Key Drivers Affecting Project Management within the Minerals Industry

A Research Report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfillment of the requirements for the degree of Master of Business Administration

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Abstract

The purpose of this study was to investigate project management success in the minerals industry. This was conducted through an analysis of project management in the De Beers Consolidated Mines operations via an interviewing technique and reviewing of company reports.

A definition of project success was suggested that consists of not only time, cost and quality but a number of other parameters. The relative importance of these parameters should be weighted according to individual project and company goals that are dependent on business factors prevailing at the time.

The key management areas needed to ensure project success were identified and it was found that generally these are lacking in their proper application. The failure to acknowledge project management as a distinct discipline has reduced the probability of project success. The findings indicated that improved planning combined with the use of a systems engineering approach would increase the chances of project success. It was also found that a sound project governance policy is needed which must be enforced and supported by executive management. In line with the governance policies, a company's corporate and management structure must be aligned with project management needs in order to ensure that maximum performance results from project teams.

Declaration

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

Shane Michael Hunter

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Glossary

AAC	Anglo American Corporation
COTS	Commercial, off the shelf
Cpht	carats per hundred tons
HR	Human resources
ISO	International Organisation for Standards
JSE	Johannesburg Securities Exchange
MTBF	Mean Time Between Failure
MTTR	Mean Time to Repair
NOC	Non owner companies
NPV	Net Present Value
PAB	Project Alliance Board
PERT	Program evaluation and review technique
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
QSM	Quarterly strategic meetings
RAM	Responsibility assignment matrix
ROC	Required Operational Capability
ROI	Return on investment
TPM	Total Project Management
TQM	Total Quality Management
URS	User Requirement Statement
WBS	Work breakdown structure

1 INTRODUCTION

1.1 Purpose of the study

The purpose of this research report is to investigate the level of competency of project management within the minerals industry. It appears that unsuccessfully completed projects are not uncommon. A number of self acknowledged project failures in the De Beers group (De Beers Consolidated Mines, 2002) provoked an initial concern. Other project difficulties in the minerals industry are reported. Oakely (2003) refers to low stock market prices of mining companies resulting from project failures. S. Diachenko (personal communication, 10 September 2004) mentions a major underground copper project where planned production rates failed to materialise a number of years after construction completion. Willis & Buyens (2003) suggested that not having clear objectives, no user buy-in and a lack of accountability were responsible for failed projects on South African gold mines. Macfarlane (2001) when discussing new mining technology projects mentions that amongst a number of successes there have been some disappointing failures. It appears that De Beers are not alone in finding themselves in a position of poor project delivery.

Firstly the definition of what is a failed or successful project needs to be understood. Secondly it should be asked, are the definitions of failure or success actually needed? The key drivers and influencing factors affecting project performance were investigated and the degree of their successful use ascertained.

Project management within the De Beers group of operations was analysed to gather insights on the state of project management in the minerals industry. As South Africa is dominated by the large mining houses it is likely that the findings from a study into the De Beers group could be representative of the industry at large.

It is intended to explore the De Beer's culture and management style to ascertain whether or not internal policies and procedures may be assisting or hindering sound project management principles being used. This research is intended to arrive at management solutions to identified problem areas and proposals for future projects. This should assist in improving project management performance within the De Beers group and other enterprises in the minerals industry.

1.2 Background to the problem

The discipline of project management is divided into nine knowledge areas by the Project Management Institute (2000). The Association of Project Managers (2000) subdivides project management into 42 knowledge areas. In either instance the whole business spectrum is covered under the heading of project management. Burke (2003) adds that the resources needed to accomplish all the business related project tasks are normally restricted. He further mentions the importance of the project team in achieving project success. Pelligrinelli (1997) then adds that external stakeholders must be managed in projects. These stakeholders can be bankers, environmental groups, contractors or end users. All these descriptions point to the difficulties that could be expected along the path to project completion.

For the purposes of this research the De Beers organisation is considered to be representative of the minerals industry in South Africa. De Beers is a diamond exploration, mining and marketing company with over a century of operating experience in South Africa. The company has exploration activities on all continents and has embarked on the opening up of new mines in Canada. The company has a number of diamond mining operations in Southern Africa. These operations include open pit mining, alluvial mining, underground mining and marine mining. Organic growth as opposed to acquisitions has been the back bone of De Beers continued success in this part of the African continent. This situation drives the business strategy to be one of company exploration and subsequent green-field projects to initiate mining operations. All of De Beers mining activities have at some stage been through a project type environment that brought them into a state of mining production. In addition to projects that are created to initiate mining activities, the majority of these mining operations undergo upgrade and expansion projects at some stage of their working lives. What results is an organisation that relies on projects to sustain the continuing growth and sustainability of the operational division of the company.

In addition to mining related projects De Beers also has projects of a more general business nature. These include for example information technology (IT) and human resource (HR) initiatives. Together with the mining projects, this creates a company that has projects underway on an almost constant basis. This creates a need for

professional project management skills from project management staff on a permanent basis.

It has been accepted by De Beers that improvement is needed in project management performance due to a number of self acknowledged project failures. This has been openly stated on the company intranet site (De Beers Consolidated Mines, 2000). This shows firstly a maturity in acknowledging failure and secondly is the first step needed in moving towards improving project management processes. De Beers has embarked upon a programme of Total Project Management (TPM) which has the strategic intent of delivering world class standards in project process, quality and performance (De Beers Consolidated Mines, 2000). Learnings gathered from this programme and from the findings of the research as a whole will therefore likely benefit the minerals industry.

1.2.1 An understanding of projects within the context of De Beers

For this study, projects of the more general business nature such as IT or HR for example were not considered as projects of this nature are not part of the core business of diamond production in the Southern African operations. Projects relating to the core business of diamond recovery were the focus of the study. However this does not preclude IT and HR issues, (say) from being included in the study where these disciplines form part of a greater mining project.

In the context of mining projects, geological exploration takes place prior to the construction of a mining operation. This exploration may have taken place by De Beers geologists or by those of another company, whereby De Beers would have purchased the mining rights from the other company. For the purpose of this report the project stage will initiate from when the decision is made to begin investigations on a possible mining or mineral processing operation.

The projects that are described in this report are capital intensive in nature. Minerals related projects such as those studied here often have lead times in the order of years. This creates projects occasionally requiring billions of Rands. Hundreds of millions of Rands are needed for the majority of the rest. The projects that will be investigated

here are very complex in that many engineering disciplines are needed along with accompanying logistical, legal, purchasing and financial support.

One distinguishing factor regarding projects in the De Beers context is the breaking away from Anglo American Corporation (AAC) in 1998 (P. Armstrong, personal communication 9 June 2004). Prior to this date De Beers was a division of AAC and projects were handled from the AAC Project Office. This Project Office had vast resources under the AAC group and this expertise was used across all divisions of AAC including De Beers. The consequences of this split were a loss of skilled and experienced people and knowledge (P. Armstrong, personal communication 9 June 2004).

Post 1998 De Beers built up its own project division as a totally internal department. Consequently a new project culture has begun and the initiation of the TPM methodology is setting the scene for a greater awareness of project management within the organisation. TPM has been developed from the Project Management Body of Knowledge (PMBOK®) and the ISO 10006 guidelines for Quality in Project Management. PMBOK® is published by the Project Management Institute (PMI) and is recognized as one of the leading texts on project management practice (J. Priest, personal communication 20 February 2004). The management of the TPM methodology and it's processes is now under the guidance of a Projects Office at a corporate level. This is attempting to strengthen the commitment to project management principles throughout the group. However it is worth noting that TPM is a relatively new concept in project management for the company and it been suggested that currently TPM methodologies are not fully dispersed throughout the group (K. Botha, personal communication December 11 2003)

1.2.2 An understanding of project success or failure within the context of the minerals industry

To say that a project has failed sounds somewhat harsh. At first glance one would imagine that the desired result was not achieved at all if the term failure is used. Here there is a need to introduce the measures of project success. Completed projects are measured by their cost, their time to completion and their quality and their acceptance by the customer, all measured against a plan (Kerzner,2001). It could be suggested

that because a project came in two months late and R500,000 over budget, that it was a failure, would be extreme when considered in the context of large minerals related projects. These projects are likely to run for a number of years and at a cost of a few hundred million Rand. So these variances as an example could be in all likelihood be tolerable to some degree when considering the dynamic business environment that prevails.

The success of a project is ultimately measured by the satisfaction of the client (Kerzner, 2001; Nicholas 2001). In this case the client is the board of directors of the particular company who represent the shareholders. The De Beers board measures a project via the Net Present Value (NPV) of the cash flows as stated in the final feasibility study (D. Porter, personal communication 20 August 2003). However the NPV can only be measured once the entire life of the operation has run its course. In response to this, a decrease in NPV will be felt immediately from commissioning if there are cost over-runs, a delay in operational start up or a decrease in throughput due to a lower quality than specified (Porter, personal communication 20 August 2003). Therefore any deficiency in either cost, quality or time will show a lower revised NPV than originally planned.

The NPV that is generated by the project is therefore the major measure adopted by the directors and the shareholders of De Beers (D. Porter, personal communication 20 August 2003). From the viewpoint of the project team, technical managers and operational managers, time, cost and quality will be the measures. Therefore we have two measures of project success, the financial value and technical attributes. It is possible therefore that a project could deliver a higher than expected NPV due to a higher then planned grade or diamond value. Then in the eyes of directors and shareholders the project could be a success. This is irrespective of the technical outcome of the project. It could so have happened, that quality, time or cost was deficient yet the previously mentioned increased grade or value pulled the project back above the planned NPV. That is, a certain amount of luck was involved. If the project NPV is lower than planned then this must be due to one of the parameters of time, cost or quality being deficient (in the case of diamond grade or value being lower than planned then the *quality* of the mineral resource estimate is lower than planned).

In the context of this report the aim is to examine the technical competence of the De Beers project management environment. Therefore the measures that will be studied here will be time, cost and quality along with other measures that the research uncovered. De Beers at this stage do not have a clear definition of a technically failed or successful project. Currently it appears that consensus amongst senior management is what defines a failed project (T. Stewart, personal communication, 15 August 2003). Therefore a clear definition will not be proposed at this stage of the study.

1.3 The Research problem

This research study investigates key factors that affect minerals industry project management performance and identifies possible barriers to implementing successful project management practices.

The sub problems:

1. To determine a clear definition of a failed or successful project
2. To identify the key drivers that affect project performance and the success in using these key drivers
3. To identify possible barriers that obstruct sound project management principles being used

1.4 The Research questions

The research problem for this study is based around questions. That is propositions will *not* be used. Rowley (2002) describes an outline of research centered on propositions. She states that when using propositions the researcher makes some speculation on what the expected findings of the research will be. This speculation is based on literature reviews and any earlier work done. The research will then be carried out in order to either support or refute the propositions. In this research study, the literature points out that there are many aspects of project management that can possibly affect performance. Although project performance is measured according to time, quality and cost, the context within which each of these parameters are found will dictate what is success or failure. The question must then be asked, what *are* these factors affecting

performance within the found context? This guides the research problem being stated in the form of questions. That is, the true project drivers for De Beers will only become known once the research is completed. Therefore the sub problems of the research were addressed by research questions;

1. What is the definition of a failed or successful project?
2. What are the key drivers affecting projects and how well are they adhered to?
3. Are there potential barriers to implementing sound project management principles?

1.5 Limitations and de-limitations

Only projects managed by De Beers operations in South Africa, Botswana and Namibia will be considered in this research report. Due to the split from AAC in 1998, only projects from this date onwards will be examined. This is so that the findings that will develop from this study will then be more valid for the De Beers moving into the future. Projects that overlapped this period will be included in this study. Projects of a more general business nature such as IT or HR for example will not be examined. The reasoning behind this is that core minerals projects are the most critical to De Beers. It is often the case that these more general projects are outsourced regarding project's management and are not handled by De Beers staff.

1.6 The importance of the study

As was described earlier, projects in the minerals industry have not enjoyed a great deal of success. South Africa is still heavily reliant on the minerals industry. In 2002 the minerals industry added 7.5 percent to the gross value added to the South African Economy. An estimated additional 10.3% was added through associated multiplier effects (Department of Minerals and Energy Affairs, 2002). Since South Africa has a top five world ranking for reserves in seventeen minerals found in this country (Department of Minerals and Energy Affairs, 2002), the minerals industry will continue to add value

to the economy. Therefore any study that can possibly enhance project management of new mining operations will be of benefit to the minerals industry and the country in general.

Over the last decade it has become apparent that the majority of projects in De Beers have been running through to completion either over cost, over budget or delivering below expected performance (De Beers Consolidated Mines 2002). This has lead to a realization by De Beers that there is a problem in this area of the company. This need is openly acknowledged by De Beers (2002) as stated on their intranet site

> *"With the high growth of voted capital planned and the failure of many projects to meet requirements, a need to develop a total project management system to improve the way we manage our projects was needed."*

The fact that these "failures" are being acknowledged is a sign of business maturity. This sets the scene for a determined effort to improve project performance within the organisation.

Included in current projects, the Cullinan Diamond Mine near Pretoria is currently in progress with a feasibility study for a potential R7 billion mining operation. In the coming years, three of De Beers major mining operations are planned to begin underground mining (from current open pit methods). These three mines, Venetia, Orapa and Jwaneng will all require capital estimates in the order of billions of Rands (K. Botha personal communication 4 March 2004). The majority of the other De Beers operations all have expansion projects currently underway. Therefore the path is clearly set that highlights the importance of projects to De Beers and the cost to the company if projects are failing to meet desired performance.

Although project management is primarily about projects, any results from this study could have an influence on normal day to day management of operations within the minerals industry. This is as Nicholas (2001) describes project management as a common approach for every day business. He uses the term, managing by projects, to describe the management of any discrete piece of work.

Project management in general is applicable across all industries that engage in projects and findings from this study may add to the body of knowledge in this field.

2 LITERATURE REVIEW

2.1 The structure of the literature review

The aim of the literature review is to examine in a logical way the theory and current published thinking that impacts upon project management. This led the research to where investigation was needed in order to provide answers to the research problems.

A review of theory in general was briefly undertaken in order to understand why a theory (of a topic) is needed and what are its benefits. The discipline of project management was examined. This is in order to understand the unique attributes of project management relative to day to day business. This discipline of Project management was then broken down into discrete areas of business and theoretical processes. This helped develop the key areas of project management that provided additional understanding of where the critical issues for this research lay. This breakdown also provided a method of how to investigate De Beers management of each of the critical areas of project management.

The Guide to the Project Management Body of Knowledge (PMBOK®) authored by the PMI (2000) lists nine knowledge areas of projects that must be managed. These are as follows;

1. Integration management
2. Scope management
3. Time management
4. Cost management
5. Quality management
6. Human Resources management
7. Communications management
8. Risk management
9. Procurement management

PMBOK® (2000) is generally accepted as one of the leading texts on project management principles. The area of cost management was excluded from the study as

it was found that this area of project management did not surface from the findings as being a critical issue. The remaining eight areas were reviewed in the literature.

According to Kerzner (2001), project management is an outright growth of systems management and thinking. This leads to an examination of systems theory. Systems theory provides an insight into the interaction between the wide range of disciplines that are found in a complex project management environment (Kerzner, 2001; Nicholas, 2001). Project management as such encompasses management of many disciplines and functions so general management theory is applicable. The above nine areas as highlighted from PMBOK® (2000) also need an over-arching management process that manages this collection of discrete areas into the total project environment. To summarise, the areas from literature to be examined will be theory itself, systems theory, the discipline of project management, eight management areas from PMBOK® (2000) and general management.

2.2 The need for a theory

Why do we need a theory and what can be expected from it? Koskela (2002) proposes the following functions that can be derived from a theory:

1. a theory provides an explanation of observed behaviour. This provides a prediction of future behaviour
2. a theory when shared, can be used as a common language or framework to enable collaboration in collective undertakings
3. a theory can be seen as a condensed piece of knowledge. It empowers novices to do things that formerly only experts could do. This is instrumental in teaching.
4. when explicit, testing the validity of a theory in practices leads to learning.

From the above points it can be seen that a body of knowledge such as PMBOK® (2000) greatly assists in providing direction and promoting learning in the project management field. The fact that a theory has been built around project management should promote the use of sound project management principles in any organisation.

The use of a theory further provides measures that can be used to gauge the relative success of management of projects. Without measures the performance of any work becomes hap-hazarded and subjective.

Stretton (1993) adds that having a body of knowledge can eliminate the need to re-invent the wheel. When an organisation such as De Beers has a continual life in projects, knowledge and experience should be carried forward for new practitioners to pick up with relative ease. This agrees with the point from Koskela (2002) in which novices gain knowledge from a current theory.

It is also maintained by Stretton (1993) that a body of knowledge provides direct referencing for practitioners. This statement reinforces the benefit that a theory provides guidance to the industry.

2.3 Project management as a discipline

At this stage of the research report it must be attempted to make clear the definition of a project and project management. Kerzner (2001) describes projects as having the following attributes:

1. having a specific objective to be completed within certain specifications
2. having definite start and end dates
3. having funding limits
4. consumes human and non human resources
5. they are multi functional

Turner (1992) supports the above definition with the addition of proposing that projects bring about beneficial change. This implies that things will be done somewhat differently after the implementation of a project. PMBOK® (2000) adds to the above description regarding the definite end date of projects. It maintains that projects often have intended or unintended consequences that far outlast the life of the project. These consequences usually have social, environmental and economical impacts. This point is noteworthy when considering projects within the minerals industry. Most minerals or

mining related projects produce operations that are long lasting, have effects on local communities and can be environmentally sensitive.

A description of project *management* is also needed. Kerzner (2001) maintains that project management involves project planning and project monitoring. This means that under planning, the work to be done, the quality and quantity of the work and the resources to be used must all be defined. Under monitoring, the progress of the work must be tracked, variances measured to analyse the impact and adjustments made where necessary. These descriptions imply that a number of activities must be managed. This supports a feature of project management proposed by Avots (1969) where he suggests that project management demands more management attention than normal functional areas.

Nicholas (2001) provides a number of characteristics of a project that lay the foundation for further study. Below are the seven attributes he describes.

1. Projects have a defined end purpose or result
2. Projects are unique, they are usually never repeated
3. Projects are temporary activities
4. Projects cut across organisational lines, many professions and organisations are used
5. Projects involve unfamiliarity, i.e. uncertainty and risk
6. The organisation involved usually has something at stake, failure could jeopardize the orgainisation's future
7. A project is a process that has many distinct phases

The points regarding uncertainty and risk, and the distinct phases of a project add to the attributes listed by Kerzner (2001).

PMBOK® (2000) provides another attribute of projects that is not mentioned by the other authors. That is a feature of progressive elaboration. By this it describes that the details of the project are worked out with care and detail in a steady incremental fashion. This PMBOK® (2000) attributes to the unique nature of projects. One can consider this statement and its implications. What PMBOK® (2000) is proposing is that

the full description of the project's characteristics are not known at the outset of project initiation. These characteristics will in fact only come to light as time and work effort progresses. The term of progressive elaboration does imply agreement with the characteristics of risk and uncertainty as proposed by Nicholas (2001). It is implied that work is needed to gather information that will eliminate uncertainty for future phases of the project. This view also agrees with the concept of different project phases or the project lifecycle as work progresses as also suggested by Nicholas (2001). Further, risk and uncertainty are probably two of the most unwanted characteristics for any organisation. Consideration of this project elaboration is thus needed when carrying out projects.

To summarise these characteristics of projects, Nicholas (2001:7) provides a rather daunting description of projects.

> *"Managers are faced with the problem of putting together and directing large temporary organisations while being subjected to constrained resources, limited time schedules and environmental uncertainty".*

These characteristics support the need for a theory to provide guidance and general management techniques that appear to be essential to complete projects successfully.

2.3.1 The project life cycle

PMBOK® (2000) expands upon a project characteristic already mentioned by Nicholas (2001) that is unique to projects. That is the distinct phases of a project or the project life cycle. The concept of project elaboration introduced the reader to this concept earlier. PMBOK® (2000) suggests that a project is divided up into phases in order to better manage the risks inherent in projects. There will be definite deliverables at the end of each phase. Examples of deliverables would be a feasibility study, detailed engineering drawings or a working prototype. These phases with their respective deliverables allow project performance to be measured, potential errors to be corrected and to determine if a project should proceed to the next phase (PMBOK®, 2000). This implies that breaking a project up into phases enables the project to be more easily managed. Steyn, Basson, Carruthers, du Plessis, Prozesky-Kuschke, Kruger, van Eck, & Visser, (2003) agree on the use of the project life cycle. They suggest that information

gathered in phase one should be used to reduce the risks of the second phase and so on. However PMBOK® (2000) then goes on to say that subsequent phases may begin without approval or closure from a previous phase if the risk is acceptable. This practice is known as fast tracking. Baker (2002) calls this technique concurrency and suggests that it is a necessary tactic in a competitive environment. He counters this suggestion in the same article however with the phrase "concurrency kills" (Baker, 2002:56). Therefore one could conclude that concurrency should be used with caution, as also indicated by PMBOK® (2000) when it mentions that the risk of fast tracking must be acceptable to the project. In Baker's (2002) article about a failed U.S. Air Force Training Jet project, he asks the question why was concurrency needed in this particular project? (he cites concurrency as one of the reasons for the failure of this project). He suggests that in this particular example it was not needed as there was no war time emergency, or internal crisis. Again this statement implies that concurrency should be avoided. Burke (2003) also mentions that the pitfalls of concurrency in project management were already noticed as early as 1965. Here he cites an example of the TSR-2, swing wing bomber (another air force example, coincidently). In this example production of the bomber was started before the design was completed and approved. The project was eventually scrapped due to increases in the scope of work and cost over-runs. Steyn *et al* (2003) also warn of the dangers of fast tracking, saying that it can accelerate a project but that it is risky and must be carefully managed. The general view appears to be that fast tracking is risky and that the distinct phases in the project lifecycle should be maintained.

Steyn *et al* (2003) provide a slightly different view on the term concurrency as they describe it as involving multiple disciplines concurrently. As an example consider an engineering team designing a product from where the production team will normally take over for manufacturing. Under this view of concurrency, the production team will be involved in the design stage along with the design engineering team. This according to Steyn *et al* (2003) improves the quality of the work, improves communication flow and reduces barriers within the organisation.

Mihm, Loch & Huchzermer (2003) maintain that the current paradigm in projects *is* concurrency and that design is inherently iterative. Mihm *et al* (2003) however do not provide a clear definition of their understanding of concurrency. However the author

suggests that concurrency cannot be automatically assumed solely due to an iterative design process. It could be that many iterations of a design could take place before final approval leading to the next phase. It could then be suggested that concurrency and an iterative process are not one in the same. If a project team accepts that design is inherently iterative then they would expect modifications after proceeding to another stage. No surprises would then arise when a design was changed. This view is not aligned with the earlier authors as they suggest that concurrency means moving on earlier to a following stage without a desire or possibility of moving back to the preceding phase.

Jaafari (2000) proposes a different view on the project life cycle and also promotes the use of concurrency. He proposes that facility (or product) delivery has been the main focus of project management. He then maintains that this project management model has limited focus on the business objectives or relevant market dynamics. Among the functions of Jaafari's (2000) proposed model is the aim to deliver the project in a single phase, promoting integration and concurrency. This view counters that of the previous authors who advocate the use of multiple phases of a project. The other key function of Jaafari's (2000) model is installing the project's core business objectives as the basis for decision making throughout its life. At this stage one would want to speculate that the term "project's core business objectives" actually means the objectives of the ongoing operation or company subsequent to the delivery of the product. This assumption would then give more weight to Jaafari's (2000) statement. He names his model, "Life Cycle Project Management", (Jaafari, 2000: 45). He later expands his description of business objectives to include financial objectives and customer satisfaction. Customer satisfaction within the context of the minerals industry would mean considering customers as being the managers, stakeholders and operators of the project's operational product. In discussing the profits expected by the organisation are recommendations made by Steyn *et al* (2003). They describe the project life cycle and the product life cycle. The longer the project life cycle takes before the product is delivered, then the longer is the period before the organisation earns revenues. The longer that future revenue is delayed the more riskier these returns become (Steyn *et al,* 2003). This suggests that the project life cycle must be made as short as possible. They add that perhaps additional funds and resources could be added to the project life

cycle to possibly speed up the delivery of the product. This would be a business decision based on the value of the planned future earnings versus the additional costs needed to reduce the time needed to start earning these revenues.

Although different industries may have different project life cycle phases an organisation should develop a standardized set of phases for projects within that organisation (Steyn *et al*, 2003). This will then enhance the ability to generate policies, procedures and check lists of deliverables for these projects. They also suggest that this structure provides guidance to new comers to the organisation or to project teams within the organisation. It also provides common terminology and adds to the project culture within the organisation. Separating each phase are milestones, which is a point where the project team looks back at the work done and looks forward to the next phase (Steyn *et al*, 2003; Kerzner, 2001). In addition, the external stakeholders study the work achieved, the progress made and the technical results. Depending on the results it could be decided that certain work must be re-done. It could be possible that projects are terminated at a particular milestone. Stakeholders also review the work for the next stage at the particular milestone. This means that sufficient plans and recommendations must be available so that this next phase can be authorized to proceed.(Steyn *et al*, 2003). The same authors also recommend that all the key stakeholders be present at suitable milestone meetings to formally accept the closure of that phase and agree to proceed to the next phase. Key milestones in projects within De Beers would be signing off of a mineral resource statement for a mining project or defining the metallurgical characteristics of an ore type for a recovery plant design. These milestones are critical as changes to these inputs for the following phases will mean major changes and re-work during those subsequent phases. This is an area where concurrency is definitely risky.

2.4 The theory of systems

General systems theory can be classified as a management approach to integrate and unify scientific information across many fields of knowledge (Kerzner, 2001). This theory aims to solve problems by looking at the total picture rather than the individual components. Systems theory then tries to create a management technique that cuts

across all disciplines within an organisation. This definition is supported and expanded by Nicholas (2001) as he describes the systems approach to management. He states that organisations exist in a universe of forces and are comprised of interrelated units in a changing environment. The goals and effects of these units must be coordinated and organized for the benefit of the organisation. In this definition, the system of the organisation is acted upon by its external environment. This is a critical point as in today's ever changing business and political environment, projects will have these factors to consider. This is especially so in South Africa with the dynamic political and transformational issues that currently abound. Nicholas (2001) further describes systems thinking as being the opposite of analytical thinking. Here he describes analytical thinking as where components are progressively broken down into smaller parts. Blanchard and Fabrychy (1990) however implicitly mention that analytical thinking is *part* of systems engineering. They outline that systems are composed of three elements:

1. components - the operating parts of the system consisting of inputs, processes and outputs
2. attributes - the properties of the components of the system
3. relationships - the links between components and attributes

Any system would begin with the components and this is where analytical thinking would be needed as one must have an understanding of each component in order to build the system. From the above description one can see that traditional engineering disciplines would be comfortable with components and the attributes of those components. The relationships between these different components and attributes seems to be the defining crux of the systems approach. This is where strictly defined engineering functional areas would need to expand their thinking to include their relationships with other disciplines and areas within their business environment and external environment.

Blanchard and Fabrychy (1990) then discuss the purpose or objective of a system. They say that the purpose or objective must be explicitly defined and understood and therefore be measurable. They add however that establishing a purpose and defining a measure of effectiveness is often a most challenging task. In the context of the

minerals industry, projects are about delivering a product that is usually an operational entity. Therefore one could imagine measures being tons per hour or carats per ton at a certain cost per ton. At first glance this would not appear to be difficult. Based on the comment regarding this being a challenging task this research will attempt to identify where and how any purpose for a project was described and how it was planned to be measured. This is important with regard to the first sub-problem of the research which is "to determine a clear definition of a failed or successful project". In order to define a project as a success or failure means that a measurable characteristic must have been stated at the inception of the project. This in turn means that the purpose or objective of the project must also have been defined. In a similar vein Nicholas (2001) states that the first step in defining a system is stating the user requirements. These requirements describe what the user wants and needs from the final product or solution. Nicholas (2001) highlights the importance of accurately outlining the user requirements as they impact on the scope of work, time, cost and risk of a project. For this reason the user requirements must be formally agreed and documented. Nicholas (2001) again warns that the setting of user requirements is not always easy. Often ambiguities exist between what the user actually wanted and what is finally delivered. Both Nicholas (2001) and Rust (2003) make use of examples of vague terminology that leave potential for misinterpretation. Terms such as "must be user friendly" and "being easily maintainable" can mean different things to different people. Terms such as these must not be used and should be replaced with clearly defined requirements. For example the term easily maintainable could be replaced with "the component must be designed so that all repairs can be carried out within a half hour time period" (Rust 2003). This would imply that the design of the component would be such that if a faulty part was identified as needing longer than half an hour to repair then that part must be replaced with a new part. That is a modular design is needed. Thus the user requirements will dictate to a large degree the design fundamentals of system components.

Prioritisation of requirements is also needed according to Nicholas (2001). There may be requirements set by the different users and stakeholders that are conflicting. Therefore the requirement having the most impact on the final product must take precedence. In a similar vein Nicholas (2001) also mentions that requirements can also have margins or tolerances. That is, by how much a specified requirement can deviate

from the desired value and still meet the customer's needs. This is an important point relating to general engineering orientated projects. From the authors experience measures or target are most often expressed as a specific number without any envelope to work within. Such a tight definition leaves less room for success.

Blanchard and Fabrychy (1990) further define a system by considering the limits or boundaries to the system. Everything outside the boundaries of the system is considered to be the *environment*. Here they agree with Nicholas (2001) as they state that no system is completely isolated from its environment. These two authors are more specific however as they describe that materials, energy and information must pass through the boundaries as inputs to the system. They then say that constraints are often placed on systems by the external environment and that in fact the boundaries of the system may be set by this environment. Sandrock (1996:38) agrees with these authors regarding the external environment acting on a system but he adds two questions. He asks, (referring to the external environment), "can I do anything about it?" and "does it matter relative to my objectives?" Sandrock (1996) then maintains that if the answer to the first question is no and the second is yes, then the "it" is part of the environment. This passage agrees with the theories of the previous authors and it now becomes clearly apparent that this external environment is fixed and the developers of the system of interest cannot alter this environment. Thinking more deeply however, one would imagine that steps *could* be taken to alter many external environments. Perhaps a degree of lateral thinking is needed to modify these environmental issues favourably towards a project that at first glance may appear to be rigid and unyielding.

Blanchard and Fabrychy (1990:13) now provide a summary description of systems thinking:

> *"Engineering in the systems age must be a team activity where various individuals involved are cognizant of the important relationships between specialities and between economic factors, ecological factors, political factors, and societal factors. Engineering decisions of today require consideration of these factors at an early stage of system design and development. Conversely these factors usually impose constraints on the design process."*

Blanchard and Fabrychy (1990) also refer to the system life cycle as part of systems thinking in somewhat more detail than that described earlier by PMBOK® (2000) and Jaafari (2000), when referring to projects. They describe life cycle activities of large scale systems as beginning with identifying a need, then research, design, construction, evaluation, consumer use, maintenance and support and ultimate retirement. Although not being as explicit as Jaafari (2000), where he described the financial objectives of projects as being important, Blanchard and Fabrychy (1990) do maintain that competitiveness in the market place is needed. They further maintain that this potential competitiveness has been neglected in the past. This is because engineers have focused on competitiveness only once a system has already been brought into being. It is suggested that engineers be sensitive to operational outcomes during the early stages of systems development and assume responsibility for life cycle engineering.

Blanchard and Fabrychy (1990) name two distinct phases of systems that can be related to projects, that is the acquisition phase and the utilisation phase. This appears to be a critical point for this research as minerals related projects are largely dependent on ongoing maintenance, support and consumer (the operators) use, for long term success. It is possible that adequate design of these utilisation functions during the acquisition phase may be lacking according to Blanchard and Fabrychy (1990). They go further when they explain that users of purchased manufactured products, must also be wary of how well these manufacturing companies deal with the design of their products during the acquisition phase. Blanchard and Fabrychy (1990) suggest that when these manufacturers are not the final consumer, it is less likely that long term operational issues would have been addressed during design and development of the product. This is definitely relevant to this research as minerals industry projects purchase a large number of capital and operating items from the market place. Therefore it is possible that a number of these items may be lacking in the life cycle approach advocated by Blanchard and Fabrychy (1990).

Mihm, Lock & Huchzermeier (2003) although not explicitly mentioning systems, discuss how in projects, individuals components may be designed separately but will influence one another. This agrees with systems thinking but here more emphasis is placed on interdependencies within the internal project environment. They then maintain that these interdependencies can make design of individual components unstable. To

elaborate, they suggest that products are designed by separate teams that make autonomous decisions on individual components that have an overall impact on the system's performance. They indicate that research has shown that within complex projects this phenomena leads to cost and schedule over-runs and missed specifications. This point highlights potential danger areas in projects when teams are working on separate components that will ultimately form a larger system or product. This potential scenario is likely to appear in most large minerals industry projects due to the many interfaces and engineering disciplines that exist in the final product.

These views on systems thinking leads into the theory of project management and how it may be applied due to the multi functional nature of projects.

2.5 Integration management

According to PMBOK® (2000) the focus of this area is planning and change control. There will be a plan that is developed to manage the project feasibility phase and a plan to manage the execution or construction phase. Throughout the project, changes of many types will be expected across all areas of the project (PMBOK®, 2000). These changes must be managed and documented. Planning and change control are thus management areas that encompasses all areas of the project lifecycle.

2.5.1 Project planning

Globerson & Zwikwael (2002) discuss project planning within the context of PMBOK®. They maintain that all nine of the project management knowledge areas involve planning. Their study on 282 project participants investigated the quality of planning that went into each of the nine knowledge areas. Their findings will be discussed under the respective knowledge area headings.

Research was carried out by Yates & Eskander, (2002) into planning issues in the construction industry. Construction is an integral part of most minerals related projects so is relevant here. They have defined the major categories of delays to project development or planning. Their three major delays categories are:

1. Constant changes in project requirements

2. Developing multiple projects at the same time causing delays to projects that are less important when other projects take precedence
3. Lack of communication between various divisions of the project

Construction projects are also similar to minerals industry projects due to the long time frame needed in the development stage. The longer it takes to develop (plan) the project the more costly it becomes (Yates & Eskander, 2002). They maintain that unplanned delays increase the project development phase. It is also asserted by Yates & Eskander, (2002) that this cost of delay is difficult to calculate. It could be proposed that most project staff would not *want* to calculate this cost. The cost of the project team clearly increases as the development phase continues and there is the time value of money lost as project start up is delayed. The fact that these costs are normally not measured means that they are unlikely to be managed. Yates & Eskander, (2002) conclude that there is no standardized procedure for project development, which explains these cost over-runs. This statement must be viewed with caution as PMBOK® (2000) outlines a number of processes that are used to develop the project plan. One of the major planning processes is the work breakdown structure (WBS). The WBS allows the project team to capture and decompose all of the work of the project. All of this defined work must be planned, estimated, scheduled and authorised. It would be expected then that during this stage contingency can be allowed for, and potential delays built into the schedule. If this planning phase is done correctly then deviations from the plan should be greatly reduced. PMBOK® (2000) also mentions four other inputs into the project development phase, these are;

1. historical information – estimating databases, past records and previous project performance
2. organisational policies – quality management guidelines, financial controls, personnel administration
3. constraints – applicable restrictions that will effect project performance
4. assumptions – factors considered to be applicable to the planning process

It could be concluded then that by making use of a WBS and the four points above that a sound plan for a project feasibility study can be developed.

Archibald (1993) also lists key steps that must be thought through during the planning for each task in a project feasibility phase. These are;

1. who does the work
2. who must be consulted
3. who must be notified of the work
4. who must approve the work

From the above list, the point of "who must be consulted" is not entirely clear in its meaning. One could assume that this is meant to list the relevant experts or advisors that would be deemed suitable to assist the project team in arriving at a professional and acceptable result regarding certain tasks. This point is worth consideration. It is the experience of the author that when project sub-teams have presented finished work, senior people in the organisation have asked, "did you consult . . . ?" This has then meant going back and consulting with the desired person and often making changes to the original work.

One would believe that if the above listed inputs to the project development phase and work plan were used thoroughly then unexpected delays would be minimised. For example there is a certain risk associated with most planning assumptions (PMBOK® , 2000) but this should be accounted for during the planning phase with adequate contingency. This view of anticipation of problems is backed up by Avots (1969) when he argues that the project manager must be informed in all areas of the project and must anticipate problems. The project manager must then develop methods to deal with these potential problems. In today's world of mega and complex projects it could be expected that the project manager could delegate this work to the discipline managers of the project.

It could be concluded then, that it is possible that the unexpected project delays listed by Yates & Eskander (2002) above are due to a lack of proper planning techniques being used, rather than an inherent deficiency in project management planning theory. However the results reported by Yates & Eskander (2002) indicate the reality of project planning and that it may in fact be deficient. This points to a lack of training and awareness in project management regarding planning techniques.

One technique mentioned by Avots (1969) to reduce planning risks is the ability to frequently re-plan when being in a dynamic project environment. Not only must the actual area directly affected by a new situation be re-planned but all areas linked to this area must be re-planned. Avots (1969) further maintains that automatic linking of scheduled tasks seldom exists and that planning reviews are needed to ensure the entire project's plan is still feasible. Posner (1987) in his research on effective project managers found that planning ability was the second most discussed attribute that was essential to project management. The reader (of Posner's article) is however left to review other literature in order to find out what effective planning actually is.

2.6 Scope management

PMBOK® (2000) describes this phase of the project as the process required to ensure that the project includes all the work that is required and *only* the work required. Turner (2000) agrees and maintains that scope management is the heart of a project. He defines the scope as having three purposes. An adequate amount of work is done; unnecessary work is not done and the work that is done delivers the stated business purpose. This process of scope management is especially critical for the minerals industry due to the large number of disciplines that are encountered in the larger projects. These disciplines may include geological drilling, shaft sinking, direct mining, underground machinery, mineral processing, personnel management, security, control and instrumentation, management systems and civil constructions. PMBOK® (2000) also mention the importance of adequate scope definition when referring to the large amount of work done on projects by contractors. Scope changes can normally be accommodated without too much undue cost and delay if handled in house. However when legal contracts have already been drawn up describing work required from a contractor, changes to this work will often be more difficult to accommodate within the required time frame.

Scope management is divided into two areas by PMBOK® (2000):

1. product scope – the features or functions that characterise the final product

2. project scope – the work to be done to deliver the product

With regard to the product scope the first step of the project manager is to collate a list of the major stakeholders. Their needs and requirements must be understood. Only once this is done can a scope statement be developed (Steyn, *et al* 2003). They maintain that often stakeholders have conflicting views and the project manager has to enter into a series of negotiations in order to help the parties reach consensus. This view was also expressed earlier by Nicholas (2001) under discussions on systems thinking. It is advisable for the project manager to have an alternative solution from that originally proposed that will be acceptable to all the major stakeholders. Steyn *et al,* (2003) do provide a number of examples of detailed scopes for small text book example projects. Obviously the details of the scope statement will differ from project to project. They do however provide a useful acronym to provide a guide to compiling the scope of work. This is SMART, stating that the work must be;

Specific **M**easurable **A**greed **R**ealistic and **T**ime-bound

Once the project scope is defined a scope change management plan is still needed according to PMBOK® (2000). Here it is proposed that a plan must be in place to determine how scope changes will be identified and classified. It is further maintained that this is a difficult exercise. This view is supported again in PMBOK® (2000:62) where it is said "when there is poor scope definition final project costs can be expected to be higher because of the inevitable changes which disrupt project rhythm, cause re-work, increase project time and lower the productivity and morale of workers". Based on this description many facets of a project can be negatively affected by poor scope definition. However it can be concluded that most project teams must be prepared for these situations as PMBOK® (2000) also suggest that the expected stability of the project scope (how much it will change, how often and by how much) must be part of the initial scope management plan. Therefore it appears that scope change is inevitable and expected. One could therefore conclude that flexibility and speed in re-planning and action would be a key feature of a project team. This view is supported by Steyn *et al,* (2003) where they maintain that as a result of uncertainties, changes to the scope will occur during the project lifecycle. They state that members of the project team must evaluate the implications of these changes of scope on technical risk, schedule

and cost. These implications must be made known to the stakeholders who agreed to the original scope of work. Changes must also be necessary and beneficial to the project. Therefore it is possible that proposed scope changes could be rejected if the deviations to the project are unduly onerous.

PMBOK® (2000) add an important comment to conclude their discussion of scope management. They suggest that the causes that lead to scope changes should be documented as part of the lessons learnt from the project. This is due to the fact that both positive and negative factors can cause scope changes. There may have been a technological improvement during the course of the project that necessitated a change to the scope. Conversely there may have been an omission or error in the original estimate of the scope. This information will add to the body of knowledge within the particular organisation.

2.6.1. Configuration management

Under the heading of scope management Steyn *et al* (2003) also discuss configuration management. This is where the technical details of the project's product or sub-systems are described in detail. They also discuss that changes to these technical characteristics of the product or sub-systems do occur throughout a project life cycle. Hajek (1984) suggests that these changes are brought about by both external and internal factors. External factors could be revised performance objectives, modified physical characteristics or substitution of improved modules or components. Modified physical characteristics is an issue that is likely to appear in minerals related projects. This is where test work done on rock strength characteristics and ore-body grades say, are likely to change as more test work is carried out in the early stages of the project. Internal factors could be correction of errors or revisions to a sub-system brought about due to a documented change to another related sub-system. Steyn *et al,* (2003) propose that changes to a technical specification often have a domino effect. That is where improvements to one part of a system could have detrimental effects on another part of the system. They suggest that people who do not understand the whole system often make local improvements that jeopardise the global system. These thoughts echo those of earlier authors when describing the theory of systems thinking in chapter 2.5. The importance of this issue is also highlighted by Hajek (1983) as he suggests that a

Configuration Control Board, chaired by the project manager should be put in place in all major projects. The main responsibilities of this board being the following;

1. review and approve or reject proposed changes
2. ensure adequate coordination of the changes between the affected systems of the project
3. ensure that all affected parties are kept informed of the changes
4. provide for adequate records of the agreed changes
5. ensure that changes to the schedules, contracts, costs, drawings and other actions are documented.

Steyn *et al,* (2003) provide a definition of types of changes to configured specifications. *Modifications* are permanent alterations to a design whereas *deviations* are planned temporary changes.

2.7 Time management

PMBOK® (2000) states that time management encompasses activity duration estimation, sequencing, scheduling and schedule control. The goal of these activities is to bring the project feasibility or product to completion on time. The first step, activity duration estimation is developed from the WBS (Work Breakdown Structure). There are a number of methods that can be used to estimate the duration of activities according to PMBOK® (2000). Historical information usually is the first place to start when similar work has been completed before. Expert judgment would be the next best alternative. PMBOK® (2000) also suggest that the WBS should be developed in the correct sequence as this drives the sequence of work needed in the project.

Scheduling is needed to determine *when* work is needed to be done. This knowledge allows resources such as manpower, materials and finances to be sourced and made available at the correct times (Steyn et al, 2003).

Yates & Eskander, (2002) discuss the consequences of delaying a project. They say that the longer a project takes to develop, the more expensive the project becomes. This is

due to the increasing cost of the project team, loss of profit and inflation. They ranked delays that impact negatively on project schedules, the number one problem being constant changes to the project requirements. Their work is based on responses from 101 engineering and construction professionals. These findings would fit the project environment within the minerals industry due to their construction orientation. The fact that the number one delay was ascribed to requirement definition problems is unusual in one respect. There is a branch of Systems Engineering specifically called Requirements Engineering which adopts an approach intended to produce formal documentation stipulating clearly what the requirements of the end product are to be (Rust 2004). The importance of defining client requirements has been raised earlier by Blanchard and Fabrychy (1990), Nicholas (2001) and Yates & Eskander (200). It can only be concluded that formal requirements engineering is largely unknown to the majority of practitioners, not being used or not being used effectively.

De Meyer, Loch & Pich (2002) maintain that most time overruns are due to a lack of anticipation of uncertainty. They say that all projects have uncertainty and so an uncertainty profile should be created for projects. The uncertainty profile is a team's subjective measure of what uncertainty types are more important in relation to the particular project. Methods used to arrive at a ranking may include, previous experiences, complexity of technology, market forces or scenario planning. Once the profile is created executable plans must be formulated that will be used when an uncertain occurrence arises. What De Meyer *et al* (2002) maintain is that if no one has planned for variation, then the project manager will have to resort to fire fighting to maintain the project schedule if unplanned events do occur. Most often this technique will not work.

A more rudimentary method of eliminating time delays is proposed by De Meyer *et al* (2002) where they suggest that buffers should be built into strategic points in the project. Another similar term used to describe buffers is that of reserve. This is where time is added to schedules to deal with contingencies or unplanned events (Steyn *et al*, 2003). These authors provide examples of how this reserve should be controlled. They maintain that it is incorrect to allow each functional manager or engineer to plan their own reserve. The reserve must be under the control of the project manager which leads to less total reserve being needed for the entire project. The example used is

where *n* vehicle owners have no insurance on their vehicles each valued at an amount *m*. For these people to provide their own reserve against the loss of their vehicles would require collectively *n* x *m*. If these same owners insured their vehicles with one insurance agent, this agent would require considerably less then *n* x *m*. This is since it is highly unlikely that the loss of all the vehicles simultaneously would occur. A second reason proposed by Steyn *et al* (2003) for project level reserve as opposed to activity reserve is the student syndrome. This they say is where a person who knows he has time available will use that time and usually leave the bulk of the work to the last minute. By having the project manager controlling reserve, the project members do not "see" this additional time and are therefore less likely to waste time. There is another consequence of the student syndrome offered. That is when work is left to the last minute and problems do arise, then there is no time left, to complete the task and there is a schedule over-run even though the schedule included reserve.

2.8 Quality management

It is not just the traditional resources that managers need to manage but intangible aspects such as quality and knowledge (Handy, 1996). Firstly one would want to define quality. Most people will be able to give their opinion of quality. It could also be agreed that many definitions would be forthcoming. In a project sense it is suggested by Eddy (2004) that the definition of quality should not be left to opinion or interpretation. Therefore he proposes that quality is conformance to requirements. This conformance must be able to be measured and links back to the thoughts on systems engineering regarding the need to provide clear measurable requirements for the project scope.

In dealing with quality management, a definition is provided from PMBOK® (2000:95) which states that it is "the process required to ensure that the project will satisfy the needs for which it was undertaken". Carruthers (2003) and Kerzner (2001) add to this explanation when they insists that the needs of the stakeholders must be satisfied. Therefore it appears that the customer or end user of the project product will define the quality standards. Carruthers (2003) suggests that these needs are not always self evident as often the customer does not fully know themselves what their true needs

are. Carruthers (2003) then mentions that skilled project members are needed to ask the right questions and prompt the customer or stakeholders to draw out their true needs. This echoes the statements of Blanchard and Fabrychy (1990) and Nicholas (2001) when they expressed the difficulty in defining project objectives and customer requirements. It is sometimes also required from the project team to suggest possible solutions to the customer that the customer may not have considered. This idea is supported by Mendelssohn (1990) when he suggests that negotiation usually takes place to arrive at the stated needs of the customer or stakeholder. He proposes that the stated needs only become valid after agreement is reached that, (1) the need can be satisfied and (2), that the project management team agrees to satisfy it. Adding to the negotiation process, Mendelssohn (1990) insists that agreement must be reached between the project team and the customer of how quality of the stated needs are to be measured. These measures must be based around what is important to the customer not what is convenient to measure.

In the context of minerals related projects the customers are the operational users of the product and the senior managers who represent the owners of the company. Mendelssohn (1990) adds to the list of customers or stakeholders when he states that internal project members who are next in line to receive work output from a previous phase are also customers in the quality context and must be considered within the project process scope of work.

Only once the needs and thus the solutions have been fully described can quality be planned. These needs of the customer are usually specified in a User Requirement Statement or URS (Rust 2003, Nicholas 2001). Here the more specific terms and measures needed as proposed by Mendelssohn (1990) to define quality can be described. For example the Mean Time Between Failure (MTBF) and the Mean Time to Repair (MTTR)[1] can be specified for individual components within a system. These and other quality measures are also be used to determine performance measures from suppliers and contractors who supply goods and services to the project (Carruthers, 2003). Quality can also be expressed as performance as proposed by Armstrong

[1] These measures are usually expressed in hours

(2004). Performance could be such things as the required tons per hour output of a plant or mine. It could be agreed that this is just a matter of semantics and the performance or quality issue has the same intention and can both have specific measures.

PMBOK® (2000) provides a breakdown of quality management into four components. These are:

1. quality planning – identifying the quality standards that are relevant to the work
2. quality assurance – evaluating overall project performance on a regular basis
3. quality control – monitoring specific project results to determine if they comply with the relevant quality standards and eliminating causes of unsatisfactory performance.
4. quality improvement

It must be noted that although quality improvement is described as being one of the components of quality management no further detail is provided. PMBOK® (2000) does however refer the reader to Total Quality Management (TQM) and the International Organisation for Standards (ISO) 9000 and 10000. With regard to the quality planning, Carruthers (2003) suggests that this must be done in conjunction with the main project planning. He also emphasizes that this main project planning must be done with great care. If not, normally shortcuts are taken which is usually at the expense of quality.

A distinction is drawn by PMBOK® (2000) between the difference of grade and quality which is important to note. A product may have a planned low grade, i.e. it has only the basic features required to perform a particular task. Another product may have a planned higher grade where it will have numerous features and perform additional functions compared to the low grade product. In this case low grade does not mean low quality if the low grade product performs as required. Conversely a high grade product may have defects in the product and thus have low quality and not perform as expected. Burke (2003) re-iterates this view as he maintains that the term “quality “ is often misused. He proposes that a product is a quality product if it conforms to the need of the client. The level of excellence or grade of the product is a separate issue.

This is a area of project management that is to be examined in this research. This understanding backs up an argument from Carruthers (2003) where he advises that the benefits of the quality of a product must outweigh the cost of implementing that quality.

Sandrock (1996) when referring to research by Marriot (1987) maintains that 50% of poor quality is due to the failure of the quality control system itself. This warns us that the quality issues proposed above by PMBOK® (2000) may only be part of the solution towards maintaining quality. Marriot (1987) adds one further dimension to this warning when he states that every major failure in recent times has occurred despite the use of a formal quality assurance and quality control plan, which had been *considered satisfactory* until the failure happened. Therefore with all the best intentions it appears that quality failures do occur. A potential explanation is provided by Sandrock (1996:60) when he argues that total quality is a "moving target". This implies that possibly organisations may define quality issues early in the project life and then manage towards a quality goal assuming that the original issues remain for the life of the project. It appears then that quality management requires constant reviewing and updating.

The reviewing of the quality process is reinforced by Mendelssohn (1990) as he proposes a plan, do, check, act cycle or PDCA. As work processes are planned and implemented it is necessary to continue to check them to ensure that the customer's requirements are still being met. If not then action must be taken.

Kerzner (2001) proposes that quality must be built into products during the design stage and continued into the production phase. This is intended to replace the concept of inspection which will only remove defective products but will not treat the cause of the low quality. This concept reinforces the aim of the URS as highlighted earlier where customer needs are stated at the outset of the project and hence quality can be designed at the earliest possible stage.

People often associate the term "defect" with quality issues (Nicholas, 2001). It is maintained that a quality plan must be designed to rectify defects at the earliest possible stage. Fixing a defect in an unattached component may be easy and relatively inexpensive. Fixing the same defect becomes more costly when the component is

assembled with others, and even more so when embedded into a system. The defect that causes the greatest cost is the one that results in a malfunction or failure while in customer use. (Nicholas, 2001). Nicholas (2001) adds a view to the commonly heard phrase of “zero defects”. He maintains that trying to eliminate all defects is not always possible. This is because aiming to eliminate all defects may cause other constraints such as time and cost to over-run. These constraints of time and cost may be more important to the customer than a minor defect. This leads to the term “good enough quality” (Nicholas, 2001:131). This is where only the most important quality issues are satisfied. This concept is backed up by Bach (1995) where he suggests that often a client will not even notice the difference between the best possible quality and pretty good quality. However he adds that it is the customer who judges what is good enough quality. Therefore the customer must be kept appraised of any potential quality defect issues throughout a project.

2.9 Human resources management and organisational structure

Du Plessis (2003) describes human resource management as one of the most critical areas of project management. This is because she maintains that people either contribute to problems or constraints or provide solutions and opportunities, in her words they determine the success or failure of the project.

PMBOK® (2000) describes human resource management as the processes needed to make the most effective use of people involved in a project. Three key areas describe the processes needed from its viewpoint:

1. Organisational planning – identifying, documenting and assigning project roles
2. Staff acquisition – getting the right individuals assigned to the project
3. Team development – maximizing individual and team competencies to maximize the performance of the project team

Organisational planning should be one of the earliest phases of the project (PMBOK® 2000; du Plessis, 2003). This will determine what skills are needed on the project and

when they are needed. Project structures are also set up at this stage. It could be realised that specialized skills may not be available when required. Therefore training of team members could be needed and should be planned for (du Plessis, 2003). It should be noted however that it is possible that having the required competent specialists on a project do not necessarily make the best team (Dinsmore 1984). He suggests that team work and the right project manager creates the extra synergistic push.

Organisational behaviour can help explain why certain teams are more successful than others. Although many complex issues may explain the variation in team performance, Robbins (2001) proposes four main variables. The ability of the team's individual members, the size of the group, the level of conflict and the internal pressures within the group. Robbins (2001) then introduces another factor that affects a team's performance. That is the external conditions imposed on it from outside the group. He goes on to describe that in the large organisation these are, the strategy of the company, authority structures, formal regulations, performance evaluation and reward systems and the organisation's culture. Within the environment of minerals related projects it was considered how this external environment affects a project team's performance in this study.

It must be made clear as Robbins (2001) does, what is the difference between a team and a group. He makes the view that a group will merely add their individual contributions together. There is no synergy that creates a level of performance greater than the sum of the inputs. A team on the other hand generates positive synergy through coordinated efforts. The level of output is greater than the sum of the individual efforts. Burke (2003) provides agreement, with his description of groups and teams. He describes teams as a number of people working closely together to achieve shared common goals. It is this interaction that will enhance creativity, innovation, problem solving, morale and performance. A group however is a collection of individuals, who although working together on the same project do not necessarily interact with each other. This is an important distinction as Burke (2003) explains further that when project managers interact with project members individually, unity of purpose becomes a myth. Clearly the theory indicates that teams are better than groups. It needs to be examined therefore, under what mode project "teams" are actually performing. The view of increased capability of a team is supported by

Lumnsaine, Lumnsdaine & Shellnutt (1995). They maintain that working in teams has a trigger effect. This is where ideas from one person triggers other ideas from the rest of the team members.

Another variable is ascribed to affecting team performance, that is the physical work setting (Robbins, 2001). No real examples are provided in this text however. As one potential example the author was involved in a business visit to Vega Advertising School in Johannesburg in May 2003. Here the school used a “space room”. This was a room that had no furniture except for a few bean bags. All four walls were painted different colours and used as black boards for writing on. The idea being that in order to bring about lateral thinking, a totally different environment is needed from the normal working day environment. Project teams could perhaps look at their working environment and consider if that environment is best suited for a particular project or phase of the project.

According to Robbins (2001), one of the key factors that is an output of a project team is decisions that must be made, usually regarding alternative courses of action and competing technologies. Robbins (2001) maintains that teams generate more complete information and knowledge than individuals. Further he adds that teams bring increased diversity of views which adds up to more accurate decision making. Therefore it appears that project teams are more effective at decision making than individuals. The issue of diversity and depth in the decision making process must be considered more deeply in the De Beers context however. Following on from the team’s decision making ability, Robbins (2001) describes task complexity and how it affects decision making. Here he maintains that research has found that larger teams are more effective when it comes to dealing with problem solving situations where a solution is needed. However when the solution needs to be implemented, a smaller group is best. Each additional member does not add to the implementation process as the process has already been largely defined. In fact they detract from the process rather like the theory of diminishing marginal returns (Robbins, 2001). Steyn *et al* (2003) add to the issue of problem solving. They mention that during the initial stages of a project where conceptual thinking and problem solving is needed, right brained people are required. These are people that have a high tolerance for change and ambiguity. During the latter stages of the project where more structured routine work is needed, left brained

people are required. These type of people prefer standardized work methods and enjoy stability (Steyn *et al*,2003).

Lester (1998) discusses the make up of the total project team. He maintains that cross functional teams are more likely to deliver a successful project, in line with the view of Robbins (2001) above. This theory links back to systems theory as discussed earlier. Organisations are realizing that complex projects are about a complete system that is made up of many parts or sub-systems. It is the successful linking of these sub-systems that will result in a successful project (Rust, 2003). Generally engineers are used to working in their specialist silos and probably think they don't need to interact with other disciplines all that often, if at all. It is even suggested by Rust (2003) that psychologists play a role in defining and planning systems. This is due to virtually all commercial system products having human interaction of some kind.

According to Prevost (1987), who was a vice president of a $6 billion hydro electric project in Canada, team spirit was extremely important. This was to such as extent that any person who did not display the expected team spirit was removed from the project. Projects have a very strong team environment within the minerals industry largely due to the complexity and range of disciplines needed. The need to examine group behaviour within the context of minerals related projects therefore is important due to a number of reasons. The first is the characteristic temporary nature of projects. Once the project is completed the team members disband and may return to other operations, or perhaps to join a new project. This is a different dynamic to that of the day to day running of a going concern where teams are *generally* more stable. Therefore project team members are generally new to each other and a period of time will be needed in order for the team to begin functioning optimally. The project manager needs to be aware of this according to PMBOK® (2000). They suggest that the project manager must select techniques appropriate for such transient relationships. They do not however outline what these techniques are.

Another of the characteristics of projects is the educational level of the members. Gaddis, (1959) suggests that a project manager manages a higher proportion of professionals relative to a day to day operation. This situation necessitates a different management style. Gaddis (1959) maintains that the project manager must let the

how, that is the work methods, be established by the employee. Gaddis (1959) then provides a supplementary condition to this by saying that these professionals must have performance standards of the highest order. He also adds that these professionals must be accountable at a professional level. In the South African context this would mean project members should be affiliated to a professional institution such as the Engineering Council of South Africa, as an example. This would required engineers signing off designs at a professional level. This act of signing off plans or designs as a registered professional should ensure a greater level of thought and dedication.

Kerzner (2001) maintains that in the project environment conflict is inevitable. He says this is so because irrespective of the degree of planning there will be changes in scope, movement in personnel and other unforeseen developments. Thus a need exists to understand team dynamics and the dynamics between the project team and other stakeholders within a context of potential conflict. These other stakeholders may be senior executives within the organisation, government officials, community leaders, contractors and labour unions. Herzog (2000) maintains that trust between these groups plays an important role in the success or otherwise of group work and that conflict must be avoided. She maintains that high trust groups will be better able to innovate organizationally since a high degree of trust will permit a large variety of social relationships to emerge. Conversely, low trust groups will only co-operate under a system of formal rules and regulations. These rules and regulations have to be negotiated, agreed to, litigated and enforced (Herzog, 2000). This she suggests will cause transaction costs to arise which is a form of tax on economic activity. This concept is noteworthy within the context of De Beers projects. All major De Beers projects involve the use of contractors during the design, feasibility and construction phases. These contractors have been largely governed by contractual documents. Generally it is a commonly held belief that there is a culture within the mining industry whereby conflict generally exists between the client and the contractor. This climate probably matches the low trust scenario described by Herzog, (2002) where additional transaction costs are present.

Robbins (2001) talks about the five stages of group development that are applicable to the team environment. These are:

1. forming – characterised by uncertainty
2. storming – characterised by intra-group conflict
3. norming – characterised by close relationships and cohesiveness
4. performing – the group is fully functional
5. adjourning – concerned about wrapping up activities rather than performance.

Steyn *et al* (2003) propose that in projects the team must arrive at the performing stage as soon as possible due to the time constraint of the project environment. Robbins (2001) provides further comments regarding the output from these stages. He proposes that groups in stage two, the storming stage may be more effective than those at stage three or four. This is due to the fact that a degree of conflict is conducive to high team performance. Another model of group behaviour is also proposed by Robbins (2001). This is the punctuated equilibrium model. In this model a major period of activity takes place midway through a project's life cycle, preceded and followed by periods of inertia. It is proposed by Robbins (2001) that this model is more applicable to groups of a temporary nature that have deadlines to meet. This model then would appear to be more suited to the project environment. This concept seems to appear in projects from the earlier years of the project discipline and has been documented by Gaddis (1959). He describes that one of the roles of the project manager is to preserve a sense of momentum throughout all layers of the project. Gaddis (1959:53) describes a "dead centre" of a project where staff have an overpowering sense of general inertia and there seems to be no sense of direction in which to advance. If theory and experience suggest that there are periods of inertia from a project team then the reasonable project manager would want to be aware of this and try to eliminate these periods. The project manager would also be well advised to be aware of which of the five stages above the team is currently at. He or she would want the team to advance to the norming and storming stages as soon as possible.

2.9.1 The role of senior management

The role of the Project Manager and other senior managers is seen as critical for successful projects. (Steyn et al 2003). PMBOK® (2000) describes the project managers role mainly as a leader being involved in the following:

1. establishing direction – producing a vision for the future and developing strategies for reaching that vision
2. aligning people – communicating the vision by words or deeds to all those that play a role in the project
3. motivating and inspiring – helping people to energize themselves to overcome obstacles to change

Sutcliffe (2003) agrees with the last point and states that senior managers must set direction and motivate others in the face of ambiguities and conflicting demands. From the earlier discussion on the characteristics of projects, change, conflicting demands and possible ambiguities appear to be rife in the project environment. Therefore as suggested by Sutcliff (2003) the project manager must be aware that the work do be done must be done in this turbulent project environment.

Steyn *et al* (2003) describe the usual list of attributes expected from a manager such as planning, leading, organizing and controlling, however one attribute not commonly mentioned in everyday use is that of emotional intelligence. This they describe as the ability to control emotions and avoid irrational behaviour. According to these authors this is critical in projects as often the constraints of time, quality and cost are difficult to meet and stress can permeate the environment. It can be construed from these statements that the senior managers are expected to lend a claming voice when these constraints and stressful situations appear. One other noteworthy attribute listed by Steyn *et al* (2003) is the ability of the project manager to identify problems *early* in the project life cycle (emphasis added). This they maintain, allows the project team members more time to develop solutions to these problems if they do occur.

According to Delisle, Jugdev and Thomas (2002) research has shown that many senior executives continue to view project management as an operational tool that is not on their level of focus. It is held by a number of authors however that management buy in

and stakeholder involvement is crucial to project success. For example, Shenhar & Dvir (1996) have identified customers as one of the major critical success factors for projects. In the case of minerals related projects, customers are the managers who take ownership of a project product once it has been commissioned. Lester (1998) also identified senior management commitment as a critical project success factor. Therefore this study will attempt to investigate the level to which future operational managers and senior executives are involved in the projects as they unfold.

2.10 Communications management

This is the process that is required to ensure the timely generation, collection, storage and dissemination of project information (PMBOK®, 2000). Communication is a two way action which entails performance feedback to project management and the project sub-teams. Generally communication is thought to involve all the project staff, which it is. However communications management also involves determining *what* information must be passed onto stakeholders (PMBOK®, 2000). In the context of minerals projects, stakeholders are the future operations managers and operators, government officials, local communities, head office discipline managers, contractors, unions and the media. Kruger (2003) describes communication as including arguing, convincing, persuading, negotiating and managing conflict. This latter description would likely be needed when dealing with all of these stakeholders.

What information, how and when it is passed onto these parties would clearly require some thought and planning. What is being suggested is that a communication plan must be compiled for the project team.

PMBOK® (2000) describes communication planning as having a formal outline of the following:

1. who needs what information
2. when they will need it
3. how the information will be given to them
4. who will be responsible for passing on the information

It is suggested by PMBOK® (2000) that the project's organisational structure will greatly assist in determining the communication plan. That is, what departments, technical disciplines or management functions exist and what interfaces exit between them. Kruger (2003) adds to the four points of PMBOK® (2000) when he states that feedback is just as important as transmitting information. That is the audience must understand and interpret the information as was intended by the transmitter. Feedback can be written or verbal, it can also be in the form of changed behaviour or intended actions. The evaluation of this feedback by the transmitter in fact then becomes a quality control mechanism for effective communication (Kruger, 2003).

Dinsmore (1984) provides a more detailed outline of planning communications when he discusses the steps that should be taken prior to any important communication event. Firstly he mentions that advance warnings should be sent out to set the scene for later more detailed information. This could include preliminary drawings or illustrations that provide initial understanding of the subject matter. Secondly he recommends the use of expert opinion to back up the subject in question. This is due to the natural tendency of human nature to have more belief in subject matter that is based on expert knowledge. Thirdly Dinsmore (1984) proposes that one should be prepared to negotiate after receiving feedback from the intended audience.

Communications planning is one area of project management that is found to be lowest on the scale of performance by Globerson & Zwikael (2002), based on their research of 282 project participants. This agrees with the research already stated by Yates & Eskander (2002:43). They found that of all the causes of delays to project planning, the third most common reason was "a lack of communication between different divisions". Their research further suggested that an effective project manager would reduce the potential of this problem. How exactly this would be done is not made clear from their findings however. Posner (1987) agrees with the view of Yates & Eskander, (2002). His research of 287 project managers revealed that 84% of those interviewed proposed that "being a good communicator" was essential to being a good project manager, (Posner, 1987:52). Again, what being a good communicator is, is not clearly defined.

Robins (2000) provides a succinct definition of communication which is not evident in the literature thus far. He says that communication is the transference and

understanding of meaning. He expands further when describing four major functions that are served by communication. These are:

1. control of behaviour, e.g. by verbal or written instructions
2. motivation, e.g. by feed back on performance and goal setting
3. emotional expression, e.g. team members may display their feelings of satisfaction or frustration
4. information, e.g. team members use information for decision making

These four functions highlight more strongly the importance and breadth of communication not evident in the earlier literature. This becomes more obvious after considering Robbin's (2000) statement that individuals spend nearly 70% of their waking hours communicating. He also adds another dimension to communication that is often heard when using the phrase, "its not what you say but what you do" (Robbins, 2000:288). Therefore managers on projects need to consider their actions as well as their words. This becomes more important when according to Robbins (2000), if actions and words are divergent, followers are more likely to focus on actions.

To repeat a possible problem area highlighted earlier in the literature review regarding systems thinking, Mihm *et al* (2003) discuss research showing that within complex projects autonomous teams designing in isolation lead to cost and schedule over-runs and missed specifications. They suggest that communication is needed between groups of engineers at each decision point and that the status of other components in the system or project be considered. These steps are consciously needed as they propose that engineers design with their own local component performance in mind and neglect overall system performance. Although this desired communication can be forthcoming it is often delayed leaving other decision makers with obsolete information (Mihm *et al* , 2003). What this is suggesting is that key areas of interdependencies must be identified and be made known to all concerned. The hope then being that any design changes and decisions are communicated to these other team members in a timeous manner. It is suggested that the release of preliminary design data is beneficial to other project design teams and helps to minimise the planning isolation syndrome, (Mihm *et al* , 2003). However empirical research has indicated that engineers are reluctant to release

what may be called “half baked” information (Mihm *et al* ,2003:744). If this is the case then a quite a change in culture will be needed to allow the flow of the preliminary information.

The above concepts lead onto performance reporting whereby project progress and forecasted expected progress must be reported up to the project’s management and external stakeholders. PMBOK® (2000) maintain that this is to keep project managers informed on the ability of meeting the overall project objective. Kerzner (2001) adds a somewhat cynical view that effective performance reporting will reduce or even eliminate meddling by senior managers. He describes effective performance reporting as including perceived risks, expected constraints on project schedules, costs and quality and procurement information. One could thus assume that by keeping senior managers fully informed they will leave the team members to continue working with little interference. However to highlight the difficulty of performance reporting Kruger (2003:290) refers to an unknown author who once stated that “project teams detest progress reporting because it vividly demonstrates their lack of progress”.

2.11 Risk management

Chapman & Ward (1997) propose that all projects involve risk – the zero risk project is not worth pursuing. They further maintain that organisations that better understand risk and manage risk more effectively can avoid unforeseen disasters and thus work within tighter margins with less contingency. This will assist the company in freeing resources for other activities. PMBOK® (2000) describes project risk as an uncertain event or occurrence that has a positive or negative impact on the project. PMBOK® (2000) then states that project risk management is the systematic process of identifying, analysing and responding to this risk. Nicholas (2001) provides a succinct description of risk with two points:

1. The likelihood that a problem will occur
2. The impact of the problem if it does occur

Although risk can never be totally eliminated according to Nicholas (2001) it can be reduced by using the following three techniques of risk management. These are risk

identification, risk assessment and risk response planning. Thomsett (2002) suggests that the need for improving risk management exists as he uses an example of a research study. The study showed that the majority of senior managers questioned did not understand project risk. Thomsett (2002) then goes on to explain his theory of managing risk using four steps in the process. These are analysis of the risk, risk reduction, risk tracking and risk reporting. The risk tracking and reporting is a variation on the steps proposed by Nicholas (2001) in that constant monitoring of the risks already identified are needed as opposed to just having a static plan of action. Thomsett (2002) is thus emphasizing the fact that risk is a dynamic entity that can change over time. This view fits well with the earlier systems view from Nicholas (2001) where he describes the changing environment as being a critical management factor for projects. It appears therefore that risk is a variable that must be managed throughout the life cycle of the project due to the changing nature of the project environment. This scenario definitely applies to the minerals industry mainly due to the long lead times of projects. In these cases, Rand exchange rates, government policy, changing head office staff and commodity prices can vary from those values that the project was initiated under, for example.

De Mayer *et al* (2002) describe their four types of project uncertainty with methods of dealing with them as follows:

1. variation – this comes from many small influences and are too small to plan for. The project team should plan for collective variations, say weather, delivery delays and worker sickness. Buffers should be built into the project schedule.
2. foreseen uncertainty – identifiable and understood influences that a project team cannot be sure will occur. This requires full blown risk management with contingency plans. Keep all stakeholders aware of the potential changes to the project execution and increase awareness of a changing environment.
3. unforeseen uncertainty – these influences cannot be identified during the planning phase. The project scope must be able to accommodate new tasks. Managers must be able to solve problems as they occur. New partners must be able to be mobilized if needed as new challenges arise.

4. chaos – the basic structure of the project plan is uncertain. Managers need to frequently redefine the project. Replace contracts with partnerships. Solicit constant feedback from technology providers and the market. Make the most of the learning's along the way.

De Mayer *et al* (2002) go on to say from their research that project team members fail to understand these different types of uncertainty. They propose that this lack of awareness is understandable due to the common perception that a project is just defining the tasks up front and then simply carrying out the work. Aligning this view with the observation by Thomsett (2002) above, indicates that risk training and awareness could be lacking in projects. Levitt (2002) supports a lack of proper risk management within organisations when he maintains that managers only address risks that are within the their own knowledge and experience base. No further comment is made on this aspect of risk by Levitt (2002), but one can propose that a conscious effort must be made to identify risks not normally considered by management within their normal day to day experiences. In other words managers must think the unthinkable. Burke (2003) introduces a slant to risk management in line with the view of Levitt (2002) as he discusses risk management responsibility. He maintains that current practice is to push risk management down the hierarchy within the organisation. This he suggests will force different discipline managers to provide risk management plans for *their* particular scope of work. This process seems to be designed to enable all possible risks to be managed. Adding to this, Watkins & Bazerman (2003) propose that a culture must exist in an organisation that allows staff to speak out when risks are perceived or detected. This comment seems to imply that staff must feel free to speak up about risks outside of their own disciplines.

Nicholas (2001) discusses two methods for identifying risks that apply to projects within the minerals industry. That is the maturity and complexity of the project product. Regarding maturity (of the product), an organisation may be using technology based on current experience and pre-existing knowledge. This will be less risky than using new or cutting edge technology in which the organisation has little experience (Nicholas 2001). Complexity deals with the number of steps, components and interrelationships present in the final product. Clearly, the greater the number of these steps and

interrelationships then the greater the risk to the project. Minerals related projects must consider both of these aspects of risk.

A question should be posed then, of how does an organisation ensure that all relevant risks are identified. Based on the previous literature one would expect that discipline managers and their subordinates with experience in those fields would identify all possible risks. This is not so according to Watkins & Bazerman (2003). They argue that people from outside the organisation should be brought into the risk identification process. This they maintain is due to the common self serving biases found in company employees. They mention that scenario planning is the best method with which to use outsiders in the risk process. An alternative suggestion is made by Pells (1993) that adds to the possibility of identifying all possible risks in a project. He proposes that the Work Breakdown Structure[2] be used to identify risks. This principle will therefore identify risks associated with all the specific elements within a project. In contrast with the idea of using discipline managers alone as proposed by Burke (2003) this method of Pells (1993) would more than likely bring many managers together as each element of a project is discussed. As was discussed earlier under the section for Human Resource management and Organisational Behaviour, group thinking is described as being beneficial to problem solving. Therefore one may conclude that group thinking in risk identification should also be beneficial.

Kerzner (2001) adds another dimension to risk identification. He suggests that organisations usually attempt to forecast technology trends. Kerzner (2001) however mentions that this data is not readily published as most organisations consider this type of forecasting part of strategic planning or proprietary work. This then is critical for projects taking a number of years to complete. He maintains that computer technology doubles every two years and engineering technology doubles every three years. The project manager must therefore consider the impacts of changing technology on the project product. No suggestion is made by Kerzner (2001) on how technology forecasting is done however. One could assume it requires research into current trends and investigations into what relevant institutions and technical bodies are investigating.

[2] The WBS outlines all the individual work elements that collectively describe the entire project

Burke (2003) also raises another dimension not specifically mentioned by the other authors. That is a disaster recovery plan. The object being to minimise consequences of a disaster that *does* occur. He then expands this concept by bringing the training of people into the disaster recovery plan. They must be able to "hit the ground running" (Burke, 2003:256). One example of this concept applicable to minerals projects is in shaft sinking where (unplanned) water is intersected in the shaft. This will appear without warning and requires "all hands on deck" with stipulated procedures immediately being put into action. A disaster recovery plan that has spent all its time in the bottom draw will be of little use when actually needed.

Watkins & Bazerman (2003) propose that the psychology of risk causes failures or incidents to occur. They maintain that the often substantial and certain short term costs associated with providing for risk reduction looms greater than the uncertain long term costs of inaction. What is being proposed here is that managers would rather take the chance of future uncertain incidents not occurring as opposed to accepting a certain cost now in the hope that the risk will not occur. This implies a short term view which is not really acceptable in the context of long life minerals projects. This view can also be associated with the earlier literature on systems thinking and the Project Life Cycle. Under these concepts project managers must be considering the long term effects of present action and how inaction today can affect the ongoing operation of the project product.

PMBOK® (2000) adds the dimension of risk prioritisation to this topic. This appears to be common sense and would indicate why no further discussion is given on the subject in its discussion. Expanding on the concept however, one would assume this means ranking the risks according to their impact on a project. Clearly those possible risks identified that have greatest potential to upset the project need to receive the greatest efforts in risk management and planning.

Stewart (2001) describes risk specifically in the context of minerals related projects. He says that projects have four types of risk:

1. investment risk – this is the financial return that is expected due to the risk attributes of the project. These are country risk and political risk, indicating

that minerals projects in general expect a higher return than less riskier projects

2. schedule risk – this is based on the time needed to bring the project to fruition. Any delays in the project will delay revenue. Minerals projects normally have a long lead time.
3. estimating risks - this is the risk inherent in estimating the cost of the project and the extent of the mineral resource that provides the revenue component.
4. design risk – this is the chance that engineering designs proposed for the project will not provide the expected operational results. This includes detrimental environmental factors that could affect the project due to a lack of design.

Stewart (2001) expands his views on design risk by suggesting that computer simulation will reduce the likelihood of design risk. In this context computer simulation makes use of specific software that uses Monte Carlo sampling to mimic a real life situation over time. However he argues that this method of risk reduction is not commonly used as there is a general lack of awareness and expertise in this area.

Burke (2003) discusses ways to mitigate against risk in the project environment of which the primary method is by contracting. Here any perceived risk is not necessarily eliminated but passed on to a contractor. The most desirable option from the client's perspective is the fixed price contract. Here the contractor completes a scope of work at a pre-determined and agreed price. One point worth noting is that the scope of work must be well detailed as the contractor will not carry out work unless it is in the contract (Burke, 2003). This then becomes a risk in itself, as work not documented is not done and further contract negotiations, costs and time are required to have what may have been originally intended actually done. Usually it has been generally agreed in industry that contractors will build a risk factor into the contract price to cater for the risks that have been passed onto them via the contract. This normally makes this the most expensive contracting method.

Another contracting method proposed by Burke (2003) is the cost plus, contract. Here the contractor charges a percentage fee based on the underlying costs of the work

done. This is seen as the most flexible contracting method in that the client can change the scope or have a low definition of scope and the contractor will perform whatever work is required according to changing plans. In this case uncertainties in the project can more easily be accommodated. However the risk of higher costs are possible as the contractor has no incentive to control the underlying costs or improve productivity (Burke, 2003). It is then left up to the client to monitor and control costs.

Another method of mitigating risk with contracting is a payment retention system. This is where say, 70% of contractor costs will be paid upon delivery, 20% upon successful commissioning and 10% after an agreed warranty period (Prevost, 1987). This method is intended to guard against possible poor performance from a contractor.

Prevost (1987) mentions another contract strategy designed to minimise risk to both the project and the contractor. This is target based contract management. Here a target cost is set for the completion of certain work. If the actual cost comes in under this target, the contractor and the project share the savings. Conversely, if the work comes in over budget, both parties share the additional expense. It is not made clear by Prevost (1987) how and who sets the target. One could only assume that the contractor must also have input into this process in order for them to agree to this contracting method. This method of contracting is similar to the concept of Alliancing which will be discussed under the section on General Management.

De Mayer *et al* (2002) discussed earlier the idea of managing unforeseen uncertainty. They added that contracting can assist in managing these uncertainties. It was stated by this group of authors however that trust is critical in the partnership. If trust is lacking no contractor will co-operate until a contract is drawn up. This need for contracts reduces flexibility and becomes a barrier in handling unforeseen events rapidly. This is in agreement with Herzog (2002) as was stated earlier where a low trust environment causes transactions costs to manifest themselves.

Hajek (1984) indicates that different contract types are applicable according to the type of risk that is prevalent. Where say a research and development element exists, to estimate costs and time would be difficult. In this case a cost reimbursable type contract would be best suited. Here is there is low risk of over payment as the

contractor is paid according to what needs to be done. When a scope of work is clearly defined the fixed price contract would be more applicable.

This passing on of risk to a contractor then forms one of the four methods of risk mitigation as proposed by (Levitt, 2003). He makes use of the four T's. These are, transfer (as with contracting options), terminate, tolerate or treat (the risk). Nicholas (2001) suggests that the degree to which and organisation will accept risk depends upon the experience of the stakeholders and managers. He goes on to propose that less experienced people tend to be less risk averse because they have not yet felt the consequences of certain risk occurrences. This level of experience then would in part determine how much risk is terminated, tolerated or treated as described by Levitt (2003). In the case of projects therefore, one could conclude that project managers experienced in the relevant technical fields are needed to properly judge the right mix of the four T's.

Shevel (2003) refers to a Deloitte and Touche survey of 25 top South African companies. The survey indicated that senior managers only supported risk management in order to comply with regulatory and corporate governance issues. The survey also concluded that these companies as not integrating risk management into the organisation, rather risk management is seen as a stand-alone project. This however will not make risk management sustainable within the organisation according to the report. Shevel (2003) also refers to the King II Report stating that Johannesburg Security Exchange (JSE) regulations requires explanations from companies if they do not adhere to certain risk management strategies. De Beers, now being an unlisted company would not be ruled by the JSE. However in the interests of corporate governance it would surely be advisable for De Beers to match or exceed King II guidelines.

Finally Keynes (1936) provides an insight into risk that he applied to economics, however the concept holds equally well in projects (or any decision making arena in fact). That is, when a decision is irreversible then it becomes extremely risky. This is worth consideration, the degree of irreversibility should be taken into account when considering the likely outcomes from a particular course of action.

2.12 Procurement management

This is the process of identifying which project needs will best met by procuring products or services outside of the project organisation (PMBOK®, 2000). These processes must consider whether to procure, how to procure, when to procure and how much to procure. It is important to realise the consequences of this area within the context of De Beers. One of the key areas of minerals projects is of procuring contractor services. These contractor or consulting services can be procured in the project feasibility stage, in the construction phase, in the commissioning phase and in the operation itself. Therefore contract services may span the entire project life cycle.

When procuring capital items, a number of strategies exist. One is the use of Commercial off the Shelf (COTS) items (Rust, 2003). Under this strategy commercially produced goods are purchased that eliminates internal development and testing and thus speeds up the acquisition phase of a project. The end result of this strategy is a saving of time and money (Baker, 2002). This would appear to be a totally accepted and recommended strategy when capital items are of a standardized nature. Baker, (2002:56), however adds a rider to the use of this strategy as he quotes from the US Department of Defense;

> *"A commercial off-the-shelf (COTS) item is one that is sold, leased, or licensed to the public: offered by a vendor trying to profit from it, available in multiple, identical copies:* ***and without modification of the internals*** *"* (emphasis supplied)

What Baker (2002) is in fact alluding to is that there are situations where project teams purchase COTS items and then set about modifying them to meet unique characteristics of their particular project. He expands his statement by suggesting that there is often a gap between what is commercially available and what the requirements of the project team actually are. Modifying the commercial item may not be the best way to bridge this gap however. More explicitly, Baker (2002) is maintaining that modifications to COTS items will invalidate that particular component's reliability or effectiveness. One can conclude that minimal modifications may be warranted and acceptable but where does one draw the line? Based on the review of systems engineering as discussed earlier, there could be other problems. It could be envisaged that modifications to a

COTS item will have an impact not only on the COTS item itself but on other systems that interface with the said item. A second potential problem area is mentioned by Baker (2002) that although distinctly separate in his eyes, can be linked to the COTS issue. He mentions that hardware must be tested in the environment that it is planned to operate in, including the people that will operate the component or system. This is similar to the concept of physically modifying a COTS item in that the environment or expected skill level of the operator is being (probably unintentionally) modified by operating the item in a different environment than what it was designed for. This is potentially possible in South Africa as COTS mining and mineral processing equipment is often designed and built outside South Africa. Mining companies, will then import and use this equipment in the local minerals environment. There are differences generally prevalent in this country and with diamond mining in particular that probably have not been considered during the design and development stages of this imported equipment. The main characteristics unique to diamond mining in South Africa are the general low level of education amongst the workforce and the unique properties of kimberlite rock[3].

2.13 General management issues

It can be seen that there are a wide variety of management areas within the project management body of knowledge. What is needed in addition to these individual disciplines is an aim to co-ordinate them into one coherent endeavor. This means one overarching management exercise to co-ordinate activities towards the project goal would be useful.

There are many views as to what management actually means. Lowe, Thorpe, & Easterby-Smith (2002) use the classical view of management in the modern era as the functions of planning, organising, coordinating and controlling. Nicholas (2001) agrees with these attributes and adds the function of leadership. He then states that all these functions are performed to achieve organisational goals. Nicholas (2001) then outlines how the manager will perform these functions. His idea is that the five functions

[3] Kimberlite is the host rock in a diamond bearing orebody and contains a high clay content. This results in a lower strength, rapid weathering, difficult transport and diamond separation characteristics.

discussed are not always done in any particular sequence, that is all of these activities are needed constantly. This is partly due to the changing nature of the business environment in which the business manager must constantly adapt to. Based on the literature reviewed thus far it can be seen that the above functions are all present in a project environment. Leadership especially is a critical issue as was discussed under organisational theory.

Krajewski & Ritzman (1999) discuss how management involves making decisions, where decisions are strategic or tactical. They describe strategic decisions as less structured, cutting across the entire organisation and having long term consequences. Projects are seen as having strategic consequences to an organisation as the result of projects often delivering long term change in one form or another (Nicholas, 2001). Strategic decisions taken at the start of a project also have consequences on the entire project. For example the author is familiar with strategic decisions such as only using proven technology, or only sourcing equipment from existing company suppliers. These decisions then place bounds on many other decision areas.

Tactical decisions on the other hand are more routine, repetitive and have short term consequences. (Krajewski & Ritzman, 1999). It is these tactical decisions that are more likely to be in the domain of project manager's day to day life. This decision making ability becomes prominent in projects when design decisions must be finalised and signed off as the project proceeds. Mihm *et al* (2003) describe how making final design decisions becomes more difficult in projects as the complexity and size of projects increases. They describe how design decisions tend to oscillate exponentially as the project size increases before a final decision is made. This oscillation of design decisions obviously uses up more time. Project teams realise this and may freeze a design after what is considered a reasonable period of time to prevent further iterations. However this potentially leads to sub-optimal design decisions being made (Mihm *et al*, 2003). They suggest product quality will suffer as a result. These authors suggest that modularization of a project will decease the potential for this oscillation. What this is doing is reducing the interdependence of project segments and makes isolated decision making easier. This concept goes against the views proposed earlier regarding systems thinking, where understanding of interdependencies was promoted. However Mihm *et al* (2003) do offer a word of caution if attempting this method. They say that

reasonable thought must go into creating the sub-divisions that will reduce the de facto system size. This seems to imply that they do have an understanding of the systems concept and its importance.

Webster (1987:66) refers to what he calls “empire building” in most bureaucratic organisations. Although his definition is not clear one can construe that he is suggesting that managers orientate their efforts strongly towards their own functional areas with the exclusion of other areas in the organisation. This he argues will cause local optimisation at the expense of global optimisation. This argument agrees with what was stated previously when discussing systems thinking theory. Kerzner (2001) explained that a business (or a project in this case) must be analysed in its entirety and include all interactions with the internal and external environment. Therefore work done in isolation of other interacting areas due to staff preferences is likely to result in the overall goal or project not producing the optimal result. The role of general management can thus be seen to aid in bringing a systems approach to the separate disciplines of project management.

2.13.1 Alliance partnerships and contracting

Contracts can form an integral part of a project every step of the way from the initial planning stages through to the finalization of the project (Prozesky-Kuschke, 2003). Therefore one could consider that contracting would fall under the guise of general management regarding projects. Contracting was discussed earlier under risk management but in this section the general management of the project is discussed with the aid of contracts. Prozesky-Kuschke (2003) list the types of contracts the project manager would expect to encounter in the project environment;

1. purchase and sale of equipment
2. lease agreements for equipment
3. staff employment contracts
4. letting and hiring of work, i.e. sub contracting
5. loan agreements with banks and financiers
6. partnership agreements

7. joint venture agreements

She further suggests that engineers and other technical professionals have none or only a very basic knowledge of contract law which often leads to problems later in the life of the project. This then is likely to be a potential problem area for minerals related projects as project managers and senior project staff are usually from an engineering discipline background. PMBOK® (2000:156) appear to back up this potential problem area when they warn that

> *"the legal nature of the contractual relationship makes it imperative that the project team be acutely aware of the legal implications of actions taken when administering contracts".*

Prozesky-Kuschke (2003) then state that every foreseen and even un-foreseen circumstances must be planned for. This would appear to be a difficult task, especially when considering the changing and dynamic environment that it is suggested by earlier authors that projects find themselves. In line with this thought, PMBOK® (2000) discuss a contract change control process that allows for modifications and dispute resolution in contracts. They add that possible contract modifications should fall under the integrated change control process for the entire project. Prozesky-Kuschke (2003) does agree with PMBOK® (2000) when she writes that contractual remedies are needed when things do go wrong and that the contract is the only weapon upon which to fall back on.

Laubscher (1999) discusses the essential aspects that must be in place for a contract to be enforced. These are

1. consensus
2. capacity to contract
3. legality
4. possibility of performance
5. formalities

Laubscher (1999) suggests that in terms of contractual work the latter four points listed above are normally a matter of course in the environment of large corporate entities. Laubscher (1999) then warns that the consensus issue is potentially the major problem

area as there can be ambiguity regarding the scope of work or deliverables expected. That is, what the client expects to have done may not be interpreted in the same manner by the contractor. It has been earlier described under the section on Scope Management how this, (defining the scope) is one of the unique aspects of projects (Turner, 2000; PMBOK®, 2000). Therefore one could expect that sound planning and management of the scope of work applied to a project should automatically carry over to equally sound contractual agreements.

Under traditional forms of contract, responsibilities and risks are allocated to the different parties (Laubscher, 1999). There are then commercial and/or legal consequences for these parties should they fail to discharge their duties and obligations. A relatively new area of management that is especially applicable to projects is Alliance Partnerships. Alliancing is where various types of collaborative ventures between an owner and service organisations take place in order to deliver a single project (Ross, 2003). Partnerships (as opposed to contracts) were also suggested earlier by De Mayer *et al* (2002) as a more suitable method of dealing with external service providers. Ross (2003) maintains that under a pure alliance:

1. all participants assume collective responsibility for delivering the project
2. all participants take collective ownership of all project risks
3. all participants share in the (monetary) pain or gain of the project

These steps will potentially remove barriers that otherwise create commercial misalignment between contracting parties that normally exist in non-alliance contracts. According to Ross (2003) it is well documented that adversarial conduct under contracting usually arises because the owner company tries to transfer as much risk as possible to the contracting companies. Further, these contracting companies are not usually in the best position to manage these risks. It is generally accepted that risk should be borne by parties best able to manage the risks (Ross, 2003). It is suggested by Ross (2003) that this is the owner company.

The concept of the alliance partnership revolves around a unique payment structure to the contracting or non owner companies (NOC). Ross (2003) proposes a three limb 100% open book compensation model. The three limbs are as follows:

Limb 1 - Project costs and project specific overheads for the NOC are reimbursed based on audited actual costs

Limb 2 - A fee paid to the NOC to cover corporate overheads and normal profit for the NOC

Limb 3 - An equitable share of the (monetary) pain or gain of the actual project outcome for all partners in the alliance.

An explanation is required to fully understand the Limb 3 component. Any financial saving on either cost or time on the completed project relative to the planned budget is shared amongst the partners. Conversely if there is a cost or time over-run, the additional financial costs are also shared amongst the partners.

Typically the maximum downside risk to the non owner company is no limb 3 gain and the loss of their entire limb 2 fee. Beyond this point the remaining risk or loss is carried by the owner company. Note that under this arrangement limb 1 payments are guaranteed, irrespective of the outcome under limb 3 at the conclusion of the project. This means that the worst case for the non owner company is that they recover their basic fees with no profit margin. Another key aspect of the Alliance agreement according to Ross (2003) is that a Project Alliance Board (PAB) is formed that consists of executive level members of the partnering companies. This PAB replaces the need for legal remedies when any disputes arise. The aim being that consensus must be reached by the PAB and that all project issues will be resolved at this level as formal contractual clauses are not used in the Alliance agreement.

This alliance partnership arrangement is currently underway at a number of projects within De Beers and will be investigated as part of this research.

2.14 A summary of the literature review

The literature review maintains that the success of a project is measured according to time, cost and quality of the work as measured by the client. There are key knowledge areas of projects, that if managed properly will lead to a greater chance of success. These were found to be;

1. Integration management
2. Scope management
3. Time management
4. Quality management
5. Human Resources management
6. Communications management
7. Risk management
8. Procurement management

It was found that planning is needed in each of these areas in order to be fully effective in project management. It was also suggested that it is the consideration of each of these knowledge areas as part of a system that is essential to project success. Further, there will be external stakeholders and issues that must be considered to be part of the project system. This systems approach suggests that management of these interfaces is vital in achieving the project goals.

The project lifecycle was described that indicates that the knowledge areas are not discrete one time events but on-going issues that must be managed throughout the life of the project.

Contracts were found to be used throughout many areas of projects and these can be used to manage project risk. However warnings were made that a thorough understanding of the scope of work and legal implications are needed to avoid ambiguities between the client and contractor. The Alliancing model was proposed as bringing a more commercial rather than legal orientation to contracts in projects. This model is aimed at sharing the profits or losses of a project between all project partners.

The above summary indicates the wide range of issues that project managers in the minerals industry find themselves dealing with. The following section outlines the methodology used in this research in order to gain a better understanding of how these issues are actually dealt with.

3 METHODOLOGY

3.1 Qualitative research

The nature of the research questions posed for this study requires a qualitative approach. An broad description of qualitative research is provided by Leedy & Ormrod (2001). They maintain that the researcher must dig deep and collect numerous forms of data. These data must then be examined from various angles to construct a rich and meaningful picture of a complex and multi-faceted situation. This complex and multi-faceted situation aptly describes the project management world within the minerals industry due to the wide ranging activities that are found in projects. Another reason for selecting qualitative research is that it focuses on phenomena that occur in the real world (Leedy and Ormrod, 2001). This description fits the “real world” of projects in the minerals industry.

Given the characteristics of a qualitative paradigm as described by Leedy & Ormrod (2001), a qualitative approach is also proposed here based on the following reasons:

1. the purpose of the research is to describe and explore
2. the variables are unknown
3. the research is context bound and encompasses personal views
4. the samples size is small, and
5. in-depth semi-structured interviews are used to collect data

A different slant on qualitative research is provided by Miles & Huberman (1984) as they argue that words rather than numbers are collected during a study. More specifically they propose that the source of the data will provide well grounded, rich descriptions and explanations of processes occurring in local contexts.

A slight area of disagreement arises in qualitative research regarding the role of the researcher however. Leedy & Ormrod (2001) maintain that researchers must strive to be objective in their research. A researcher’s observations should be influenced as little as possible by any perceptions or biases that they have. Leedy & Ormrod (2001) further maintain that with this objectivity the researcher will maximize their chance of arriving at the truth of the matter. Yin (2003) on the other hand suggests that one’s own prior

expert knowledge should be used in qualitative research. This helps in demonstrating awareness of current thinking in the topic. This view is supported by Lowe, Thorpe & Easterby-Smith (2002) as they use the example of Frederick Taylor's key insights into scientific management being based upon his experiences while employed at the Midvale Steel works during the 1880s. Lowe *et al* (2002:61) further generalise this view when discussing researchers who study areas of their own organisations,

> *"their insights are likely to be deeper than those of researchers who arrive from outside the organisation".*

These last opinions indicates a definite advantage for a researcher who is directly involved in the organisation being studied and who has expert knowledge in the topic being studied. In this study, the author definitely has direct involvement in project management within the De Beers organisation, while aspiring to match the second point. Leedy and Ormrod, (2001) do finally in part support this concept of prior knowledge as they maintain that the researcher must be well versed in the literature of the topic. This is so that the researcher can separate important details from unimportant ones as data is collected. However it is to be noted that the author of this study remained objective when discussing the topic with De Beers employees and while exploring written data. (Yin, 2003) provides a method to achieve this objectivity, proposing that all the evidence must be examined and the interpretations should account for all the evidence and leave no loose ends.

Finally, qualitative research usually formulates general research problems and general questions (Leedy & Ormrod, 2001). This agrees with the problem statement and sub-problems defined earlier which are broad in their definition.

3.2 Gathering the research data

This research was discussed with two group managers, one each from the Projects Office and from the Mining Office. These discussions resulted in agreement for the research to take place using interviews with company staff. Based on this a letter stating the support from De Beers and the purpose of the study was written as an introduction to be sent to the people to be interviewed. This letter is shown in Appendix

A. The interviews were based around a set of questions that were developed to produce findings for the three sub problems. The questions were developed so that the main knowledge areas as described in the literature review could be investigated. A copy of this questionnaire is attached in Appendix B. The questionnaire was sent out in advance to each respondent in order that they could spend time thinking about the topic and be better prepared for the interviews.

The aim of the research methodology was to have face to face interviews with all the chosen participants and to review company reports. There are a number of advantages in using an interview technique to obtain primary data. These are described by Rummel & Ballaine, (1963). They maintain that face to face situations eliminate any possible misunderstanding or ambiguities from written questions. They also mention that observations of facial expressions, physical and vocal reactions are important in adding to understanding the true meanings behind data.

From the selected candidates it was found that one person had retired and one other person had been transferred to Botswana so that not all people could be interviewed in this manner. Two other people from the mining operations in Namibia were also not able to be interviewed directly. These four respondents were sent the questionnaire via email and they replied electronically.

For this research study 25 project staff from De Beers operations were interviewed. The range of project experience from the interviewees was from five to fifteen years. The data gathered from the interview process constituted the primary data.

Secondary data from company reports in the form of project retrospects were also examined in order to either confirm or pose alternative insights from the interview process.

3.2.1 Primary data

There are two groups of people that are affected by projects within De Beers. There are those employees that are, or have been directly involved in a particular project(s). Secondly there are those employees that are the “clients” to the project product. This latter group of employees are not directly involved in the project work itself but will receive the final product and will then take over the management of the ongoing

operations. It is likely however that these clients will keep themselves aware of the projects progress and so are valuable sources of information.

The direct project employees were selected based on their management roles in projects. This was since these employees had exposure to the entire project management discipline and thus would have insights and views on all relevant issues. This was found to be the case. It was expected that the second group, clients to project management products would provide perceptions and views on project management that could be used to corroborate with information received from the direct project employees.

The different disciplines and their respective numbers and category of respondents are shown below;

Table 1. Description of interviewees

DISCIPLINE	NUMBER	NUMBER OF PRACTITIONERS	NUMBER OF CLIENTS
Metallurgy	3	3	0
Mining	8	6	2
Engineering	10	8	2
Legal	2	0	2
Finance	2	1	1

This range of disciplines was selected to attempt to uncover all possible areas of project management principles.

The interviews were based around the three main tasks of the investigator as stated by Rummel & Ballaine, (1963).

1. The respondents must be informed about the nature of the research and why their co-operation is needed
2. The respondent's interest must be motivated so that they will co-operate

3. The desired information must be obtained

These interviews were recorded and then transcripted verbatim. It was requested that the interview be recorded. It was explained that the process of recording will enhance the data capturing process via the elimination of the interviewer having to hurriedly take notes and possibly losing concentration from the flow of the interview. The recording of the interview also enhanced the validity of the data discussed. It was also stated that the recording could be dispensed with if so desired by any potential interviewee. There was a guarantee of anonymity for all the interviewees and an offer to them of speaking off the record was be made. The purpose of this was that there may be issues that an interviewee may not want to have recorded but may have felt that the disclosure of this information would provide something meaningful to the data. It was found that nearly all of the respondents were quite happy for their views to be made public if needed. These statements seem to indicate a level of insistence that their views were of importance and that they should be made known.

Primary data was also gathered by observation. This was through direct work on a current project by the author, including attendance of company meetings. This was able to be done as the author was working in a project environment currently within De Beers at the time of the study.

3.2.2 Secondary data and triangulation

Data gathering in the form of company reports was also used to identify issues that may be perceived to affect project performance. This secondary data was expected to aid in the corroboration of the primary data.

The use of a number of different sources that were used to gather data for this research assisted in gaining convergence around this data, as described by Leedy & Ormrod, 2001; Perry, 2001). This is especially important due to the fact that many opinions were offered from the interviewees. Rowley (2002) adds to these views with three key principles of data collection, he suggests that the following techniques should be used:

1. triangulation – where evidence is collected from multiple sources to corroborate the findings

2. a study database – this increases the repeatability and transparency of the research and includes notes made by the researcher during the study
3. a chain of evidence – the report should make clear the sections of the study database that it draws upon by appropriate citations of documents and interviews

Triangulation was provided by the interview process, company reports and direct observations.

3.3 Content analysis

The design of qualitative study to be used in this study was content analysis. This is “a detailed and systematic examination of the contents of a particular body of material for the purpose of identifying patterns, themes or biases”, (Leedy & Ormrod, 2001:155).

A study database was developed firstly by having all interview transcripts written in Microsoft Word documents. Secondly by virtue of the content analysis process the key issues were further transferred into Microsoft Excel under the key areas of project management. This provided a chain of evidence that supported the findings of the study.

A method used to analyse data is suggested by Perry (2001). He proposes that groups of words from initial transcripts be coded according to categories. These categories allow the researcher to quickly cluster information for recognition, retrieval and organisation (Miles and Huberman, 1984). From the interview responses received and from company reports number of common themes began to emerge. These categories are listed below:

1. project success
2. planning
3. systems engineering
4. contract issues
5. project training

6. risk management
7. quality management
8. communication
9. stakeholders
10. project teams
11. project governance
12. company issues

Under each of these categories the main points of the responses were grouped using Microsoft Excel. This format allowed a process of copying and pasting text directly from the Word document transcripts into Excel. The use of Excel allowed these main points, comments and quotes to be moved around easily in text boxes to the category that they belonged. A number of iterations were needed to correctly place these pieces of text in the correct categories. It was found that a number of issues discussed by the respondents could have been placed under more than one category. The point of these comments could still be absorbed into the research findings in one knowledge area say, but often this particular point supported a general underlying theme that was found to be emerging in other areas. In each text box, the initials of the respondent were placed. This aided in checking through each interview transcript to ensure all interviewees were recorded into the Excel content analysis sheet. Where company reports were used and relevant data was found, this was coded in the same manner in the Excel file. The content analysis sheet is shown in Appendix C. The Excel content analysis file did provided a clear indication of the themes and issues emerging from the study. However due to the narrative style of the interviews, it was needed to examine the interview transcripts in conjunction with the main points to grasp the full context of these main issues. Thought was also needed when examining each of the main comments and quotes as they could often be found to emanate from an underlying issue. For example a number of problem areas could be traced back to a lack of adopting a systems thinking approach.

3.4 Validity and reliability of the research

In a quotation from Leedy and Ormrod (2001:103) two words stand out,

> *"your research effort will be worth your time and effort only to the extent that it allows you to draw **meaningful** and **defensible** conclusions".*

By meaningful it is meant that the results of the research will be useful within the context of the organisation being studied, namely De Beers. That is, recommendations have been put forward that will improve the performance of project management within De Beers based on the findings of the study. By defensible it is meant that the results are open to scrutiny and can be justified via the analysis used in the data uncovered. These concepts were kept in mind throughout the study. There are two aspects to validity proposed by Leedy and Ormrod (2001), that is internal validity and external validity. Explanations of these aspects along with reliability are noteworthy and are explained below.

3.4.1 Internal Validity

Leedy and Ormrod (2001:103), describe internal validity of a study as

> *"the extent to which its design and the data that it yields allow the researcher to draw accurate conclusions about the cause-and-effect and other relationships within the data".*

This description supports the one above regarding the results being meaningful. Adhering to the three principles outlined earlier by Rowley (2002) of triangulation, the use of a study database and providing a chain of evidence will greatly assist in maintaining accuracy.

Perry (2001) also supports the use of triangulation as stated by Rowley (2002) and further adds that company documents and memos can be used to confirm interview or questionnaire data. A suggestion by Patton (1990) is to use colleagues to review transcripts and documents to provide a second view of the data that could be missed by the researcher. This method was used where a number of issues were not entirely clear from the interview process as one can miss nuances when continually being immersed in a topic for long periods.

3.4.2 External validity

External validity of a research study is the extent to which its results apply to situations beyond the study itself (Leedy and Ormrond, 2001). Although the focus of this research has been on De Beers it is the considered opinion of the researcher, however, that due to the wide ranging scope of project management, a number of the findings of this study may be applicable to other minerals related companies and other industries.

3.4.3 Reliability

Perry (2001) describes reliability as how consistently a technique measures concepts so that other researchers will get the same results. Using a study database greatly assisted in this endeavor. The use of the Excel content analysis file provided a layout of the key findings of the research and provides the results for scrutiny. Perry (2001) suggested that a steering committee should be formed to design and monitor the research study. As this study took place with the authorisation of De Beers the sub problem questions were discussed with the two company sponsors to ascertain whether any specific areas of projects from their viewpoint should be included.

4 PRESENTATION AND INTERPRETATION OF RESULTS

The literature review has provided the reader with a number of knowledge areas that must be well executed in order to be successful in project management. The findings of the research now reveal the importance of these areas and explains the reasoning behind the relative success or otherwise in their application. This chapter divides the findings of the research study into the three areas proposed by the research question sub problems, namely;

1. To determine a clear definition of a failed or successful project
2. To identify the key drivers that affect project performance within De Beers and the success in using these key drivers
3. To identify possible barriers that obstruct sound project management principles relevant to De Beers being used within De Beers?

4.1 The definition of a "failed" or "successful" project

4.1.1 Time cost and quality

Literature is very clear in that a successful project is one that meets the targets of time, quality and cost. Most authors added that the product delivered must meet these three criteria as measured by the client. Then by interpretation, a project that fails to meet these three criteria must have been a failure. Therefore there are only two states that a project can meet, either success or failure, according to literature. We should ask the questions however, what is the actual target for time, cost and quality. If a project was 5% over on the time schedule did that mean that the project was a failure? If a R1.0 billion project was overspent by 2% (R20 million), does that mean that the project was a failure? One De Beers executive interviewed proposed that there should be an envelope around the time and cost targets. The project team must define this envelope. The board of directors will then determine whether the envelope is acceptable depending on the prevailing business environment.

This concept of the envelope around time and cost was raised by only a few project practitioners but from a more senior level within the overall group of interviewees.

What if the time and cost budgets were not realistically set? This point has a two sided argument according to this group of managers. The cost and time budgets may have been very optimistic, as say in the “half, half” principle with one particular recovery plant project, (the aim was to build the plant at half the normal cost, and in half the normal time). Then failing to meet these very optimistic targets will be extremely difficult and perhaps should not be called a failure. On the other hand as one corporate level project manager mentioned, meeting a very leisurely time schedule and an extremely conservative cost budget may be easy. In this case, a success in terms of the stated targets could be claimed but maybe not when compared to industry standards. This leads to the application of our minds as to what the targets should be. It could be asked, do we want to measure project success relative to De Beers internal targets or relative to international or South African benchmarks. The answer to this question could in part be influenced by who is going to finance a project. Any external financing would surely promote the use of industry standard performance to attract risk capital. In line with the De Beers vision to be the diamond miner of choice then project targets should be measured against international standards. This aim is further backed up by the De Beers Total Project Management (TPM) guidelines where it is stated that the objectives for De Beer’s global business is to deliver world benchmark performance.

A large number of people stated that the net present value (NPV) or ROI (return on investment) of the project was the key measure. This is seen from the eyes of the client (the De Beers Executive). This was also seen as difficult to measure in the short term as cash returns usually take a number of years to accumulate once the project has been delivered. One executive member however countered this by saying that if at project completion, there is any time or cost over-run or quality deficiency then we already know that the NPV is being eroded. The new time, cost or lower performance figured would then be entered into the project’s business model and the new lower NPV now gives the value lost due to the variations on the targets.

4.1.2 Additional measures of project success

All but two of the people interviewed agreed that a project cannot be measured as a success or failure based on time, cost and quality alone. The view from this group was that the terms failure should not be used as there are too many variables that are

needed to measure project success. It has been proposed by those with this opinion that a number of measures are needed.

These additional measures proposed are;

1. The benefit of the project to the image of De Beers
2. The benefit to the community where the project's facility is situated
3. The success in assisting PDSA's (previously disadvantaged South Africans)
4. The degree to which areas of the Mining Charter are met
5. The effects that the project has on the environment
6. The success in building and retaining future project staff
7. The success of the future operation post project completion, including
    - operability and maintainability of the facility
8. The learnings generated for the company
9. Proving new technology
10. The degree to which the requirements of all stakeholders are met.

Points number one through to five are taking cognisance of the environment external to the project. Starting with the image to the company created by the success or otherwise of a project, these measures are aimed at satisfying external stakeholders. This is stating that a company could have a sound technical and financially viable project but if any local community or environmental issues became problematic then the project could be jeopardised. The measures around the Mining Charter Scorecard and PDSA's are also posing a warning at a broader level that external stakeholders must be considered in minerals related projects.

To be more specific on point number six, it was discussed that if project team members were disenchanted with project work as a result of working on a difficult or poorly managed project then this was failing to build future project intellectual capacity. It was even suggested that people can and have suffered from health problems as a result of stress while being on a project. Loss of these people to the company or to a lesser degree to projects, will only reduce the quality of knowledge management for the

company in this area. The comments about building and retaining project staff was in part supported by the often stated criticism that De Beers was not doing enough to train project managers. This is discussed in more detail in the following section.

Point number seven regarding the success of the future operation brought out discussions that could fit into a number of areas of project management and is almost a topic on its own. It is no good delivering a product or facility that fails to perform for the operators that take over. Every person interviewed agreed that getting buy in, agreement and sign-off on the project plan from the people who are going to operate the facility is critical. This is seen as reducing the chance of the facility failing to deliver the desired performance. The majority of people interviewed stated that the future operators must be brought into the project (temporarily) at the conceptual stage to get consensus on the way forward for the remainder of the project plan. It was also strongly motivated that operating foreman level staff should be brought onto a project during the construction and commissioning phase. Further, it was mentioned that these people should have input into the design. The view is that since these people will have to run and maintain the plant and equipment they must have ownership regarding the design and process. If not, they may not have the dedication needed when things go wrong, responding in this case with “well it was not our design anyway”. It is suggested that when people have ownership of a design or plan then they can be held accountable for it. This concept is more likely to ensure a team will make something work. An example of this was at a new recovery plant where the project team had designed conveyors for an area in the plant. De Beers head office changed the design to pumping which was not agreed to by the project team. This incident did apparently cause problems in the overall project as it would appear that buy in and thus accountability had been lost. One other severe example was used where it was suggested that a particular foreman had intentionally sabotaged a plant facility’s performance because he did not agree with the design.

In line with this view of accountability it was also suggested that project staff remain on in the operation in the early stage of commissioning and production. A degree of accountability must remain with the project design team in getting the facility up and running. In fact one long time De Beers manager suggested that there should not even

be a “hand-over” to the operational staff. There should instead be a gradual blending from project to permanent operational staff.

The staff resources needed from a brown fields operation to take part in this early buy-in process was stated a number of times as being problematic. Due to the production pressures at the operation, staff are not released when needed to take up the stakeholder role in the project conceptual, planning, design or commissioning phases. It was suggested that planning could go into this area and a detailed schedule could be agreed to, to release the key people when needed.

Points number eight and nine highlighted the need for improving the knowledge base of the company. The point was raised that too much work is done in isolation and past experiences are not passed onto new project teams. The issue of proving new technology was only mentioned by two people. This however is an important point that may only surface from time to time. This is due to a common strategy observed by the author whereby a project may state that only proven technology will be used in order to reduce risk. There will however be a need where new technology must be tested to improves operational efficiencies or reduce costs. It would be the goal of these types of technology advances to provide a long lasting group wide benefit. Here the usual measures of time, cost and quality were suggested as being of lessor importance.

Point number ten was highlighted as a measurable success factor. The expectations from different stakeholders are likely to be quite varied. These needs and expectations should be defined and be measurable. These measures will then form a matrix type scorecard that can be used as a gauge of success at project completion. It was also highlighted that each group of stakeholders need to be educated as to the needs of the other stakeholders. This is likely to reduce the chance of conflicting needs and requirements being brought to the project scope of work. The term stakeholders was used in a broad context here by a number of respondents. stakeholders can be external to the company as well as internal stakeholder, i.e. the managers and operators of the project’s product. The main point stressed here however was that there must be *measurable* requirements for each group of stakeholders.

4.1.3 Weighting of the success measures

A minority of those interviewed suggested that the above mentioned measures should be weighted according to their relative importance for the particular project. However those that did put forward this suggestion were all at a more senior level than those that did not. It was generally agreed amongst this group that even time, cost and quality should be weighted according to needs of the particular project. It was also suggested that weightings of the measures would be dependent on the business environment prevailing at the time of the project.

A number of people proposed that the sensitivities of the project cash flows must be investigated. This will indicate the relative importance of issues driving the revenue stream. One senior project manager stated an example of this clearly;

> *"Some projects are revenue sensitive and more focus must be placed on the quality and sustainability of meeting long term production targets rather than aiming for a shorter implementation window or capital cost saving".*

Although difficult to measure, one De Beers executive proposed that "there should be no surprises" (at the end of the project). Elaborating on this point it was suggested that all known risks should have been identified and the consequences understood by the project team.

The conclusion to the problem of a definition of a failed or successful project therefore seems to lie in using a number of measures and not just time, cost and quality. Weightings of these parameters would then be set according to the individual project and the prevailing economic, marketing and risk climate as seen by the company. The combined scores should then be the measure of the project success. Also, we should probably not expect 100%, taking into account the dynamic project and business environment that minerals related projects find themselves in. However, what is a pass or fail score? As one project manager interviewed stated, at any academic institution (regarding examinations), over 75% is a distinction. Maybe this is a good starting point.

4.2 The identification of the key drivers affecting project success or failure and the success in their use

Literature outlined a number of knowledge areas that must be considered for successful project management. The findings of the research pointed towards condensing these areas into seven main headings.

1. planning,
2. quality and risk management
3. human resources management
4. communication
5. contracting
6. the systems approach
7. project governance

This research strove to seek out whether these issues are needed on projects in De Beers and how successfully they are dealt with. The research also aimed to seek out influential drivers that may be unique to minerals related projects or to De Beers as a company. This chapter outlines the key project management areas and the level of capability that De Beers project staff see the company delivering currently.

4.2.1 Planning

Literature highlighted that planning covers all the knowledge areas of project management (Yates & Eskander, 2002; PMBOK®, 2000). Planning therefore has consequences throughout the project lifecycle. This area received a lot of comment from the general body of interviewees. To get straight to the point it was stated that planning is not done well in De Beers projects. The major reason given agrees with the concept of systems thinking proposed by Blanchard & Fabrychy (1990), Steyn *et al* (2003), or a lack of it, that is engineers tend to think in isolation when planning. Most of De Beers project staff are from an engineering background and more specifically individuals are from *one* engineering background. These people then will naturally have a strong focus on their own discipline to the possible detriment of other disciplines. It was discussed that planning of most tasks in De Beers projects

encompass a number of engineering disciplines as well as accompanying logistical and service functions. It appears that not all these disciplines, service and logistical issues are included in the planning stage when a plan is compiled by single discipline engineers.

A number of authors from the literature review proposed that the correct setting up of the customer requirements paved the way for successful planning of a number of activities. Nicholas (2001), Carruthers (2003) and PMBOK® (2000) warned of the difficulty in setting up proper customer requirements and it is evident that this lack of clear understanding of the project requirements is one area causing sub-standard planning. It was also proposed from a number of interviewees that project team members themselves were "customers" in the requirements context. Therefore a lack of proper requirements planning can erode the efficiency of the project team not just the project's product. This problem area when considered in a planning context agrees with the findings of Yates & Eskander, (2002) where they found that the number one problem causing delays on projects was constant changes to the project requirements. Another quote sums up a lack of using a wider systems approach to planning when one project engineer stated that "we don't see beyond the battery limits[4]".

It was also mentioned by a small number of project practitioners that the business concept is not adequately considered when planning projects, as again engineers, it is suggested do not always have the company's business goals in the forefront of their minds. A number of people suggested that engineering staff tend to seek the best "engineering" solution, this may not always be the best solution in terms of the business however.

Suggestions were given that more attention is needed regarding a retrospective view of planning success. Retrospects are taking place in De Beers projects and the aim regarding planning retrospects is to analyse how close actual results were achieved compared to the original plan. Retrospects are used at the end of a project and perhaps at the end of a major phase. However the suggestion was more pointed in that project teams should analyse planning on a more regular basis during the project work rather

[4] The boundary of work for a particular project task

then wait until the end of the project. This feedback on planning is needed sooner rather than with more accuracy later. A number of instances were quoted where this reviewing process does take place. In these cases if there are deviations noted between actual and planned activities often the baseline plan is changed as a result so that deviations are hidden according to a number of project managers. When this happens unintended consequences occur as was highlighted by Avots (1969). He stated that often the inter-relationships and effects on other project areas from the adjusted plan are not considered which leads to problems later in the project. A number of project managers acknowledged this problem of re-adjusting the original plan without proper understanding of the consequences.

An alternative to this retrospective view of planning is that project staff should look forward into the plan. We must manage in advance and not in arrears as one project manager stated. It is suggested that the question must be asked, what do we need to do to make sure this plan is met? This is a more pro-active stance that aims to "plan" to meet the plan, rather than look back after the work is done. This view on planning agrees with another quote from one project practitioner,

"The plan is nothing but the planning is everything"

The key word in this quote is planning. In other words the thought process that goes into the planning is what makes the plan work. The importance of thinking in the planning process was in fact highlighted by a number of staff.

One solution proposed to aid the planning process is to make use of planning facilitators. This (professional) facilitator will draw out the relevant information, task details and inter-relationships from a group of multi-discipline project team members. Ultimately these team members will contribute to compiling the plan so ownership and thus accountability will still be with the project team. This it was suggested will result in a more holistically correct plan.

The planning process on projects is discussed as not being repeatable in the company. This statement then seems to demand a standardized approach to planning. A high number of interviewees together proposed through various replies what is in fact an existing solution in De Beers. This is the standardized approach outlined within the TPM framework. The great need for correct project procedure during the early phases of the

project was emphasized. This is where the following documents are needed to be compiled and well defined;

1. Project briefs
2. Project charters
3. User requirements statements
4. Project execution plans
5. Stakeholder management plans
6. The work breakdown structure (WBS)
7. Quality plans

What is not be happening in the company is the strict use of these documents according to most project staff interviewed. One member of the project fraternity even suggested that the time had come to start forcing people to adhere to the TPM governance procedures. It was also suggested that experienced and dedicated people be utilised in setting up this early stage of documentation. It can be construed from this comment that project teams are not doing this.

Section 4.1 (the definition of a successful or failed project), discussed the importance of creating buy-in from operational stakeholders to a design or process to be used on a new operation. The buy-in issue with the commensurate accountability also surfaced during discussions on planning. An interesting tale was told by a previous mining manager who related how his group of mining personnel dealt with a particular mine plan. In brief the episode went like this;

> *We were given this plan from the "engelse" [5] on how to mine this one area. The plan was a stuff up yet we just carried on and mined according to this plan. On looking back now I can't understand why we carried on mining according to this plan when we knew it was wrong, but we just kept on mining like they wanted because THAT WAS THE PLAN!*

[5] A slang term for "English" senior company executives

This incident highlights the loss of accountability due to a lack of consensus, consultation and buy-in to a plan. This reinforces the concept regarding the setting up of the correct level of operability (with consensus) at a new facility as being one of the measures of successful planning.

This issue was also summed up by one senior project manager when he stated that senior De Beers group managers and executives are not generally accepting of bad news. He suggested that they needed to be more accepting of when projects were being delayed or that plans of actions should be reviewed instead of just carrying on regardless. This view was backed up by another project manager who stated that the project teams must be prepared to offer the bad news when it does occur. He suggested that this is not usually the case.

It was also suggested that the amount of planning should be commensurate with the estimated execution cost and risk of a particular area of the project. This should follow from the risk management plan which will identify the high impact areas of the project. The appropriate funds and resources for the planning phase should then be allocated to the higher risk and cost areas.

4.2.2 Quality and risk management

Authors highlighted in the literature review (Carruthers, 2003; Nicholas, 2001; Blanchard & Fabrychy, 1990) have suggested the difficulty in arriving at clear requirements from project stakeholders. The influence of this on planning has already been discussed. It was seen that quality was defined from these requirements. Marriot (1987) then indicated that quality failures are occurring in spite of quality assurance plans being in place. The quality issue then becomes one of risk to the project.

It was stated by one mining manager that at De Beers Quarterly Strategic Meetings (QSMs) only the financial and scheduling issues regarding projects are discussed. Minimal discussions around quality and risks of projects seem to surface. One other project engineer stated that these issues were generally discussed but it was suggested that these issues *must* be addressed in these forums along with the staffing plan for the future operation. To corroborate this view, staffing on projects was seen by a number of other respondents as being a potential quality and risk issue. This staffing

risk surfaced in a number of areas. Firstly there was the issue of operational personnel, in that current skills levels do not readily enable leading technologies to be successfully used. There were examples of where training of operators was done at one facility but they would be utilised on another new project. The training arena did not have the level of technology that was going to be implemented at the new project. This lead to a disconnect between the level of skill required at a new operation and that actually possessed by the workforce. Mention was also made of bringing in existing operators onto newly commissioned projects without the correct level of change management. It was also highlighted that the supervisors were key in this change management process as they would largely set the tone of acceptance for the operating level staff. Turner (2002) highlights the need for change management and this was supported implicitly by PMBOK (2000) as they mention that consequences often arise after the completion of a project.

Secondly the skills level of contractors and sub-contractors was raised as quality and risk management issues. Examples were presented where contractors had apparently hired people “off the street” to perform work on De Beers projects. The resulting lack of skill was reported to have caused problems in construction and commissioning phases. It was suggested that De Beers staff take it for granted that even reputable contracting firms have the requisite labour ability. One project retrospect report even went as far to suggest that quality and workmanship were problems in South Africa generally. The point was thus raised that project managers must take a more active role in scrutinizing the capacity of contractors regarding skills levels of these contractor employees.

The role of external vendors and suppliers was raised under the area of quality regarding purchasing of commodities. It was strongly suggested by two project managers that De Beers staff must not assume that vendors and suppliers have the requisite quality entrenched in their products. This view was backed up by another project metallurgist when he suggested that in spite of a paper audit trail, deficiencies were found in supplier products he had used on one project, agreeing with the suggestion of Marriot (1987) earlier that quality procedures do not always guarantee quality. It was pointed out that experienced technologists should inspect vendor’s goods and not just rely on paperwork from the vendor. These technologists could be specialists from outside of De Beers if needed. An extension to this issue was suggested

that in addition, vendors must remain on site until their products are installed, commissioned and running at the required performance rates.

The general problem of risk management concerning suppliers was summed up in a more general sense by one project manager. He stated that De Beers projects must investigate and understand the internal risks of the contracting companies themselves that are used on projects. This could mean bringing their representatives into the early risk planning stage with updating of these contractor company risks as the project proceeds.

The majority of people commented that generally risk management is gaining in prominence in De Beers projects but improvement is still needed. A number of managers discussed past projects where no risk management had been done at all. However the common theme coming through was that risk management was not treated as a dynamic entity. Usually there would be an enthusiastic first effort with the accompanying brainstorming and risk identification done. However often this risk plan was left alone and not re-visited again. This view was corroborated by a project retrospective report which stated that emphasis must be placed on risk management throughout the project, (this statement implied that this had not been the case on this particular project). This report also suggested that risks change as the project proceeds and these changing risks need to be identified. Having one attempt at a risk management plan would definitely not address the dynamic risk environment that most projects find themselves in. One project manager suggested that risk is not considered within the context of a system and that individual disciplines still only investigate risks within their own “silos”. This manager proposed that project teams should consider the systems within the project scope rather than each traditional engineering discipline.

There was also a perception that only enough risk management was being done in De Beers to fulfill the basic requirements. This seems to be in line with the findings of the survey on 25 South African Companies as highlighted earlier by Shevel (2003), where this was the case. A solution offered was that senior managers should take more responsibility to drive this area. It was often suggested that bringing risk management more to the forefront in projects would greatly reduce negative incidents further into the project lifecycle. It was felt that most senior managers did not involve themselves in

gaining the required knowledge in this area. One opinion was that senior managers felt they did not have to learn any further (about risk management) as they were already "senior" enough in the company.

4.2.3 Human resource management

The overwhelming response on this issue is that project managers in De Beers are not given the requisite training to enable them to manage projects professionally and according to the required governance procedures. There seems to be an expectation within De Beers that operational managers can be easily moved into projects and manage the project processes without any further training or preparation. The people selected to manage projects also do not have the experience needed for large projects according to the body of people interviewed. However it was proposed by a number of project staff that the split away from Anglo American Corporation did reduce the number of experienced project managers available at the time. A number of suggestions were proposed to address the perceived lack of capability currently experienced. These were:

1. Send managers to other companies to gain project experience
2. Instill a career path for project management as a discipline in the company
3. Bring identified project managers up through smaller projects
4. Institute a level of training and competency that must be reached and tested before a person can manage higher category projects
5. Provide a dedicated project management mentoring process

One other suggestion raised as a shorter term solution is that peer assists should be used more frequently where there is a recognized deficiency of the correct level of project management skills. This is where other more experienced project staff from other areas of the company are called to review project work and make recommendations where necessary.

It could be agreed that all operational General Managers for example will have projects occurring on their operations at some stage under their tenure. It was therefore suggested that in general, all senior managers in De Beers should understand the

principles of project management. This would enable these managers to follow the project processes and provide the correct sponsorship of a project. It was further commented that senior managers tend to demand responses from a project team that are not suitable in a governed project environment if they do not understand the basic principles themselves. These senior managers must have a good grasp of TPM principles so they understand why the project team is doing certain activities at a certain time, especially during the early stages of project definition and planning. This view was in line with a perception from a number of project practitioners in that for many senior managers, documentation such as Project Charters, User Requirement Statements and Required Operational Capability statements are seen as a waste of time. A fair number of those interviewed stated that senior managers are not abiding by the principles of TPM or that they do not realise the benefits of TPM.

A clear view was made that in addition to having the correct training and experience, project managers and perhaps project staff selection is needed according to the phase of the project. It was suggested that the conceptual and planning stage of a project was often placed in the hands of relatively junior people and that more senior staff should be selected for this phase. It was explained that these junior people don't have the experience and long range business thinking skills to consider all the possibilities and consequences during conceptual stage thinking and planning.

The type of person needed to manage the construction or execution phase of a project on the other hand would more likely be an operational manager. This person would be more comfortable working according to a pre-determined plan. It was suggested by three respondents that using tools such as the Meyers - Briggs personality measures as an example could be used for selection of managers and team members. It was suggested generally that the person or people that were currently available at the time were selected to take part in projects without to much thought on the person's capability.

The general consensus is that with the large number of projects on the drawing board, De Beers is not ready with the required trained and experienced project managers. This observation prompted a number of suggestions that De Beers should be outsourcing project management. It was proposed that De Beers should build a small group of high

level experienced client project managers. These staff would liaise with professional project companies who would be used to provide the actual project planning and management skills These De Beers staff would manage the interface between the project company and De Beers as the client. This it was suggested would also serve to counter the problem of retaining project staff during periods of low project activity.

4.2.4 Communication

All De Beers staff interviewed agreed that communication was critical to successful projects. Most also proposed that it was not done well in De Beers. It was suggested that project communication across disciplines is not carried out at the desired frequency. It was also suggested that communication does not take place enough vertically within a discipline. These thoughts concur with Mihm *et al* (2003) who warned that communication between divisions is often lacking in projects. The effects of poor communications as suggested by study respondents are to alienate team members, decrease the ability to plan according to systems thinking and decrease the opportunity for drawing innovative ideas out of team members. This lack of communication between disciplines in project teams also points to the warnings of Robbins (2001) and Burke (2003) where they suggest that individuals often act together as groups and not as a team with all the synergies that accompany team behaviour. These authors did not explain what causes group or team behaviour but it can be proposed that this lack of communication would tend the project members more towards the group behaviour. If group behaviour is more prevalent than true team behaviour, as proposed then work efficiency will be lacking and overall project performance will undoubtedly suffer.

The answer to the perceived communication problem as suggested by the vast majority is to treat communication more importantly than is currently the case. Suggestions aimed at improving communication included the following:

1. treating communication as a separate discipline, compared to mining or metallurgy
2. creating a detailed communication plan for projects including stakeholder engagement
3. having a communication officer or manager in the project team

4. executive project sponsors to take a more active role in communication
5. more regular formal communication on projects from the project manager (at least weekly)
6. the project office to drive communication as part of project governance

Virtually everyone interviewed highlighted the importance of the stakeholder communication plan as a key element in project success, even to the extent that this becomes a measurable parameter on a project scorecard. Overall most respondents stated that stakeholder management has improved greatly on projects. A wide array of suggestions were offered to improve stakeholder engagement further. One suggestion was the need to identify the stakeholders individually and plan how each individual would be managed. That is, what are the personality characteristics of these individuals? This concept makes sense when one considers the wide range of expectations and roles covered by the key stakeholders. The need to identify stakeholders at the beginning of the project lifecycle was also emphasized by most people interviewed and it was suggested that this would aid in individual communication management plans as suggested above.

Another disruption which surfaced while discussing stakeholder engagement was alternative work methods used to arrive at engineering solutions. The example used was where a trade-off study was conducted to select an underground ore transport system for a certain project. The work was largely done using Excel spreadsheet models to arrive at the most cost effective system. Upon presentation of the work, with the proposed solution by the project team, the consulting engineer announced that he wanted a computer simulation done to represent the different alternatives before agreeing to the proposed solution. This meant a further two months work for the team when they had in their minds, just brought the task to its conclusion.

The specific objective of *marketing* the project was highlighted by a small number of project staff. Their intention was to make the project look as appealing to the company as possible. In a conversation with another project practitioner it was suggested that presenting projects internally should be modeled on presenting a business plan to a

bank for financing. In this case the project would be made to look as “sexy” as possible so as to get the best possible response from the financing bank. It was suggested marketing and public relations skills need to be brought to the project environment to improve the perception of a project proposal and the way the project is presented. An example was re-counted where a particular project took seven months to get approval for a continuous operation permit from the mining inspector. In hindsight this project manager admitted that the mining inspector had not received any briefings about the project. He had suggested that the unduly long time to get the permit was due to the lack of engagement with the inspectorate and implicitly proposed that a more marketing like approach was probably needed.

The majority of people interviewed maintained that more effort should be put into sharing information throughout the group. This is where project retrospects are used in De Beers to firstly document the learnings from a particular project and secondly to disseminate this knowledge throughout the group. Those that discussed this topic believe that the retrospective process is not being fully utilised. One project manager, as an example, asked why no one from another current major project in the company had ever met with his project team to discuss any learnings or general project management issues.

4.2.5 Contracting

As with most engineering orientated companies, the operating division of De Beers enters into formal contracts with contracting and supplier companies during project work. These agreements have been along the lines of conventional legal contracting principles. The success or otherwise of these contracts was investigated during this research.

As an opening statement to set the scene regarding project contracts, it was stated by a legal staff member that the traditional approach to engineering contracts has frequently failed to deliver completed projects on time and within budget. A number of instances were described by project managers and engineers where major disputes had arisen during construction and commissioning work on De Beers projects. The suggestion was then made that the disputes arose primarily due to a lack of clarity in the scope of work and deliverables as outlined in the contract. It was pointed out by a

smaller number of project staff that issues were being missed when spelling out the requirements to be followed by the contractor. An example was given on one project where a contracting firm believed that they had met a commissioning deliverable but De Beers engineers believed they had not. In retrospect it was found that the clause describing the deliverable in the contract was actually ambiguous according to the engineer concerned. The issue here is that although the intention of a contract is to clearly spell out what is required from the performing party, this does not always happen. It was highlighted by Burke (2003) that the contract defined by a scope of work has a high degree of risk as any deviations from that scope call for re-negotiation and often as shown here, contractual disputes. The message therefore is that the client must be very sure of the work that is needed, the terms of the work and the deliverables must be stated unequivocally to fully benefit from the fixed price contract. This again points to having a clearly defined set of project requirements.

One project participant from a recently completed large project suggested that De Beers management had planned to pass on as much risk as possible to the contractor but had been unwilling to pay the risk premium required by the contractor to accept these conditions. This example points to the misuse of contracting principles and promotes the potential for conflict.

Another project engineer stated that how at a project meeting a group of contractors admitted that they would try and tender the lowest bid possible to win a particular contract. Once awarded the contract they would then plan to issue variation and standing time claims to actually make the required profits. This statement was suggesting that conflict would be an eventual and expected part of the contracting approach.

The issue of quality assurance was raised in the context of contracting. A number of De Beers staff from the legal department were questioned on this area. They proposed that legal clauses are needed in contracts to properly define the quality expected from contractors and suppliers. Normally project contracts refer to other De Beers standards and policies regarding the quality expected. It was stated that this issue was too loosely dealt with and that legal staff were often called in at the last minute and asked to insert the requisite clauses into contracts when they had very little understanding of the

process already followed. It was also suggested that quality issues were sometimes discussed via emails and informal communication methods by engineering staff. This is in contrast to being expressed in legal terms that are needed to ensure proper understanding of the required quality measures. This scenario matches the warnings given by Prozesky-Kuschke (2003) and PMBOK® (2000) earlier in that engineers must be wary of legal implications within projects. This is due to their suggestion that most engineers have a low level of understanding regarding legal matters.

The use of the Alliance partnership has been discussed in the literature review as a relatively new method of working with external entities. The basic principles of the Alliance were discussed earlier by Ross (2003). The Alliancing concept was not able to be deeply investigated in this study due to the unfamiliarity with this partnering method by most De Beers project staff. Discussions did emerge however with a small group of people who have been investigating Alliancing and who have had limited experiences both in De Beers from other organisations.

Generally those who discussed Alliancing did state it was a positive step with regard to engaging external contracting companies. Three project managers did agree however that maybe Alliancing was seen as a potential panacea for contracting due to the poor handling of contracts in the past. That is perhaps pure contracting in itself is not deficient, it is the problem with the contract scope definition and the way contracts are managed in De Beers. It was stated by a number of managers that in their opinion Alliancing is not delivering the expected benefits. These comments do not go un-noticed. One young project manager lamented that he had heard senior managers in De Beers disparaging the Alliancing model. His comment was then, “well, what are we supposed to think about Alliancing if we hear this”?

One project manager advised that on his project Alliancing was only going to be used from the execution stage and not in the feasibility stage as he felt that this model was not appropriate during a feasibility stage. However, the planning undertaken from the feasibility stage was such that the future Alliance was catered for at the later stage. This indicates that the Alliancing model may not be appropriate for all project phases.

One issue was raised regarding the lack of legal remedy that is available when project commitments are not carried out within the Alliancing model. Under a normal contract,

the wording of the contract will provide the guidance in a legal dispute. Under the Alliancing method, there is no legal contract so any disputes would be referred to the Project Alliance Board to find a solution through consensus (Ross 2003). If this avenue fails and legal action is needed then common law will prevail. It was suggested by a previous project manager that in this case, having to prove damages becomes far more onerous for the party seeking remedy. This was resulting in De Beers losing the safety net of contractual terms. Again according to legal staff it was stated that in the traditional contracting model, rights and obligations are allocated in advance and breach gives rise to predictable legal remedies. The Alliancing model, on the other hand, relies on the strength of relationships and commercial incentives (rather than the force of law) to ensure performance.

It was also suggested that De Beers management needed to consider the Alliancing concept when things start to go wrong. It was proposed that as Alliancing is still relatively new to the group, that it was only being looked at from a positive view point currently. One manager referred to a previous less formal alliance with a supplier company and stated that “we still kicked their backsides if we needed to”. He was referring to the need to keep quality and service issues under scrutiny when applicable. He and others felt this avenue was being lost via the proposed project Alliancing method.

As a final issue it was stated that when engineering staff are called to deal with any contractual disputes or claims, then their efforts are being distracted from the technical areas of the project. As projects have deadlines to meet this state of affairs can only detract from the successful completion of feasibility plans and finished facilities.

4.2.6 Systems thinking

Literature highlighted the need for a systems thinking approach to projects and the subsequent benefits (Blanchard & Fabrychy, 1990; Nicholas, 2001; Baker, 2002). There is a general agreement amongst De Beers project practitioners that the company needs more Systems Engineering thinking and practice. It was also stated that this capacity is not instilled into the company’s project staff currently. More than one interviewee suggested that mining engineers are probably the worst at using a systems approach, seemingly because they do not think widely beyond their own discipline.

A number of examples were given where interfaces between discipline boundaries were not considered, explaining the lack of systems thinking. A striking illustration on a current project was where the recovery plant head feed rate was planned at 1200 tons per hour. The mine however had been planned to deliver 1800 tons per hour. This type of misalignment will eventually surface and be rectified but usually after time, effort and money has been wasted. It was suggested by the person who posed this example that systems specialists should be developed in De Beers. A similar example was provided from a completed project where the philosophy of no surge capacity in the process flow was accepted. In this example, a drying process was needed to be taken off-line for repairs at certain intervals. The design neglected to consider that the dryers needed two hours to cool down before repairs could begin. As there was no surge capacity, the entire downstream process ceased operation for two hours even before the repairs had begun. Surge capacity was later designed in.

A large group suggested that interfaces and dependencies must be identified during the conceptual phase and all discipline representative should be involved during this stage. This would probably reduce another problem area uncovered from the interviews in that separate disciplines within a project tend to act in isolation. Bringing the systems thinking process on board from the conceptual stage will help this method of thinking remain throughout the project lifecycle.

There was one systems thinking issue that also has a possible inclusion under stakeholder communication but will be described here. There were instances highlighted where consultants and advisors were brought into a feasibility study late in the proceedings. This had the effect of bringing about changes to a piece of work while at the same time the effects (due to the requested changes) on the overall system were not considered. Two examples provide a clear picture of the undesirable consequences. The first example was on a recovery plant design that did not have cladding on the external structure. This design had been approved by the project team. At a final design review a senior head office consultant suggested that cladding be added to the design. A quick calculation was done and it was found that the additional cost would be R3 million. The addition of the cladding was then approved. Upon subsequent design work it was found that the cladding would add considerable wind forces to the plant building and that the structural columns would have to be increased in strength. Further

consequences of this was that the foundations had to be increased to cater for the new larger columns. The final cost was actually R30 million.

A second example was on a chute design for another recovery plant. After a design was finalised by the project team an external consultant was then approached and he suggested a three degree alteration to the angle of the chutes. This alteration appeared small and was accepted. Upon redesigning the chutes, it was unexpectedly found that the height of the plant building increased to accommodate the new higher chutes. The relative position of two plant buildings moved as a result of the change to the building re- design and the footprint of the plant area increased. Finally an unexpected 15% increase in costs was the result.

The lesson here is that all stakeholders, including consultants in this case, must be identified early in the work programme so that they are aware of work as it proceeds. Secondly, all the consequences of a design change must be fully considered prior to accepting this change.

The use of systems thinking carries over into project services regarding the incorrect use of key performance indicators (KPIs). It was mentioned by a small number of respondents that individualistic KPIs drive efficiency in isolated areas that together may not produce the desired business results for the company. One example given was regarding a mine store's KPI of reducing stock holding time. However when a particular project critical spare was needed, it was found to be not in stock due to the stores elimination of this long shelf time item. It was suggested that the need to have the spare part available was more critical to production and thus the business than reducing stock holding time in the mine store. Another example was related regarding a project where no procurement personnel were represented on the project team. This was suggested as being the reason for a project delay. The delay was when a critical item was shipped to the project site but took a long and arduous route across half of the country finally arriving much delayed to the project team. It was proposed that bringing on board a procurement officer as part of the project team would eliminate problems in these logistical systems.

The idea of systems thinking also can extend to the management of people to a degree. When merit salary increases and annual performance appraisals are done they

focus on the individual. There is no measure based on the performance of a team. It was suggested by a number of people that the team performance should be measured as well as individual performance.

Although interviews were directed towards projects this area of discussion often flowed towards operations. However upon reflection it can be recognized that where systems thinking weaknesses were outlined at a working operation, correct project design and planning which included the final operation as part of the project life-cycle system could eliminate a number of these faults.

4.2.7 Project governance

Koskela (2002) earlier discussed the need for a theory, and she proposed that a theory provides guidance for novice practitioners. Considering the loss of experienced project staff after the split from AAC and the fact that many current practitioners are relatively new to projects in De Beers means that the use of Total Project Management (TPM) will play a role in building improved project performance. Through the TPM policy De Beers has stated a commitment to international standards regarding project work. This fact however seems to be lost somewhat as will be seen from the findings below.

The overwhelming response from those who took part in the interview process is that TPM is an excellent methodology and governance tool for project management in De Beers. The other overwhelming comment was that TPM is not being used anywhere near the desired level. The majority of people who commented on this suggested that the Corporate Project Office and senior management in general should be taking a more active role in advancing the cause of TPM and promoting governance procedures.

4.3 The identification of potential barriers that obstruct sound project management performance being used

This area of the research was aimed at identifying any company entrenched policies, cultures or procedures that may pose barriers to performing sound project management.

A large number of people interviewed bemoaned the company purchasing and approval policies when it came to ordering materials and authorizing project expenditure. This group said that the normal organisation route for going to tender boards, and ordering goods was too cumbersome and slow. It was suggested that projects must have their own tender boards, and have the empowerment to order equipment as it was required. A counter to this was pointed out indirectly by those who mentioned the lack of systems thinking in the company. They suggested that there was a need within the company to align the purchasing of certain capital goods and materials. This is for the optimisation of maintenance policies, spares holding and training methods. Therefore this freedom in capital spending must be tempered with adhering to agreed group purchasing policies.

It was proposed by a high number of interviewees that the approval process for signing off project work was too cumbersome. This was mainly because there were too many people in the chain of authority and thus too many opinions to be dealt with. It was suggested that the number of stakeholders external to the project be reduced. There were also a number of complaints about the time taken for authorization to be given, which could be expected when considering the number of people involved. However one particular project manager stated that even after agreement had been reached with his senior managers about the turnaround time to sign project documents, these group managers were still not approving documents in the allotted time frame.

It is suggested by PMBOK® (2000) that companies that have adopted managing by projects have implemented management principles that are designed for project work. Non project based companies will not have management systems designed to support projects. It is suggested by PMBOK® (2000) that the absence of project orientated structures makes managing projects more difficult. It appears here that there is the possibility that this absence of project related structures exists in De Beers.

Changing of the goal posts is recorded in literature as being obstructive to sound project management performance. It is probably one of the most commonly used negative comments used in the project arena. This issue brought varied responses from those interviewed. One senior project manager described this phenomenon as a “nightmare”, while another said changes were inevitable but just needed to be

managed. Dealing with the last opinion first places a more flexible approach on projects. Here it was suggested that changes should be accommodated as change is more than likely in the dynamic project environment. More often than not a significant change will requires a degree of re-planning, maybe additional resources and an extension to the project schedule and budget. The problem arises when senior managers do not allow the required change to the project parameters. They will expect the same deadlines and budgets to be met and then wonder why detrimental effects on the project surface shortly after.

The majority of respondents however agreed more or less that changes should be kept to a minimum. The general view from this body of project practitioners was that changes *can* be kept to a minimum by the correct level of up front planning and stakeholder engagement. The role of the User Requirement Statement, Project Execution Plan and Required Operational Capability documents were highlighted here as being critical. This group also suggested that if the requisite level of risk management has taken place then most changes will be more easily accommodated within a planned envelope of project scope. Overall however, the majority of the interviewees did not want changes brought into the project once underway. It was suggested from a substantial group that the required sign-off needed at the completion of project phases is not adequate. As highlighted earlier in the literature review, Steyn *et al* (2003), the information delivered at the completion of one phase provides more details for re-planning (with more accuracy) of the succeeding phase. This life cycle phasing is one of the unique aspects of projects and should be used to minimise changes as the work progresses.

5 CONCLUSIONS AND RECOMMENDATIONS

The aim of this chapter is to summarise the findings already presented and conclude with the key learnings and recommendations from the study. This research study ultimately aims to propose practical suggestions that will improve project management performance in the minerals industry. The majority of the recommendations come from De Beers project practitioners interviewed during this study. The fact that these proposals came from industry participants should make the implementation of these proposals more acceptable to staff and senior managers within the minerals industry.

The three sub problems of the research are now summarised.

5.1 The definition of project success

In order to be able to measure the level of proficiency in project management success, measurable parameters are needed. It is clear from this study that time, cost and quality are not the only measures by which a project should be considered. There are a number of new measures that have surfaced that are applicable to the South African minerals industry. These are largely based around external stakeholders which are local communities and government departments. Guardians of the environment which was raised as a measurable parameter are also largely under the auspices of government departments. The requirements of these external stakeholders are also governed by legislation in the Minerals and Petroleum Resources Development Act and the Mining Charter contained within this Act. In order to attain and maintain new order mining rights as stipulated in the Act certain criteria focusing on these external stakeholders mentioned above must be met. (Republic of South Africa, 2002). It can be suggested therefore that not meeting the requirements of the Act can jeopardise any minerals project irrespective of the technical success.

Further measures are proposed that pertain to the success and growth of the project management profession within the company itself.

These parameters should be expressed in a scorecard or matrix table format. The layout of a possible project scorecard with is shown below;

Table 2: A scorecard to measure project success

Project Parameter	weighting	score	weighted score
Safety record	10%	85	8.5
Meeting of time schedule	8%	65	5.2
Meeting of cost estimate	10%	65	6.5
Quality - stakeholder 1	12%	70	8.4
Quality - stakeholder 2	15%	75	11.3
Operational readiness	15%	80	12.0
Impact on community development	4%	70	2.8
Impact on the environment	3%	70	2.1
Company image	3%	60	1.8
Success in creating improved project practitioners	3%	85	2.6
Degree of governance processes followed	3%	75	2.3
Meeting of Minerals Act requirements	10%	72	7.2
Company learnings	4%	70	2.8
	100%		**73.4**

The weightings and scores are examples only. The weightings would be selected according to the relative importance of each parameter as seen by the particular project team and company management at the time. It may be that not all of the above measure are needed. The individual scores (at the completion of the project) out of 100 say, are then weighted accordingly and a final project score of 73.4 in this case would indicate the level of success. In line with the concept of an A from academic grading being a distinction, this project would score a B. It would be needed that each parameter has its own scorecard in order to arrive at each individual score. Notice that quality is rated for a number of stakeholders as it will be expected that there are a number of customers who will measure quality. In fact each stakeholder's final quality score would in all likelihood consist of a number of requirements. In this scorecard there is no measure for NPV, it can be suggested that by adequately meeting the measures of time, cost, quality, and operational readiness that the expected revenues will be forthcoming.

A scorecard of this nature then defines what measures will indicate project success from the outset of the project. All stakeholders, the project team and the company's management must reach agreement on the measurable parameters at the start of the

project. This method of measuring project management performance will provide a clear and agreed classification that is not left open to opinion or interpretation at the end of the project.

5.2 The key drivers for project success

The knowledge areas of project management as described by literature have a large impact on projects in the minerals industry. Although not explicit from the research interview process, the need to adopt a systems thinking approach regarding projects has surfaced as a key foundation when considering the entire range of issues. In conclusion the key drivers will be discussed under four areas that this study has found to encompass the key areas of project management. These areas are planning with a systems approach, human resource management, communication and the use of a project governance framework.

5.2.1 Planning with a systems approach

Deficiencies with planning and a lack of a systems thinking approach strike a similar cord as was evident from this study. The underlying philosophy needed, is that, it is the thinking that goes into the planning stage that actually provides improved project success. There must be inclusion and consideration of all activities, engineering and business disciplines, individuals and groups and company goals that are part of the project system concerned. The inter-relationships between these entities must then be understood and managed. It appears that it is during the feasibility stage of projects that a solution is most needed for the perceived deficiency in the planning process. Steyn *et al* (2003) propose a method of preparing the planning phase that although not directly mentioning a systems approach does by default promote this type of thinking. That is the use of a Responsibility Assignment Matrix (RAM). A modified version is shown below that would be applicable for a total mining operation feasibility study.

Table 3. Responsibility assignment matrix

	TEAM MEMBERS														STAKEHOLDERS						
Task	Project Manager	Geology	Mining Engineer	Logistics	Geomechanics	HR	Procurement	Legal	Engineering	Finance	Communications	External consultant 1	External consultant 2	Metallurgy	Consultant 1	Consultant 1	Operating mine rep	Public relations	labour unions	D.M.E. 1	Government 1.
Resource definition	I	R	I		I			S			I	C		I	A			I		I	
Rserve definition	I	I	R		S					I	I		S	S	A			I		I	
Ore dressing studies	I										I	P/S		R	I	A	I				
Metallurgical plant	I			S			S		S		I	P/S		R		A	I				
Trackless equipment	I		P/S				S		R		I				I		I			I	
Labour	I		S	S		R		I	S		I						I	I	C	I	I
Rock support	I	S	S		R		I		I		I		S/P		A		C		C	C	
Ventilation	I		R								I	C			A						
Mine Plan	I		R		S		I		S		I		S/P	I			C		I		
Geo-hydrology	I	S			R			I			I				A						I
Environmental	I		S			S		I			I		R		A			I		I/P	A
Shaft trade-off	I								R		I					A/P				I	
Rock handling trade-off	I		R				S		S		I		P	I		A	C				
Project financial model	I									R	I					C					
Study Estimate	I		S	S	S	S	S		S	R	I				C						
Study report	R	S	S	S	S	S	S	S	S	S	I			S	C						I

The tasks required in a project feasibility study (examples are used here) are listed in the left column. The team members are listed along the top along with the required stakeholders. The role of each person is then coded according to the legend describing the different roles required. The roles are as follows;

1. R – Responsible
2. S – Supporting
3. I – Inform
4. A – Authorise
5. C – Consult
6. P – Plan

The person responsible would deliver the final product of the particular task. The person(s) supporting assist in the work with the responsible person. Certain others need to be informed about the work being done to ensure inter-relationships are understood and maintained and will be informed by the responsible person. Stakeholders will be required to authorise and sign-off completed work while others will be consulted for input for certain pieces of work. A recommendation made here is when a major piece of work is needed within the project, plan the work with the authorizing stakeholder including the appropriate work process to arrive at the solution. Others will need to have input into the planning of the individual tasks, say operators from an

existing operation. It is advised by PMBOK® (2000) that external consultants or advisors to the project team should be involved in the planning stage as early as possible as they will bring their experience and expertise into the process sooner rather than later when work is nearing completion.

The use of this matrix serves a number of purposes. The work breakdown structure (WBS) would provide the list of individual tasks that feed into the RAM. This step promotes a careful and detailed planning phase to compile an accurate WBS which is the backbone of the project scope. The people involved in each task in their different capacities are then selected. This will identify who is needed in the project team and highlights where staff training and recruitment may be needed. By listing all major project tasks, disciplines and stakeholders, the project team will then consider who needs to be informed about certain work and will be more conscious of the systems approach with the relevant inter-relationships. The matrix will identify key authorizing stakeholders to promote early interaction with them about the work methods needed for successful sign-off of individual tasks. Further detail regarding a stakeholder engagement plan should follow from the RAM as a result of this stakeholder identification. The use of the RAM will also provide clarity as to who is doing what in the feasibility stage. This will eliminate duplication of work and misunderstandings that may lead to work not being done.

It is suggested from both literature and the study respondents that setting up the correct customer requirements is the first step in the planning stage and is crucial to the success of a project feasibility and final execution. Requirements engineering is a formal sub-set of systems thinking and almost forms a separate discipline (Rust 2004). The successful definition of customer requirements sets up the foundation for a number of subsequent project activities. It should be noted here that internal project customers also have requirements that enable then to carry out certain work. If their needs are clarified and documented and their requirements met then it should follow that project sub tasks are more likely to be done on schedule, within costs and with the appropriate level of quality. This concept informs the project team that each task item listed under the RAM (and listed in the WBS) must be planned according to the requirements of a customer, either internal or external.

5.2.2 Human resource management

The study indicated the need to create professional project managers. The creation of professional project managers should come about by a combination of training and experience. A career path is needed for project managers and practitioners and projects should not be just seen as something that anyone can do. As a foundation to further advanced training and experience, project management teaching should be promoted at the tertiary institutional level including postgraduate studies. As an example from the author's experience, AngloGold, a number of years ago recognized a need for more professionally trained Mineral Resource Management (MRM) practitioners in the gold mining industry. This need was addressed through a collaborative effort with the Mining Department of The University of the Witwatersrand and dedicated MRM courses were designed and existing courses emphasized as part of a MRM Graduate Diploma in Engineering and Masters of Science course. A similar effort should be placed on Project Management teaching.

There must be a set of relevant courses within mineral industry companies aimed at certain levels of project practitioners that are mandatory for a person to have passed before taking on project roles. This can be seen in comparison to a career in the mining discipline as an example. In this case a person must pass a government issued blasting ticket. Following from this depending on the level of operational management that the person wishes to attain, further government issued certificates of competency, a mine overseers certificate and a mine managers certificate are required. Normally a diploma or degree is then required to achieve a senior management or executive positions. If project management is seen as a separate discipline, as it should be, then a similar range of formal qualifications are needed for professional practitioners. It is proposed that project managers should become accredited with the Institute of Project Management before managing large projects. This accreditation involves having a certain level of documented experience and passing the institute examination.

Literature has advocated team development as part of project human resource (HR) management. The area of team development was not mentioned by the majority of people interviewed in this study. This implies that currently HR management as an enabler is not visible in the project arena. It is therefore required for improving team

performance and thus project management generally that a more enabling team development environment is provided. It is required that HR should play a more active role in monitoring project effectiveness regarding individual and team performance. For example, managers in projects could be monitored regarding their general management skills, effectiveness in meetings and arriving at the goals of the project. Mini-retrospects could be held and facilitated by HR to monitor project performance as the project work proceeds. The capability and effectiveness of the project team should be monitored on a regular basis with learnings documented for improved future performance. The mode of the project members should be monitored with efforts being made towards promoting and maintaining the true team mode as opposed to the group mode. To support the concept of the team mode, performance appraisals should be conducted not only for individuals but for a project team as a whole.

It is reported that project orientated training has been and is underway in De Beers. It can be concluded that other companies in the minerals industry also provide training in project management and/or make use of external training consultants. The effectiveness of this training should be monitored. The question must be asked, is the theory and training actually being turned into improved project performance? There is a role for the HR discipline in this area. HR must monitor the effectiveness of project practitioners post any training interventions to verify that the knowledge is being carried through into the business environment. These roles suggested here in turn require that the HR function begin build their own capacity to fulfill this enabling role.

5.2.3 Communication

Communication is a key issue that can be improved in projects. After the warning from Mihm et al, (2003) that communication between divisions of companies is often lacking, this would appear to be an area of concern across the minerals industry. It is suggested that a communication plan is needed from the beginning of the project inception. The role of a communication officer in the project team is proposed and would bring more thoroughness to this area of projects. Again the RAM can assist here by identifying internal and external project communication needs. This is because the tasks, people and interrelationships within the project are highlighted in the RAM. The RAM also

identifies the external stakeholders and will assist in prompting the communication needed with these people.

Steyn *et al* (2003), Baker (2002) and Burke (2003) emphasise the importance of using milestones and reviews during the project lifecycle. The control of these reviews should fall under the guidance of the proposed communication officer as this is another form of communication that formally accepts work done and agrees on the plan for the following phase. This is especially important in light of the role that external stakeholders will play at these milestone meetings. It was also stressed in the literature that the information gathered and accepted from one phase of the project was used to re-plan the succeeding phase with more accuracy. Considering that planning has already been identified as lacking in projects it appears to be essential to conduct these milestone reviews throughout the project life cycle.

The need for a systems approach has been mentioned and the concept can be seen to aid in project success. By increasing the importance of, and formalising the role of communication, this further provides a mechanism with which to implement systems thinking in minerals related projects.

5.2.4 Project governance

De Beers has developed a project governance methodology in Total Project Management (TPM). As TPM has been developed primarily from PMBOK® (2000) and ISO 14000, project governance is seen as being an industry wide requirement. This governance policy outlines the major tasks and management areas and how they can be successfully applied. Therefore it is suggested that all projects will require governance methodologies of some description. The minerals industry is one project arena that that can make great use of governance methodologies due to the wide range of disciplines and external stakeholder issues. Not only does a governance policy provide guidance to project practitioners but this gives senior executives an auditing process by which to ensure sound project principles are being used.

It is suggested that the governance methodology of TPM as an example is needed for even experienced project staff such is the wide array of activities and tasks needed in projects. Based on the value of current and planned future projects in minerals related

companies it is recommended that a director of projects be appointed at the board level. It is suggested that this projects director embark on a road show to project teams and operations and commit the company's support to the enabling principles of their particular governance policy. Following this initial drive, continued visible support of their governance principles are needed at the project operational level from senior executives. Including project governance on the agenda at all project review meetings should show this support. Notwithstanding these recommendations it is up to the individual project practitioners to start using the governance polices. This study has shown that project practitioners agree that governance policies must be in place.

One manager used an example of the level of commitment that should be shown by senior management. He referred to another large mining company in South Africa. In this particular company the technical director has signed a pledge committing this organisation to the highest levels of project governance.

It is needed that the chosen governance policy remains a live system and is revised with time. For example one project manager proposed adding Value Improving Principles as a process within project management. Another project practitioner mentioned that PMBOK® (2000) is in the process of being updated. These updates must be carried over into TPM as an example in the De Beers case. The chosen governance policy will have to remain contemporary to retain credibility.

5.3 Potential barriers to successful project management

It is under this heading that company wide issues that influence project performance are summarised. These are usually areas that are beyond the direct influence of project practitioners themselves.

It was suggested that operational procedures are forced onto project teams and that *project* procedures are needed for *projects*. There must be a linking of the company strategy (regarding projects) to the company structures. It has already been stated through TPM in the De Beers group that the project strategy is aiming to deliver internationally benchmark performance. Confining the dynamic and often difficult world of projects to the more regimented operational procedures does not advance this

cause. The aim of a project structure will be to provide dedicated services to projects and enable project staff to progress without external hindrances. It is suggested that senior company managers and other company service providers have key performance indicators based on their service to the projects that they are dealing with.

Currently De Beers has a group balanced scorecard. No mention is made of any parameters based on project performance. The latest updated scorecard is shown below.

Figure 1. The De Beers balanced scorecard

Group Performance Scorecard

Group Performance Scorecard Overview

Financial	Actual	Target	Status	Move	Trend	Last Updated
DTC Sales (US$ mill)	5518		■	▲		17/3/04
Diamond Jewellery Market Growth (%)	4	3.6	✓	▲		7/5/03
Cash Flow Target (US$ mill)	3917	2900	✓	▲		7/4/04

Organisation and Learning	Actual	Target	Status	Move	Trend	Last Updated
Group Leadership Development	1318	4938	✗	▲		3/6/03
Group Management Development	121	825	✗	▼		3/6/03
"Best Company to Work For"	32	10	✗	▲		13/5/03

Customers	Actual	Target	Status	Move	Trend	Last Updated
Increased Trade Marketing Spend (US$ mill)	177	96	✓	▲		21/5/03
Efficient Initiative Sales (%)	23	15	✓	▲		25/8/03

Business Processes	Actual	Target	Status	Move	Trend	Last Updated
Carat Production (Carats in Millions)	33.28	35.28	✗	▲		13/10/04
Diamond Pipeline Length (Months)	5	5	■	▼		28/6/02

The fact that certain of the measures of the scorecard were last updated in 2002 indicates a lack of application of this business tool. From the findings of this research it has already been proposed that project management needs to be considered as a distinct discipline for practitioners. It is recommended that the role of projects in a company needs to be further considered as a distinct business process along with operations and marketing and sales. Therefore the scores of projects (as suggested by the scorecard in table 1) being completed could be measured against a target under the business processes of the company scorecard.

With the advent of Alliancing or even if conventional contracting remains in place, there must be a separate scorecard based on the ability of external organisations to meet the goals of minerals industry companies. These service providers will usually be engaged

across industry companies and must match the project standards that the client company has set down.

The general view from the body of people interviewed in this research study has indicated that the will, skill, tools and enthusiasm exists within the industry for potential improved project performance. There seems to be a further need for uniting this energy so that the efforts of individuals and project teams are better aligned to reach a company's stated project performance goals. This uniting of efforts needs to be driven from the top management levels by providing a more project orientated culture. The appointment of a projects director will go along way towards achieving this objective. In conjunction with this, insisting on professional project qualifications and documented experience for project practitioners will instill a culture that recognizes projects for what they are, the foundation for operational success and ultimately future sales and revenues.

5.4 Areas of further research

Although discussions regarding Alliancing did surface during this research, this area of project management in De Beers is in its infancy. There seems to be divided views currently on Alliancing as was reported from the number of people who did have comments on this subject. It was noted that the legal department in De Beers had been called on to make a recommendation on the viability of Alliancing. Their view is mainly from a legal standpoint. Currently their view is that it is purely a commercial decision on whether Alliancing is preferred to the conventional contracting route (P. Russell, personal communication 15 November 2004).

Minerals related companies will continue to engage external contractors both as suppliers and service providers. The most optimum method by which to connect with these organisations must be found. It could be that a combination of Alliancing and conventional contracting could be the solution. It could be that Alliancing is more appropriate at certain stages of projects or only for certain categories of projects. This research has not been able to provide an answer to these questions. However what is clear is that currently De Beers in this case is not speaking with one voice on this issue

of Alliancing. What is needed is an unambiguous mandate from the De Beers executive on the way forward. Perhaps this mandate will only be forthcoming after the conclusion of a number of current projects using the Alliancing model. If Alliancing is to be used on minerals related projects, two questions must be asked. Is there is an inherent deficiency in conventional contracting or is it that the manner in which contracts are being compiled and managed that is deficient? From the findings of this study it appears to be yes to the latter question. Perhaps efforts should be expended in resolving this issue prior to a full scale switch over to the Alliancing model. De Mayer *et al* (2002), earlier proposed that partnerships should replace contracts when there is a state of chaos, or being more polite, when the plan is uncertain. This could serve as an indication as to why Alliancing partnerships are being proposed.

It is recommended that further research be done to find the true causes of contractual conflict and the reasons why contracts appear to not deliver the expected performance from external service providers. Concurrently, research should be done on the results that are forthcoming from projects utilising Alliancing to ascertain what level of project success is delivered from this model.

5.5 Limitations

One of the limitations that was discovered throughout the course of the interview process was the apparent lack of preparation by the interviewees. The questions for the interview had been sent out in advance in order to allow people to prepare and thus relate meaningful experiences and insights. Generally this was the result although it appeared from the interview process that nearly everybody spoke from their immediate thoughts. This resulted in the author having to be prepared for a lot of prompting in a number of cases to draw more comments from the interviewees.

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Appendix A. Letter of Introduction

One of our employees, Shane Hunter who is currently working at the Centenary Cut project is finishing studies at Wits Business School. As part of his course work he is undertaking a research report in conjunction with the Company. The research will be on project management in the minerals industry. This research has the support of the SPO and the Mining Office.

The research will be centered around interviews with De Beers company employees who have been involved with projects within the group. The idea being to identify;

- What determines a failed or successful project for DBCM
- Key drivers that promote successful project management within our organisation.
- Possible internal barriers that prevent ideal project management principles being used in DBCM

One of the aims of the research will be to arrive at possible recommendations that may improve our project management skills thus resulting in improved success in our project delivery.

As you are aware there are a number of large projects currently underway within the group. The future success of the group will also in part be dependent on new projects coming on stream. Therefore projects are critical to De Beer's future growth.

Please give consideration to making yourself available if contacted by Shane for an interview. He will be sending out emails to selected employees with more details about the interview process including possible questions that will be asked. Your cooperation will ensure that the research provides meaningful results for the company.

Regards

Dave Porter

G.M. SPO

Appendix B. Questions for Project Management Research Report

This research study will investigate key factors that effect project management performance and will attempt to identify possible barriers to implementing successful project management.

Sub Problems

1. What is the definition of a failed or successful project?

Questions:

- Do we need to say a project is a "failure" or a "success"? (we don't seem to have a measure for anything in between)
- How would you measure the "success" of a project?
- Would we want to assign equal importance to time, cost and quality?
- Are we more concerned about the NPV or the technical competence of a project?
- How do we need to consider the operators who will take over the product of the project, say the new mine or plant or whatever?

2. What are the key drivers that make a project a success or a failure?

Questions:

- Planning is often cited in literature as a critical success factor, how has planning affected projects you have been exposed to? Consider defining the scope of project work.
- Quality management and risk management have been highlighted in literature as receiving low attention in project management. Can you comment on this?
    - Also what about using or not using proven technology?
- Can you comment on the training or experience of colleagues or managers on projects that has either a positive or negative effect on the project?
- Systems Engineering thinking warns about local optimisation at the expense of global optimisation. Have you noticed where one team within a project have optimised their

own aspect of the project but this did then not mesh well with other areas of the project once brought together?

- Communication is usually important for any operation. This is especially so on large complex projects. Have you any comments to make on communication on projects you have worked on? Remember that communication also entails feedback on performance to the project managers and stakeholders.
- Have you worked on projects outside of DBCM? If so, are there any noteworthy aspects worth remembering?

3. Are there barriers that obstruct sound project management principles relevant to DBCM being used within DBCM?

Questions:

- Have there been contracting/supplier company issues that have affected projects that you have worked on in some notable manner?
- Literature cites that “changing of the goal posts” is commonly a problem in achieving successful projects. Have you had any experience of this?
- Does any Head Office policy detract or enhance project management effectiveness at the operational level in any way.
- If you could make any suggestions to improve project management performance what would you propose?

Appendix C. Excel content analysis data.

Mining | Engineering | Metallurgy | Finance | Legal | Company reports

PROJECT SUCCESS

- BH: We shouldn't try to get the exact goals of
- MP: Use the deliverables and measure these with a weighted scoring system.
- RL: Were the original objectives correct?
- DT: The stakeholders are the main thing, but the stakeholders must understand the requirements.
- DT: There are other issues apart from TCQ, what about all the other external stakeholder?.
- JT: yes, a project must be measured as a success ot failure
- MP: Use the deliverables and measure these with a weighted scoring system
- RL: The project must deliver the required objectives within time cost and safety constraints Assuming that the proper objectives were specified correctly in the first place
- BH: We never bothered too much in the pst because projects were always a success (we threw so much money at them)
- GE: The project is a success when the stakeholders are satisfied.
- GE: You must look at the ROI
- BB: We should Bench Mark against international industry
- BH: Measuring on the main TCQ, factors does no give you the overall picture
- BH: measure project safety and the growth of the team for the future of DB
- GE: measure the project against international standards
- J.S. We must therefore move away from tagging a project as a success or failure as there are just too many issues
- J.S. All stakeholders need to be educated to understand what the needs of other stakeholders are
- KB: Use the original ROC as a measure
- GB: The design criteria must have been met – an operational capacity
- GB: There must be a scientific way of measuring project
- PN: Time cost and quality are the only measures
- CS: If the objectives have been met; financial, production, safety, socioeconomic etc
- KJ: The stakeholders must be satisfied
- KJ: Sometimes the technolgy success is more important than the revenue
- HvW: When we analyse the project, the best place to start is against the original requirements

RISK MANAGEMENT

- BH: We don't look at the risk of low production or the risks of the people coming onto the execution phase
- JP: Lack of training in risk management
- JP: Senior managers not well trainined in risk management. They think they don't need to learn any more as they are "senior" enough
- JP: Only do enough to cover our
- RL: low emphasis given
- MP: We spent too little money on the MD part of the feasibility which is the highest area and risk of the project.
- BH: Not treated as a dynamic
- JG: Was a problem, is getting better and TPM should help
- PA: we tend to look at RM as an event not as part of the project life
- GE: There should be an independent risk manager on the project team
- DT: We need risk meetings more often as risk planning is ongoing
- GE: Risk management is there in TPM
- GE: There shold be a risk manager on the project team
- BB: Everything you do should be viewed in a Q / R manner
- CS: Someone must own the risk
- AR: There is a risk assessment in the PEP and it should be updated.
- J.S. Both these aspects have become very important and in most cases completely neglected
- KB: Better understanding of risk is needed. TPM will help us
- GB: Then (after P&lds were signed off) we had all the disciples together, permits, engineering, metallurgy all over three days with
- HvW: We don't have the balls to de-risk the problem and start again
- !Gereip: So when we visited some of the contractors, and asked "what is your safety system?", they answered "what safety system

COMMUNICATION

- JP:Need for a communication manager
- RL: Definitely need a communication plan + more interdisciplinary meetings
- BH: This is critical with the lower level work force
- RL: CHQ should be showing more interest (in communication)
- JP: Generally poor and people are alientated
- MP: Communication takes time and effort.
- BH: Need for a communication officer
- CS: project staff do not like to communicate "bad news"
- BB: We don't put enough effort into this plan
- CS: The PM must make sure that the engineers know what they are to deliver and the client knows what to expect
- CS: Retrospect are not used properly in DBCM. They only scratch the surface
- J.S. Every project must have a stakeholder management plan
- J.S. Very important but extremely poorly managed by De Beers
- KB: People believe meetings are a waste of time. This is wrong
- DT: The more competent/mature the team the less communication is required
- GB: The WBS should look at a s/holder plan. "This is how I will talk to my s/holders"
- AR: Our application to run CONTOPs took 7 months. We never used the inspector properly.
- AR: Sometimes we don't know understand the whole food chain
- KJ: Communincation is key
- HvW: It is difficult do get operational people to give constructive input to the new proposals on paper
- Dab: A lack of information impacted on the project.
- PAUC: Sharing human capital is in its infancy in DB
- PAUC: Plan the work methods needed with CE up front

SYSTEMS ENG.

- BH: Where was the line between the two? (at Finsch) This was asked?? Because no-one actually knew!!,
- MP: Take a group approach. (don't just think about the mine)
- JP: Not all members of the business system part of the
- RL: often parts of the project team act in isolation
- JP: M&E engineers; They understand systems engineering more than Mining Engineers.
- JP: SE is needed more throughout DBCM as a whole. It underscores every engineering
- DT: We miss the interelationships all the time.
- JG: The Geriep project was criticised a bit after it was canned (due to a lack of a systems
- DT/TL: KPIs misaligned x 2
- BB: We still are silo orientated and generally we don't understand the interactions between
- GE: We should have more modular plants and not design a plan from scratch
- BH: We need to improve on this front. We (as engineers) do not generally understand all the othe disciplines
- CS: The delivery of mining was not tested with the metallurgical needs and this caused problems
- CS: Systems integrating let us down
- CS: The best definition of the facility is needed
- KB: We don't have an understanding of SE in DBCM
- DT: All the time! (there is
- GB: We are not good at this. We have identified this as needing
- AR: On big projects there is a lack of understanding and consequences between the
- KJ: The cradle to the grave approach is needed. We do get this from the training in DB
- PAUC: Make sure people understand the whole project

STAKEHOLDERS

- BH: Get the people involved in the design and let them have responsibility
- MP: They (the PO) must help us with the project and the processes needed
- TS: engage the stakeholders
- TS: buy in from the operators
- TS: Clarify needs for new labour
- RL: Approve the URS from operators
- RL: perform an audit on the URS trail
- RL: The SPO is not doing enough on governance
- JT: we must bring the mine operators into the project at an early stage
- KB: The SPO is not giving enough direction on Cat 3/4 projects. We have to drag them along with us.
- CS: We have too many stakeholders that have decision making authority.
- GE: We allow consultants to come into the picture too late
- GE: bring the new operators in early
- GE: Use a sound case to prove or refute the proposal, when operators want changes
- KB: Identify who must be involved manage all of them differently
- BB: Consider them from day 1
- BH: At the detail design stage the clien needs to be happy with the equipment as they need to maintain it. We don't do this enough
- BH: Your metallurgical manager should understand your TPM principles for example.
- DT: The philosophy should be decided up front, for the operators (in the requirements phase).
- GB: ID the owner and have representatives from the conceptual stage up to hand over
- KJ: Get the operators involved from day 1 to prepare for operational readiness.
- AR: Get the operators on the team from day 1
- HvW: We must consider these people
- Dab: Client and stakeholder expectations must be clearly understood and accounted for in the project deliverables
- !Gariep: There was an atmosphere of cooperation between all parties on this project; between the De Beers project team, the contractor, the subcontractor, even the Germans.
- !Gariep: If we had got together six months earlier, we could have come up with a much better and more realistic baseline programme

CONTRACTING

- RL: There is often potential for conflic with contractors, particularly in the execution stage
- RL: But we have scoped the work badly in this example
- JP: There was no flexibility in the contracts.
- MP: The "Alliance" does not allow us to kick their butts
- MP: The CDM Dump treatment project was done well with a contract
- GE: Alliancing is removing the safety belt (from contracts)
- JG: I have been lucky but have heard some horror stories
- CS: The recent partnering initiatives are leading to less time and effort being spent on in-fighting and more time on problem solving
- GE: Are the contractors ISO
- GE: We are chucking away the safety belt by not having any contracts (in Alliancing)
- BB: The VS Alliance is only beneficial from execution stage
- BH: Too much fat in the system is still a risk in Alliancing
- CS: Conditions of contracts: We miss a lot of the issues
- CS: The alliance partnerships must look at the DBCM people as well
- DT: Poor communication on requirements was the problem
- GB: A contracting company would put another 10% on a contract price just in case there was something they have over looked in all the contractua
- KJ: Alliancing is the way to go
- KJ: EPCM worked well as we got better value for money than with AAC designs
- KJ:Check that the Alliance partner has the right structure and culture to partner with us
- AR: Some senior people say it is not good. So what are we as junior people in Db supposed to think
- HvW: senior people at CHQ thought that we could pass on all the risk to the contractors, but we do not want to pay the risk premium to the contractors.
- TL; Contracts were always unclear, with a scope that was generally poorly defined
- TL: Claims were common from the contractors. Wasting more time again.
- PR: The scope is often not clearly defined in the contract
- PR: It is clear that the traditional approach to engineering contracts has frequently failed to deliver completed projects on time and within budget
- CTP Screen Ret: Foster partnerships with vendors and suppliers earl
- CTP Screen Ret: Get the different suppliers and vendors together as a team. This worked well at CTP
- JP: We did not understand contracts and how they are compiled.

Appendix C. continued

PLANNING

MP: Planning is not crucial, thinking is needed

RL: Planning was good at Finsch due having a very good planner

JP: planning not given the right emphasis

JT: we don't so enough trade-offs during the planning stage.

JT: We always use engineers who often don't see the whole picture

JP: I believe there is complacency regarding the importance of up-front thinking.

JG: Planning is key but there are too many inexperienced people who don' understand this.

KB: we don't do enough planning reviews

CS: We don't create enough ownership in the plan

JG: Planning links everything

KB: The plan should not be used to beat people with

BH: Done poorly

PA: Generally done poorly

GE: We don't review out planning well.

BB: Planning? Badly done: scope change is a problem

BB: Being proactive: What must I do in the next month to keep to the plan?

BB: We must manage in advance and not in arrears

CS: We use low level planners that often do not have the right expertise

J.S. This is the most neglected aspect and the biggest cause of project failures in De Beers.

DT: More detailed planning will help

GB: We may get 100 -200 tasks as a starting point. Then you may get up t 1000 points in the WBS.

GB: Planning is a skill. Planning to the power n is needed

KJ: The plan is nothing bu the planning is everyting, i.e. the thinking

AR: We should do the PEP properly. This will cover project work from the pre feasibility to the final feasibility stage

TL: Piss poor

Dab: Detailed clearly defined project plans should be in place before the commencement of any project

Dab: The inferred resource turned ou better than we thought, but this affected the plant design

PAUC: Very little detailed planning was done

CTP screen ret: Use actions plans before any execution and review the plan again prior to the event.

CTP screen ret: Management stopped activities to allow proper planning

CTP screen ret: Contingency must be built into plans and must be made known to all parties.

QUALITY

BH: We only look at $ at the QSM's, but not of the quality of

MP: Set the targets internally bu benchmark (against industry standard world wide and SA projects and De Beers).

RL: lack of supervision resulted in poor Q

RL: TPM is not being implemented well enough. SPO should be doing this

JT: QM is essential. We have not been doing this in the past

JT: Quality is number 1, (out of time cost and quality)

CS: Don't take it for granted that vendors and supplies have good quality.

DT: Quality is in TPM but we are not using TPM

JG: TPM will sort this out, it is up to the people now

GE: TPM is built around quality management

BB: Everything you do should be viewed in a QR manner

CS: I would have an independent (from both DBCM and the Contractor) auditor investigate the contractors quality.

J.S. (Q) which has been neglected for too long and in many cases cost us dearly

KB: Quality, no substitute, this reduces risk

DT: Agreed! (low attention) Quality resides with TPM

GB: The definition of Q must be

GB: We need to spend enough time to ensure we get the right technical decision. We are not mature enough to do this

DT: Poor communication on requirements was the problem. If we tell them clearly what we want this will usually ensure Q

KJ: Appoint experienced people fo QM

TL: The poor designs were forced on the supplier by us. (at the CTP)

L: The formalities needed for quality control with external parties are not always there

PR: The legal people should be brought in earlier regarding the QA issues which could be improved as a result

F: Supplier support should have continued for a longer period post-commissioning.

CTP screen ret: We need dedicated people checking on equipment quality

Dab: Inexperienced contractors (amongst others) made it difficult to get the project going

!Gariep:Accepting achievable targets up-front, instead of forcing the schedule and costs, allows you to have the opportunity to work

TRAINING

We also don't look at the people who will operate the plant or the training o the people

MP: We are poor at this issue

RL: Very little done on PM in the company generally

RL: Everyone should have a working knowledge of TPM

RL: More senior PM should have the right experience

TS: Change management is needed at projects where current staff will be used

JP: There should be a career path for PM.

GE: A total lack of training in PM

KB: there has been little of this but we are improving

BB: There is no career path for PM, we should have one

BH: We take people who are good in a technical field and we put them straight into project management. Only 10% of these people actually succeed

CS: We use operational managers and we expect them to function as a projec

J.S. Projects fail as a result of inexperienced managers and/or the lack of experienced dedicated resources

DT: They (senior mangers) often don't follow the TPM guidelines

GB: It is not adequate to take people from operations

GB: The training needs to be improved

GB: We have let them go back to operations (those that have done well on projects).

AR: Senior managers need the (PM) training also

AR: I need more experience to get to manage Cat 4 projects

KJ: The right project experience is needed and there must be training

HvW: We take operational people and pu them into projects. This does not always work

TL We don't select our (project) people properly

PR: We are not experts in construction

F: With the Project Team withdrawing, there was inadequate technical expertise to fully commission the plant.

PROJECT TEAM

BH: You cannot have just specialised project people there must be a mix with good managerial skill:

RL: Every one in the project team should have a functional knowledge o TPM, which we don't have currently.

JT: there should be different people for the concept, design and execution phase. We don't do this.

JT: there should be outside consultants on a project steering committee. They don't have empires to protect and are unbiased

MP: Team selection is critical.

MP: Team buiding sorts out a lot of the team problem issues

BB: What skills profiles do we need?. We often don't do this

CS: Develop teams of skilled project staff

GE: There is no process for how we out a project team together

DT: Without the team bonding no benefits will be realised

JG: people are everything or your stuffed.

GB: The constitution of the team is the most critical thing. This is the single most important area for success

AR: We need to look at the cultural issues within the team

AR: Our exco members probably don't fully understand projects

KJ: Use the Myers Briggs team role measures

HvW: Did we have a set of requirements for the job as PM for the C Cut? Probably not

Dab: Staff stability and knowledge retention is critical throughout the project.

Dab: The client and project sponsor must be different people.

CTP screen ret: The team worked well because everyone doing the work was involved in the plar

F: The Jwaneng engineers did not fit the profile needed for the technology.

KD: There should not be production people working on a project as the project takes a back seat

SM There is no measure based on the performance of a team:

GOVERNANCE

RL: TPM is suitable for our projects but must be implemented.

JT: TPM will help us with risk management

JP: What we have in TPM is world class but we are not using it!

MP: No one from the top level is supporting the use of TPM

JT: All of TPM is not needed on all projects

DT: Senior managers are not using and enforcing TPM

JG: TPM is available, it is up to the people to use it.

GE: We are lacking the capacity to fully support TPM

BB: We are not using TPM enough

BB: We need to keep up with the latest thinking on projects (adding into TPM) such as VIP

CS: We need to focus on the Needs Requirements and concepts and exploration

DT: There is not enough support for TPM due to the lack of understanding of the benefits.

DT: Some senior people say TPM is a load of rubbish

GB: The people who say tpm is ooo; they have not done a project before

GB: It is all in there. E.g someone could read tpm and start the project after a week and a bit of guidance

KJ: We are going the on the right path with TPM

AR: It is not always applied but it does add value to PM

HvW: It must become a way of life as opposed to a burden

HvW: Due diligence is not used. We must embrace it at project level

Dab: A project charter should be drawn up. The scope and deliverables must be comprehensive and fully documented

KD: The project management did not go well

KD: A lack of understanding of the complexities and the scope of the project by senior management

NP: Maybe we need to force people to use it as they are not on their own

COMPANY ISSUES

JP: The buyers did not have the same urgency as the project in getting stuff to the site

BH: Senior people in Db don't like hearing bad news

TS: The priorities of these CHQ staff may not be aligned with a particular project in the same manner as the particular project team.

TS: . There must be a community of PMs in the group.

GE: the company should have a project director

GE: the project should have their own tender board

DT: The stores KPI was different to that of the operation

BH: We could outsource purchasing as an example.

BH: Signing off of approvals is a pain

BH: There is an internal tender board within the project team

BH: Be prepared to challenge (DBCM) specialists. Projects are always unique

BB: We (CHQ) take too long to sign docs

BB: The business processes in DB are not project orientated for projects

CS: We need to define the resource

CS: We involve too many stakeholders to make a decision

CS: Approval authority at CHQ is not needed for a lot of what we do

J.S. Senior managers have not been educated to understand and be able to manage the enabling environment required for project management

KB: The ore-body was not understood

KB: There must new sets of rules for projects. The grinding wheels of the company slow you down

KB: People are coming into the picture but we have had to drag them in

DT: Beauracy must be reduced

DT: We need to recognize PM as a discipline as supported by Top Level Management

GB: We are deploying resources on projects that may never run. If we come back to a project that was rejected once we will not use any of the old work

GB: Some of the rules change for a project team, i.e. they may want their own tender boarc

KJ: Supply chain does not have the same KPIs as the project

AR: Mentors help a lot on projects

AR: Senior people disparage TPM when we are supposed to be using it

Dab: They realised the importance of knowledge transfer to other projects, i.e. Sendlingsdrift

KD: Experience and knowledge was lost We need to make more use of knowledge management tools