally. CCS is an uncertain environment and there are no guarantees that the technology will achieve the objective, i.e. carbon abatement.

Huijts, *et al* suggest that in place of knowledge, people act based on trust, i.e. trust is the replacement for knowledge. Not trusting the political structures to act in the interest of the public can become counterproductive. Trust is an important element as it sets the platform for people to be exploratory in terms of new information. Huijts, Midden *et al* support Huijts and Midden argument which is that there was a relationship between public reaction to carbon capture and storage and the level of trust in government. It also influences the view of the public with regard to carbon capture and storage risks and benefits. It requires an understanding of the manner in which the feelings of trust is developed and it boils down to the perception of competence and the perception of intention. The key promoter of the natural

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[261] Markusson, N, Kern, F, Watson, J, 2011, Assessing CCS viability – A socio-technical framework, 5744-5746

environment in the climate change argument in the Netherlands is the NGO's. NGO's will try to influence the process of public debate as well as influence social acceptance[262].

To create an environment that will promote learning within an organisation is not an easy task as it deals with multiple individuals with different mental models which influence interpretation. Sharing of information and knowledge on a global scale is much more complex. Shifting the direction of innovation to comply with ecologically friendly requirements requires a catalyst. The organisation will use existing knowledge assets in the innovation process since it is the most economically viable. This does not promote the ecological agenda and requires the intervention of policy makers. One however cannot dispute that the ecological challenges extend beyond borders and therefore to attempt to deal with it as a nation-state will not yield the required results. Policy to promote ecologically friendly innovation has to be considered on a multinational level, with the understanding that different nation-states will apply it differently based on local conditions. Ecological modernisation theorists would agree that CCS is an innovative approach to address the GHG issue. There is however no evidence that this innovation will yield the desired outcome. Whether government incentives for CCS makes the initiative feasible for organisations to fast track the development of the technology must still be determined. As a consequence, it will slow down the process of codification, abstraction and diffusion and as a result the generation of new insights. Economic viability and sustainability of the organisation will influence the direction of learning.

4.5 The South African Context – Climate Change

South Arica's primary source for generating power is fossil fuel, which is estimated to be around 90%. In 2009 coal was estimated to produce approximately 65.9% of the energy requirements, with oil and gas producing approximately 24.3%. This demonstrates the dependence of South Africa on coal, which is the case with most countries. The dependency on coal is expected to increase as the additional power requirements at least in the short term will be derived from the coal-fired power stations under construction. South Africa, from a demand perspective, entered a period of crisis management in the energy sector in 2008, and the deficit in terms of capacity became evident. As renewable energy technology is not

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[262] Huijts, NMA, Midden, CJH, Meijnders, AL, 2007, Social acceptance of carbon dioxide storage, 2780-2783

sufficiently mature to provide South Africa with its immediate and medium term needs, coal fired power plants is the only option. For climate mitigation strategy development, South Africa has to look at carbon capture and storage[263]. This suggests that South Africa as a country has taken a decision to support the development of coal fired technology. As a result, if South Africa is to support the implementation of a carbon mitigation strategy, all learning and knowledge development will be based on the decision to support coal fired technology. It once again reflects the influence that policy has over the direction of innovation and knowledge creation. Renewable energy has not been excluded from the local development cycle however the pace of development will be slower. The level of codification, abstraction and diffusion will be less than that of the coal fired technologies.

The United Nations Framework Convention on Climate Change is a commitment by participating nations to implement amongst other things, legislation that will manage the release of CO_2 and other gases into the atmosphere which arises out of human activity. South Africa is one of the participating nations[264].

4.5.1 Carbon Capture in South Africa

To implement a carbon mitigation strategy the Department of Energy has launched a study to determine the gaps in the current regulatory framework that will promote carbon capture and storage. The South African Centre for Carbon Capture and Storage (SACCCS) was established in March 2009 with the aim of developing a state of readiness for the introduction of carbon capture and storage. This initiative is aimed at undertaking research and development for both the technical and human development required for the successful implementation of carbon capture and storage[265]. SACCS primary objective is to undertake all preparations and construct a demonstration plant in South Africa[266]. Effecting regulatory change prematurely will have dire consequences from a economic perspective, however from a learning and development perspective, it will direct the learning process. Knowledge creation takes place irrespective of whether the outcome is positive or negative economic outcome. Due to the large investment requirements, the South African government has

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[263] Council for Geoscience, 2010, Atlas on geological storage of carbon dioxide in South Africa, 9 - 11

[264] COP 17 fact sheet, 2011, Climate change in Africa and South Africa: An overview, 2

[265] Council for Geoscience, 2010, Atlas on geological storage of carbon dioxide in South Africa, 17

[266] http://www.sacccs.org.za/organisation/

initiated this pilot to gain insight and develop knowledge and expertise in CCS. CCS has implications for society and organisations however there if no evidence to direct policy makers in developing policy. The codification process will be a trial and error approach in which outcomes will influence future amendments of policy. A strategy has been developed for the advancement of the technology. Clearly a direction for innovation has been set and all data which does not promote the CCS objective will be discarded

The process of development and using the incremental approach also provides the basis for gaining the necessary experience and developing the human capacity to work with the technology[267].

4.5.2 South African Regulatory Roadmap

There has been a considerable amount of activity in South Africa regarding further studies to determine the feasibility of the identified storage site. With regards to regulatory matters, the Department of Energy and the IEAGHG Executive Committee held a joint workshop to obtain direction from international experts on the work-plan that has been implemented by the South African Centre for Carbon Capture. South Africa is using other studies that have previously been carried out to assess the current legislation in relation to the carbon capture and storage framework. It is however premature to take a decision now on the direction of regulation[268].

In terms of directing the learning process, a technology choice has been made. This choice required a paradigm shift and all future interpretations will be based on this shift. Data and information that is analysed at the is based on the policy direction of the organisation, which is influenced by the external environment. Ecological modernisation theorists all agree that government policy and regulation sets the ecological agenda for technology development. Policy is also a critical success factor in creating an environment that promotes learning for the technological development CCS products. It is instrumental in changing the way society and industry view carbon emissions, as well as the requirements for carbon mitigation. The success of the strategy is dependent on the codification, abstraction and diffusion which make it available at different levels to society and industry players alike.

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[267] http://www.sacccs.org.za/roadmap/roadmap/

[268] IEA, 2011, Carbon Capture and Storage, Legal and Regulatory Review, 49-50

4.6 Summary

Following on from the introduction, carbon capture and storage is a case study that I used to demonstrate that a relationship exists between learning and the organisation's environment, both internal and external. Strategic management is responsible for developing a suitable response to external environmental factors taking into account internal capability and knowledge. The response to any challenge us usually based what can be absorbed in the current structure causing the least disruption but achieving the overall objective. This approach to innovation is incremental to ensure that is economically feasible and least disruptive, but that it also satisfies the needs of the market. For a more aggressive approach, especially with regard to the carbon mitigation technology development, a more aggressive strategy is required. A catalyst of sorts is required to incentivise strategic management to disrupt the organisation. Ecological modernisation theorists argue that policy and regulation is required to manage the ecological challenges as GHG is not based on borders. It requires multinational organisations such as the IPCC who has been tasked to find solutions to the carbon emission crisis. It comprises of 189 countries and this makes available a large pool of experts to provide insight into research and development programmes that can achieve the objective.

Experience and knowledge of existing technology has been identified throughout the research as the least disruptive and most economically viable option from an ecological modernisation perspective and a learning organisation. Development of the carbon capture strategy has taken into account the extent of the coal based technology and the experience available, and determined that the most viable economic option is to develop carbon capture and storage technologies. This decision directs the learning process and future technology developments. There is no doubt that learning takes place from an ecological modernisation perspective as well as an organisational level. To promote the continued research and development of coal based technology, the coal industry has provided funding for continued research and development for carbon capture and storage. The interpretation of the external environment has changed their investment strategy to include knowledge creation for carbon abatement. This decision has been guided by policy and regulation, as well as economic.

In the short to medium term, coal is argued to be the cheapest fuel available due to its availability globally. It is cheaper than oil and gas in the production of electricity. The infrastructure investment in power stations is also significant and cannot realistically be discarded and replaced currently by an alternative technology at a reasonable cost. Ecological

modernisation promotes the view that the development and introduction of policy will accelerate innovation and improve efficiency for ecological benefits and fuel economic development[269].

The external environment through policy creates a boundary which organisations have to comply with and operate in. As a result strategic management will set objective based on the information and the organisation will respond to achieve these objectives. The learning process is guided by rules and boundaries. Research and development for carbon capture and storage will be steered by government policy and industry that is responsible for carbon emissions towards achieving an effective and efficient infrastructure and technology for the capture, transport and storage of carbon. The costs for implementing carbon capture and storage are very high and governments are addressing this challenge by introducing the features of smart policy into the development process.

South Africa has established an entity for piloting a carbon capture and storage project. Using the gateway system which is designed to manage the learning and development process, the project is now at stage 3, which is the pilot for CO_2 injection. South Africa aims to develop capacity internally through its membership of multinational bodies. These bodies, like the IPCC, have as one of its values, information sharing and knowledge transfer. It acts as an environmental feedback loop and a policy development body for nation-states.

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[269] Gouldson, A, Murphy J, 1996, Ecological Modernization and the European Union, 11

Chapter 5

Learning and Ecology – the case for Carbon Capture and Storage

5.1 Introduction

It is apparent that for any development or progress to take place, knowledge creation is essential. Learning is influenced by both the internal and external environment. However, the internal organisational environment is shaped in part by the external environment. There is thus a complex link between the direction of the learning process of an individual which is generally based on organisational objectives versus that which is promoted by society. Society and the associated action groups have a higher degree of variety than that of an organisation, and therefore the organisation will attenuate that which is believed to be noise and amplify that which will promote the sustainability of the organisation. This influences the mental models of the individuals within the organisation that will promote a particular agenda which will direct the learning process. Their views and perspective is important especially if they are part of the circle of influence of the organisation. In this research, Daft, Weick and Kim have been used to elaborate on this, i.e. the interpretation of the individuals and how this promotes a particular thought process within the organisation.

Resolving ecological challenges are complex and environmental groups usually apply the all or nothing principle. From an organisational and economic perspective this is viewed as counterproductive. In Chapter 3 Booth argues that ethical and moral considerations can influence the "value" associated with natural environment.

To produce new or enhanced technology requires innovation, a directed organisational learning process is required. Together with the development of technology there is also a drive to derive more value from less resource with the aim of greater economic gain. It is this concept that is promoted to demonstrate that technological development, using the principles of ecological modernisation works in favour of the natural environment as argued by theorists such as Huber, Mol, Spaargaren and Jänicke . There is general consensus that government policy and regulation is necessary and a key consideration in the development of ecologically

friendly technologies. It acts as an incentive if the policy and regulation is developed as a win-win such as smart regulation.

 The regulatory environment is a complex environment and establishes a governance framework. By implication it requires that industry subscribe to the intended aim of the regulation, and failure results in penalties being instituted to non-compliant organisations. This is a key driver in setting organisational direction in terms of ecological knowledge creation.

5.2 Structures in promotion of an agenda

Chapter 2 discusses the area of int erpretation and depicts how it influences the analysis process. The argument is based on the fact that both information and data is perceived by the organisation and therefore the individuals based on the parameters that have been set for the development. Innovation processes are therefore influenced quite significantly as information and data that do not promote the agenda or expected outcome is discarded in the search for desired outcome. Organisational hierarchies are designed in a manner that will set a boundary for the individuals in terms of what is a permissible outcome and anything outside of this is recognised as failure. Research and development are therefore directed towards an outcome and the process will not necessarily test the effectiveness of the outcome when compared to other options. However when the existence and sustainability of the organisation is threatened, a paradigm shift occurs that will extend the boundary and create the environment to test "new" ideas[270]. Organisations that consider the external environment in which they operate as stable and therefore do not need to change, are typically forced to shift significantly.   This shift caters for the changes in the perception of the external actors, such as carbon abatement initiatives.

In Chapter 3, the concept of ecological modernisation is introduced as a technology innovation approach using fewer physical resources to produce a product. This is favoured from an economic as well as an ecological perspective as it promotes both economic growth and the natural environment. It is the creation and utilisation of knowledge to integrate various disciplines in promoting the ecological issues. It is necessary to create an

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[270] Daft, RL. Weick, KE, 1984, Toward a Model of Organisations as Interpretation Systems, 285 – 288

environment that will promote this agenda. This requires the use of tools such as regulation to influence organisations in the "direction" of their research and development initiatives.

In Chapter 3, the case presented was that of the paper and pulp manufacturing industry. This demonstrated the power of the social groups and networks as well as the power of the market in determining whether a more friendly technological change will be accepted by the industry. It did require government support to successfully change the use of technology and this once again demonstrates the need for regulation and policy. As the case demonstrated, market and action group pressure 'forced government to respond to the ecological requirements. Organisations are challenged to continuously adapt to external environmental pressures, specifically the market and policy environment, and channel there research and development and innovation processes to generate ecologically friendly outcomes.

5.3 Carbon Capture Strategy

This research is not a technical assessment of the carbon capture and storage process. Carbon capture and storage is used as a case study to demonstrate factors that influence ecological technological development learning[271]. Learning and innovation is a continuous process that is either iterative and incremental or discontinuous and radical. Technology development for CCS uses both learning strategies. With the case of combustion and other support technologies used in power generation, the learning and embedding can be attributed to the length of time that these technologies have been used. The experience and knowledge[272] with coal based technologies globally is significant, and abundantly available. It stands to reason, from an economic and knowledge asset perspective that an iterative and incremental strategy will be favoured. It is the least disruptive and the most economically viable. Yeh and Rubin demonstrated that iterative improvements in the efficiency of boiler technology from 1920 to 2002 continuously improved efficiency[273].

 Boiler efficiency improvements are insufficient as a carbon abatement strategy. To comply with global policy and regulation, both industry and government have adopted carbon capture and storage as a viable alternative. This is a globally accepted strategy, endorsed by nations

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[271] Huijts, NMA. Midden, CJH, Meijnders, AL. 2007, Social Acceptance of carbon dioxide storage, 2780

[272] Gibbins, J, Chalmers, H, 2008, Preparing for Global Rollout: A 'developed country' first demonstration programme for rapid CCS deployment, 503

[273] Yeh, S. Rubin, ES. 2007, A centurial history of technological change and learning curves for pulverised coal-fired utility boilers, 1997 - 1999

for which various development organisations have already been created and legislative frameworks and "smart" policies are being developed and considered. South Africa is amongst the lead nations to develop policies and regulation with the aim of implementing a demonstration project[274]. As part of the implementation strategy and to promote carbon abatement, carbon capture and storage is being sold as the most economically viable alternative taking the existing plant into account[275], albeit a complex solution. A key motivation for industry to participate is the introduction of penalties for carbon producing technologies.

Carbon capture has been successfully implemented previously in other industries[276] and in demonstration projects in the energy sector in the Norwegian sector of North Sea and in Algeria[277]. The proposed strategy still as a number of areas that is uncertain in terms of the technical feasibility and the downstream ecological impact of transport and storage[278].

There are social groups that support and criticize CCS as a viable strategy however no certainty exists regarding the effectiveness of this proposed technology[279].

What has been made abundantly clear in the literature reviewed is the following:-

1. New knowledge creation is the key to success for the development of the technology;

2. Regulation and policy is necessary to promote and fast track the innovation and knowledge creation process. and

3. Pressure from action groups and society has influenced nations in regulating industries that generate harmful products such as carbon.

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[274] IEA, 2011, Carbon Capture and Storage Legal and Regulatory Review – Edition 2, 49

[275] Markusson, N. Haszldine, S. 2010, 'Capture Ready' regulation of fossil fuel power plants – Betting the UK's carbon emissions on promises of future technology, 6697

[276] WORKING GROUP III, 2005, IPCC Report on Carbon Dioxide Capture and Storage, 5

[277] Gibbins, J, Chalmers, H, 2008, Preparing for Global Rollout: A 'developed country' first demonstration programme for rapid CCS deployment, 503

[278] Stephens, JC. Jiusto, S. 2010, Assessing innovation in emerging energy technologies: Socio-technical dynamics of carbon capture and storage (CCS) and enhanced geothermal systems (EGS) in the USA, 2021

[279] Stephens, JC. Jiusto, S. 2010, Assessing innovation in emerging energy technologies: Socio-technical dynamics of carbon capture and storage (CCS) and enhanced geothermal systems (EGS) in the USA, 2025

5.4 Regulatory actors

The regulatory environment is crucial in setting a framework that will promote the protection of the society and still provide leeway for the development of new technologies. An enabling environment for research and development is a combination of policy-makers which act on behalf of society and the scientific community and the experts from multiple disciplines which take charge of a problem.   Policy-makers and organisations are therefore jointly responsible for setting the direction in the search for a solution.

In promoting a concept as a solution to a problem, it is necessary to identify sponsors that are willing to support an initiative. In the case where it has a positive ecological impact at significant cost, the importance of the sponsorship is even greater. The fact that CCS is a global issue, it impacts the global coal industry. It will also influence energy security. Therefore the United Nations seems an appropriate organisation to co-ordinate an integrated research and development initiative. The Intergovernmental Panel on Climate Change is one such sponsor. This advisory body, comprising of 195 member states provides valuable research through its member states to promote the carbon capture and storage agenda. It provides governments the necessary insight that will assist them in creating enabling environments through regulation for the implementation of carbon abatement strategies linked to carbon capture and storage.

The European Union as a multilateral organisation has also developed frameworks for developing legislation to manage and regulate industry in the promotion of implementing carbon friendly technologies. As a region, there is an emphasis on sharing of information and research to promote the region, however the framework, like the IPCC is not prescriptive. Member states apply the framework in the development of their legislative environment which is influenced by social actors and the general public. The awareness of the public is a key driver in determining the extent to which governments will implement carbon abatement strategies in the energy sector, with specific reference to coal[280].

In Chapter 3, the need for "smart regulation" for the promotion of innovative technology is discussed. Governments can determine the extent to which companies will be prepared to spend on research and development in a particular area through incentives that assist in the funding of the initiative. This type of incentive will direct the research and development

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[280] http://www.ipcc.ch/organization/organization.shtml

process towards achieving a particular outcome. Social actors influence the direction of research by applying pressure on the legislative bodies, forcing them to firstly acknowledge their contribution towards global warming and secondly to redirect research to achieve a more favourable outcome for the natural environment[281]. This would include subsidies as well as other incentives made available to technology development entities to direct their innovation processes towards carbon capture and storage.

5.5 Alternative Options

Social movements play a role in assessing technological development options tabled by industry and endorsed by governments. However social movements are no longer considered to be radical groups that are interested in de-industrialisation. These groups do however exert a great deal of influence in the markets especially with the communication technology available. Information dissemination becomes easier and communication is not restricted to nation-state borders. This creates a complex environment for organisations especially since social groups are influential in the transformation of a society[282]. Greenpeace as an action group is capable of promoting an alternative strategy such as renewable energy, which is currently the case. Greenpeace suggests that the carbon capture and storage initiative is not a long-term solution for carbon abatement. Governments are developing regulation to promote carbon capture and storage as well as renewable energy. Greenpeace through studies commissioned also demonstrates that alternatives to coal are possible, however there are technical challenges[283]. This demonstrates the point that interpretation and learning of the groups associated with Greenpeace are different to those of organisations however governments do take the agenda of these groups seriously. This is visible in the regulatory environment, i.e. there are allocations made for power generation from renewable energy.

5.6 Conclusion

Learning and the knowledge creation takes place within the context that is set by the organisation. As a result, the learning outcome is motivated primarily by economic benefit. More often than not, it is at the expense of the natural environment, which includes

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[281] Stephens, JC. Jiusto, S. 2010, Assessing innovation in emerging energy technologies: Socio-technical dynamics of carbon capture and storage (CCS) and enhanced geothermal systems (EGS) in the USA, 2025

[282] Sonnennfeld, DA, 2002, Social Movements and Ecological Modernisation: The Transformation of Pulp and Paper Manufacturing, 2 – 5.

[283] Greenpeace, 2009, [r]enewables 24/7 Infrastructure Needed to Save the Climate

externalising the cost of by-products and waste to improve economic viability. An effective tool to manage the technology development process and the impact it has on the natural environment is regulation. This does not occur without social pressure. In Chapter 3, policy-makers were forced to regulate the use of chlorine based technology in the paper and pulp manufacturing industry. It does require action groups to have alternative knowledge creation programmes to counter industry.

Carbon capture and storage is more complex than the issue experienced by the paper and pulp industry especially since the technology has not been implemented in a large scale deployment. Furthermore, unlike the paper and pulp industry in which the sanitary products for females were used to demonstrate the harmful effects directly, carbon released into the atmosphere does not have a direct demonstrable effect. Ecological impacts of carbon emissions are global, i.e. it is not contained within nation-state borders. Organisations such as Greenpeace are sufficiently effective in that they are still able to influence research and development strategies through governments and supra-national bodies such as the European Union and the United Nations IPCC. This is due to the fact that they have significant support from society, across the globe. To this effect, governments are developing policy for carbon abatement for both fossil fuels based technology as well as renewable energy. In the fossil fuel technology development, industries to secure their investment are prepared to acknowledge and support the development of carbon abatement strategies since it impacts their sustainability. This is achieved either through research and development or making funding available for research and development. The research and development programmes of these industries will promote the use of fossil fuel technologies and look at ways and means of reducing carbon. This will guide/direct the process of interpretation of the individuals/organisations participating in the research and development programme. The learning is directed in favour of improving the ecology, although the viability of the system of carbon capture and storage cannot yet be determined.

The transformation of society is dependent on information from both environmental groups promoting the ecology as well as established industries, each 'marketing' its position. The relationship between learning and the ecology is not linear, however one of the key factors that influence organisations is policy. This is also the case with carbon capture and storage and renewable energy.

5.7 Future Research

The definition of the problem is a key determinant in the interpretation and direction of the research and development process. Mature industries usually exert significant influence over regulators and have sufficient financial backing to provide empirical evidence to suggest that the ecological impacts are not as severe as indicated. Like forecasting demand, the environment is complex and has multiple actors that influence the outcome with varying degrees, including economic impacts. Although society plays a role in determining the direction of regulation, it is usually at the stage when the ecological crisis is upon us. As pointed out earlier in the text, a crisis is an effective means for creating a learning opportunity. It creates sufficient momentum from social actors that accelerate the research and development process. The extent of the influence that social actors and agents have is not clear even though theorists have identified that government structures in the 1980s were reconfigured due to social pressure. The extent to which social movements has impacted government re-structuring is not clear. The complexity of the relationships needs to be assessed and studied in depth to determine the extent to which social movements influence policy making structures. As the research process unfolded, it became evident that pressure points exist and exploiting this initiates a process for legislative reform. An area of research is an empirical study of how social movements as agents of society can influence smart policy development.

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