

CREATING VALUE THROUGH KNOWLEDGE TRANSFER

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ABSTRACT

Knowledge transfer is becoming an increasingly important component of the offerings produced by technology organisations. These organisations face the challenges of understanding how the transfer of knowledge creates value for their clients and how to facilitate this transfer of knowledge. The purpose of this research was to discover the components of the created value and the mechanisms which can be used to assist the transfer of knowledge.

The main findings were that value is created by building the client's tacit knowledge about the technology and by embedding knowledge explicitly in the form of technological tools and related processes. A model for efficient knowledge transfer was developed and a case study revealed ten practical mechanisms based on this model.

DECLARATION

I, Thomas Küsel, declare that this research report is my own, unaided work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

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1 INTRODUCTION

1.1 Context of the study

1.1.1 The importance of knowledge in the business world

It is widely acknowledged in the business community that knowledge is becoming one of the most valuable resources of organisations (Drucker, 1993; Dawson, 2000). Well-known business writers such as Peters (1992) and Stewart (1997) have helped organisations understand the fundamental importance of knowledge in creating a sustainable competitive advantage.

1.1.2 The status of research in the field of knowledge management

As a result of its importance, research into the field of managing knowledge has grown significantly during the last few years (Petrash & Edvinsson, 1998; Sullivan, 1998):

- Early research in the field of knowledge management focussed on the nature of knowledge, mechanisms to create new knowledge and the theory of learning (Nonaka, 1994; Polanyi, 1967; Kolb, 1984).
- Turning to the commercially useful application of knowledge, the theory of core competence emerged (Prahalad & Hamel, 1990; Javidan, 1998; Gallon, Stillman & Cotes, 1995). This theory proposes that business should limit their activities to what they do best. These activities should be based on a set of core competencies – a combination of skills, processes and tools – which are hard to imitate, create disproportionate value and can be used to create a diversity of offerings (Prahalad & Hamel, 1990).
- Further application studies formed the movement to intellectual capital management. It concentrated on the components of knowledge and how they can be used in combination to create value for the organisation (Sullivan, 1998; Sveiby, 1997; Teece, 1986; Hall, 1998; Saint-Onge, 1996; Edvinsson, 1998; Lev, 2001).

Most of the initial research concentrated on the ***internal component*** of knowledge management (Dawson, 2000). The focus was on creating value by growing the

intellectual capital within an organisation. Developments in the late 1990s have highlighted the importance of the **external component** (Normann and Ramirez, 1993; Dawson, 2000; Sveiby, 1997), which focuses on mechanisms of creating value for clients or client organisations through knowledge.

One of the key questions in the field of knowledge management has now become: How do organisations create value for their clients through knowledge-intensive offerings (Dawson, 2000)?

1.1.3 The emergence of the technology-based professional service organisation

Technology organisations have always realised that their knowledge assets fulfil a central function as a source of innovation and product design (Cooper, 1993; Sullivan, 1998).

However, in the late 1990s the function of knowledge in technology organisations began to take on an even more significant role. Organisations were increasingly becoming more service orientated (Dawson, 2000) and taken to the extreme, Peters (1992) even suggested that all organisations are becoming professional service firms.

It is becoming evident that two types of offerings are being produced by technology organisations:

- **Technology-based offerings** or 'black box services' are the traditional mode of value creation. Offerings are in the form of devices (patents, designs, products, etc.) and associated methods (e.g. processes) which improve the efficiency of the client organisation (Cooper, 1993). Black box services are those services which are closely associated with the device and the client is left with only what he needs for the specific product at the time of delivery (Dawson, 2000).
- **Knowledge-intensive offerings** or 'knowledge transfer' is a new type of offering. In contrast to the 'black box' service, the knowledge transfer leaves the client more knowledgeable as a result of the interaction. The client's long-term capability and hence his competitiveness is improved (Dawson, 2000).

This increasingly significant function of knowledge has resulted in refining the key question: How do technology organisations add value to their clients through knowledge-intensive offerings, specifically through knowledge transfer?

1.2 Problem statement

How do technology organisations add value to their clients through knowledge transfer?

1.2.1 Sub-problems

1. What forms of value are created by technology organisations for their clients through knowledge transfer?
2. What mechanisms are used to create these forms of value through knowledge transfer?

1.3 Significance of the study

The critical importance of creating value for clients through knowledge transfer is clear from the previous section. Despite this central function of their knowledge assets, surprisingly few technology organisations know how to measure, manage or even define their most valuable knowledge assets (Sullivan, 1998).

It has been observed that technology organisations are becoming increasingly anxious to find a suitable model for the creation of knowledge transfer. An example is the Council for Scientific and Industrial Research, which has declared its intent to move towards a Knowledge Intensive Technology Organisation (KITO) business model (Yannakou, 2003) but does not yet have a coherent model which it can use to manage the creation of client value through knowledge transfer.

Although a significant volume of literature emerged since the 1990s about knowledge management, no references could be found which deal directly with the management of knowledge in technology-based professional services organisations. Available literature forms two groups, each focussing on a particular type of organisation:

- One group of literature deals with technology-intensive product development organisations (Sullivan, 1998; Teece, 1986). This group concentrates mainly on and is thus limited to the internal management of intellectual assets to

promote the traditional 'black box' (i.e. technology-based) method of value creation.

- The second group of literature deals with knowledge transfer but not for technology organisations. It concerns other professional service sectors, specifically accounting firms, management consulting firms and law firms (Dawson, 2000; Sveiby, 2001; Lev, 2001; Edvinsson, 2000; Saint-Onge, 1996).

There is thus no literature on the topic of how knowledge transfer is being used by technology organisations to add value to their clients. Although the associated literature suggests that the mechanisms of creating client value through knowledge transfer should be generic (Dawson, 2000), it is not clear why this should be the case. Also, all available examples of how this value creation occurs (Sveiby, 1997; Dawson, 2000) are applicable in only those specific service sectors.

1.3.1 Purpose of the study

It is the purpose of this study to:

- Create a consolidated model from the literature of how client value is created through knowledge transfer.
- Confirm whether or not the mechanisms of value creation in technology organisations are similar to those in other organisations.
- Find examples of such mechanisms of value creation in technology organisations.

1.4 Delimitations and limitations

1.4.1 Delimitations

The scope of the research was limited in terms of the type of organisation. The study looked only at technology organisations which are primarily focussed on scientific and technological research and development. In other words it excluded R&D sub-divisions of organisations who have a different primary focus, e.g. production.

The scope of the research was also limited in terms of the type of offering. The study focussed on the knowledge transfer offerings of technology organisations and not on

traditional technology-based offerings, i.e. the 'black box' offerings described in section 1.1.3.

1.4.2 Limitations

A case research methodology was used (the choice of a case study is motivated in section 4.1). A case study is inherently limited in terms of generalisability, because it represents only one instance of the population and the respondents are specifically chosen for their expertise and not randomly selected.

Further limitations and how they were addressed, are discussed in section 4.7.

1.5 Assumptions

There are no fundamental assumptions which underpin this research.

1.6 Definition of terms

The term "Knowledge" is defined broadly as the capacity to act effectively towards commercially useful goals (Sveiby, 1997). While the arguments of traditional epistemology emphasise truthfulness as the essential attribute of knowledge (Nonaka, 1994), the definition given by Sveiby (1997) focuses on the utility attributes of knowledge. This definition includes both tacit and explicit components of knowledge, and is also referred to as intellectual assets, intellectual capital or competence.

2 LITERATURE REVIEW

2.1 Knowledge as a primary source of value

Fritz Machlup is said to have been one of the earliest economists to highlight the importance of knowledge in transforming the United States (US) economy (Sverlinger, 2000). As early as 1958 he estimated that knowledge production contributed almost 29% to the adjusted US Gross National Product (Machlup, 1962). Soon after that, Peter Drucker contended that knowledge had become the foundation of a new economy, based on knowledge rather than goods (Drucker, 1969). Since then, many authors have followed to recognise the paradigm shift and the importance of knowledge. The Third Wave (Toffler, 1980) and the Post-Capitalist Society (Drucker, 1993) are some of the well known texts.

Besides being an important source of wealth for nations (Porter, 1990), knowledge was also recognised as a primary resource for organisations (Zack, 1999). Arguments to motivate why knowledge is an important resource for organisations include:

- **Firstly**, an argument based on empirical evidence. This argument states that, in general, intellectual capital represents an increasingly large proportion of the market value (market capitalisation) of companies. The market values of companies are often much higher than accounted for by their balance sheet assets (Sullivan, 1998; Lev, 2001). The average ratio of market value to book value in the late 1970s was one-to-one, in the mid-1990s it increased to an average of three-to-one and in 2000 it was six-to-one (Edvinsson, 2000). This market premium arises from a company's intellectual assets and ability to leverage them (Sullivan, 1998).
- **Secondly**, the realisation that the current business environment of ever shortening business cycles and rapid technological change calls for a dynamic value-creation framework. Intellectual capital management can provide such a framework in the knowledge era (Saint-Onge, 1996).

In summary, the value of knowledge lies in its properties of enabling organisations to act more effectively in a rapidly changing world. This ability to act more effectively

translates to higher levels of future free cash flows, elevated market capitalisation and increased value to shareholders.

2.2 Different views on knowledge management

Although the term knowledge management is fairly new, Tiwana (2000) points out that the concepts of knowledge management have been part of business for a long time. This includes the spreading of PERT (Program Evaluation and Review Technique) in the 1950s, the issue of centralisation and de-centralisation in the 1960s, the experience curve in the 1970s, corporate culture in the 1980s and the learning organisation in the 1990s. As the application of knowledge management in organisations became more formal, a number of perspectives emerged (Sverlinger, 2000).

- The formal application of knowledge management in organisations became widespread in the 1990s (Wiig, 1997a) and was therefore heavily influenced by the surge in information technology. Most writers on knowledge management define it as getting the right knowledge to the right people at the right time so that it can be of the most value to the organisation. This is closely aligned with information systems thinking and views management of knowledge as an **asset**.
- A second perspective on knowledge management is the **control** perspective, asserting that knowledge management is the systematic, explicit and deliberate building, renewal and application of knowledge to maximise the effectiveness and returns of all knowledge assets of the organisation (Wiig, 1997b; Van der Speek & Spijkervet, 1997).
- Knowledge management as a **process** is a third perspective, which focuses on the processes that are used to collect, distribute and transfer knowledge in whatever form (tacit or explicit) to produce the biggest payoff (Davenport & Prusak, 1998; Hibbard, 1997; O'Dell & Grayson, 1998).
- A fourth perspective is provided by Sarvary (1999), which states that knowledge management is a **business process** through which an organisation creates and uses its institutional knowledge.

2.3 Components of knowledge

Polanyi (1967) points out that we can know more than we can tell or explain to others. A useful taxonomy differentiates between ***tacit and explicit components*** of knowledge. In order to manage knowledge effectively as a resource in business, it is important to be aware of these two components of knowledge (Hansen, Nohira & Tierney, 1999).

These different components of knowledge have been given many names in the business literature and are also referred to as ***components of intellectual capital*** (Sveiby, 1997; Sullivan, 1998; Saint-Onge, 1996; Hall, 1998; Stewart, 1997).

2.3.1 Tacit knowledge in the form of individual competence

Much of our knowledge is tacit. We are often not aware of what we know and the knowledge that we are aware of can be very difficult to explain or communicate to others (Polanyi, 1967).

In the business context, Sveiby (1997) defines tacit knowledge as the “individual competence” of all the staff that have direct contact with the client. Ulrich (2002) states that individual competencies include both functional or technical competencies (e.g. individual abilities in engineering) and social competencies (e.g. inter-personal skills).

Tacit knowledge is also referred to as “human capital” which cannot be controlled or owned by the organisation and remains captured in the minds of the individual people (Stewart, 1997). Human capital is extremely important to organisations because it is the source of innovation – the source of all future organisational value (Edvisson, 1998).

However, smart individuals on their own do not necessarily make for smart enterprises. Leveraging this knowledge into stakeholder value requires structural capital (Stewart, 1997).

2.3.2 Explicit knowledge and structural capital

Explicit knowledge can be put in a form that can be communicated to others through language, visuals, models or other presentations (Polanyi, 1967).

This explicit knowledge or “structural capital”, as it is often referred to in the business community, includes systems and structures which enable people to leverage their knowledge into value for clients (Saint-Onge, 1996).

Structural capital includes the following components:

- **Organisational processes** (routines, procedures, structures, responsibilities, accountabilities, etc.) enable the collaboration between individuals in an organisation (Saint-Onge, 1996; Sullivan, 1998; Sveiby, 2001; Edvinsson, 1998; Stewart, 1997; Teece, 1986; Dawson, 2000; Javidan, 1998; Prahalad & Hamel, 1990; Gallon, Harold & Cotes, 1995).
- **Organisational tools** (models, computer programs, laboratory equipment, prototypes, etc.) enable organisations to capture and manipulate knowledge (Sullivan, 1998; Javidan, 1998; Prahalad & Hamel, 1990; Gallon, Harold & Cotes, 1995).
- **Intellectual assets** (documents, concepts, templates, designs, etc.) are codified pieces of knowledge which have been made independent of the individual and can be stored and ‘owned’ by the organisation (Sullivan, 1998; Teece, 1986; Stewart, 1997; Sveiby, 2001; Edvinsson, 1998; Javidan, 1998; Prahalad & Hamel, 1990; Gallon, Harold & Cotes, 1995).
- **Intellectual properties** (patents, copyrights, trademarks, trade secrets, etc.) are intellectual assets which are legally protected and form part of the structured capital of an organisation (Sullivan, 1998; Teece, 1986; Sveiby, 2001; Edvinsson, 1998).

The form and combination of structural capital required by an organisation depend on the nature of its offerings and the context in which it operates (Sullivan, 1998).

2.4 Organisational learning: Intra-organisational knowledge transfer

The two components of knowledge (tacit and explicit) are central to the theory of creating new knowledge, i.e. the theory of learning. Garvin (1993) provides a useful overview of definitions and critical comments on organisational learning.

2.4.1 Individual and organisational learning

According to Schein (1996), learning is basically an individualistic concept, drawn directly from psychology. Senge (1990) and Kim (1993) also provide useful frameworks for individual learning.

Other authors make a strong case for organisational learning and the similarities with individual learning (Sverlinger, 2000). This view states that learning at the organisational level has occurred when learning on the individual level is reflected in actions of the organisation. According to Shrivastava (1983), organisational learning can be viewed from four distinct perspectives:

- The ***adaptive learning perspective*** states that organisations adapt to changes in the environment by re-adjusting their goals and rules. The result of organisational learning is thus changes in action patterns (Levitt & March, 1996).
- The ***institutionalised experience effects perspective*** is related to the learning curve effect. Argote (1999) provides an overview of this perspective.
- The ***assumption sharing perspective*** takes the view that actions in an organisation flow from “theories-in-use” (assumptions and cognitive maps shared among organisation members). Organisational learning occurs if these theories-in-use are constructed and modified (Argyris & Schön, 1978).
- The ***development of knowledge base perspective*** views learning as the process whereby knowledge about action-outcome relations is developed. In this view, organisational learning occurs in three activities: (1) when knowledge is shared among individuals, (2) when knowledge is verified by others and (3) when knowledge is integrated with other related bodies of knowledge. (Duncan & Weiss, 1979).

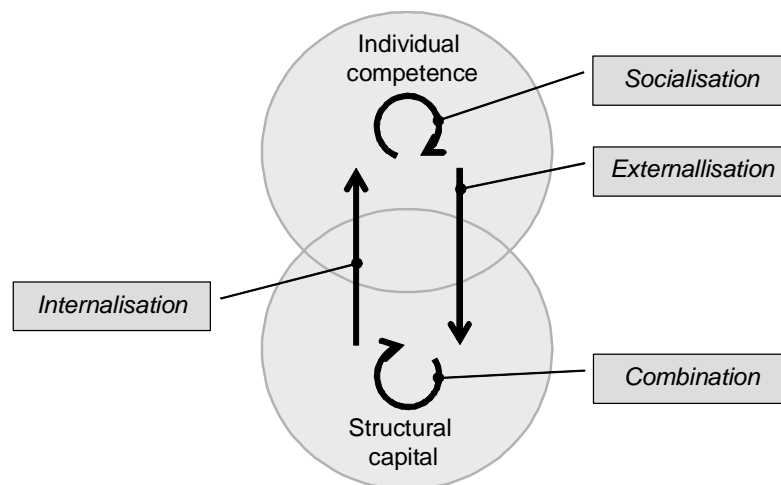
2.4.2 **Mechanisms for knowledge transfer**

All these perspectives on organisational learning rely on mechanisms for sharing tacit and explicit knowledge within the organisation. Nonaka (1994) provides a popular and useful description of how knowledge is created and transferred. He proposes that this happens through a social process between individuals and conversion between tacit and explicit forms. He identifies four modes of knowledge conversion that facilitate learning:

- ***Socialisation*** (tacit to tacit) is a mode of knowledge transfer between individuals without the use of language or other explicit forms of knowledge. An example is an apprentice gaining knowledge from his/her mentor through observation and imitation. Members' working in one team is an important form of socialisation. Senge (1990) also emphasises team learning as one of the important disciplines that an organisation must master.
- ***Externalisation*** (tacit to explicit) is the conversion of an individual's knowledge and experience into a form that can be shared with others. An example is the creation of a computer model by an expert.
- ***Combination*** (explicit to explicit) involves the use of social processes to combine different bodies of explicit knowledge, such as the sorting, adding, re-categorising and re-contextualising of explicit knowledge.
- ***Internalisation*** (explicit to tacit) is the mechanism of obtaining a tacit understanding or "feeling" of a real-world phenomenon by studying explicit forms of knowledge.

Sveiby (1997) relates these knowledge conversion mechanisms to the creation of new knowledge in the organisational context by describing them as a system of "knowledge flows" within the organisation. For example the process of externalisation can be described as a flow of knowledge from the tacit form of individual competence to the explicit form as structural capital. These knowledge flows within an organisation are shown in Figure 1. This model provides a useful framework for understanding the creation of new knowledge within organisations.

Figure 1: Knowledge flows within an organisation



Source: Adapted from Sveiby (1997).

2.4.3 Enablers and facilitators for learning and knowledge transfer

Sverlinger (2000) provides a well referenced description of various enablers and facilitators for learning and knowledge transfer.

Enabling conditions are characterised as sets of contextual factors and conditions that provide a proper environment for learning, knowledge creation and knowledge transfer, whereas facilitating activities often fulfil enabling conditions. Enabling conditions and facilitating activities can be merged into six types (Sverlinger, 2000): (1) organisational structure; (2) communication and monitoring of strategy; (3) enabling processes; (4) a knowledge orientated culture; (5) systems for training and learning and (6) technology and infrastructure.

2.5 Creating client value: Inter-organisational knowledge transfer

Thus far the *intra-organisational* aspects of knowledge transfer have been discussed: the inherent value of knowledge, components of this knowledge and modes of growing this knowledge. This section explores the *inter-organisational* aspects of knowledge transfer and how this creates value for the client.

2.5.1 Professional Services Organisations

Many types of services organisations have been described. One type of services organisation which is particularly dependent on highly educated and skilled personnel is called professional services organisations. Nachum (1998) defines two

distinguishing **features** of this type of organisation: (1) Knowledge is the core resource and is both the input and output of their production process. (2) Their clients are other organisations which use the output of professional services organisations as an input to their production processes.

Alvensson (1992) summarises six **characteristics** of professional services organisations as: (1) Problem solving and non-standardised production; (2) creativity of the individuals within the organisation; (3) strong individualism and independence of personnel; (4) highly educated personnel; (5) traditional assets are not essential but individual competence, networks and service delivery systems become critical; (6) strong dependence of employee loyalty.

These characteristics lead to a **resource view** of knowledge for professional services organisations (Sverlinger, 2000). They emphasise the importance of people and their tacit knowledge rather than explicit knowledge, or structural capital. However, it is important to realise that these individuals must still interact with each other and interact with their clients. All these interactions involve the transfer of knowledge and in many cases make use of explicit knowledge as a communication medium. The client relationships or external capital (Sveiby, 2001) is seen as another important knowledge resource.

The **process view** on professional services organisations emphasises three main components of the service delivery: (1) Managing client relationships, (2) project management and (3) performing the detailed professional tasks (Maister, 1982).

The **outputs** of professional services organisations consist of processed knowledge which must be packaged and transferred to the client. Outputs typically include written reports, oral presentations, drawings, software and specifications (Sverlinger, 2000).

2.5.2 Technology organisations

One type of professional services organisation is technology organisations, also called Research and Development (R&D) organisations. These organisations either focus on a particular industry, for example resources, or focus on a horizontal technology like electronics (Khalil, 2000).

The innovation process starts with a novel idea that occurs in response to some combination of needs, problems, commitments or possibilities. It then proceeds with an investment in people using tools to find new knowledge. This knowledge, which exists only in people, is then transformed into a technology capability, consisting of tools, processes and skills. This technology capability is in turn transferred to the client organisation where it is applied. The end goal is to create value in the client organisation by enhancing its competitive advantage (Miller & Morris, 1999).

Miller & Morris (1999) describe the historical development of R&D organisations in four phases:

1st generation R&D: The first R&D organisations were established in response to industrialisation in the 19th century. In 1865, the first industrial R&D lab was established by the German chemical giant BASF. Soon after that, in 1876 Thomas Edison started his laboratory in New Jersey. Based on Edison's early successes, others corporations founded their own R&D labs. The industrial era and two world wars resulted in huge investments in R&D by industry and governments. As a result, funding was abundant and scientists were free to choose their own research topics. The R&D laboratories were managed by scientists who selected and conducted their own research. The result was an almost unbounded search for scientific breakthroughs. Research was often directed purely by beliefs about market needs.

2nd generation R&D: By the end of the two world wars, corporate managers realised that they should manage their laboratories with greater focus on the needs of their business. Project management became an important process to achieve this.

3rd generation R&D: As the scale of corporate R&D continued to grow and technologies became more sophisticated, the inherent risk in R&D investments became a more significant component of the corporations' overall financial

exposure. As a result, R&D investments were evaluated using tools similar to those used to assess other risky investments. The concept of an R&D portfolio emerged as a method of balancing high risk activities that might offer important commercial breakthroughs in the long term with low-risk activities that represented more modest commercial potential in the short term. R&D management was also concerned with strategic planning of technologies in relation to the technology cycle and in line with the corporate strategy (Roussel, Kamal & Erickson, 1991).

4th generation R&D: Miller & Morris (1999) propose that a new generation of R&D is emerging. Due to the increasing specialisation of technologies and the high sophistication of markets, it is becoming increasingly difficult for R&D organisations to create discontinuous innovations. Single R&D organisations or departments are bounded by their market knowledge and technological knowledge, creating a situation where they can, at best, create incremental innovation. In order to break this cycle, R&D organisations must work across organisational boundaries with partners and clients in order to uncover latent client needs and to source new technologies. This creates a new set of challenges, including the transfer of knowledge across organisations and the management of intellectual property rights.

In summary, technology organisations are facing new challenges, where they have to work across organisational boundaries to source and deliver technological knowledge.

2.5.3 Technology transfer

The users of technology are often not the creators or inventors. Most technology solutions are created outside the organisations that benefit from them (Khalil, 2000). Technology has also become so sophisticated and expensive that even the largest organisations cannot afford to do it all themselves (Leonard, 1995). Therefore, successful importing and absorption of technological knowledge has become an important management activity for many organisations (Leonard, 1995). **Technology transfer** is the term used for the process that permits the flow of technology from a source to a receiver. Jain & Triandis (1990) define technology transfer as a process by which science and technology are transferred from one individual or group to

another that incorporates this new knowledge into its way of doing things, followed by its useful commercial application.

Technology is intangible and flows easily across boundaries, provided that the channels of flow are established. Khalil (2000) identifies three types of channels that allow the flow of technology:

- **Public channels:** Technology transfer is done through the public domain. Information is made available publicly with limited or no restrictions on its use and is then harnessed by users and applied to their purpose. These channels include education, training, publications, conferences, study missions and exchange of visits.
- **Reverse-engineering channels:** These channels involve no active participation from the source. The receiver of technology breaks the underlying code of an existing technology and develops the capability to duplicate it in some fashion. This is feasible, provided that the host has the knowledge to do this and there is no legal violation of intellectual property rights.
- **Planned channels:** The technology transfer is done intentionally, according to a planned process and with the consent of the technology owner. There are several types of arrangements that permit access to and use of new technology. These include licensing, franchising, joint ventures, turnkey projects, foreign direct investment and joint R&D projects.

The focus of this study is on the **planned channels** for technology transfer. More specifically, with technology-based professional services organisations, the planned channel agreement is usually in the form of a technology consulting project.

Lopes (1994) describes the transfer of technology as containing two elements that run in parallel:

- The **relocation phase** includes the identification of a specific technology and a donor organisation, negotiations and legal agreements and the relocation of the “hard” technology to a foreign site. This first phase is relatively easy to measure and control.

- The **absorption phase** is lengthier, has no specific breakdowns and is more subjectively measured. The process is only complete once the recipient of the technology has mastered the technology. This phase is the most important of the entire transfer process and also the most complicated.

2.5.4 Creating client value through the transfer of knowledge

Dawson (2000) states that the value created for clients will increasingly be realised by means of sharing knowledge with them, i.e. making them more knowledgeable. In an economy in which knowledge is the most useful resource, knowledge transfer to clients has the potential to add the greatest value and attract the highest rewards.

Professional services organisations are increasingly moving away from the “black box” method of consulting and towards the “knowledge transfer” method (Dawson, 2000):

- Traditionally, professional service organisations mainly provided “prescriptive” or **“black box” services** in which the outcome or result is of value but the process is not revealed to the client. The value is therefore temporary or “once off”.
- In contrast, the **“knowledge transfer” service** provides the client with insight into the process. This service includes implementation and co-creation of knowledge and allows the client organisation to solve its own problems in future. It thus leaves the client organisation with a more sustainable advantage, which in turn makes this type of service much more valuable.

The notion of knowledge transfer between supplier and client organisation is also embedded in the concept of “customer capital”, which is often described as a third component of intellectual capital (Saint-Onge, 1996; Sullivan, 1998; Sveiby, 2001; Edvinsson, 1998; Stewart, 1997).

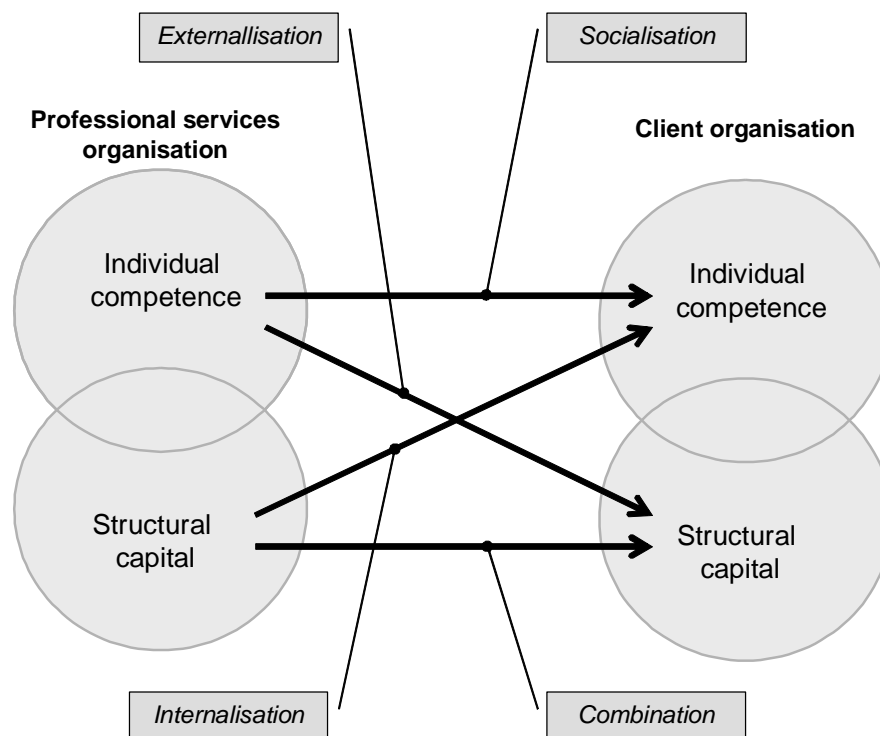
One of the key challenges facing organisations today is therefore to extend the field of knowledge management beyond their organisations to encompass all members of the extended enterprise, especially their clients. In other words, the knowledge supply chain between organisations must be understood. This supply chain is realised through a transfer of knowledge (by means of externalisation, internalisation,

combination and socialisation) to improve the capability (individual competence and structural capital) of the client (Dawson, 2000).

The knowledge transfer service is diagrammatically presented in Figure 2.

This model provides a useful representation of *how value is created* for the client organisation *by improving the capability* of the client *through the transfer of knowledge* in the form of knowledge-intensive offerings.

Figure 2: Mechanisms of knowledge transfer



Source: Adapted from Strydom (2003)

3 PROPOSITIONS

Based on the literature review, the answer to the research question “How do technology organisations add value to their clients through knowledge transfer?” can now be proposed:

3.1 Sub-problem 1:

What forms of value are created by technology organisations for their clients through knowledge transfer?

Propositions:

1. Technology organisations add value to their clients by enhancing the clients’ skills through the transfer of knowledge.
2. Technology organisations add value to their clients by enhancing the clients’ tools and processes through the transfer of knowledge.

3.2 Sub-problem 2:

What mechanisms are used to create these forms of value through knowledge transfer?

Propositions:

3. Value is added by enhancing the clients’ technology skills through the transfer of tacit knowledge by means of a process of socialisation.
4. Value is added by enhancing the clients’ technology skills through the transfer of explicit knowledge by means of a process of internalisation.
5. Value is added by enhancing the clients’ technological processes and technology-based tools through a transfer of tacit knowledge by means of a process of externalisation.
6. Value is added by enhancing the clients’ technological processes and technology-based tools through the transfer of explicit knowledge by means of a process of combination.

4 METHODOLOGY

Chapter 4 describes the research methodology which was used in the study.

Section 4.1 motivates the selection of a methodology. Section 4.2 describes the underlying assumptions of the research methodology. Section 4.3 describes the design of the research. Section 4.4 introduces the case which was chosen for the study. Section 4.5 explains the data collection process that was used. Section 4.6 gives details of the process which was used to manage the research. Finally, section 4.7 describes the quality limitations of the research (reliability and validity).

4.1 Selection of a methodology

This section motivates why qualitative research is appropriate for this study and why a case study is a suitable research methodology.

4.1.1 Qualitative research preferred

The choice between qualitative and quantitative research depends on the nature of the data to be collected and on the purpose of the research. According to Leedy & Ormrod (2001):

- Quantitative research is concerned with specific questions about ***measured variables*** with the purpose of ***predicting or explaining*** phenomena and for testing theories.
- Qualitative research, on the other hand, is used to answer questions about the ***nature of complex phenomena*** with the purpose of better ***understanding or describing*** the phenomena and for building theory.

The purpose of this study is to investigate the complex mechanisms which are used by organisations to deliver value through knowledge transfer. The purpose is to gain a better understanding and description of these mechanisms and involves a good deal of theory building. Qualitative research would thus be a more useful mechanism to collect data, analyse data and to communicate the findings.

4.1.2 Case study preferred

A case study has obvious limitations in terms of its external validity, because it represents only a single sample in a large population. However, this method is useful

for learning about poorly understood problems (Leedy & Ormrod, 2001). According to Yin (1994), three conditions should be considered when deciding whether case study is the preferred method over other qualitative techniques such as historical analysis or experimentation:

- ***The type of research question:*** Case studies are useful for exploratory research involving “how” and “why” questions. In this study the type of research question was exploratory, namely “How is value created through knowledge transfer?”
- ***The extent of control an investigator has over behavioural events:*** In this study, the investigator had little control over behavioural events which are involved in the creation of knowledge-intensive offerings. This makes a case study the preferred method over an experiment.
- ***The degree of focus on contemporary as opposed to historical events:*** The focus of this study is primarily on contemporary events in technology organisations. Technology organisations worldwide are currently struggling with the problem of creating value through knowledge transfer and no clear solution has emerged. This condition excludes historical analysis as a method and confirms that a case study is the appropriate technique to use.

4.2 Underlying assumptions of the methodology

This research was conducted in the ***functionalist paradigm*** which is based on two main assumptions (Burrell & Morgan, 1979):

- An objectivist approach to social science which assumes that there is an objective, independent world; that real knowledge of this objective world can be systematically gathered; that human nature is deterministic.
- A sociology of regulation (which is concerned with the status quo; social order; consensus; social integration and cohesion; solidarity; need satisfaction; actuality).

4.3 Research design

The aim of the research design was to ensure that there is a logical alignment between the original research questions, propositions, the theory base, data to be collected and conclusions.

4.4 Case selection and identity of empirical field

In order to identify the empirical field, the population is firstly defined, after which a case is selected based on the research objectives; finally the unit of analysis is defined to focus the study.

4.4.1 Population:

The population was defined as any organisation or project whose activities are primarily focussed on technology development and whose offerings are knowledge-intensive.

4.4.2 Case selection:

The case chosen for this study was the Ground Based Air Defence System (GBADS) modelling and simulation based acquisition decision support project, which was conducted by the Council for Scientific and Industrial Research (CSIR) for the Department of Defence (DOD) and contracted through the Armaments Corporation (Arm Scor).

(a) Rationale for choosing a single-case study:

According to Yin (1994), the following conditions justify use of a single-case study:

- The case is accessible to the researcher and represents an opportunity for scientific observation.
- The case is rare and it would be difficult to find similar cases.

It was believed that this is a revelatory case which provides a unique opportunity to gain access to the successful delivery of a knowledge-intensive offering by a technology organisation, given that this is a very new mode of operating for such organisations.

(b) Rationale for choosing CSIR as an organisation:

CSIR was chosen for a number of reasons:

- CSIR is an organisation which is focussed purely on technology development.
- It is a South African based organisation which allows easy access to the researcher.
- It has a track record of successful commercialisation of its technology offerings. In less than a decade, CSIR has shifted its position from being almost entirely dependent on government funding to now deriving about 65% of its revenue from the private sector (Business Day, 2002).
- CSIR is moving towards a Knowledge Intensive Technology Organisation (KITO) business model (Yannakou, 2003) and has been experimenting with different methods of creating value through knowledge transfer.

(c) Rationale for choosing GBADS as a project:

The GBADS project was chosen for a number of reasons:

- Based on the feedback from stakeholders, it was highly successful at creating value from knowledge transfer and should be used as a role model project.
- The project was sufficiently large and complex to represent most types of knowledge transfer from technology organisations.

Indications from key stakeholders that this is a revelatory case are (Combrink, 2003):

- The GBADS Programme Manager at the Armaments Corporation of South Africa (ARMSCOR) suggested that this project was a prime example of how to establish a technological capability in the user environment.
- Representatives from the British Defence Evaluation Research Agency (DERA) suggested that a number of mechanisms for transferring knowledge to the user community which were used in the GBADS programme should be used as a standard in future technology acquisition support projects.

- The manager of the Defence Electronics Programme (DEP) business unit in CSIR mentioned that GBADS was an exemplary project and that the mechanisms used there should be duplicated in other projects.

4.4.3 Interview Sample

The interview sample was chosen to be representative of the project stakeholders. This includes project team members, CSIR management, the contracting agency, consultants and end users. Interviewees were chosen according to their level of involvement in the project, the importance of their role in the project and their availability. A total of 12 interviews were conducted. The name, resident organisation and project role of each interviewee is given in Table 1.

Table 1: Interview Sample

<i>Organisation</i>	<i>Name</i>	<i>Role</i>
CSIR Management:	Jan Roodt	CEO: Defence Electronics Programme
	Johan Strydom	Technology Manager: Defencetek
	Francois Anderson	CSIR technical specialist
CSIR team members	Carel Combrink	Technical leader
	Ben Kruger	Project manager
	Herman le Roux	Team member
	Alta de Waal	Team member
Contractor	Rene Oosthuizen	Specialist contractor and systems engineer
Contracting Agency (ARMSCOR)	Johan Swart	Senior Programme Manager: GBADS
	Hanlo Pretorius	Programme Manager: Radar
End user organisation	Col. Jaques Baird	Project Officer: GBADS
	Col. Barney Louw	Previous Project Officer: GBADS

4.5 Data collection process

Yin (1994) identifies three good principles for data collection:

- using multiple sources of evidence;
- creating a case reference database;
- maintaining a record of chain of events.

The following three sections describe how these principles were addressed in this research.

4.5.1 Data sources and triangulation

Yin (1993) suggests that if multiple sources of evidence are used to converge on the same set of issues (in this case the research theory to be scrutinised), generalisability of the theory is greatly strengthened. This process is called triangulation. Triangulation therefore requires multiple sources of information. The following sources were used during this research:

Interviews: Interviews form the heart of the data collection activity. The interviews were conducted with representatives from the various stakeholder communities, as described in section 4.4.3. It is important that the interview questions are consistent from one interview to the next in order to improve reliability and validity of the research. Due to the qualitative nature of the methodology, it is also important that the interviews are flexible enough to capture important data which were not anticipated. Hence a semi-structured interview method was employed using a pre-defined set of questions (see Appendix A). These questions were designed to be open-ended enough not to guide the interviewee to an answer.

Interviewees were contacted telephonically to inform them of the research and invite them to participate in the study. Upon acceptance, more information was sent to them electronically, informing them on the content of the interviews and confirming the time and date of the interview. The interviews were mostly conducted at the site of the respondent. The standard list of questions used in interviews is given in Appendix A. The interviews were recorded, transcribed, coded, analysed, displayed and integrated with other sources of data.

Documentation: Review of documentation formed the second source of data for the purpose of triangulation. Specifically the following documentation was studied:

- GBADS project documentation.
- CSIR knowledge management documentation.
- Other internal documentation relating to the project, such as modelling and simulation methodologies.

Direct observation: The researcher had been employed by the organisation for a number of years and had been involved in similar projects. Although this introduced the danger of bias or subjectivity, it also improved the data collection process through

a better understanding of the organisational language, understanding of the concepts being studied, stronger relationships to interviewees and a heightened awareness of important issues pertaining to the study.

4.5.2 Case study reference database

A database was created to collect the data from interviews, documentation and direct observations. This database incorporates all the data collected in an orderly fashion so that they can be referred to at a later stage. The database is in the form of hard-copy notes and computer data. The ordering of the raw data is chronological. The ordering of the processed data corresponds to the structure of the research report.

The purpose of the case study database is to allow a third party to review the collected data and use them to verify the research.

4.5.3 Chain of events

A record was kept of the chain of events which occurred during the research process, linking the collected data to these events. The record of events covers the research process from the time of starting the research (after the research proposal was approved) to the final compilation of the research report.

The purpose of the chain of events is to allow a third party to review the process and use this together with the database to verify the conclusions of the research.

4.6 Research management process

4.6.1 Pilot interview

Yin (1994) states that a pilot study can be a very valuable instrument to test the methodology and aspects of the theory, before commencing with the full research. The output of the pilot study may be used to refine the theory and possibly to adapt the methodology. He further suggests that the pilot study be performed on a limited scope in a section of the organisation which is easily accessible.

This study therefore included a pilot interview, after which the research questions were slightly adapted. An important part of the pilot was feedback from the interviewer to see if the questions were understandable and complete.

4.6.2 Data analysis

Leedy & Ormrod (2001) define five steps for case study data analysis:

- *Organisation of the details of the case:* the data about the case were arranged in a logical order. This order also relates to the ordering of the case study database. In this research, the chain of events was used to provide the order.
- *Categorisation of data:* categories were identified which could be used to cluster the data into meaningful groups. In this case, the data were coded using data-labelling devices (highlighting with specific colours). The categorisation was based on the two sub-problems, linking each piece of data to one of the sub-problems. Data which could not be categorised into either of the sub-problems were listed separately for later analysis.
- *Interpretation of single instances:* Single instances of codified data were interpreted to retain their specific meanings in relation to the context. They were then extracted and placed into their specific clusters (clusters in this case relate to the sub-problems).
- *Identification of patterns:* Each cluster of data (with interpretations) was scrutinised for underlying themes and other patterns that characterise the case more broadly than a single piece of information is able. In this stage, the other data (not linked to specific sub-problems) were also analysed for patterns which suggest critical factors not yet identified by the propositions. The relative priorities between the results were also highlighted. Displays were chosen to represent the results in a compressed format and in a way which makes the emerging patterns clear.
- *Synthesis and generalisation:* An overall picture of the case was compiled. Findings were synthesised and generalised beyond the specific case that was studied.

4.6.3 Reporting

The synthesised and generalised findings were presented in the research report in an orderly structure and in a way which makes the context, content and logic of the case clear to the reader.

4.7 Reliability and validity

Perry (2001) defines four criteria which determine the quality of case research: construct validity, external validity, internal validity and reliability. The limitations of this research in terms of these four criteria are discussed in this section. Secondly, the methods which were employed to enhance reliability and validity are described.

4.7.1 Construct validity

Construct validity refers to the use of suitable instruments and operational measures for investigating the concepts (Perry, 2001).

A case study research has the limitation of being qualitative and in this case of being interpreted and analysed by one person – the researcher. This limits the construct validity of the research.

In order to improve the construct validity, multiple sources of evidence were used (Yin, 1993). This included:

- Interviews with different people in different parts of the organisation and at different levels of responsibility.
- Using several data sources, namely interviews and documentation.
- The researcher has been working in the organisation for a long time and understands the organisation and the client environment very well. This enables him to be sensitive to responses and to understand certain approaches, language, terminology and the context in general.

Other methods which were employed to ensure construct validity include:

- The interview questions which were used in the semi-structured interviews were reviewed by two experts before the research interviews started. Both experts felt that the questions, if applied correctly, would yield the required data.
- A pilot interview was conducted to test the questionnaire. The interview was transcribed and the data analysed. Based on this result, minor adjustments were done to the questionnaire to make the questions clearer and unambiguous.

- Member checking was done to verify that the data from the interviews were processed correctly up to the point of displaying the results without distorting the response of the interviewee. This was done by asking four of the interviewees to comment on whether the displayed data accurately represented their opinion. In all four cases there were minor adjustments but no fundamental structural or content discrepancies were found. The conclusion from the member checking was that the remainder of the displays would be sufficiently representative of the interviewee's opinion. This member checking was done for both types of displays used.
- One peer review with an expert was done to validate the interpretation of the displayed data. The peer review found that the interpretation of data was logical and without serious omissions.

4.7.2 External validity

External validity refers to the generalisability of the findings beyond the case, to the population (Perry, 2001).

A case study is inherently limited in terms of generalisability, because it does not meet statistical sampling criteria. It represents only one instance of the population and the respondents are specifically chosen for their expertise, not randomly selected.

However, validity can be enhanced if care is taken in the selection of the case and in the procedures which are followed (Perry, 2001). The first and most important step that was taken to improve external validity is the choice of a case.

The choice of the GBADS project as a case study was partially for the reason of generalisability (see section 4.4.2). The case represents a highly successful project from the perspective of its key stakeholders. The case is also sufficiently large and complex to be representative of other projects. The organisation in which the project was performed (CSIR) is also representative of a knowledge-intensive technology organisation.

4.7.3 Internal validity

Internal validity refers to the soundness of cause and effect relationships discovered in the study (Perry, 2001).

As noted by Perry (2001), causal relationships are very hard to establish in social sciences research. This limits the internal validity of a case study.

In order to enhance the internal validity of the research, prior theory, probe questions and in-depth listening (asking “why” questions and uncovering latent perceptions and causes) were used. The internal validity of the research was also checked against respondents involved in the research by asking them if the conclusions are accurate. The member checking on the displays concluded that the logical relationships between data were consistent with the respondents mental model.

4.7.4 Reliability

Reliability refers to how consistently a technique measures concepts so that other researchers, if using the same technique, will get the same result (Perry, 2001).

Due to their qualitative nature, case studies have limitations when it comes to reliability due to the interaction process in interviews and the interpretation of verbal data.

In order to enhance reliability, the following measures were taken:

- A standardised questionnaire was used for interviews.
- A pre-defined procedure was used to analyse the data. This process is described in section 4.6.
- The responses from interviewees were interpreted using the theoretical framework resulting from the literature review.

5 PRESENTATION OF RESULTS

In this section, the results of the research are presented. The case is first contextualised by describing the host organisation and the background to the project. The results are then presented in two sections, corresponding to the two sub-problems.

5.1 Context of the case

5.1.1 CSIR and the Defencetek Division

CSIR was established in 1945 as a scientific advisory body to the government. The organisation was mainly government funded for many years but has recently re-positioned itself as the “technology partner” for government departments and industry. It has been successful in attracting a large portion of its funding from external sources by performing contract research and by selling knowledge intensive, technology related offerings. CSIR consists of eleven divisions covering a wide range of technologies, from bio-chemical to building technologies to defence.

The Division of Defence Technology (Defencetek) was established in 1999 to support the Department of Defence and the South African Defence industry as a technology partner. Its primary mandate is to serve as a research institute for the Department of Defence, fulfilling the following roles (Anderson, 2003):

- Provide scientific and technological support to the DOD to enable them to be **knowledgeable buyers** of armament on acquisition projects to ensure a good choice of equipment solutions while minimising acquisition cost.
- Provide scientific and technological support to the DOD to enable them to be **knowledgeable users** of armament to ensure continued effectiveness of military systems while minimising the cost of ownership.
- **Maintain the winning edge** through the development of equipment with unique capabilities or, when conditions or doctrines change or equipment becomes obsolete, by supporting continued product improvements and/or upgrades.

- Provide equipment to satisfy **unique requirements** in the South African context in cases where the Defence Industry cannot do so.
- Provide **strategic independence** in some niche areas by enabling independent indigenous military product development, manufacturing and commissioning, thereby reducing supply vulnerability and improving the probability that special, differentiating features that may ensure a winning edge in battle, remain secret.

5.1.2 The GBADS project

The project started in 1988 during the Angola conflict. The need for an air defence capability had been identified after the South African defence force lost its air superiority in the region. The arms embargo against South Africa forced the country to develop its own air defence solution, including many of the subsystems. Johan Swart took over as the project officer in 1989, soon after it had started.

While the system was being developed, the Angolan conflict ended and the defence budgets were cut dramatically. The GBADS project was one of the first to be affected by this. The defence force still had the need for an air defence system but the project had been stopped and the solution had not been realised. From 1992, for a period of about 10 years, the country had a number of technologies and building blocks but there was no project to take these building blocks to a final solution. During that time “industry and technology survival funds” were made available to preserve some of the country’s important technology building blocks. The GBADS project received approximately R60 million to keep the base technologies alive and do incremental development on the system building blocks.

After the 1994 elections, the conventional warfare equipment became an even lower priority for the new government. However, an acquisition project was approved, albeit with very long time scales, starting in 1997 and stretching over 17 years.

The project risk was large for a number of reasons:

- The acquisition was spread over a very long timeframe. This made the acquisition complex because it had to be phased, while technologies were constantly changing. The end solution had to be technologically up to date at the time of commissioning.

- The South African industry had developed mature building blocks over many years but the new acquisition process demanded an open tender process with international players being able to participate.
- The system was large, consisting of a number of complex subsystems. The interactions between these subsystems were complex, resulting in uncertain emerging properties.
- The defence force already had some building blocks in operation which would have to be integrated into the end solution.

Johan Swart saw modelling and simulation as the best way to reduce the risk of this complex acquisition project. The British were in a very similar situation and were using modelling and simulation as a tool to integrate their current systems successfully into a modern air defence solution. After a visit to the British facilities, the GBADS project team decided to follow a similar approach in South Africa. They contracted CSIR to coordinate the modelling and simulation activities in support of the acquisition.

5.1.3 CSIR involvement in the GBADS project (the case project)

CSIR was approached by the GBADS acquisition team to perform “modelling and simulation based acquisition decision support.”

The idea was that CSIR would model the whole system as required by the end user at the time of commissioning. The models should take into account both the new, unknown building blocks, as well as the building blocks which the user already had in operation and which would have to be integrated into the end solution. The models would reveal the requirements of the new equipment to be acquired. The models would also show how the new equipment interacts with the existing capability to create an overall solution which is in line with user needs.

The project office hoped that this project would help to reduce the risk of the whole acquisition by making better acquisition decisions and eventually to ensure a better end user system.

5.2 Value created by the project

In this section, the results relating to sub-problem 1 are presented: “What forms of value are created by technology organisations for their clients through knowledge transfer?”

5.2.1 Presentation of results

The interviews were transcribed and coded by highlighting the sections in the transcript which are related to the sub-problem. The coded data were reduced and arranged in a logical order which could be consistently applied to all respondents and which would make it easy to relate the results to the original proposition. The reduced data were transformed into displays which serve as an organised, compressed representation of the original data and permit conclusion drawing.

Formats for data displays can be as varied as the imagination of the analyst and the types of problems being analysed. The format of the display depends on the type of problem being investigated (Miles & Huberman, 1994).

The choice of a display for the first proposition (i.e. the value which was created by the project) was influenced by the complexity of describing what the value of the project actually was. For example, one of the respondents started by describing the value of the project as follows:

“The outputs of [the] simulations are then analysed and processed, which are used to write documents which are then the actual deliverables, or actually, these are then used to do decision support, which is then the deliverable to the client.”

Similar descriptions from other respondents make it clear that the value cannot be described as single components but that they are related to each other, creating a chain of causally linked benefits. The “ends” of these value chains are the benefits which accrue to the end user of the technology.

Jones (1985) and Miles & Huberman (1994) propose cognitive maps as a useful way of mapping such qualitative data from interviews. Jones (1985) describes cognitive maps as comprising two main elements: the respondents’ concepts of ideas in the form of descriptions; and beliefs about the relationships between them, shown in the map by arrows or lines.

Since some interpretation is involved in moving from coded data to the display (especially regarding the structure of the display), member checking was used on four of the displays to ensure that the results are validly represented (see section 4.7.1).

One data display is created for each respondent.

5.2.2 Reading the displayed results

The individual blocks in the displays represent statements of the respondents about the project deliverables and the value that the project created. Although not always directly quoted from the coded transcripts, the content is representative of the words used by the respondent. These blocks also include the importance of specific elements as expressed by the respondents. If the respondent mentions a particular instance to be of particularly high value, or in other instances of a lower value, this qualitative weighting of the instance is included in brackets at the bottom of the block.

The arrows represent stated or implied causal relationships between these statements of value.

The top section of the display is highlighted and marked as “end user benefits”. This set of phrases represents the value which accrues to the end user of the technology and is directly related to sub-problem 1. These phrases were structured at the top of the diagram and are highlighted to make the interpretation of data easier.

5.2.3 Results

The displays of all respondents were included in the report. The reason for including all data displays is that they vary quite widely. Together, they provide a rich source of information for understanding the case study in more depth.

The displays for all twelve respondents follow. The name and position of each respondent is given to contextualise the display. The displays are in no particular order but have been arranged in the same sequence of respondents as shown in the interview sample (Table 1).

Figure 3: Value display for respondent 1

Name of respondent: Jan Roodt

Role: CEO of Defence Electronics Programme, CSIR

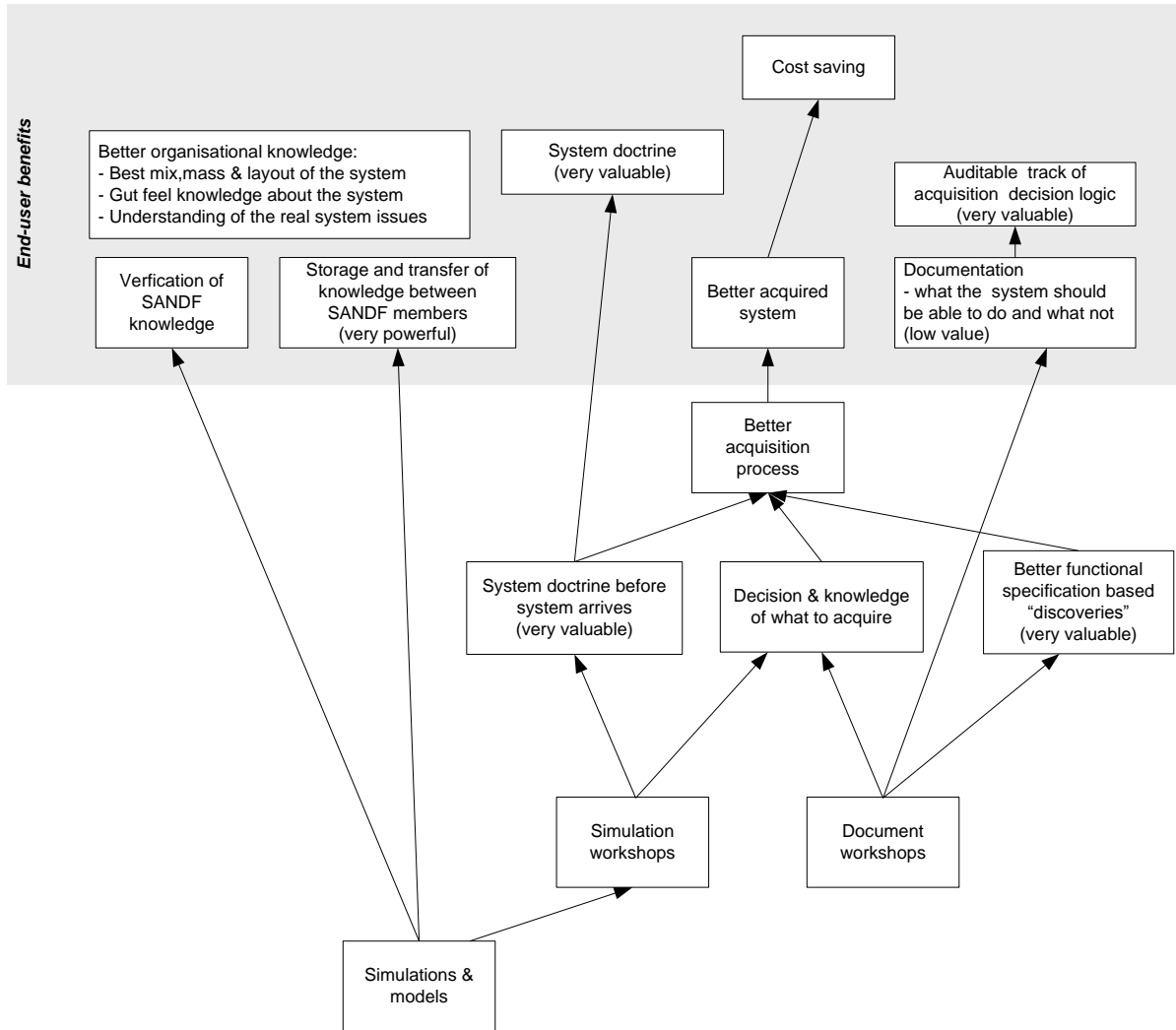


Figure 4: Value display for respondent 2

Name of respondent: Johan Strydom

Role: Technology Manager of Defencetek, CSIR

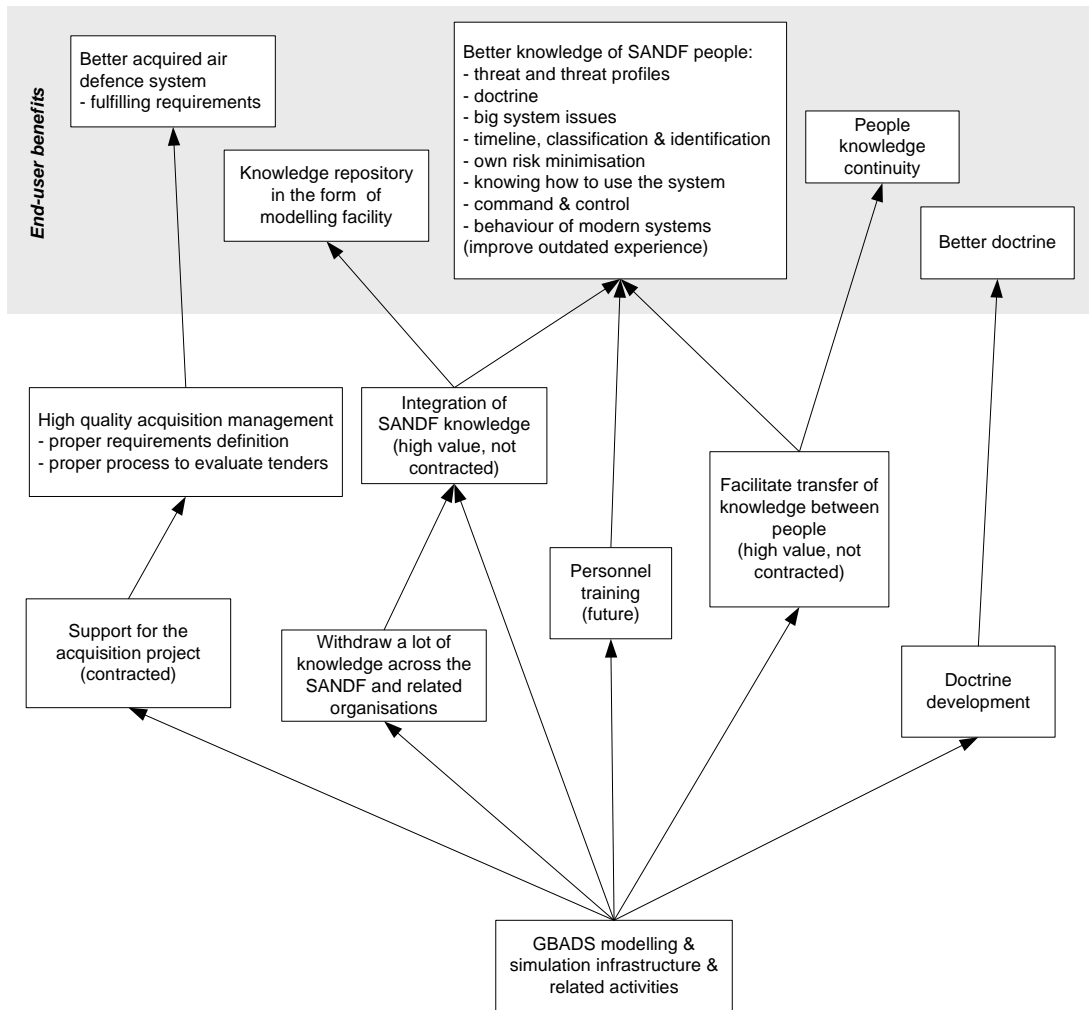


Figure 5: Value display for respondent 3

Name of respondent: Francois Anderson

Role: CSIR technical specialist

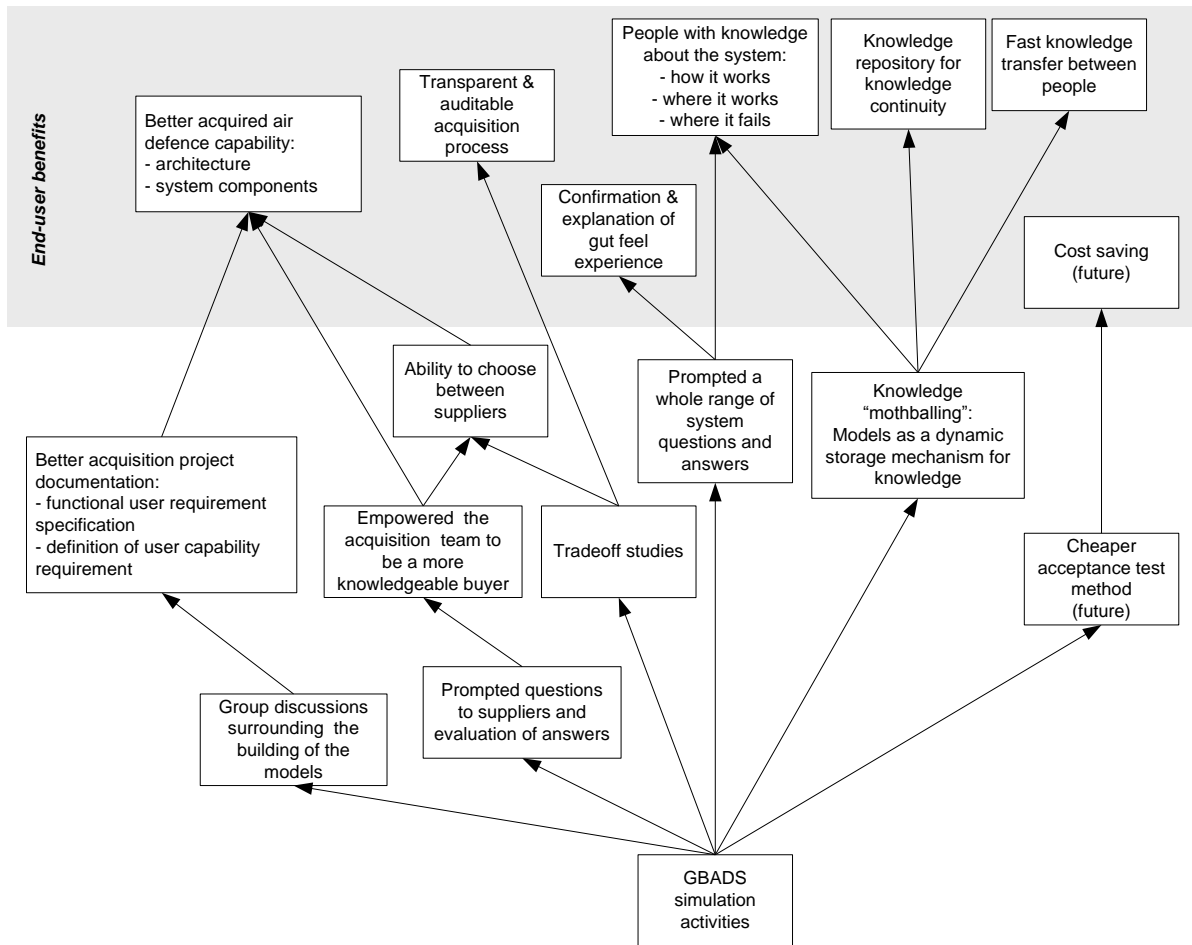


Figure 6: Value display for respondent 4

Name of respondent: Carel Combrink

Role: GBADS technical leader, CSIR

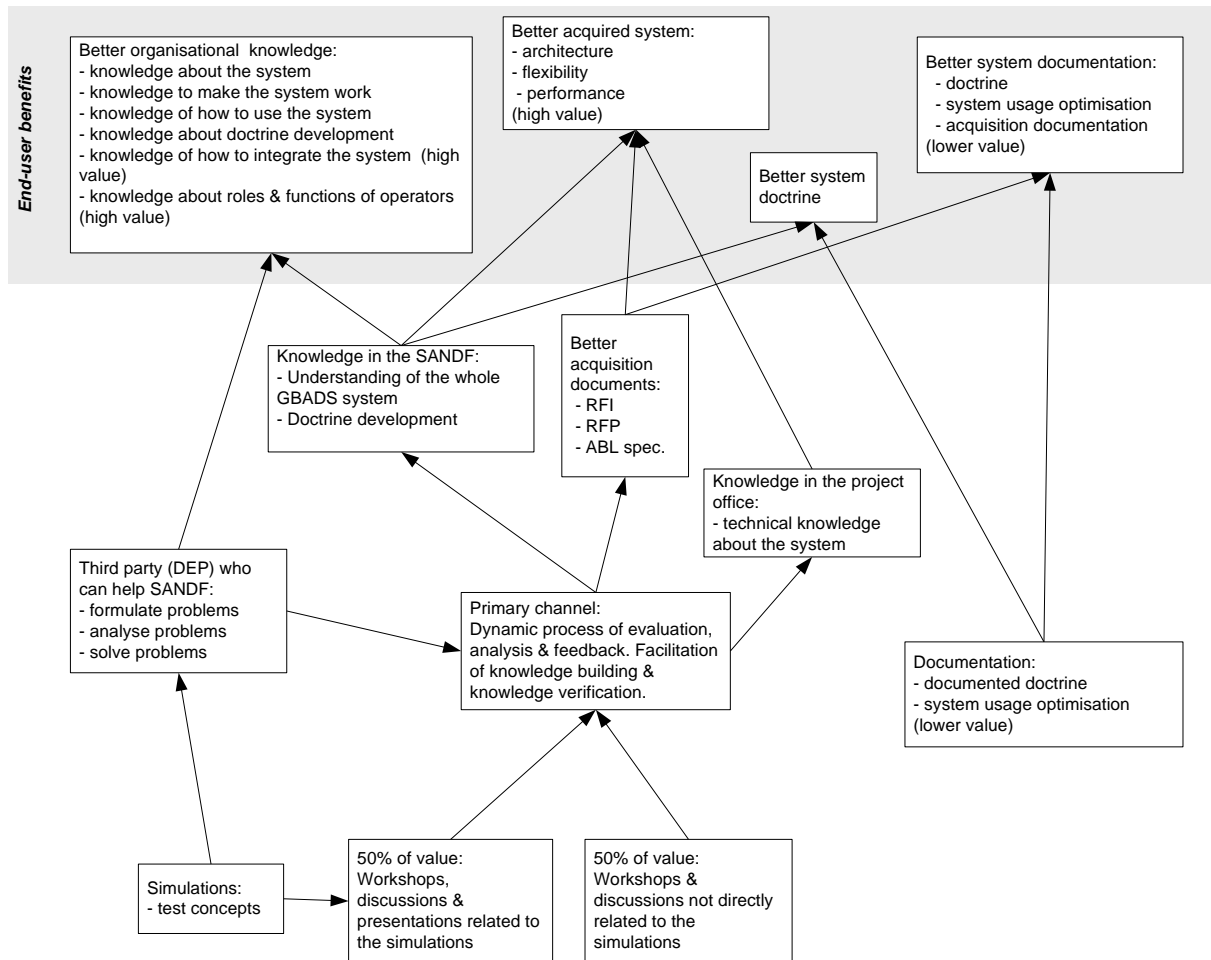


Figure 7: Value display for respondent 5

Name of respondent: Ben Kruger

Role: GBADS project manager, CSIR

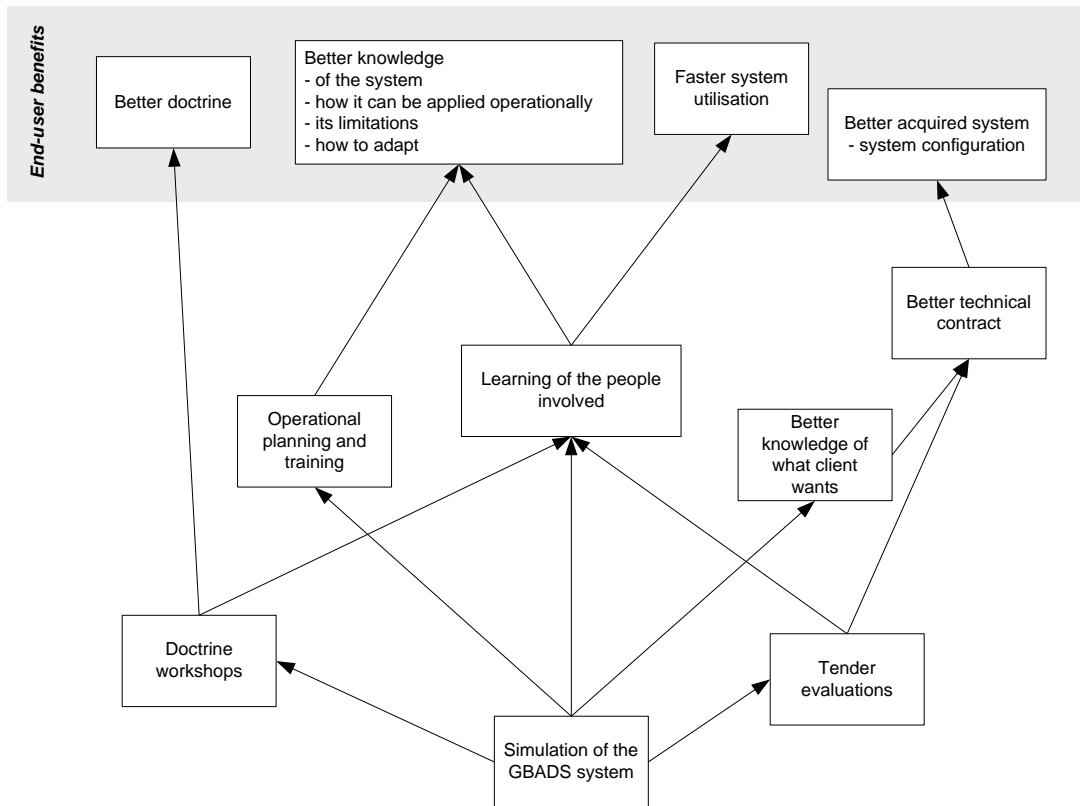


Figure 8: Value display for respondent 6

Name of respondent: Herman le Roux

Role: GBADS team member, CSIR

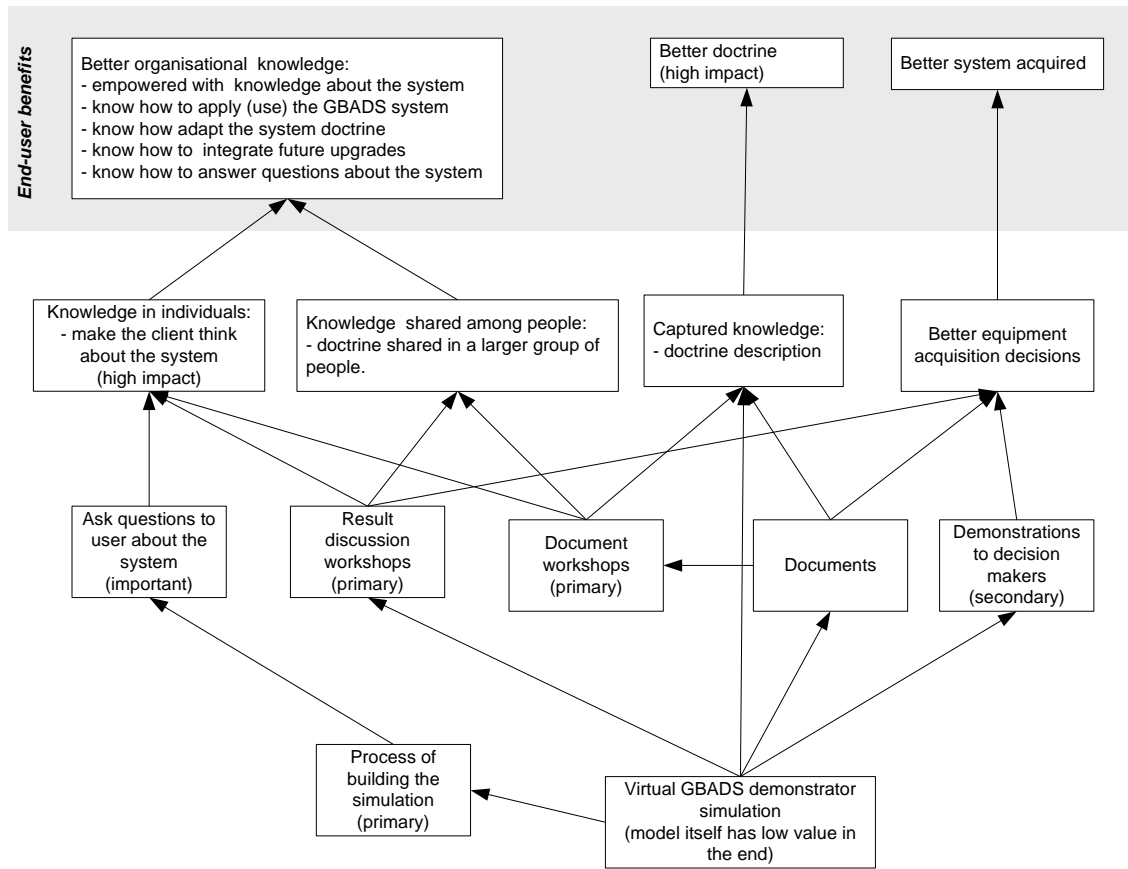


Figure 9: Value display for respondent 7

Name of respondent: Alta de Waal

Role: GBADS team member, CSIR

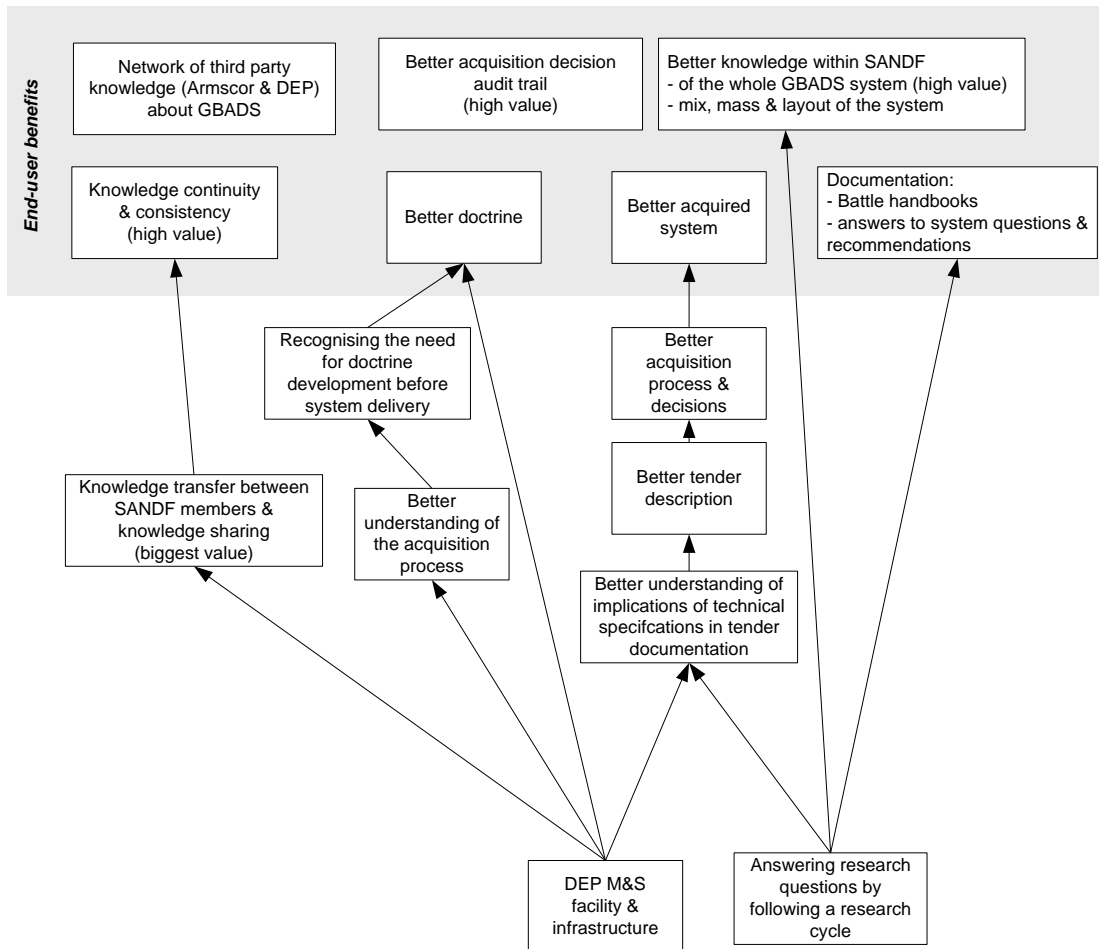


Figure 10: Value display for respondent 8

Name of respondent: Rene Oosthuizen

Role: Specialist consultant and systems engineer

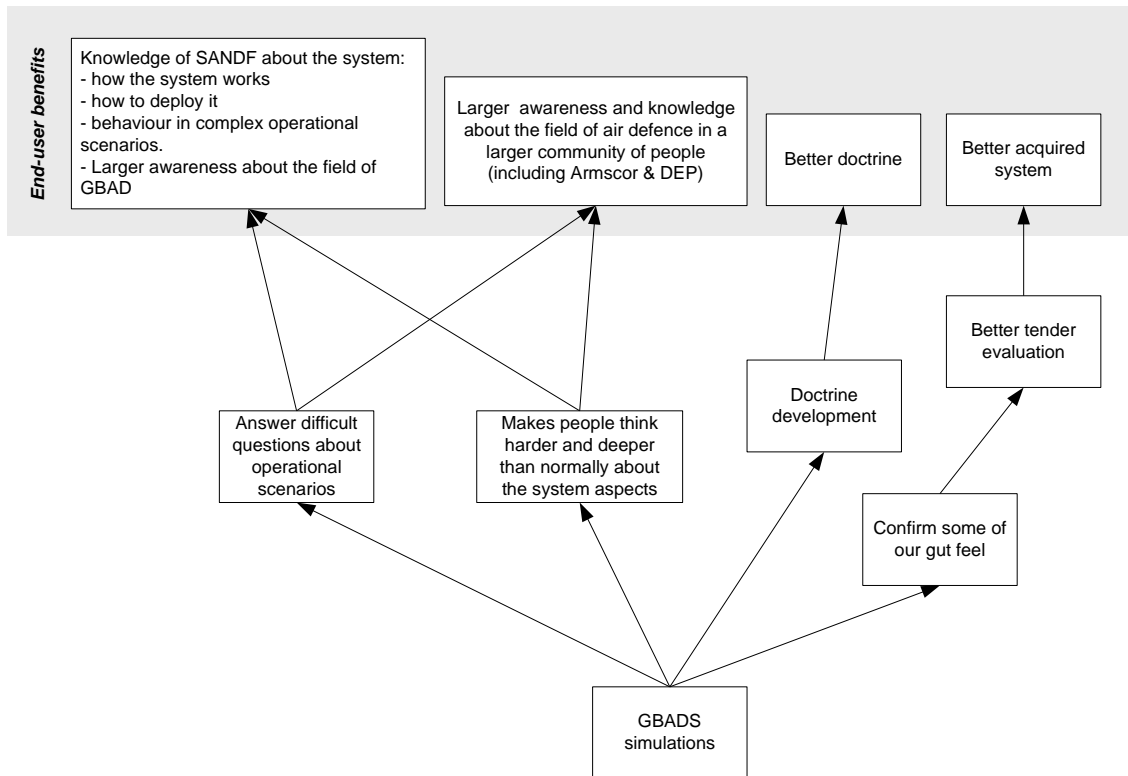


Figure 11: Value display for respondent 9

Name of respondent: Johan Swart

Role: Senior programme manager, Armscor

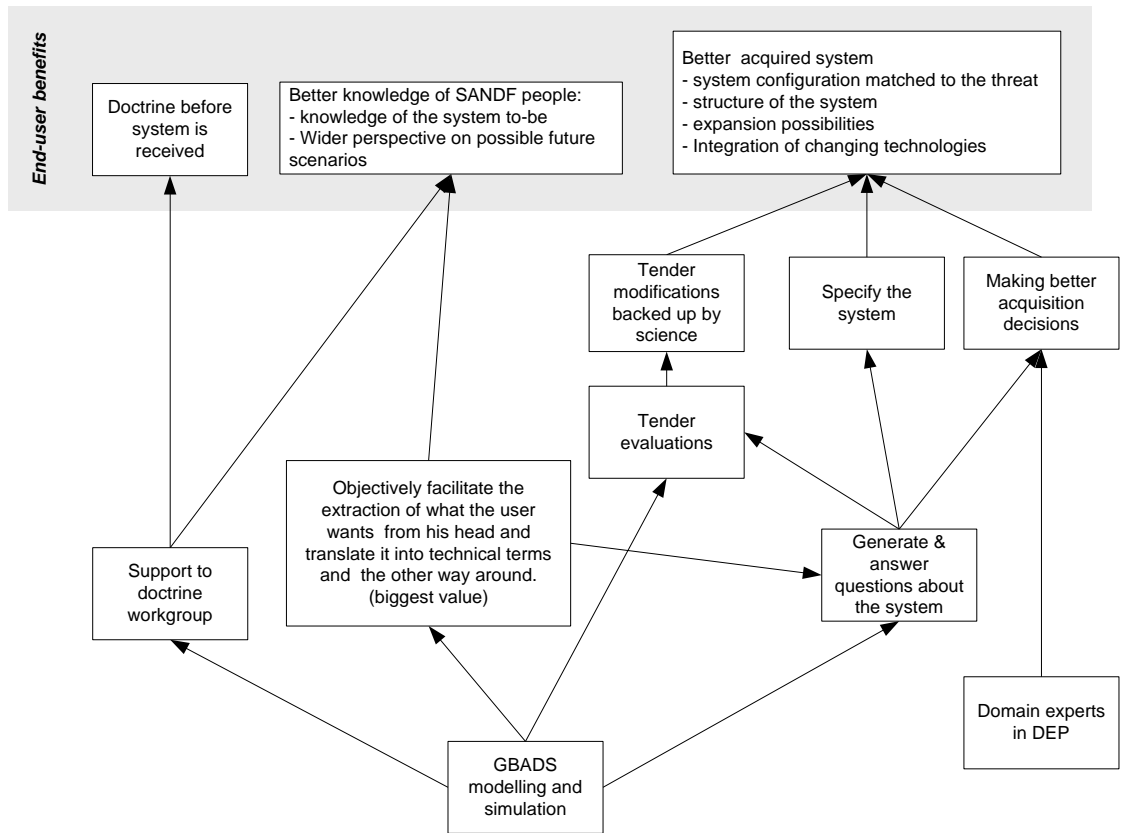


Figure 12: Value display for respondent 10

Name of respondent: Hanlo Pretorius

Role: programme manager, Armscor

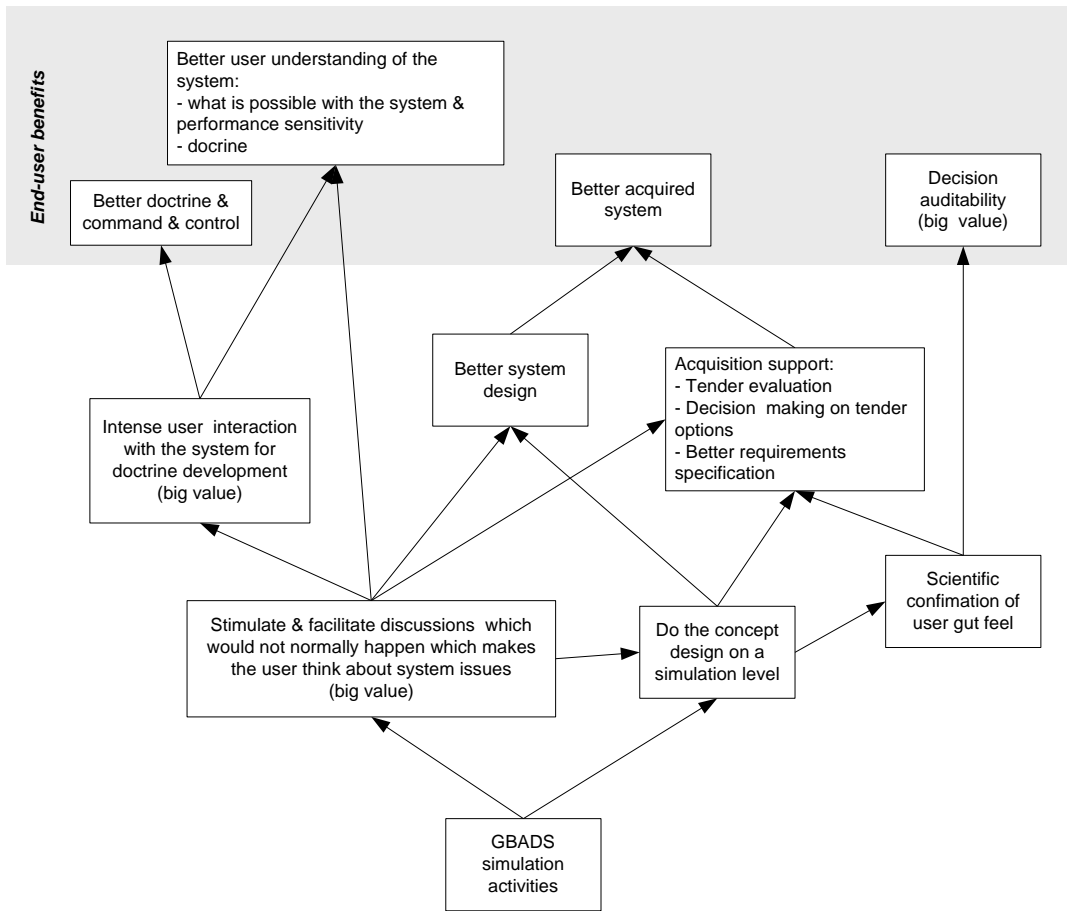


Figure 13: Value display for respondent 11

Name of respondent: Col. Jacques Baird

Role: GBADS project officer, SANDF

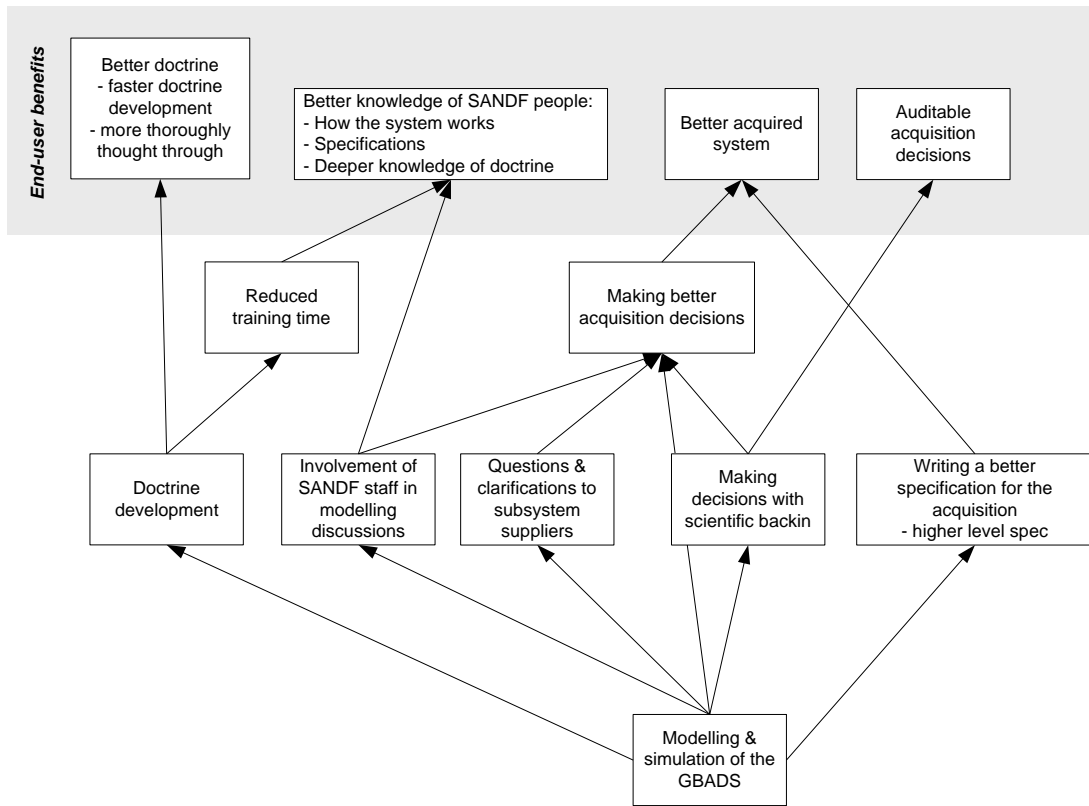
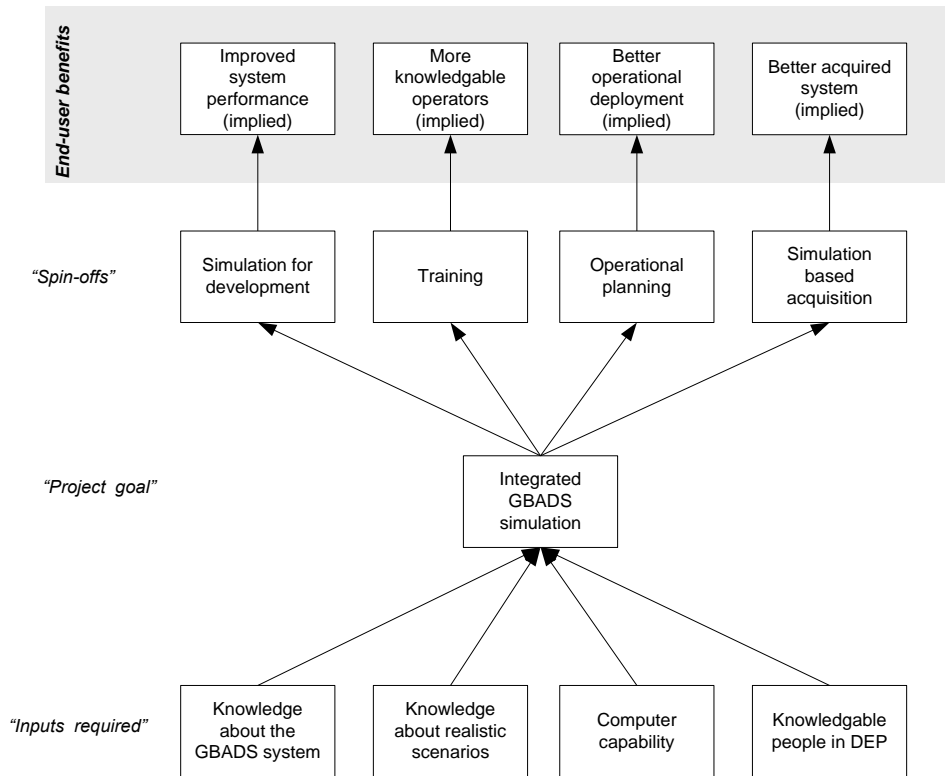


Figure 14: Value display for respondent 12

Name of respondent: Col. Barney Louw

Role: GBADS project officer, SANDF



5.3 Mechanisms used to create the value

In this section, the results relating to sub-problem 2 are presented: “What mechanisms are used to create these forms of value through knowledge transfer?”

5.3.1 Presentation of results

The interviews were transcribed and coded by highlighting the sections in the transcript which are related to the second sub-problem. The coded data were reduced and arranged in displays which could capture the information pertaining to the type of problem, as described in section 5.2.1.

The choice of a display type for the second sub-problem (the mechanisms of knowledge transfer) was influenced by a need to relate the response to the propositions. The four propositions are rather abstract (see section 3.2) and the respondents' words are usually not on the same level of abstraction. In order to make that link, the mechanisms as described by the respondents were listed and for each mechanism, an abstraction was made by the researcher in terms of the original proposition. Because some interpretation is involved in moving from coded data to the display and then to the abstraction, member checking was used on a number of displays to ensure that the results are validly represented (see section 4.7.1).

Any mechanisms which did not fit the abstraction directly were listed separately for further interpretation.

5.3.2 Reading the displayed results

One integrated display was generated for each respondent, capturing all the mechanisms described by him/her. An example of such a display is shown in Figure 15.

The text box represents the description of the mechanisms by the respondent in his/her own language.

The abstraction related to the propositions is shown to the right hand side and consists of four quadrants. Bubbles in these quadrants represent components of tacit or explicit knowledge involved in the transfer of knowledge (refer to Figure 2).

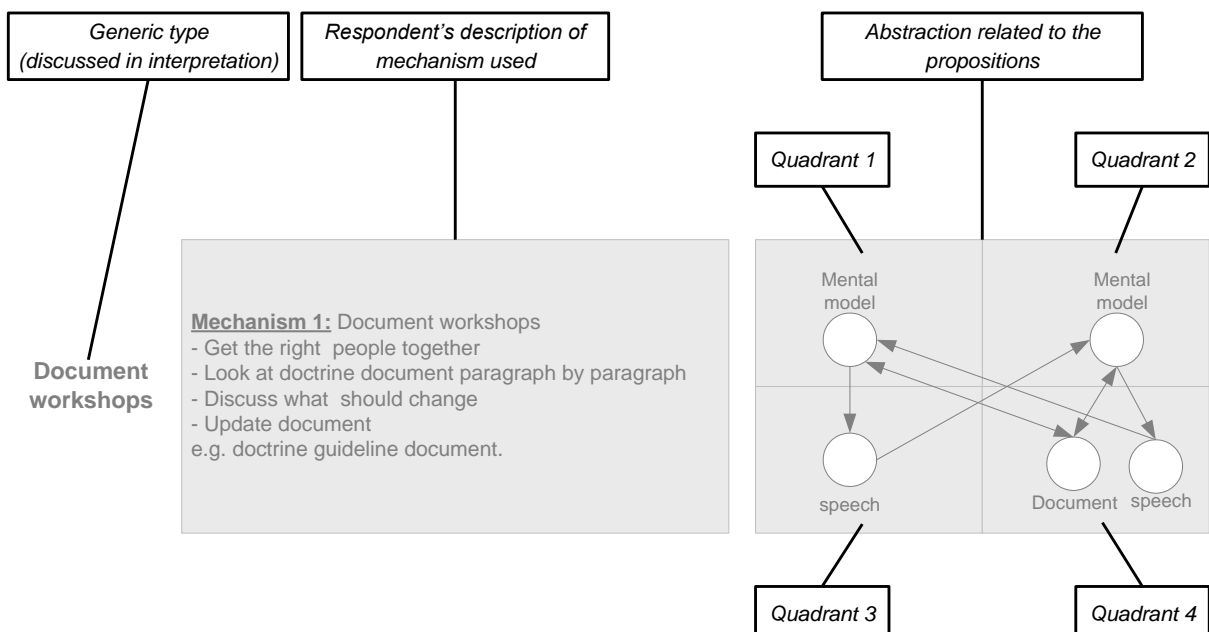
- Bubbles in quadrant 1 represent elements of *tacit* knowledge in *CSIR*.
- Bubbles in quadrant 3 represent elements of *explicit* knowledge in *CSIR*.

- Bubbles in quadrant 2 represent elements of **tacit** knowledge in the **client** organisation.
- Bubbles in quadrant 4 represent elements of **explicit** knowledge in the **client** organisation.

Arrows represent the flow of knowledge between these elements and thus the dynamics of sharing and creating new knowledge. These knowledge flows are related to the mechanisms described by respondents. The arrows relate directly to the propositions of sub-problem 2 (see section 3.2):

- Arrows moving from one of the top two quadrants (Quadrant 1 or 2) down to one of the bottom two quadrants (Quadrant 3 or 4) represent the mechanism of **externalisation**.
- Arrows moving from one of the bottom two quadrants (Quadrant 3 or 4) down to one of the top two quadrants (Quadrant 1 or 2) represent the mechanism of **internalisation**.
- Arrows moving between Quadrant 1 and 2 represent the mechanism of **socialisation**.
- Arrows moving between Quadrant 3 and 4 represent the mechanism of **combination**.

Figure 15: Explanation of the “Mechanisms” display



Other important issues relating to the mechanisms are listed at the bottom of the figure.

During the process of data analysis a number of generic types of knowledge transfer mechanisms were identified. These generic types are given on the left-hand side of the text boxes. This information forms part of the data interpretation and will be discussed further in section 6.

5.3.3 Results

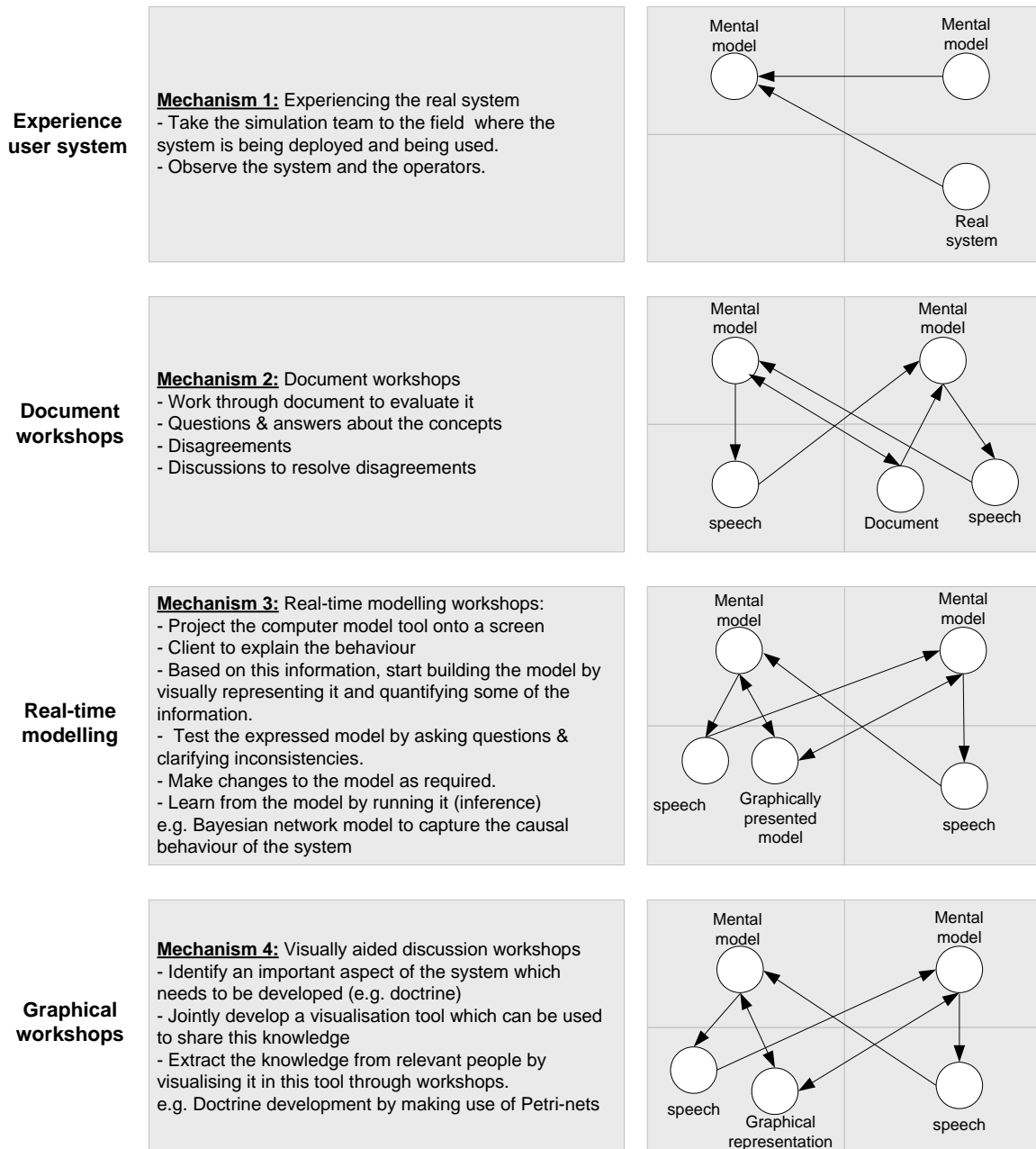
The result displays for the twelve respondents follow.

All displays were included in the report. The reason for this is that there are subtle differences in the mechanisms described by respondents. Some of these subtleties may be lost if only the generic types (described in section 6.2.1) are included in the report.

Figure 16: Mechanisms display for respondent 1

Name of respondent: Jan Roodt

Role: CEO of Defence Electronics Programme, CSIR

**Other important issues relating to the mechanisms:**

- Importance of developing a common vocabulary.
- Importance of tacit knowledge rather than explicit.
- Tools for visualisation and symbolism which were developed together to capture and present concepts.
- Importance of facilitation skills during engagements.
- Importance of the process, rather than the captured knowledge, which is fleeting.

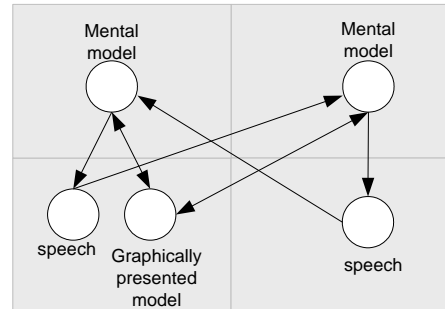
Figure 17: Mechanisms display for respondent 2

Name of respondent: Johan Strydom

Role: Technology Manager of Defencetek, CSIR

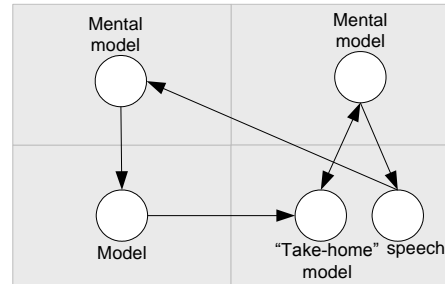
Real-time modelling

Mechanism 1: Real-time modelling (“get it out of them”)
 - Get the right people in the room
 - Withdraw the knowledge from them verbally
 - Translate it into some graphical thing which they can understand
 - Play back the model
 - Confirm whether the model behaves as expected
 - Identify gaps between expected and model behaviour (these are the learning opportunities)
 - Through discussions and modelling, understand why there is a gap and whether the mental model or computer model should be adapted.



Play with model

Mechanism 2: After action reviewer (“give it back to them”)
 - Package the model to make the outputs visual and understandable
 - Client runs the simulator
 - Learn from the outputs
 - Identifies gaps
 - Feeds back to model builder



Experience user system

Mechanism 3: Experiencing the real system (would be a valuable mechanism, not sure whether it happened)
 - Take the simulation team to the field where the system is being deployed and being used.
 - Observe the system and the operators.
 - Be a user of the system

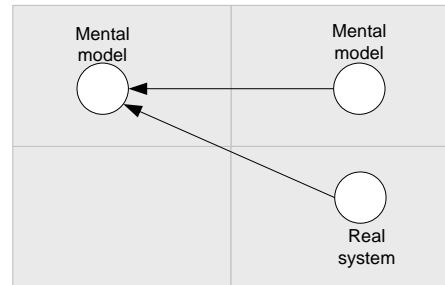
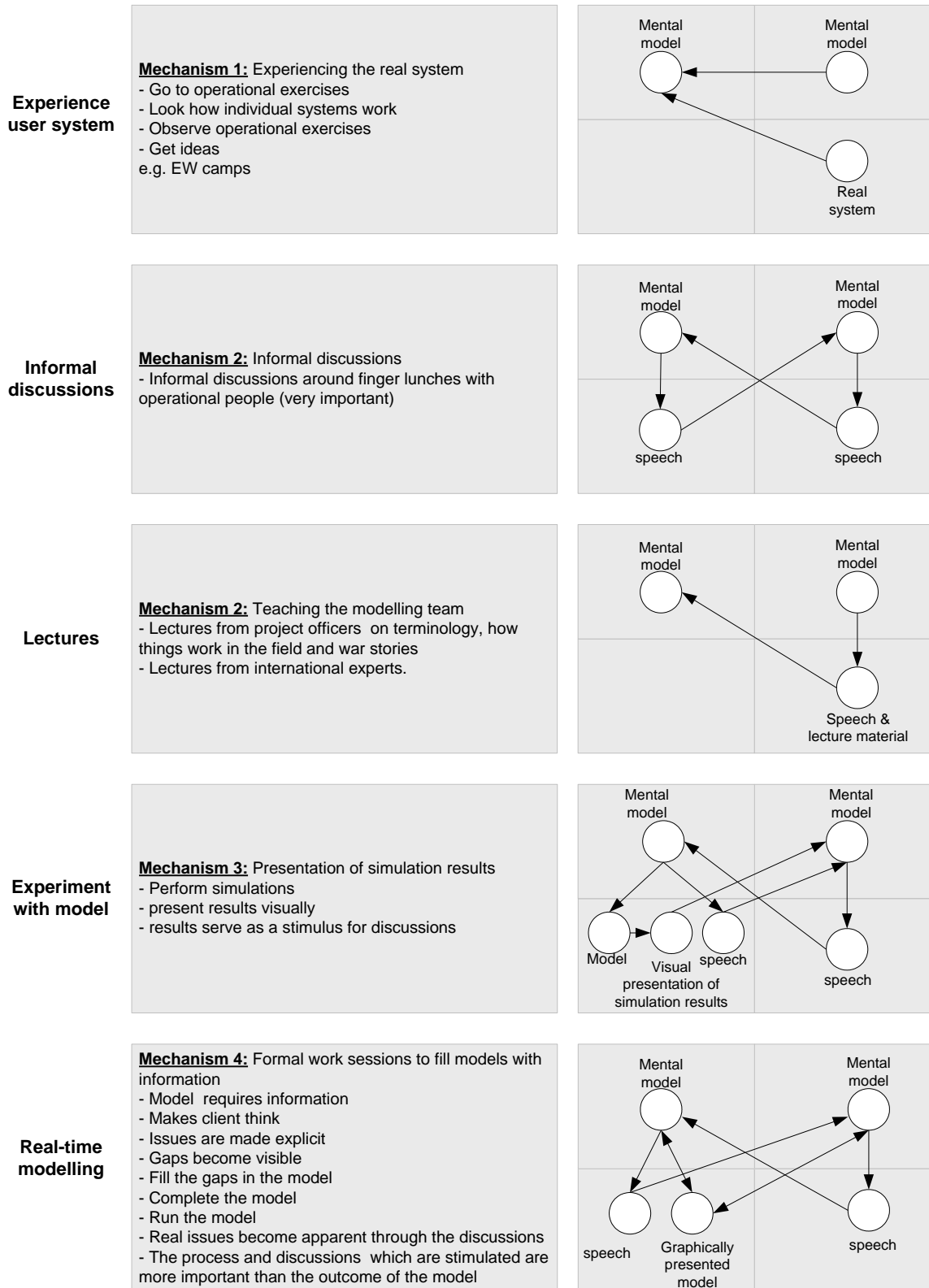


Figure 18: Mechanisms display for respondent 3

Name of respondent: Francois Anderson

Role: CSIR technical specialist



Other important issues relating to the mechanisms:

- The process to stimulate thinking and discussions is the key thing, rather than the models or the model outputs.

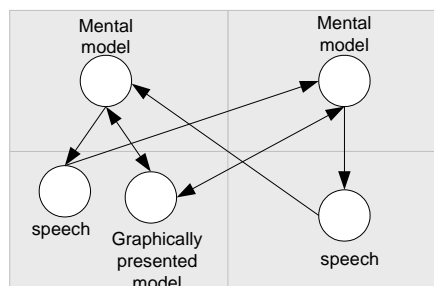
Figure 19: Mechanisms display for respondent 4

Name of respondent: Carel Combrink

Role: GBADS technical leader, CSIR

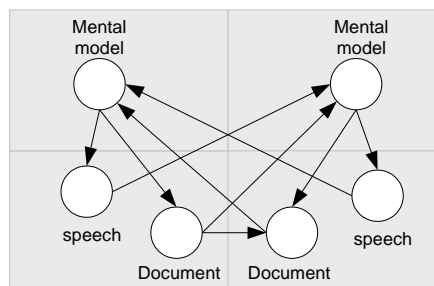
Real-time modelling

Mechanism 1: Real-time modelling workshops:
 - Put down the “bubbles” representing the main elements of the engagement process
 - Build the chains,
 - Discuss the causal influence of one element on the next.
 - quantify as far as possible
 - get a feeling
 e.g. Build a time-line model of the engagement process using Bayesian models



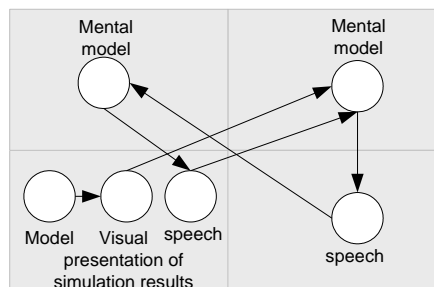
Document workshops

Mechanism 2: Document workshops
 - Capture concepts & inputs in documents
 - Ask client to document certain parts
 - Share the documentation
 - Review the document in a workshop
 - Work inputs into a combined document for client



Experiment with model

Mechanism 3: Discussion of simulation results
 - Do simulations
 - present results visually
 - discussions around the results



Other important issues relating to the mechanisms:
 - Importance visual communication tools

Figure 20: Mechanisms display for respondent 5

Name of respondent: Ben Kruger

Role: GBADS project manager, CSIR

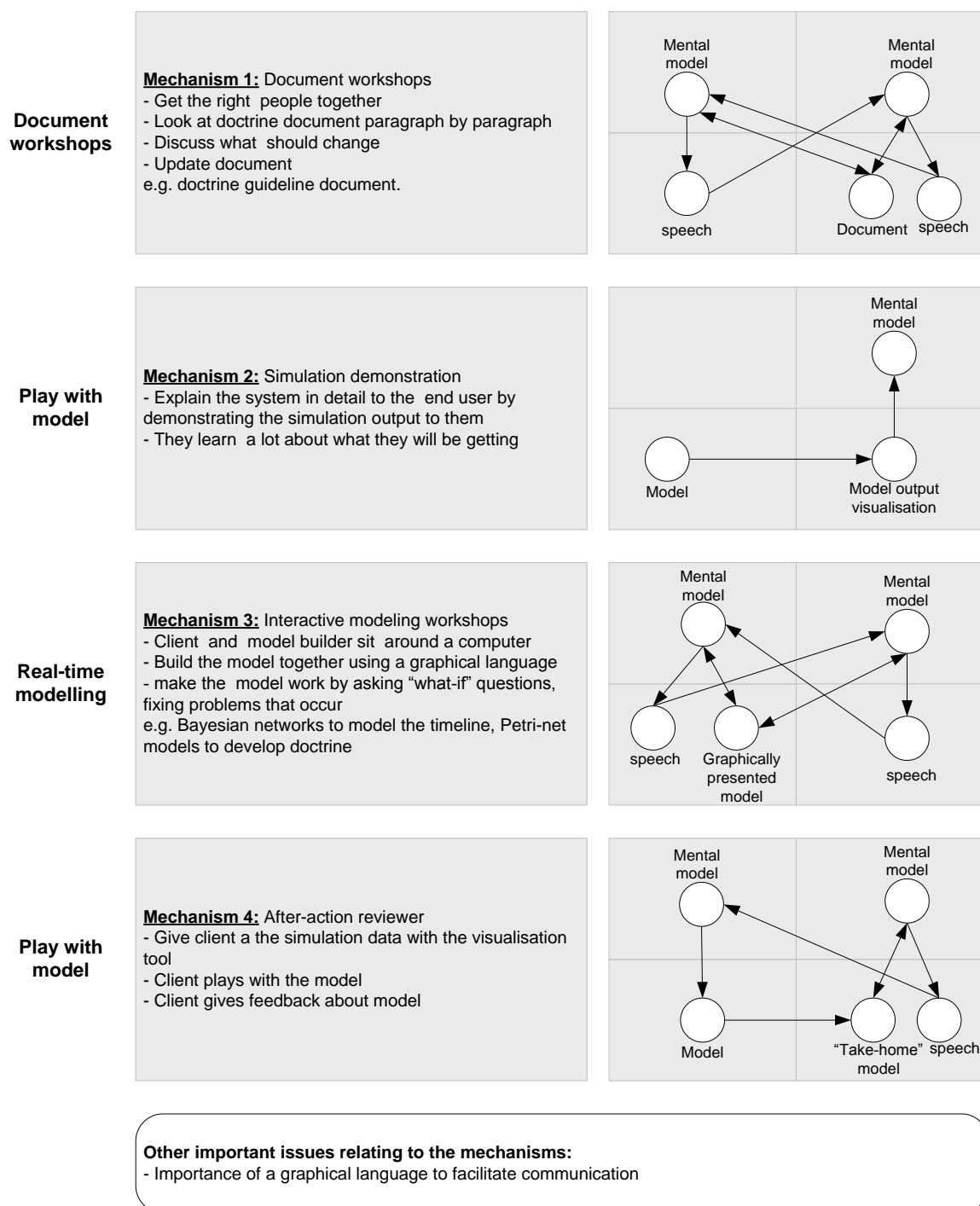


Figure 21: Mechanisms display for respondent 6

Name of respondent: Herman le Roux

Role: GBADS team member, CSIR

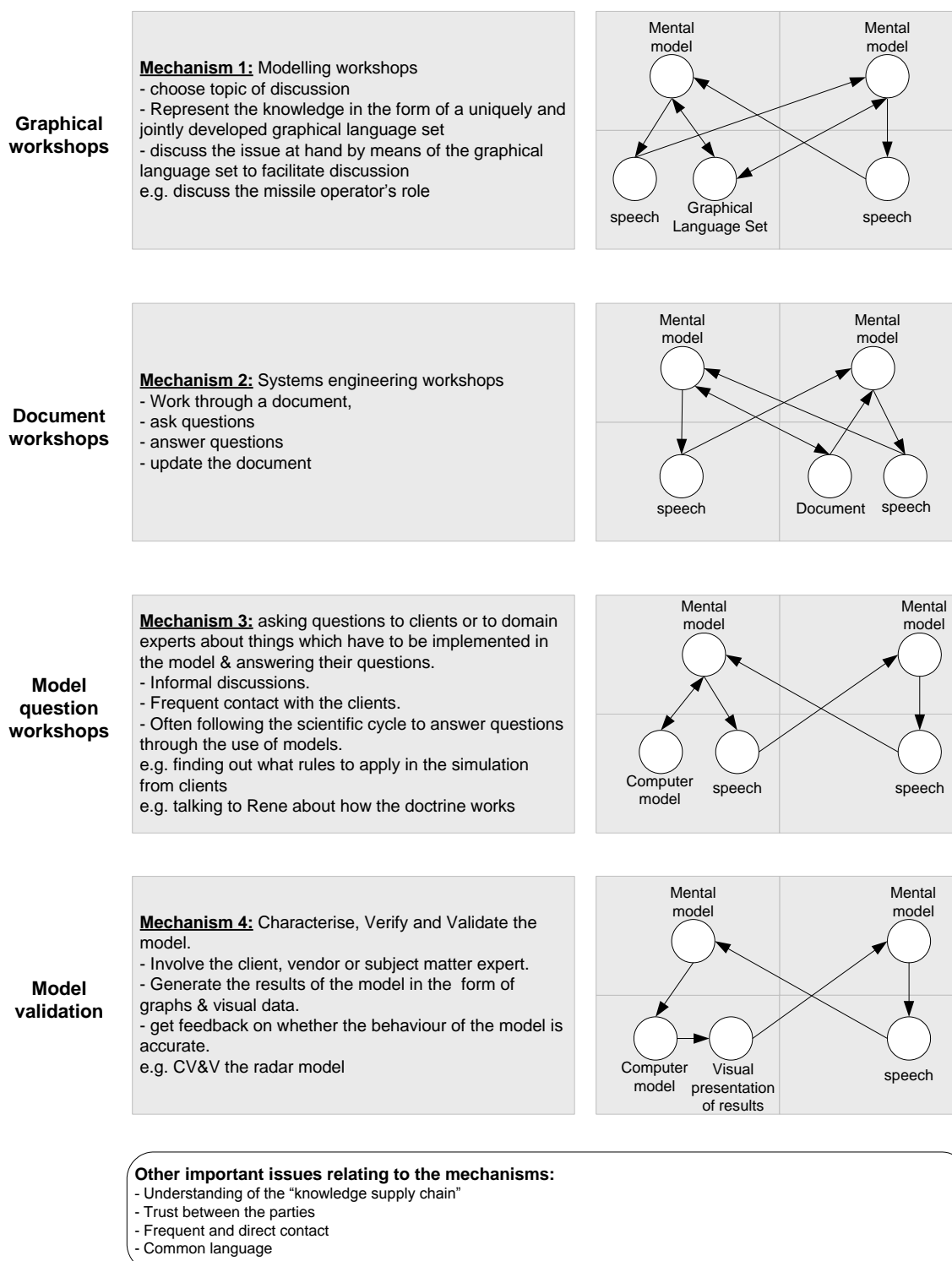


Figure 22: Mechanisms display for respondent 7

Name of respondent: Alta de Waal

Role: GBADS team member, CSIR

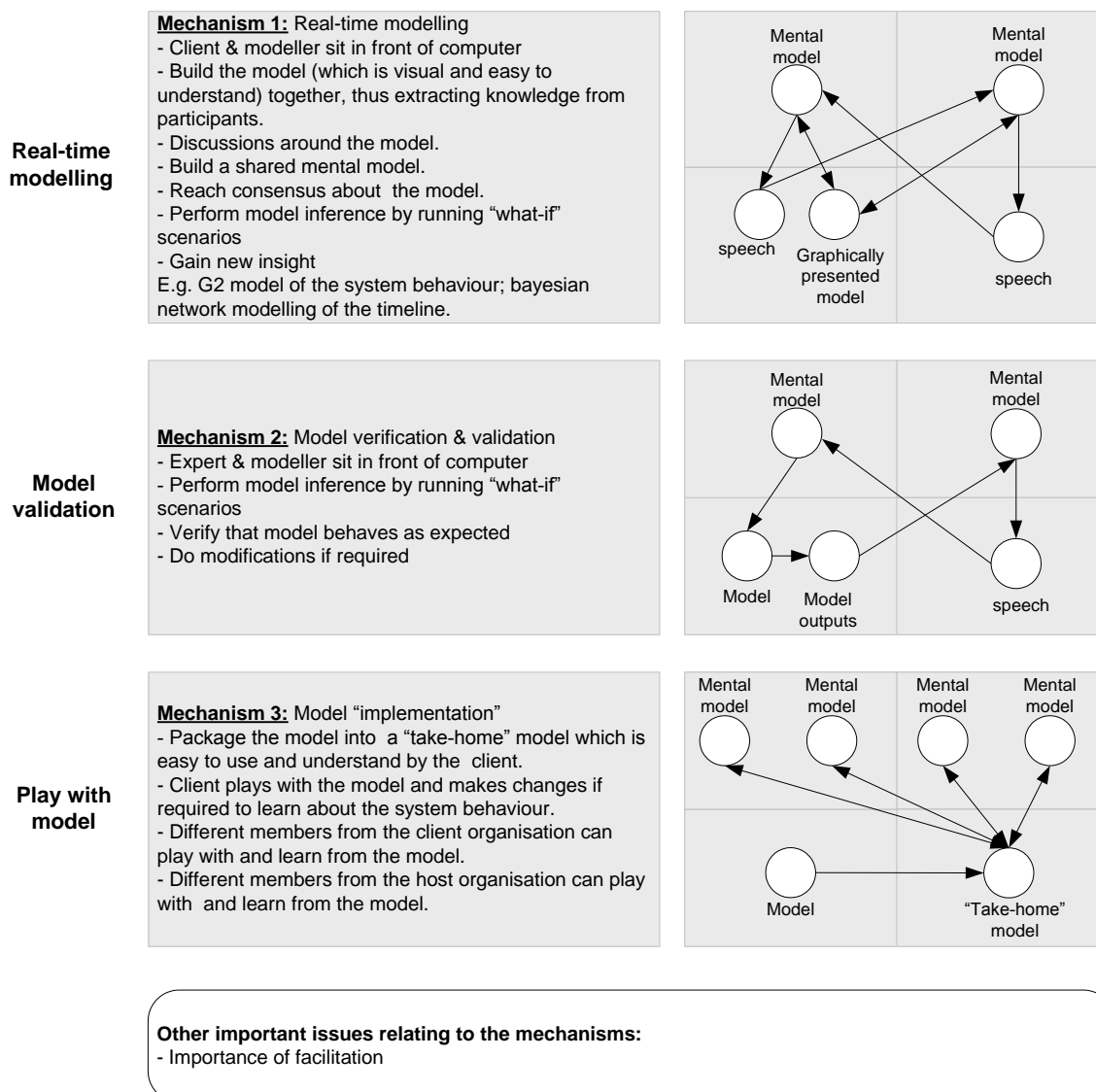


Figure 23: Mechanisms display for respondent 8

Name of respondent: Rene Oosthuizen

Role: Specialist consultant and systems engineer

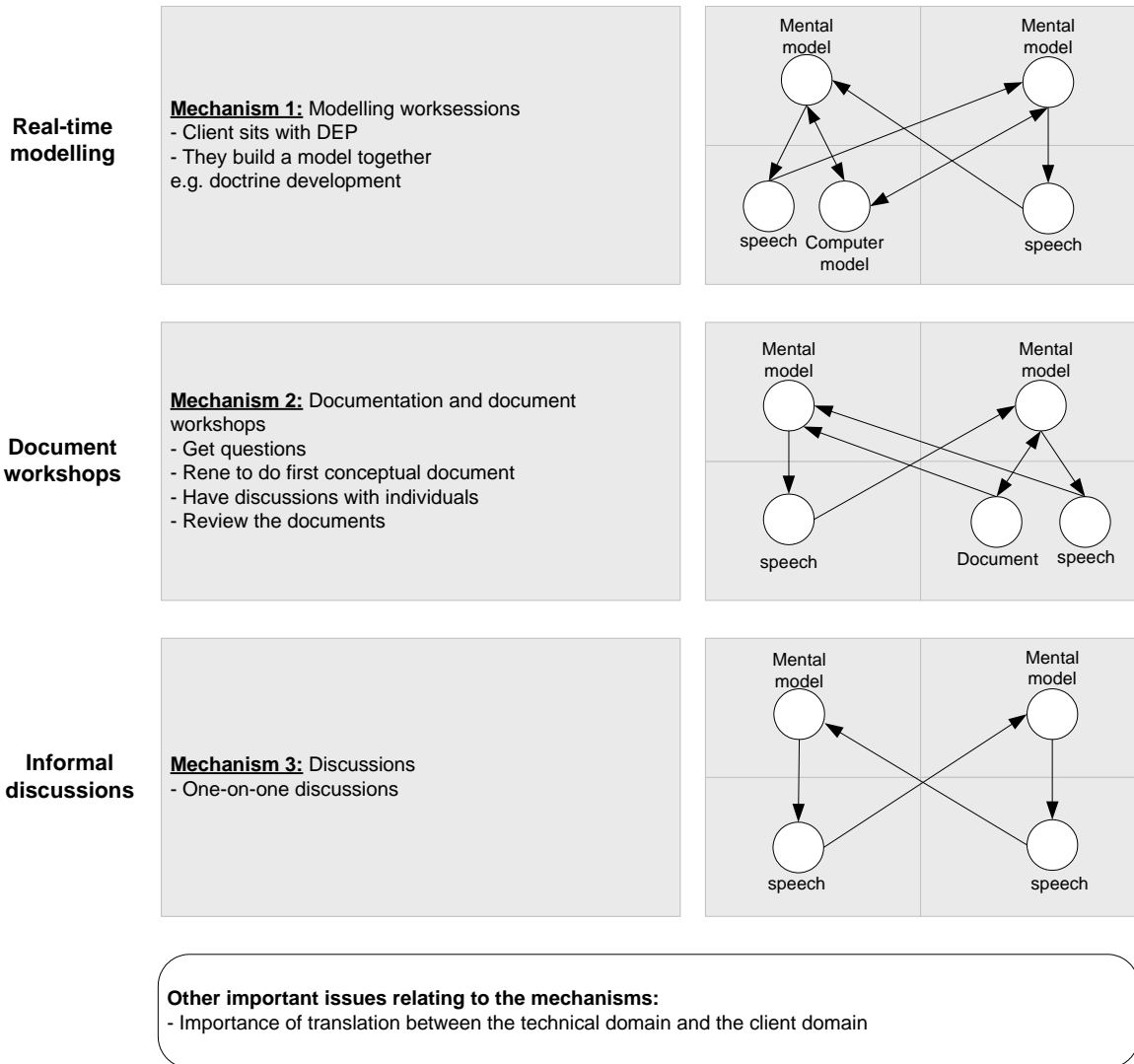


Figure 24: Mechanisms display for respondent 9

Name of respondent: Johan Swart

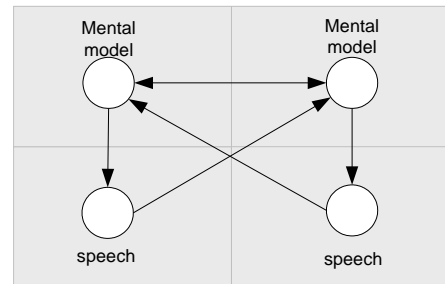
Role: Senior programme manager, Armscor

Informal discussions

Mechanism: Make people from both organizations part of one team

- Co-locate people
- Create the right environment
- People get to know each other
- Frequent contact with discussions
- Create good relations
- Expert opinions about issues

e.g. make DEP part of the acquisition team



Other important issues relating to the mechanisms:

- Importance of frequent contact between team members across organisations

Figure 25: Mechanisms display for respondent 10

Name of respondent: Hanlo Pretorius

Role: programme manager, Armscor

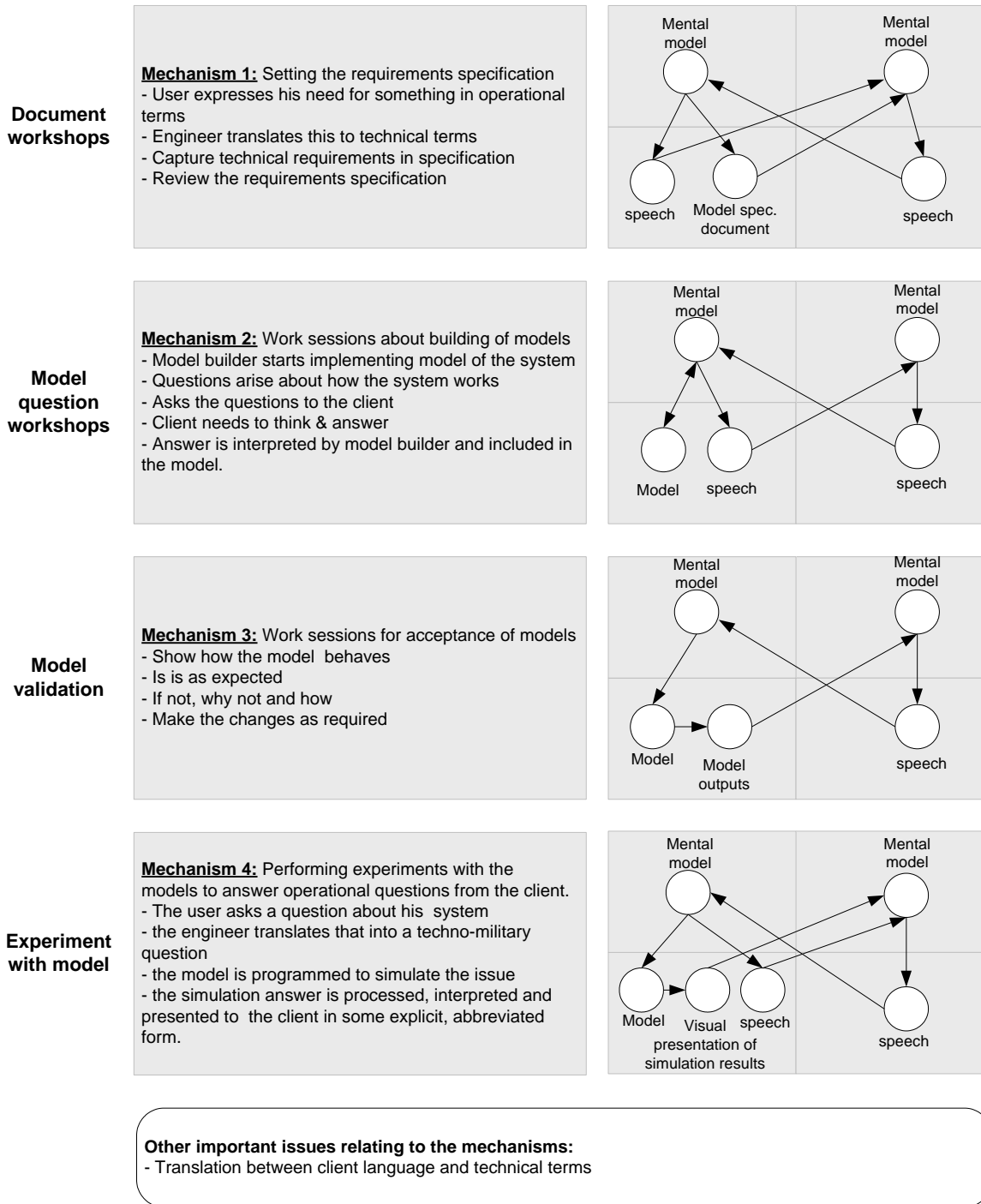


Figure 26: Mechanisms display for respondent 11

Name of respondent: Col. Jacques Baird

Role: GBADS project officer, SANDF

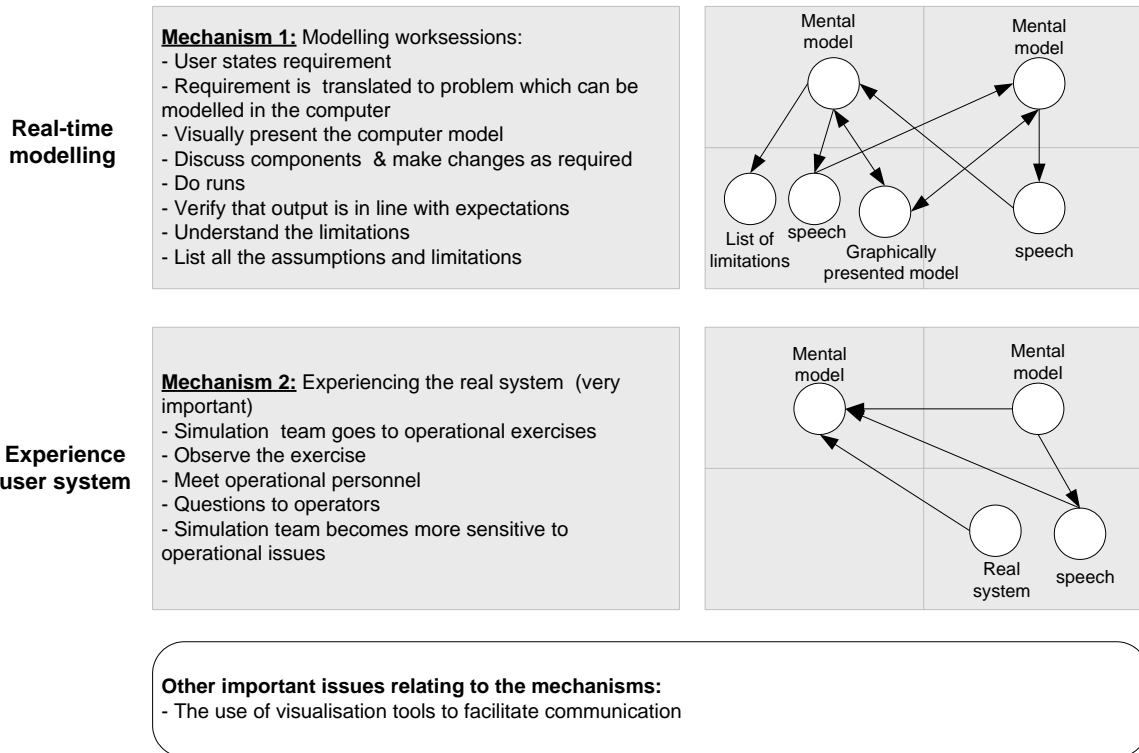
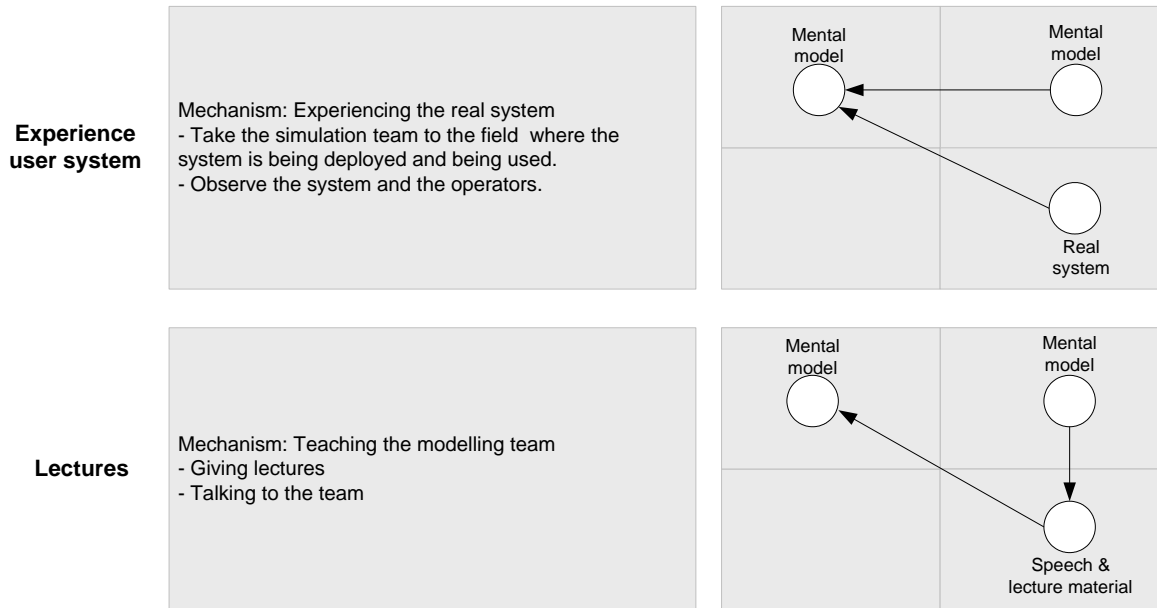


Figure 27: Mechanisms display for respondent 12

Name of respondent: Col. Barney Louw

Role: GBADS project officer, SANDF



6 INTERPRETATION OF RESULTS

This section gives an interpretation of the results which are presented in section 5. It is divided into two main sections, corresponding to the two sub-problems.

6.1 Value created by the project

In this section, the results from section 5.2 are interpreted, which relate to sub-problem 1: “What forms of value are created by technology organisations for their clients through knowledge transfer?”

6.1.1 The two components of value

Seven of the 12 respondents described the value as having two distinct components:

- The first component was described as “informal”, “not contracted”, “spin-off” or “tacit” value. This component was strongly associated with the knowledge that was gained by the people who were involved in the project and is not captured in hard deliverables.
- The second component was described as “official”, “formal”, “contracted” or “explicit” value. This component was associated with explicit forms of knowledge and contracted deliverables such as documents and models.

The other respondents also identified and described similar tacit and explicit components of value but did not specifically state that there were two distinct, main components.

6.1.2 The tacit knowledge component of value

The most important value component of the project was the knowledge to be gained by the people from the client organisation (SANDF) who were involved in the project. This knowledge contains some of the following elements:

- System knowledge (how it works):
 - Knowledge of the system design and functions (e.g. architecture & system components).
 - Knowledge of the system processes (e.g. doctrine, command and control).

- Knowledge of the system elements which have a key influence on the overall system performance (e.g. timeline, classification and identification).
- Knowledge of the system limitations (e.g. where it fails).
- Knowledge of how to upgrade the system in future.
- Application knowledge (where it works):
 - Operational scenarios (e.g. modern threats and threat profiles).
 - Knowledge of how to apply the system in an operational scenario (e.g. own risk minimisation).
 - Knowledge of how to adapt the system and its processes for a given operational scenario.

In summary, technology organisations create value for their clients by making them knowledgeable about the technology and how to apply it.

This finding matches well with the first proposition, namely that value is added by creating tacit knowledge in the client organisation the form of individual competence as described in the literature review (Sveiby, 1997; Sullivan, 1998; Saint-Onge, 1996; Hall, 1998; Stewart, 1997).

6.1.3 The explicit knowledge component of value

Another important outcome of the project was the explicit knowledge gained by the client organisation. This includes:

- Knowledge captured in equipment: The project enabled the SANDF to acquire a better GBADS system which would have a better architecture, performance and flexibility.
- Knowledge captured in processes: The project produced a better doctrine for the GBADS system even before taking ownership of the system.
- Knowledge captured in documents: Documents describe the system, the doctrine, system application, answers to system questions, etc.
- Knowledge captured in a modelling and simulation facility: Models are very efficient in capturing knowledge about the systems and processes. It is also very effective at capturing knowledge about dynamic behaviour and multi-variable dependencies, which are very difficult to capture in documentation.

- Knowledge captured in organisational structure: The work on the project produced a more effective command structure in the client organisation.

In summary, technology organisations create value for their clients by embedding knowledge in forms such as equipment, processes, documents, models, and organisational structures.

This finding matches well with the second proposition, namely that value is added by creating explicit knowledge in the client organisation in the form of structured capital as described in the literature review (Sveiby, 1997; Sullivan, 1998; Saint-Onge, 1996; Hall, 1998; Stewart, 1997).

6.1.4 Other components of value

Other components of value described by the respondents but which cannot be directly related to the propositions are:

- ***Auditable decisions to improve organisational image:*** Five respondents described this as one of the valuable outcomes of the project. The modelling and simulation gave the acquisition team the capability to simulate scenarios and play off different systems or system configurations against each other and choose the best one, based on an objective, scientific method. This would, if necessary, allow them to stand up in court and defend their decision with “scientific backing”. Objectively evaluating tenders and choosing solution providers on such big contract has been very difficult in the past.
- ***Improved sustainability of individual competence through intra-organisational knowledge transfer tools:*** Four respondents said that a valuable outcome of the project was the tools which facilitated the transfer of knowledge between SANDF members. For example, when Col. Louw left as project officer and Col. Baird took over from him, the modelling and simulation facility helped to transfer a large amount of knowledge from Col. Louw to Col. Baird within one to two weeks. Such tools provide better knowledge continuity and consistency within the client organisation.
- ***Validation of individual competence:*** Three correspondents described the validation of people’s knowledge as a valuable output of the project. A large part of the important knowledge of the operational SANDF people is based on

‘gut feel’ which comes from many years of operational experience. If simulation results are in line with this gut feel, a two-way validation occurs: the modellers have more confidence in their models and the SANDF operational staff have more confidence in their knowledge.

- ***Improved sustainability of individual competence through an inter-organisational network of knowledge:*** Two respondents said that a valuable outcome of the project was that the SANDF now had a wider network of people throughout different organisations (such as Armscor and DEP) who were knowledgeable about the GBADS system and air defence systems in general. This provides the SANDF with a more sustainable knowledge base.

6.1.5 Relative importance of tacit and explicit components

The respondents almost unanimously agreed that the tacit component of the created value was more important than the explicit output of the project. Specifically, the knowledge acquired by the SANDF staff was seen as the most important component. Perhaps an extreme point of view came from Jan Roodt:

“How do we duplicate what we have achieved here? I can guarantee you that none of those explicit things: that stack of paper or the bunch of executables which are stored in the database or any of those things, have any value at this stage... And that scares me. It is great for Armscor to say there is the stack of books and the code for which we paid X million rand. But that explicit part really means very, very, very little. So that leaves us with the tacit part...”

The reasons for this are not immediately apparent from the interviews. However, it is clearly the opinion of the respondents that knowledgeable SANDF staff are the key for creating value for the SANDF in the long term. The GBADS system is large and complex and its effectiveness depends on knowledgeable people to configure, operate, adapt, maintain and upgrade it. This results in higher system effectiveness (value) at a higher system efficiency (lower cost).

The role that people play in this process is more important than the explicit forms of knowledge such as manuals, models and processes, for the following reasons:

- Firstly, many elements of the system are flexible. Processes are not fixed, rules must be changed, the configuration of the system must be adapted to each unique deployment and the technology must be upgraded.

- Secondly, the system is very complex. The number of degrees of freedom makes it prohibitive to define explicitly all the variables and their relationships for any given deployment.

Therefore, the human in the system plays a critical role to cope with the complexities of the system and with the uncertainties of its application.

In summary, the value of tacit knowledge increases with system complexity and operational uncertainty.

6.1.6 The complex relationship of value elements: the value chain

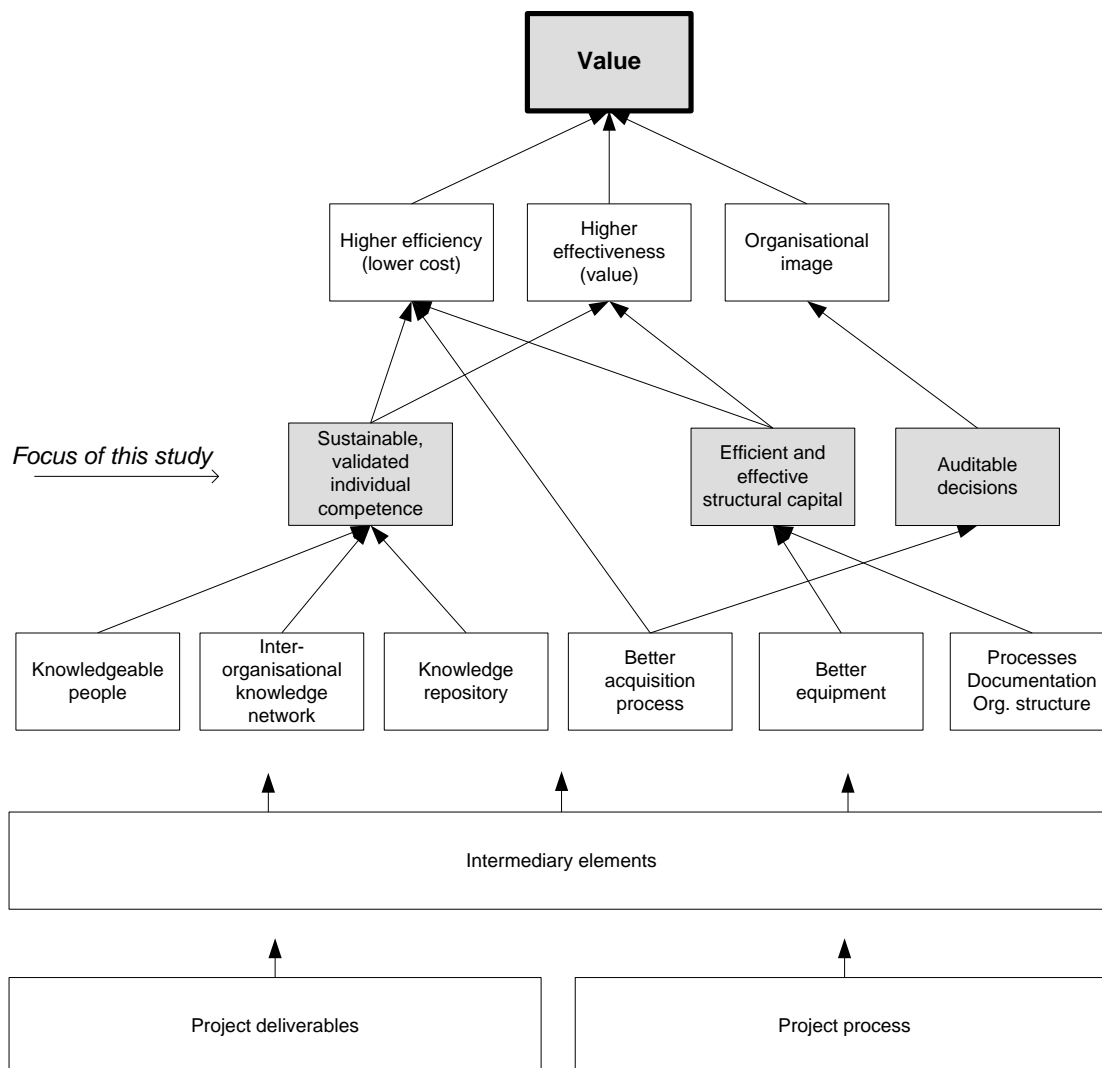
The presentation of the results makes it clear that value is not created directly but that it is created through a “chain” of causally linked value intermediaries. An example of such a value chain is shown in Figure 28.

Figure 28: Example of a value chain



The results show that these value chains can become quite complex. They are also described very differently by respondents. When describing the project deliverables, respondents often concentrated on the ‘upstream’ parts of the value chain. When prompted about the value to the client organisation, the response was often a description of the ‘downstream’ parts of the chain. A consolidated value chain was constructed by using the individual responses and finding commonalities and is shown in Figure 29.

Figure 29: Consolidated value chain for the GBADS project



The figure shows that it is important to understand the difference between project deliverables and client value. It is also important to understand the links leading from the project deliverables and activities to the client value.

6.1.7 Other complexities of dealing with tacit knowledge

Although respondents almost unanimously agreed that the tacit component was the more valuable output of the project, they also agreed that it was much more difficult to manage:

- The most valuable outcome of the project is not contracted. Existing contracting models only make provision for 'hard' deliverables such as documents, models, presentations and demonstrations. The current contracting models are not set up to measure real project success.

- Tacit knowledge is difficult to measure. Representatives from both CSIR (Jan Roodt) and the contracting agency (Hanlo Pretorius) mentioned that they were sometimes in a difficult position to justify the amount of money that was spent on the project, although they felt that good value for money was created. In one instance the project officer (Jacques Baird) had to motivate to his own high ranking officials why the project had delivered value. For such a project to work there needs to be a trusting relationship between the two organisations. Members of the client organisation need to be intimately involved in the project to absorb valuable knowledge and motivate the value to their own superiors. Also, the value is not immediately apparent and it often takes a long time to create.
- Tacit knowledge cannot be controlled, because people cannot be controlled. If a member of staff leaves the team or the organisation, the valuable tacit knowledge of that person is effectively deleted from the project team or organisation. Also, if people from the client domain are not intimately involved (e.g. project officer on the simulation team) limited value is delivered. This often puts the contracted organisation into a difficult position, because it has limited control over its client personnel.
- It is difficult to duplicate tacit knowledge. The process of transferring knowledge between people is time-consuming, complex and success is difficult to measure.

6.1.8 Summary: Results relating to sub-problem 1

- The results confirm the propositions that the created value consists of two components: tacit knowledge in the form of individual competence and explicit knowledge in the form of structured capital.
- The results provide a qualitative priority to these two components, based on the type of project.
- The results identify additional components of value which do not relate directly to the propositions.
- The results identify additional complexities relating to the creation of value through knowledge transfer.

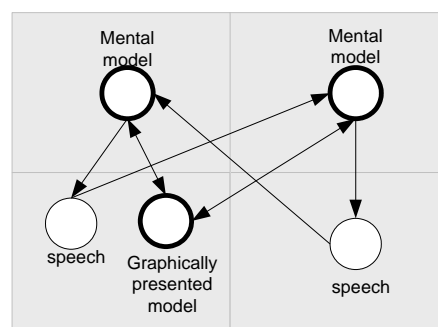
6.2 Mechanisms used to create the value

In this section, the results presented in section 5.3 are interpreted, which relate to sub-problem 2: “What mechanisms are used to create value through knowledge transfer?”

6.2.1 Generic mechanisms

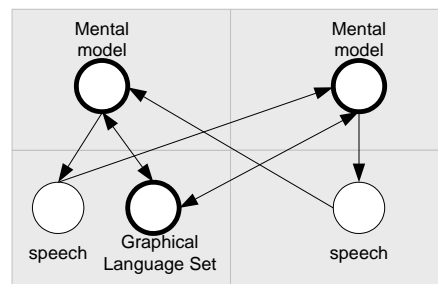
The processing and display of data revealed ten common mechanisms for knowledge transfer among all the respondents’ descriptions. These mechanisms can be used by organisations to understand their knowledge transfer processes better and manage them more efficiently. Each mechanism is briefly described and the corresponding display is included. The knowledge component on which the mechanism is primarily focussed is highlighted in bold (bold bubbles in the diagrams).

1) **Real-time modelling workshops:** Eight respondents described this mechanism and in this case it seems to be the most useful mechanism. The aim of the workshop is to **create new tacit knowledge in the form of shared mental models and new explicit knowledge in the form of an executable model.** Selected representatives from both organisations build a model together during a facilitated workshop. The representatives are chosen for their knowledge required to develop an accurate model. Representatives may also be chosen for their need to learn, in which case they will play a more passive role and ask questions. The aim of the first phase of the workshop is to externalise the mental models of the experts into a graphical model. The model is presented in some graphical format which is easy to understand by all parties. The graphical model is developed through discussions and reaching consensus about the components of the model and relationships between the components. Assumptions and limitations of the model are noted and often written down for later reference. Once consensus has been reached regarding a model, the workshop moves into its second phase. In this phase inference is done by executing the model and displaying the outputs. The model is executed by asking ‘what-if’ questions. These questions often lead to new configurations and reveal the behaviour of the modelled system. If this behaviour is in line with expectations of experts, the validity of the model is confirmed. If the behaviour is contrary to expectations, the reasons for this unexpected behaviour are investigated and discussed. The discussions may either reveal that the model was



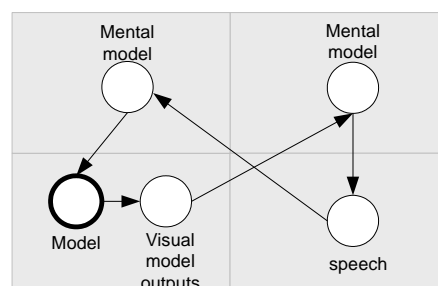
inaccurate and must be adapted, or it may reveal that the gut feel of the expert was inaccurate. These conflicts between model behaviour and expert opinion often present an opportunity for discovering new knowledge about the system being modelled. The workshop makes extensive use of internalisation and externalisation through speech and the graphical model.

2) Graphical workshops: Two respondents described this mechanism. The aim of the workshop is to **create new tacit knowledge in the form of shared mental models and new explicit knowledge in the form of a non-executable model**. It is similar to the real-time modelling



workshop but it never moves into the second (inference) phase. Another difference is the graphical representation of the explicit knowledge. Whereas the real-time modelling workshops typically make use of standardised visualisation tools such as Bayesian networks, the graphical workshops can become very effective if the graphical representation is customised for the specific purpose. This graphical representation can become even more powerful if it is jointly developed by the two organisations, in which case it serves as a common language. Respondents described this common language as a “graphical language set”. This graphical language set can serve as a translator between the two organisations. Respondents mentioned that this language became a very efficient communication tool but that it was difficult to understand for outsiders who had not been involved in developing it. An example is the Petri-net tools which were used to describe the system doctrine. This tool was jointly developed and helped to translate the operational terms into technical terms which could be simulated or implemented in the system. Externalisation and internalisation are the dominant modes of knowledge transfer.

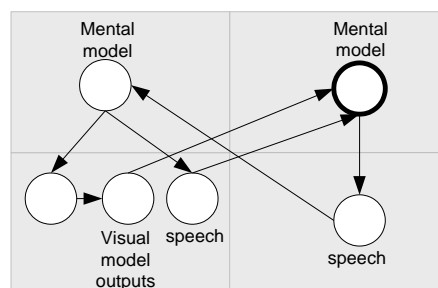
3) Model validation: Three respondents described this mechanism. The aim of this activity is to **validate explicit knowledge residing in an existing executable model**. It can be seen as a subset of real-time modelling but respondents described it as a mechanism which can be used on



its own. In this case, the focus is on validating the model, rather than building a new model. The difference between this mechanism and the previous two is also that the

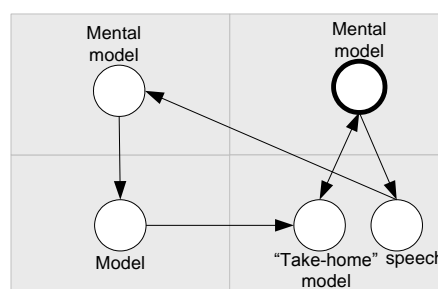
expert does not have access to the model itself, but can only view the outputs (results) of the model. The process starts with an existing model, which the modeller would like to validate against expert opinion. The modeller executes certain scenarios on the model and displays the results visually to the expert. The expert gives verbal feedback. If the behaviour of the model is in line with expectations of the expert, the validity of the model is confirmed. This activity relies on efficient externalisation and internalisation.

4) Experiment with model: Three respondents described this mechanism. The aim of this activity is to **create new tacit knowledge for the client using existing explicit knowledge in the form of executable models and using existing tacit knowledge from the service provider.** It may also



be seen as a subset of the real-time modelling workshop. However, it concentrates on using the model to answer questions rather than building a new model together. The model is used as a tool for scientific enquiry. The cycle is started by the client asking a question or stating a problem and hypotheses which need to be verified. The modeller translates this problem into a model which can verify the accuracy of the hypotheses. When the model is complete, it is run and the results serve as a stimulus for further discussion. The cycle may be repeated. This activity relies on efficient externalisation and internalisation.

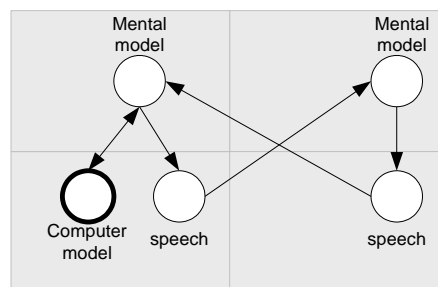
5) Play with the model: Four respondents described this mechanism. The aim of this activity is to **create new tacit knowledge for the client using existing explicit knowledge in the form of executable models.** This activity makes use of existing models to improve the client's



understanding of a system or phenomenon. An existing, validated model is packaged into a user-friendly format so that the client can easily modify model parameters and visualise the resulting outputs. The client then plays with the model, learning how it behaves and getting a good 'gut feel' of the system or phenomenon being modelled. This mechanism can be a very useful training method. This activity is mainly an internalisation exercise. However, if the person who plays with the model is an

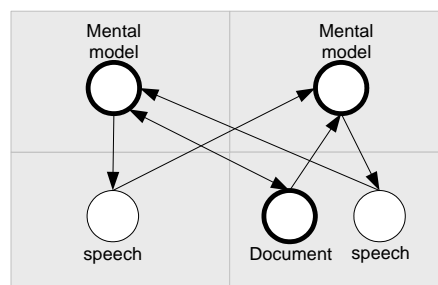
expert, he/she can give feedback to the modeller which can be used to improve the model.

6) Model question workshops: Two respondents described this mechanism. The aim of this activity is to **create new explicit knowledge in the form of an executable model using existing tacit knowledge from the client.** The mechanism



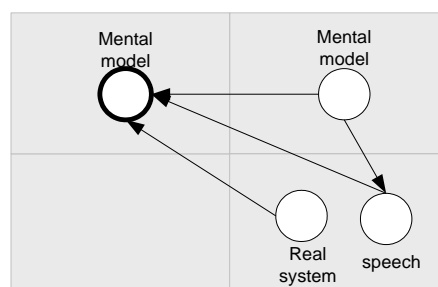
makes use of verbal interaction between the modeller and subject matter expert or client to improve the quality of a model. The modeller puts questions to the client or expert about something that he/she must implement in the model. In cases where this is the client, it has the additional benefit that it makes him/her think about the problem, thus testing his/her mental model. The modeller interprets the answer and updates the model with the new knowledge. This activity requires efficient externalisation and internalisation through speech.

7) Document workshops: Six respondents described this mechanism. The aim of the workshop is to **create new tacit knowledge in the form of shared mental models and new explicit knowledge in the form of documentation.** Key



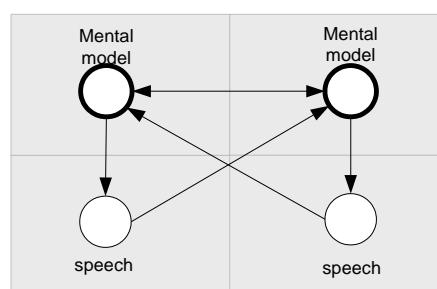
concepts regarding some important topic are captured in documents. The process is more effective if the different parties are responsible to compile different sections of the document. In the workshop, this document is then discussed paragraph by paragraph. Disagreements about sections in the document point to different mental models and create an opportunity to learn. Discussions serve to clarify disagreements. Externalisation and internalisation play an important role in this activity. Combination is sometimes used if documents are combined.

8) Experience the real system: Four respondents described this mechanism. The aim of the exercise is to **create new tacit knowledge for the service provider using tacit knowledge from the client and explicit knowledge embedded in client organisation systems.** Representatives from the

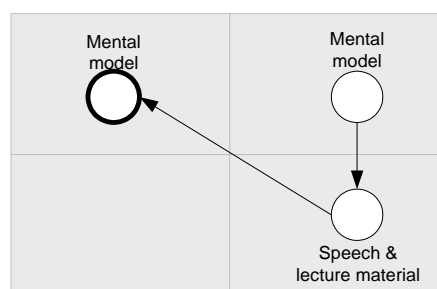


service provider organisation go to an operational deployment of the client organisation, experiencing the system or phenomenon under investigation. In this case, representatives from CSIR went to a field exercise of the SANDF where an air defence system was being deployed and used. Respondents described this as an extremely valuable experience which took only a very small amount of time and effort. Observing the client environment in operation, using the system, meeting and talking to operational people allowed the participants to gain a better understanding of the issues. The exercise also made communication between the two parties more efficient in the long term. Internalisation and socialisation play an important role in this activity.

9) Informal discussions: Three respondents described this activity. The aim of the workshop is to **create new tacit knowledge by sharing mental models**. Although seemingly very simple, this was seen as a very important mechanism for two of the respondents. This mechanism requires the co-location of people across organisations in an informal setting. Over time and with frequent discussions and good relations, knowledge is transferred from person to person. Mental models become more aligned and the communication becomes more efficient. Socialisation as well as verbal externalisation and internalisation play an important role in this activity.



10) Lectures: Two respondents described lectures as a mechanism for knowledge transfer, although not as important as some of the others. The aim of the workshop is to **create new tacit knowledge by communicating mental models**. This mechanism simply makes use of verbal and visual aids to transfer knowledge from one party to another, using externalisation and internalisation modes.



6.2.2 Comparison of results to propositions

The result displays and the descriptions of the generic mechanisms confirm that the mechanisms of knowledge transfer make use of the four proposed modes, namely combination, externalisation, internalisation and socialisation.

A number of additional aspects regarding the use of these four modes were highlighted in this research:

- Knowledge transfer makes use of an **integrated combination** of the four proposed modes of knowledge transfer. Respondents did not describe the modes of internalisation, externalisation, combination or socialisation in isolation but described a process which always includes a number of these modes. For example, the documentation workshops use externalisation to speech and documents as well as internalisation from the speech and from documents interactively.
- Mechanisms for knowledge transfer involve an **interactive, bi-directional** flow of knowledge between members of the two organisations. The transfer of knowledge is not only to the client organisation but always includes knowledge transfer from the client organisation. This usually happens interactively.
- All mechanisms involve **both explicit and tacit forms** of knowledge. Explicit forms of knowledge are often used as a tool to transfer knowledge and to store knowledge. Tacit knowledge is used to provide context and validity.
- **Externalisation and internalisation** are the two dominant modes of knowledge transfer. Almost all mechanisms use both internalisation and externalisation, because explicit forms are often used to transfer knowledge.
- **Socialisation** is less common but is still seen as a very important activity by some respondents. Socialisation facilitates alignment of mental models and improves communication efficiency.
- **Combination** is uncommon and was not regarded as an important mode by respondents.

6.2.3 Other findings regarding the transfer of knowledge

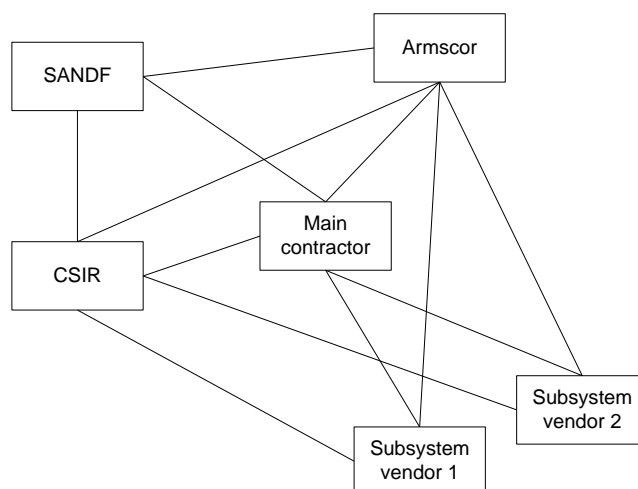
The results also revealed some issues that are important for knowledge transfer but which cannot be directly related to the propositions:

- **Language:** A majority of respondents stressed the importance of creating a common language between the two organisations. Knowledge can only be shared effectively if both organisations use this common language to

communicate. In one instance members from the two organisations specifically developed a language to communicate issues about the doctrine, which they called the “graphical language set”. Such a language is especially important if the frame of reference of the two organisations is far removed from each other, such as in this case where the SANDF has an operational military frame of reference and CSIR has a technical and research frame of reference. A good language increases the efficiency, or the ‘bandwidth’ of inter-organisational communication.

- **Facilitation tools** such as models can play an extremely important role in transferring knowledge between organisations. Six of the ten mechanisms described by respondents made use of these advanced facilitation tools. Traditional methods such as documents, presentations and speech are often not good enough.
- **Facilitation process:** A number of respondents mentioned the importance of having a good facilitation process. A good process magnifies the efficiency of the facilitation tools.
- **Relationships:** Good organisational relationships, good personal relationships and trust were also mentioned as being important enablers of knowledge transfer.
- **Knowledge supply chain:** A number of respondents referred to the complex inter-organisational network of knowledge that had to be managed during this project. A picture from one of the respondents is shown in Figure 30, showing this ‘knowledge supply chain’ for the GBADS project. The blocks show the organisations involved and the links indicate the need for knowledge transfer between organisations. It is important for the organiser of a project like this to understand the complete knowledge supply chain, the needs and knowledge contribution of each organisation.

Figure 30: Knowledge supply chain for the GBADS project



6.2.4 **Summary: results relating to sub-problem 2**

- The results confirm the importance of the proposed modes of knowledge transfer, namely externalisation, internalisation, socialisation and combination.
- The results provide a qualitative prioritisation of these modes.
- The results illustrate how these modes are integrated to form practical mechanisms for knowledge transfer and provide a description of ten such mechanisms.
- The results highlight some important enablers of knowledge transfer.

7 CONCLUSIONS AND RECOMMENDATIONS

In this section, conclusions are presented by reviewing the research objectives and summarising the related findings. Recommendations are made to the organisation where the case study was conducted, followed by suggested topics for further research.

7.1 Review of research objectives and summary findings

7.1.1 Objective 1: Creating a consolidated model from literature

The first research objective was to create a consolidated model from literature of how client value is created by technology organisations through knowledge transfer. More specifically, the objective was to find a model which describes the forms of value and mechanisms for knowledge transfer.

This was successfully accomplished through a literature review. The model demonstrates that two forms of value are created: improved client skills in the form of individual competence (tacit knowledge) and improved client tools and processes in the form of structural capital (explicit knowledge). Mechanisms for knowledge transfer make use of a combination of socialisation, internalisation, externalisation and combination.

7.1.2 Objective 2: Confirm the value creation model through a case study

The second objective was to confirm whether or not the value creation model from the literature is valid for technology organisations.

This was successfully completed through a case study in a typical technology organisation. Findings confirm the validity of the model for technology organisations and reveal additional important considerations:

- The first form of value created by technology organisations for their clients is knowledge embedded in tools, processes and other forms of structural capital. The second form of value is the increased competence of individual people in the client organisation who are involved in the project. Combined, these two forms of knowledge enable the client organisation to operate more efficiently and effectively.

- The importance of the individual competence component (in the form of tacit knowledge) increases with system complexity and operational uncertainty.
- Other forms of value include an improved sustainability of individual competence, validation of individual competence and auditability of decision making.
- Value is created through a complex relationship of value intermediaries leading from direct, contracted deliverables to the end value of improved client organisation efficiency and effectiveness. It is important for organisations to understand this 'causal value chain'.
- Some difficulties of dealing with tacit knowledge transfer projects were identified. Existing contracting models are not effective in measuring and managing knowledge transfer. Tacit knowledge is also difficult to measure, control and duplicate because it is embedded in people.

7.1.3 Objective 3: Confirm the mechanisms model through a case study

The third objective was to confirm whether or not the mechanism model from the literature is valid for technology organisations and to find practical examples.

This was successfully completed through a case study in a typical technology organisation. Findings confirm the validity of the model for technology organisations and reveal other important considerations:

- Ten generic mechanisms for knowledge transfer have been identified, all using an integrated blend of externalisation, internalisation, socialisation and combination.
- All mechanisms make use of an interactive, bi-directional knowledge flow between the organisations.
- All mechanisms make use of both explicit and tacit forms of knowledge.
- Externalisation and internalisation are the dominant modes used to transfer knowledge.
- Other factors which are important enablers for knowledge transfer include the creation of a common language, good facilitation tools, a good facilitation

process, good relationships and an understanding of the knowledge supply chain.

These results should not be seen as exhaustive. For example, the ten identified mechanisms of knowledge transfer may be expanded by performing more case studies.

7.2 Recommendations

Recommendations to CSIR:

- Project teams should be made aware of the two components of knowledge and how they create value for the client organisation.
- Before commencing on a project such as GBADS, the CSIR team should reach consensus about the causal value delivery chain, leading from immediate project deliverables to end client value. Team members currently have either a very limited understanding of the complete value chain or widely differing views on the causal relationships.
- Future projects should make use of an integrated combination of the ten mechanisms of knowledge transfer and optimise them through the use of a common language, good facilitation tools, a good facilitation process, good relationships and an understanding of the knowledge supply chain.
- CSIR should find a more effective contracting model for projects like GBADS. The current contracts do not measure or manage the most valuable outcome of the project. This makes it difficult to demonstrate value and to manage risks.

7.3 Suggestions for further research

The topic of value created through inter-organisational knowledge transfer is still very young and many areas were only touched upon in this study. Some useful topics for further research are suggested:

- Existing contracting models are not effective in measuring and managing knowledge transfer. More suitable contracting models could be investigated.

- In this study, ten integrated mechanisms of knowledge transfer were identified. The description of these mechanisms in terms of knowledge components and the associated dynamics can be very useful for organisations. However, this list is not exhaustive. A more exhaustive list of such mechanisms could be identified through multiple case studies across different types of organisations.
- The relative effectiveness of the ten identified mechanisms could also be investigated.
- Cross-organisational 'language', inter-organisational culture and other critical factors which influence the 'bandwidth' of communication between organisations could be usefully analysed in greater depth.

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Appendix A: Case Study Protocol and Interview Framework

A.1 Field Procedures

3 weeks before interview	First contact	Phone call to introduce; preferably by referral Make appointment
1 week ahead	Background information	Reminder about interview Relevant background info
During interview	Introduction	Personal introduction & building rapport Reason for the study Relevance to the CSIR Sharing of results Recording of interview
	Interview	Begin with open-ended, overall questions about the project or division. Ask questions in such a way as not to influence the respondent. Be open to unexpected responses and avoid being trapped by preconceived ideas. Listen carefully by also capturing things like mood and affective components.
	Exit	Thank for participation
	Feedback	Results of study

A.2 Interview Questions

The interview questions should be structured enough to provide consistency and to focus the response on the research questions at hand. They should also be open-ended enough to avoid guiding the interviewer towards specific anticipated answers. The interviewer should start with the open-ended questions given below and refer to the probing questions only if the response of the interviewee is not focused on answering the research questions. Other clarification questions and appropriate probing questions can be employed for each interview on the fly but caution should be taken not to guide the answers of the interviewee.

Questions relating to sub-problem 1:		
<p>What forms of value are created by technology organisations for their clients through knowledge transfer?</p> <p>Propositions:</p> <ol style="list-style-type: none"> 1. Technology organisations add value to their clients by enhancing the client's skills through the transfer of knowledge. 2. Technology organisations add value to their clients by enhancing the client's tools and processes through the transfer of knowledge. 		
Open-ended questions	Probing questions (if more probing is required)	Sources of evidence & notes for the interviewer
<p>1) What was the value that the client received from this project?</p>	<p>In comparing the client organisation before and after the project, what did the client organisation get which it did not have before?</p> <p>What were the project deliverables?</p> <p>Were there other things which the client organisation gained as a result of the project?</p> <p>Of the project outputs just mentioned were some more valuable than others?</p> <p>In comparing the client organisation before and after the project, how did the project "improve" the client organisation?</p> <p>Is the client organisation able to operate more effectively and efficiently in some ways, now that the project has been completed?</p>	<p>The aim of this question is to find the form of the knowledge-intensive offering. This form consists of two components (Sveiby, 1997):</p> <p><u>Possible intangible project outputs:</u> relates to the "Human capital" of the client organisation building the competence of individuals in the client organisation (skills, knowledge, etc.) through teaching, training, etc.</p> <p><u>Possible tangible project outputs:</u> relates to the "Structural capital" of client organisation's</p> <ul style="list-style-type: none"> • processes (routines, procedures, structures, responsibilities, accountabilities, etc.) • tools (models, computer programs, physical equipment, prototypes, etc.) • intellectual assets (documents, concepts, templates, designs, etc.). <p>In combination, these two components work together to improve the "capability" (Prahalad, 1990) of the client.</p> <p>It is important to get to the bottom of what the value of the knowledge-intensive offering is.</p> <p>The aim of this question is also to create a mechanism for prioritisation. It may be possible that some of the project deliverables were not valuable at all, while others had major unexpected benefits.</p> <p>According to Dawson (2000), the key value lies in the increased capability (Prahalad, 1990) of the client organisation, i.e. its ability to act more efficiently & effectively. This usually requires a combination of tacit and explicit knowledge components.</p>

Questions relating to sub-problem 2:

What mechanisms are used to create these forms of value through knowledge transfer?

Propositions:

7. Value is added by enhancing the client's technology skills through the transfer of tacit knowledge by means of a process of socialisation
8. Value is added by enhancing the client's technology skills through the transfer of explicit knowledge by means of a process of internalisation.
9. Value is added by enhancing the client's technological processes and technology-based tools through a transfer of tacit knowledge by means of a process of externalisation.
10. Value is added by enhancing the client's technological processes and technology-based tools through the transfer of explicit knowledge by means of a process of combination.

<i>Open-ended questions</i>	<i>Probing questions</i> (if more probing is required)	<i>Sources of evidence & notes for the interviewer</i>
<p>2) What mechanisms or processes were used to create this value?</p>	<p>How were the tangible deliverables mentioned earlier established in the client organisation? How were the intangible deliverables mentioned earlier established in the client organisation? What mechanisms were used to transfer knowledge between the organisations? What would you do differently to improve the creation of value? What activities were performed to improve the technology processes and tools of the client? What activities were performed to improve the technological skills in the client organisation?</p>	<p>The aim of these questions is to discover the process by which the knowledge transfer were delivered to the client.</p> <p>According to Nonaka (1994), the process can consist of one or more of the following types of activities:</p> <ol style="list-style-type: none"> 1) Socialisation: In this activity, the personnel from the one organisation interact directly with personnel from the other organisation, not directly through language or other explicit forms of knowledge but through activities such as observation, imitation and joint exercises. 2) Internalisation: In this activity the employees from one organisation would use some explicit form of knowledge from the other organisation (systems, processes, tools, models, drawings, etc.) to increase their tacit knowledge by getting a better "feel" for a particular problem or domain of knowledge. 3) Combination: In this activity the employees from the two organisations would bring together their explicit forms of knowledge (systems, processes, tools, models, drawings, etc.) and have discussions around these, finding differences, similarities, structures, etc. and upgrading the explicit knowledge in the process. 4) Externalisation: Is the process of "extracting" knowledge from experts in an organisation and capturing it in some explicit form (systems, processes, tools, models, drawings, etc.)

<p>3) Which of these activities were the most valuable?</p>	<p>Which activities took a small effort but seemed to make a big contribution to the success of the project?</p> <p>Which activities took a lot of effort but did not really make a difference to the client?</p>	<p>These questions are put to establish prioritisation for the types of activities. The purpose is to discover which are the more efficient and effective mechanisms for creating value through knowledge transfer.</p>
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