

Bridging the Gap between Strategic Control And Performance Measurement: A Systems Approach

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- Extent to which good performance is a function of well performing critical business processes.
- Extent to which good performance is function of “hard work” with regard to the critical business processes.
- Extent to which good performance is a function of the talent and the expertise of the personnel operating within the critical business process.
- Extent to which good performance is a function of the critical business process information provided to the manager.

It is also important to consider the following aspects with specific reference to the organization’s critical control variables:

- Extent to which good performance is a function of well performing critical control variables.
- Extent to which good performance is function of “hard work” with regard to the critical control variables.
- Extent to which good performance is a function of the talent and the expertise of the personnel working with the critical control variables.
- Extent to which good performance is a function of the critical control variable information provided to the manager.

The verifiability of critical business process and critical control variable measures specifically refers to the extent to which these measures are objective and verifiable. As previously discussed, the purpose of the verifiability filter is to filter out any unverifiable and biased measures. Considering the extent of verifiability already present within the organization will lead to a better insight of how dynamic and consistent the current operating environment is. It is therefore important to consider the following aspects with specific reference to the organization’s critical business processes (Perego, Hartmann 2009):

- Extent to which objective measurement techniques are used to collect or estimate information regarding critical business processes.
- Extent to which measurement techniques are accurate.
- Extent to which the information regarding critical business processes are difficult to manipulate.
- Extent to which information regarding critical business processes are independently verified.
- Extent to which periodical internal audits are done with regard to critical business processes.

It is also important to consider the following aspects with specific reference to the organization's critical control variables:

- Extent to which objective measurement techniques are used to collect or estimate information regarding critical control variables.
- Extent to which measurement techniques are accurate.
- Extent to which the information regarding critical control variables are difficult to manipulate.
- Extent to which information regarding critical control variables are independently verified.
- Extent to which periodical internal audits are done with regard to critical control variables.

The congruity of critical business process and critical control variable measures specifically refers to the extent to which these measures are in line with what the organization deems strategically important. As previously discussed, the purpose of the congruity filter is to filter out any measures that are not in accordance with the organization's overall strategy. Considering the extent of congruity already present within the organization will lead to a better insight of how dynamic and consistent the current operating environment is. It is therefore important to consider the following aspects with specific reference to the organization's critical business processes (Perego, Hartmann 2009):

- Extent to which good critical business process performance leads to an increase in the long term value of the organization.
- Extent to which bad critical business process performance leads to a decrease in the long term value of the organization.
- Extent to which the overall financial performance of the company is a direct function of the critical business process performance.

It is also important to consider the following aspects with specific reference to the organization's critical control variables:

- Extent to which good critical control variable performance leads to an increase in the long term value of the organization.
- Extent to which bad critical control variable performance leads to a decrease in the long term value of the organization.

- Extent to which the overall financial performance of the company is a direct function of the critical control variable performance.

4.1.3. Considerations With Regard To Signal Processing

As has been discussed earlier, the aim of signal processing is to detect and capture data that is received from the performance measurement system. Signal processing also allows the organization to identify and exploit information patterns within the data that is received. These information patterns provide valuable insights into the opportunities and threats that are present within the competitive market environment. First considering the concept of signal processing and the aspects that relate to the organization's current operational environment provides valuable insight into existing organizational structures relating the processing of information. This insight also aids in identifying how dynamic and consistent the current environment is and will also help in designing a customised solution. The following aspects relating to the concept of signal processing should be considered (Reeves 2009b):

- The availability of existing data, data structures, human capability and technology within the organization, that are perhaps overlooked, that may yield signal advantage.
- The speed at which information patterns are currently being detected and interpreted within the organization and how this compares with that of the competition.
- The speed at which identified information patterns are converted into action within the organization and how this compares with that of the competition.

4.1.4. Considerations With Regard To Adaptive Processing

The primary objective of adaptive processing, as has been discussed previously, is to identify any deviations from the prescribed performance standards and to compensate for possible errors by performing corrective actions. It therefore corrects the error that exists between what is expected by the strategic control system and what is actually measured by the performance measurement system. Insight into the current operational environment is gained by first considering the concept of adaptive processing and its relation with how the organization uses deviations to perform corrective actions. These insights will in turn aid in the design of a customisable, dynamic and consistent solution. Aspects relating to the concept of adaptive processing that should be considered are listed below (Reeves 2009a):

- The speed or rate at which changes occur within the strategic environment that the organization operates in.
- The extent to which the organization tracks and adapts to changes within the strategic environment.
- The style of adaptive strategy most suitable for the organization's current environment, structure, situation, size and technology used should be considered. These styles include sprinter, migrator, voyager and experimenter.
- The practices, capabilities or beliefs within the organization that may potentially hinder the use of adaptive principles.

4.2. Bridging System Design: Functional System Requirements

The definition and formulation of functional system requirements is the starting point of the system engineering process. A well formulated set of functional requirements greatly increases the probability of a successful design and integration. It effectively provides a point of departure, consistent with the proposed concept solution, from where the design of a comprehensive system is made possible.

The concept solution of the proposed bridging system comprises of inputs, internal processes and outputs as depicted in Figure 5-9 below.

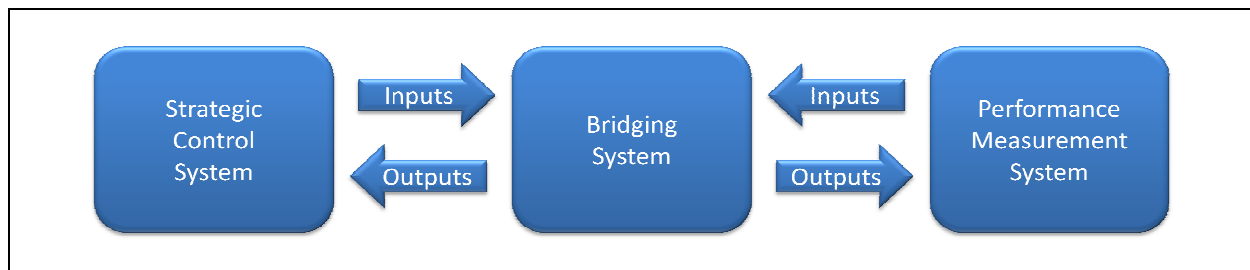


Figure 5-9: The Concept Solution for the Design of a Bridging System.

In order for the bridging system to be dynamic and promote consistency between the strategic control system and the performance measurement system it should adhere to the requirements tabulated in Table 5-3 on the next page.

Table 5-3: Functional Requirements for the Bridging System.

Requirement	Description
Requirement BS1.	The strategic control system should be able to consistently relate the strategic control system to the performance measurement system and vice versa.
Requirement BS2.	The strategic control system should be able to evaluate the strategic control system, therefore ensuring that the right aspects are being strategically controlled.
Requirement BS3.	The strategic control system should be able to evaluate the performance measurement system, therefore ensuring that the right aspects are being measured.
Requirement BS4.	The strategic control system should promote the development of new performance measures based on changes within the competitive environment.
Requirement BS5.	The strategic control system should provide a maintenance structure whereby strategic control metrics can be consistently related to the performance measurement system.

The inputs, processes, interfaces and outputs of the bridging system follow directly from the functional system requirements that were identified. It is therefore sensible to initially perform requirement analysis and to then look at how these requirements can be met through good design.

4.3. Bridging System Design: System Inputs and Outputs

In this section the system inputs and outputs of the concept solution, as it is defined in Figure 8, are identified and formulated. Requirement BS1 requires consistency between the strategic control system and the performance measurement system. Connecting these two seemingly independent systems through a common interface is the most practical way to achieve this consistency. This common interface is called the “bridging system” and it addresses the gap that has been identified and discussed earlier in this thesis. The bridging system therefore obtains consistency by providing a common interface for both the strategic control system and the performance measurement system to connect to.

It subsequently follows that the inputs of the strategic control and performance measurement systems become the outputs of the bridging system. Similarly the outputs of the strategic control and performance measurement systems become the inputs of the bridging system. Figure 5-10 on the following page visually illustrates the above discussion.

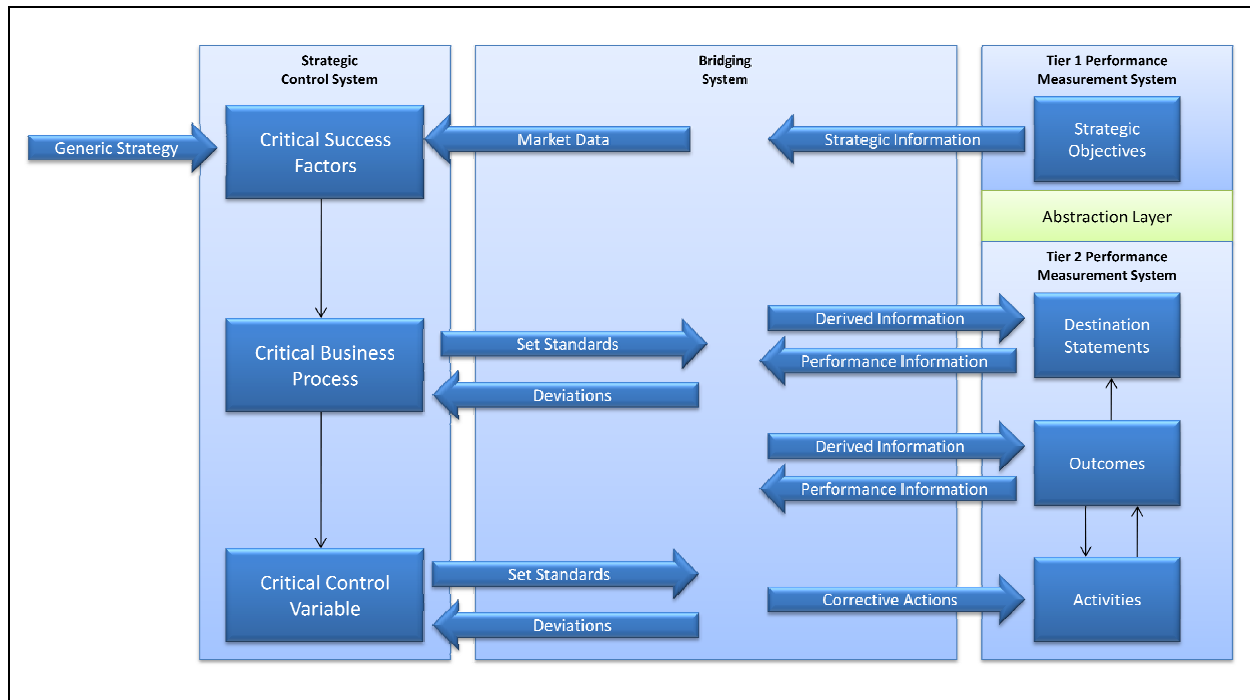


Figure 5-10: The Bridging System Inputs and Outputs.

4.4. Bridging System Design: System Processes

In this section the system processes component of the concept solution model, as it is depicted in Figure 8, are implemented and integrated. The bridging system is comprised of the three main processes discussed in the theoretical concept development section. These processes are the signal processing process, the adaptive processing process, and the filtering process respectively. Figure 5-11 on the next page visually illustrates how these processes are implemented and integrated into the bigger system. This figure will explicitly be referred to in the subsequent paragraphs.

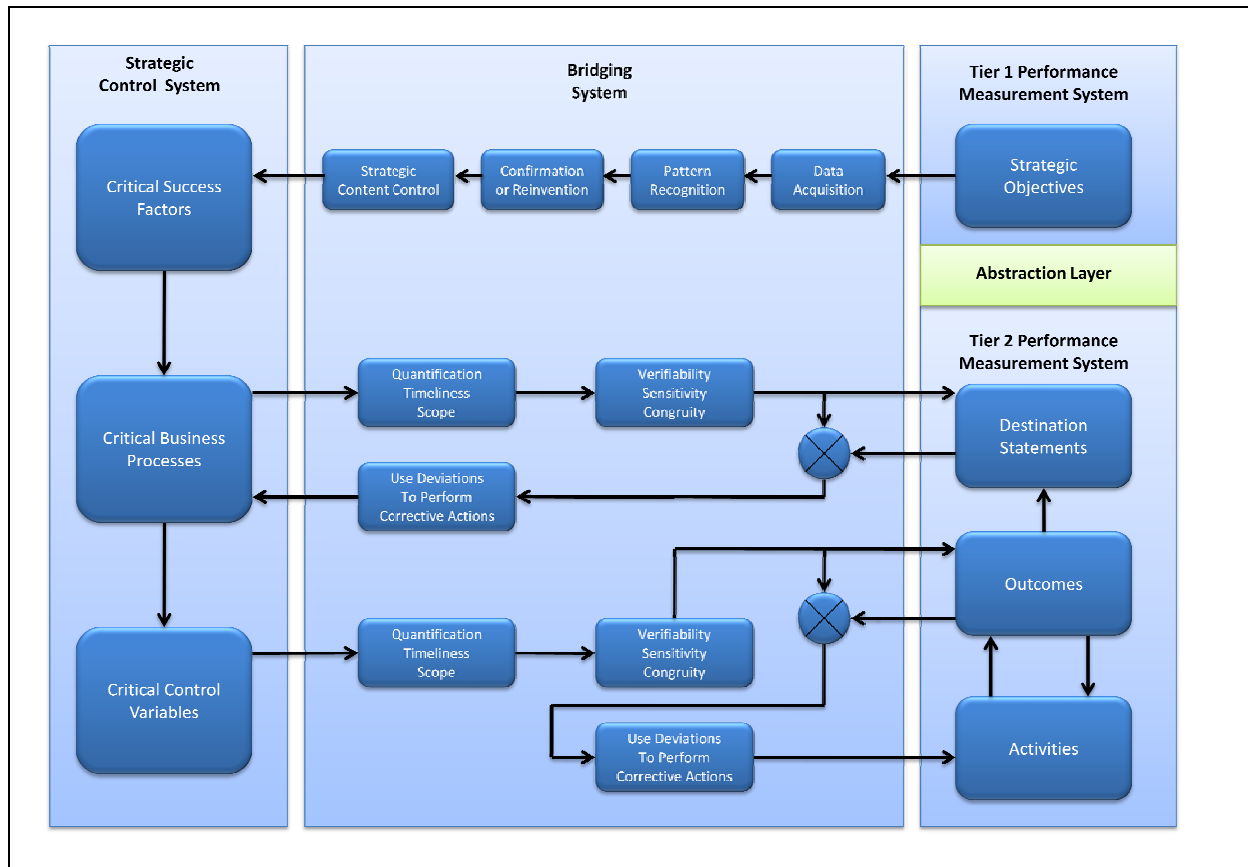


Figure 5-11: The Complete Bridging System Implementation.

Requirement BS4 states that in order for the bridging system to be dynamic and promote consistency between the strategic control system and the performance measurement system it should enable the development of new performance measures based on changes within the competitive environment. The signal processing process provides feedback and information on patterns within competitive environment with reference to the strategic objectives of the organization. These information patterns provide valuable insights into the opportunities and threats that are present, and can subsequently be used to perform strategic content control. Strategic content control proactively confirms or discards existing Critical Success Factors and it also proactively formulates new Critical Success Factors. Requirement BS4 is therefore met by implementing a signal processing process that links the strategic objectives of the performance measurement system with the Critical Success Factors of the strategic control system. For a detailed discussion on the concept of signal processing refer to the related theoretical concept development section. Figure 5-11 illustrates how the signal processing chain is implemented and integrated within the greater system.

Requirement BS5 ensures a dynamic and consistent bridging system by requiring that a maintenance structure be implemented so that strategic control metrics can be consistently related to the performance measurement system. Contingency and economic based filters are utilized in order to meet this requirement. Each of the six filters individually addresses aspects of the economic and contingency based theories on which the concepts of strategic control and performance measurement are based. Filtering, as discussed earlier in this thesis, promotes consistency by ensuring that the strategic control metrics are all relevant and that they all conform to the same standard. Being able to consistently relate the strategic control metrics to the performance measurement system not only increases the integrity of the measured results but also leads to faster strategic decision making and enhances the overall system's flexibility.

Filtering should therefore be applied to any strategic control metric that serves as an input to the bridging system. These inputs (refer to Figure 5-10) originate from the critical business processes and the critical control variables. Consistency, as required by Requirement BS5, is further ensured by respectively connecting the filtered outputs of the critical business processes and critical control variables to inputs of the destination statements and outcomes of the performance measurement system. In essence, the destination statements become the desired levels of critical business process performance and similarly, the outcomes become the desired levels of critical control variable performance. In the following section this idea will be discussed in greater detail. The implementation and integration of the contingency and economic based filters is visually illustrated in Figure 5-11.

Requirement BS2 states that in order for the bridging system to be dynamic and promote consistency between the strategic control system and the performance measurement system it should be able to evaluate the aspects that the strategic control system deems important and additionally also ensure that any deviations are corrected for. Requirement BS2 is met by implementing an adaptive processing chain that links the filtered output of the critical business processes, the output of the destination statements and the input of the critical business processes as illustrated in Figure 5-11. Adaptive processing has been discussed in great detail earlier in this thesis, but essentially it determines the error that exists by comparing the desired level of critical business process performance with the actual performance. When the degree of deviation and turbulence is determined corrective action can be performed on the critical business processes by either using a migratory, voyager, sprinter or experimenter approach. In the following section the actual interface will be discussed in greater detail.

Requirement BS3 is fairly similar to Requirement BS2 and in the same way requires the bridging system to be able to evaluate the aspects that the performance measurement system deems important and correct for any deviations. Adaptive processing is once again used to meet this requirement. An adaptive processing chain that links the filtered output of the critical control variables, the output of the outcomes, and the input of the activities is implemented as illustrated in Figure 5-11. Adaptive processing in this instance determines the error that exists between the desired level of critical control variable performance and the actual performance. The degree of deviation and turbulence is determined and corrective action is performed on the actions that directly influence the outcomes based on one of the four possible corrective approaches. In the following section the actual interface will be discussed in greater detail.

4.5. Bridging System Design: System Interfaces

The last part of the bridging system design is addressed in this section of the thesis. It deals with the interfaces between the inputs, processes and outputs defined in the preceding sections and ultimately provides a complete solution for a bridging system.

Strategic objectives are generated by the performance measurement system. The signal processing chain starts by acquiring raw data and information about the competitive environment with specific reference to the strategic objectives that served as initial input. The relevant signals are separated from the irrelevant signals which allow patterns to become easily recognizable. Pattern recognition allows for complex information to be visualized, which in turn makes it easier to interpret, therefore leading to the identification of potential opportunities and threats. The signal processing chain then either confirms existing strategic objectives or formulates new strategic objectives based on the opportunities and threats that were identified. Strategic content control ensures that Critical Success Factors are still in accordance with the strategic objectives that have been either confirmed or formulated. The output of the signal processing chain therefore ultimately ensures that obsolete Critical Success Factors are discarded, that existing Critical Success Factors are either tweaked or kept unchanged and that new Critical Success Factors can be added if deemed necessary. As a result, Critical Success Factors always remain relevant and therefore results in an overall system that is dynamic, flexible and consistent. The signal processing interface additionally allows for the continual availability of relevant data that is based on the strategic objectives and the competitive environment. The interface also provides managers with

proactive method of performing strategic content control. The critical business processes are identified based on the Critical Success Factors as discussed in Part 4 of this thesis.

The critical business process metrics are used as input to the first set of contingency and economic based filters. These metrics are filtered so that they can be consistently related to the performance measurement system. A given critical business process metric first passes through the contingency based filter which consists of three sub filters namely the quantification, scope and timeliness filters.

The contingency filter interface functions as follows:

- The quantification filter ensures that the metric can be quantified. If it cannot be quantified in either financial or non financial terms it is discarded. Non quantifiable metrics creates confusion and promotes inconsistency.
- The scope filter ensures that the metric has broad scope. If it has a narrow scope it discarded. Metrics with narrow scope leads to rigidity and do not consider the system as whole.
- The timeliness filter ensures that information and data about the metric is available on a frequent and timely basis. The metric is discarded if related information and data is available on an infrequent and untimely basis. Infrequent and untimely data leads to increased strategic decision making time, uncertainty, and an overall decrease in system integrity.

The given critical business process metric secondly passes through the economic based filter which consists of three sub filters namely the verifiability, sensitivity and congruity filters. The economic filter interface functions as follows:

- The verifiability filter ensures that there is no bias present within the metric, that measured results have little variance and that the results can be independently reproduced. The metric is discarded if cannot be reproduced with little or no variance in the results. Biased data leads to inconsistency and compromised data which cannot be trusted.
- The sensitivity filter ensures that metrics are of a sensitive nature. Sensitivity refers to the ability of a manager to influence and control strategic performance through direct actions. The sensitivity of a given metric is therefore seen as the amount of change in the mean in response to direct management intervention. Insensitive metrics are discarded in order to keep the overall system consistent, flexible and agile.

- The congruity filter ensures that metrics are in line with what the organization deems strategically important. Incongruent measures are discarded as they promote inconsistency, ambiguity and miscommunication.

The filtered metrics are then passed on to the destination statement block in the performance measurement system. The destination statements therefore represent the desired levels of performance with specific reference to the filtered critical business process metrics that it received as input.

Another instance of economic and contingency based filters link the outputs of the critical control variables with the inputs of the outcomes in the performance measurement system. The critical control variables are based on the critical business process as discussed in Part 4 of this thesis. These filters interface and function in exactly the same way as has been discussed previously. The outcomes in the performance measurement system represent the desired levels of performance with specific reference to the filtered critical control variable metrics that it received as input.

The destination statements and the outputs of the performance measurement system both represent desired levels of performance. It is therefore crucial to be able to identify deviations from these desired levels and perform corrective action to correct the error where necessary. The adaptive processing interface is the key to achieving this.

The first instance of the adaptive processing chain provides the system with an interface that determines the quantified error (a direct result of proper filtering) that exists between the desired critical business process performance level and the actual critical business process performance level. After establishing the degree of deviation, the level of turbulence and the adaptive approach, the error can be corrected for by making operational changes to the deviating business processes. It is important to note that changes to the critical business processes will automatically lead to changes in the critical control variables.

Similarly to the first instance, the second instance of the adaptive processing chain provides the system with an interface that determines the quantified error (a direct result of proper filtering) that exists between the desired levels of critical control variable performance level and the actual critical control variable performance level. After establishing the degree of deviation, the level of turbulence and the adaptive approach, the error can be corrected for by making operational changes to the activities

identified in the performance measurement system. This is largely due to the fact that the activities have a “cause-and-effect” relationship with the outcomes. Changes in the activities will therefore lead to a change in the outcomes. Operational changes are made to the activities and not the critical control variables themselves because the control variables are the by-products of the critical business processes. Making changes to the variables are therefore impossible. It is extremely important to note that deviations within the system can be corrected for by making changes to the operational activities and the critical business processes.

5. Design Verification

The bridging system design is also verified by means of a cross verification matrix. Table 5-4 below presents the verified requirements for the bridging system design.

Table 5-4: Cross Verification Matrix for the Bridging System Design.

Requirement	Where Was It Met	How Was It Met
<u>Requirement BS1:</u> The strategic control system should be able to (1) consistently relate the strategic control system to the performance measurement system and vice versa.	1. System inputs. 2. System outputs.	1. By using strategic control and performance measurement system outputs as inputs. 2. By using strategic control and performance measurement system inputs as outputs.
<u>Requirement BS2:</u> The strategic control system should be able to (1) evaluate the strategic control system, therefore ensuring that the right aspects are being strategically controlled.	1. System processes.	1. By implementing an adaptive processing chain.
<u>Requirement BS3:</u> The strategic control system should be able to (1) evaluate the performance measurement system, therefore ensuring that the right aspects are being measured.	1. System processes.	1. By implementing an adaptive processing chain.
<u>Requirement BS4:</u> The strategic control system should (1) promote the development of new measures based on changes within the competitive environment.	1. System processes.	1. Strategic content control by means of successfully implementing the signal processing chain.
<u>Requirement BS5:</u> The strategic	1. System processes.	1. By successfully

control system should (1) provide a maintenance structure whereby strategic control metrics can be consistently related to the performance measurement system.

implementing both contingency and economic based filters.

6. Conclusion

This part of the thesis dealt with the bridging system that can be implemented to help bridge the gap between the strategic control system and the performance measurement system. It started by first looking at the gap that exists between strategic control and performance measurement. This was accomplished by first looking at the origins of the gap from both an economic and contingency based viewpoints. The implications of the gap on an organization's strategy were also discussed in great detail. The section concluded with what is actually meant by the term "bridging the gap" and it was found that a dynamic and consistent system that promotes quick decision making will accomplish this task.

The subsequent section dealt with the development of theoretical concepts. The concepts of filtering, signal processing and adaptive processing were developed. The concept of filtering broadly dealt with gaining consistent strategic control metrics. Signal processing dealt with the extraction of information patterns from raw data, the identification of opportunities and threats, and ultimately strategic control. The concept of adaptive processing dealt with identifying an error from a desired level of performance and its degree of deviation. Adaptive processing also addressed turbulence and the four styles of adaptive approaches namely the migrator, the voyager, the sprinter and the experimenter.

The part concludes with a systems engineering approach to designing a bridging system. With a well established design base it was subsequently possible to investigate the basic design considerations. These considerations provided a generic look at the various aspects that influence the final bridging system design process. These considerations specifically addressed the concepts of filtering, adaptive processing, and signal processing.

Bridging system design involved the formulation of functional design requirements based on what was highlighted during the discussion on what the term "bridging the gap" entails. The bridging system design also dealt with the basic concept solutions and identified all the possible inputs, outputs, processes and interfaces. Each of these aspects were individually developed in line with the given functional requirements.

Part Six - Case Study and Results

“There is a tide in the affairs of men, which taken at the flood, leads on to fortune. Omitted, all the voyage of their life is bound in shallows and in miseries .On such a full sea are we now afloat. And we must take the current when it serves, or lose our ventures.”

William Shakespeare

1. Objectives

Part Seven of this thesis aims to validate the framework that was developed in the preceding parts with specific reference to the following:

- The intended validation process.
- The validation of the framework by means of a case study.
- The results of the case study.
- A critical review that looks at both the strong points and the weak points of the system design.

2. Introduction

2.1. Intended Design Validation Process

Validating any form of strategic control or performance measurement system is in itself a complex and often challenging feat to accomplish. This can largely be attributed to the fact that changes to business processes and related systems often only have a discerning impact two to three years after the initial change was brought about. Acquiring any form of sensible output, that can be used to corroborate such new business initiatives, may therefore take several years. The challenges faced in validating the framework design presented in this thesis are no different as it is also subjected to the same timescale predicament.

The best possible way to therefore validate the framework, given the time constraints, is to make use of a “post mortem” approach. This approach involves the practical implementation of the framework by making use of historical Strategic Business Unit plans, objectives and data. The results and findings are then qualitatively correlated with possible outcomes that could have been a direct result of successful framework implementation.

Figure 6-1 below provides a roadmap that will be referred to throughout this case study. The roadmap consists of the major parts and related concepts that have been discussed in this thesis. The colour coding scheme is exactly the same as in previous parts, with red indicating the current part being discussed.

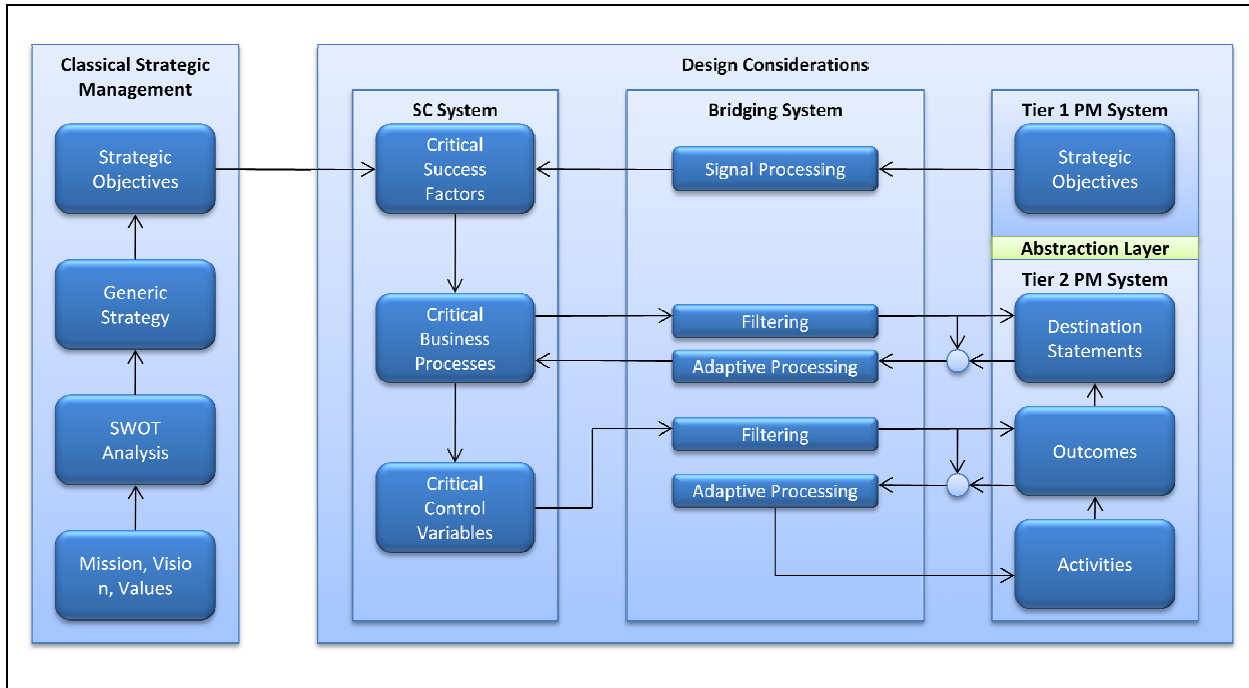


Figure 6-1: Case Study Roadmap.

2.2. Case Study Background

This case study deals with Reutech Radar System’s Mining Business Unit and specifically focuses on operations, performance and results from September 2006 up to and including September 2008. The company first intended to enter the mining business in 2004 and established a Strategic Business Unit dedicated to mining operations in 2005. The Mining Business Unit initially targeted the local market but quickly expanded so as to also target international markets. This strategic business unit is undoubtedly one of the company’s most successful and profitable business units with a present day turnover of over R 40,000,000. Movement and Surveying Radars along with other specialized sensor related solutions are supplied to a global client base that include major mining companies such as Anglo, BHP Billiton, Rio Tinto, Xstrata, DeBeers and Kumba Resources.

The Movement and Surveying Radar is in essence a low cost, highly mobile, self contained and self sufficient radar system. The purpose of the MSR is to provide mining operators with an early indication of impending slope failure in open cast mines before slope failure actually occurs. The Movement and Surveying Radar is capable of providing around the clock surveying information in areas that are not easily accessible. This information is also available in unfavourable conditions caused by smoke, dust, steam and fog. This early warning function is crucial to any mine, as a slope failure normally results in damage to expensive equipment, huge losses in production, injury and/or loss of life.

3. The Classical Strategic Management Process

The classical strategic management process in essence provides the strategic control system with strategic objectives that only serves to act as a starting point and is for this reason only briefly discussed. The process generally consists of a vision, mission and core values, as well as some form of strategic analysis (SWOT analysis in this case). Classical strategic management processes also often define generic strategies and subsequent strategic objectives. Refer to Figure 6-2 below for the case study roadmap and to the Classical Strategic Management Process in Part 2 for the theoretical details.

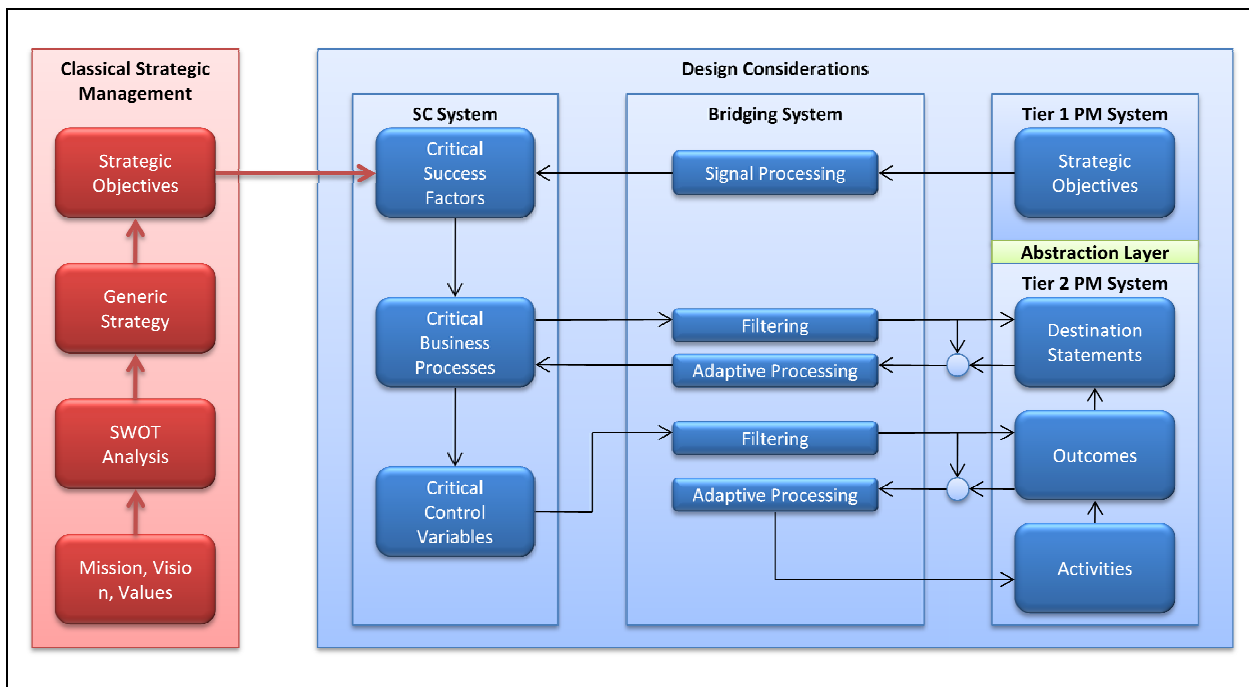


Figure 6-2: Case Study Roadmap - The Classical Strategic Management Process.

3.1. Strategic Business Unit Vision

The vision of an organization is seen as the first step in the strategic management process and is usually a dream or a promise that communicates an attractive future. The vision for the Mining Business Unit is stated as:

“Be the preferred supplier of safety and productivity enhancing solutions in the mining industry worldwide.”

3.2. Strategic Business Unit Mission

The mission of an organization is the reason why the organization exists and it is often seen as an achievable goal. The mission for the Mining Business Unit is stated as

“Growing business in the open cast mining industry via the Movement and Surveillance Radar (MSR), as well as via sensor-related opportunities driven by customer needs.”

3.3. Strategic Business Unit Core Values

The core values provide a framework that sets the values and standards within an organization and have a direct influence on the organizational culture. The core values of the Mining Business Unit are stated as:

- On time.
- Cost awareness.
- Honesty and integrity.
- Openness and transparency.
- Personal development and growth.
- Customer focus.
- Defining and defending the contractual and technical baselines.
- Excellence.

3.4. Internal Analysis: Organisation Strengths

The first part of the internal analysis is concerned with identifying the strengths of an organisation. A strength is seen as a resource or capability the organization has which can be used as an advantage relative to the competitor. Table 6-1 below summarises the Mining Business Unit's strengths.

Table 6-1: Mining Business Unit Strengths.

Area	Description
Product knowledge.	Extensive experience in the research and development of new radar systems. Although the Movement and Surveillance Radar targets the commercial market, compared to the traditional military market the company is used to, the base technology has been successfully used in several other radar applications.
Intellectual property.	Reutech Radar Systems owns the intellectual property.
Resources.	Reutech Radar Systems has a significant group of radar related resources at its disposal and access to various research organizations and institutions.
Price competitiveness.	The price of the MSR is comparable to the listed price of similar competitor products.
Innovativeness.	A wide variety of core competencies, with a proven track record when it comes to solving complex problems in innovative ways.
Reliability.	Extensive experience with defense orientated system engineering has resulted in significant competencies and abilities with regard to designing reliable, flexible and rugged operating systems.
Production capability.	SABS approved production processes and standards are well entrenched in everyday production activities.

3.5. Internal Analysis: Company Weaknesses

The second part of the internal analysis is concerned with identifying the weaknesses of the organization. A weakness is a lack of, or deficiency in, a resource that is seen as a disadvantage relative to the competitor. Table 6-2 summarises the Mining Business Unit's weaknesses.

Table 6-2: Mining Business Unit Weaknesses.

Area	Description
Commercial marketing experience.	The MBU has up until 2006 not had much commercial marketing experience.
Global support infrastructure.	The MBU has up until 2007 not had any form of international support infrastructure.
Brand.	The Reutech brand is relatively unknown in the mining industry.
Lack of mining client experience.	Traditional customers have been in the defense industry.

3.6. External Analysis: Opportunities

The first part the external analysis is concerned with identifying opportunities. Opportunities arise when a company understands its external environment and takes the appropriate actions to secure an advantage. Table 6-3 summarises the Mining Business Unit's opportunities.

Table 6-3: Mining Business Unit Opportunities.

Area	Description
New market.	The MSR provides a much needed solution to the mining industry. This exposes the MBU to a new market and exposes the industry to new radar related solutions.
First client secured.	The MBU has secured its first client. The client has expressed explicit interest in other radar related solutions. The client has also indicated willingness to help with marketing efforts, as innovation is driven by the number of systems in the field.
Surveying market.	The MSR aims to provide slope stability monitoring but the surveying aspect can be applied to non-mining areas.
Competitor high price.	The high price of the competitor product will initially help the product to compete on price.
Competitor relationship.	The competitor has a notoriously poor relationship with major mining clients.
Competitor cost of support.	The competitor is charging an extremely high price for their product support.

3.7. External Analysis: Threats

The second part of the external analysis is concerned with identifying threats. Threats arise when conditions in the external environment jeopardise the well being of the organization. Table 6-4 summarises the Mining Business Unit's threats.

Table 6-4: Mining Business Unit Threats.

Area	Description
Rate of exchange sensitivity.	Roughly 75% of all material costs are subject to the foreign exchange rate while about 25% of the projected revenue in the years from 2006 up to and including 2008 is subject to foreign exchange rates.
Competitor experience.	The competitor has significantly more experience in the mining industry.
Trade barriers.	Trade tariffs are often imposed to protect local industries.
Innovation centres.	Innovation centres such as DEBEX and CSSIP have existing relationships with the mining companies, and the companies often use them to develop new innovations.

3.8. Generic Strategy and Strategic Objectives

The mining Strategic Business Unit will follow a growth strategy. With this in mind the following strategic objective was identified:

- Increase Reutech Radar Systems' turnover by selling Movement and Surveying Radars to the South African and international markets.

4. The Basic Design Considerations

The basic design considerations provide valuable insight into the operational environment in which the framework is to be implemented. This is extremely important as it allows the management team responsible for implementing the framework design with an opportunity to gain insight into both the specific characteristics of the organizational environment and the current state of the strategic management system within the organisation. This section discusses the basic design considerations of the strategic control system, the performance measurement system and the bridging system with specific reference to the operational environment of the Mining Business Unit. Refer to Figure 6-3 below for the case study roadmap and to the Basic Design Considerations section in Part Three, Four, and Five for further theoretical details.

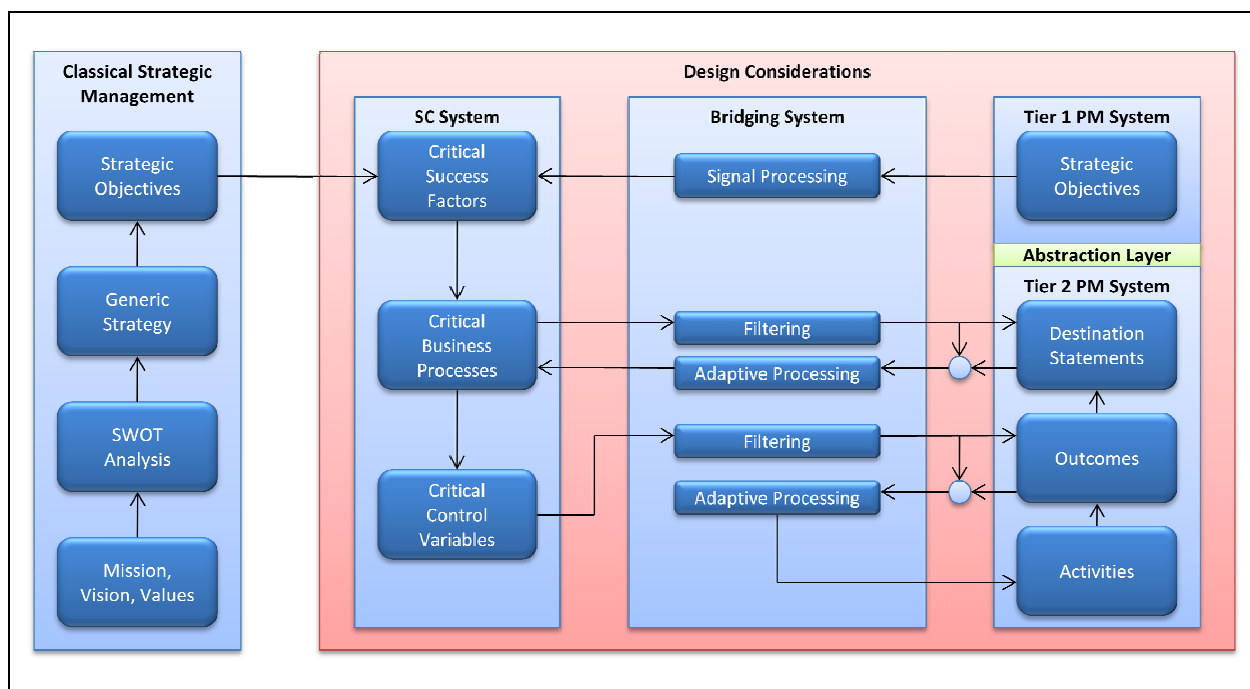


Figure 6-3: Case Study Roadmap – Design Considerations.

4.1. Strategic Control System Considerations

The Mining Business Unit operates in a hostile and turbulent environment. This is largely attributed to fluctuating foreign exchange rates, stiff competition and the commodity-based markets that the business unit targets. Operating within a hostile and turbulent environment requires the strategic control system to also consider formal, financially based measures.

The specialised Movement and Surveying Radars developed by Reutech Radar System's production department depend heavily on complicated batch production technologies driven by standardized production processes with little automation. The need for a strategic control system that focuses less on statistical operating procedures and more on statistical planning reports and related measures therefore exists.

Reutech Radar Systems has a very flat organizational structure. Even though the Mining Business Unit is separated from the other business units, it exhibits the same structural characteristics. Figure 6-4 below visually depicts the structure of the Mining Business Unit.

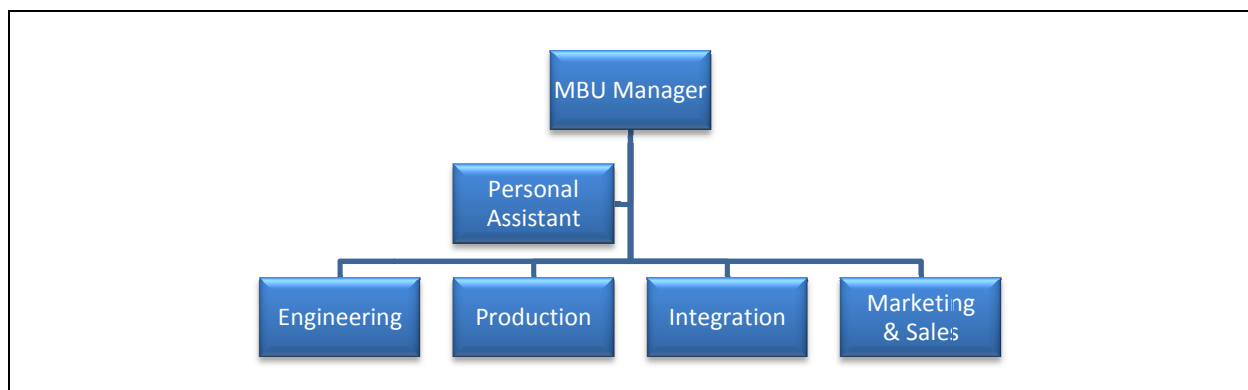


Figure 6-4: The Mining Business Unit Structure.

The business unit's high degree of autonomy, paired with the flat structure, requires the strategic control system to consider team based performance measures coupled with business unit level accounting measures. The Mining Business Unit is a small but relatively departmentalised business unit and the strategic control system should therefore also take informal measures based on the specific operations of each of the departments into consideration.

The Mining Business Unit follows a growth strategy and such strategies are usually associated with a strategic control system that depends on a good mix of both financial and non financial indicators. When looking at the previous considerations this assumption seems to be valid, as the environment in which the business unit competes, its operational technology, its structure and its size require a strategic control system that should consider both financial and non-financial measures as important.

4.2. Performance Measurement System Considerations

The overall strategic objectives of the Mining Business Unit are well known by all the departments as has been identified in Figure 4. The flat structure of the business unit places a lot of emphasis on the measures that deal with the performance of the departments as whole. The targets for these measures are currently based on revenue made as a result of sales. A proper measurement system that evaluates, rewards and provided incentives to both managers and employees does not exist. Information flow is severely restricted due to the lack of a performance measurement structure. The extent to which the business unit “learns” from past experiences is informal in nature and is purely based on personal business unit manager experience.

4.3. Bridging System Considerations

The Mining Business Unit currently makes use of very few formal reporting mechanisms. Reports providing feedback on quantified resources, outputs, efficiency and information regarding the management of both business processes and control variables are currently very limited. Reporting is confined to “Estimated Cost to Completion” meetings, where the resources, outputs and efficiency of only a few select processes are discussed. These meetings, as the name implies, consider estimated cost (hours and material) to completion, sales forecasts and actual sales. Estimated Cost to Completion meetings are held every month and audited information pertaining to these meetings are thus available on a monthly basis. These meetings currently lack in depth and detailed feedback on all of the applicable business processes and related control variables. The fact that business processes and control variable performance is not extensively tracked and monitored makes drawing correlations between current performance and other factors that may influence performance challenging. This in turn hampers the Mining Business Unit’s ability to predict the likelihood of future events based on current performance.

The Mining Business Unit manager has the ability to, through direct actions, influence and control strategic performance. This can mostly be attributed to the small size and flat structure of the business unit. There is a clear relationship between overall business unit performance and well performing business processes, the talent and the expertise of the personnel operating within these processes and the amount of process information provided to the manager. Much the same can be said of the relationship between overall business unit performance and well performing critical control variables, the expertise of the personnel influencing the control variables and the amount of control variable information provided to the manager. Current data and information about business processes and variables are financially based and are audited before they are readily made available. These results are therefore accurate, objective, difficult to manipulate, independently verified as well as subjected to an annual audit. The Mining Business Unit's value is considered to be a direct result of good business process and control variable performance. The overall performance of the organization is also a direct result of the business unit's performance.

There is a number of existing data sources that may provide the signal processing chain with relevant data that are currently overlooked. Non financial data such as system availability (Ao), customer satisfaction, call centre performance and support hub performance is overlooked and is not effectively used to the advantage of the business unit as a whole. There is currently very little known about the speed at which information patterns are being detected and interpreted within the business unit when compared to the competition. However, the speed at which identified information patterns are acted on is relatively fast. This can be seen, when for instance looking at the time it takes to implement a new innovative idea or looking at the time it takes to target newly identified customers.

Changes within the environment in which the business unit operates occur at a relatively fast pace. These changes often occur abruptly and without warning. This can largely be attributed to the commodity-based markets the Movement Surveying Radar targets. The business unit currently does little to formally track changes, but it does seem to adapt to changing customer needs and fluctuations in operational performance. The style of adaptive approach that would best suit the hostile environment the Mining Business Unit is confronted with would be the experimenter approach. The experimenter approach makes incremental modifications to certain aspects of the existing business processes and variables. The existing structures within the business unit can undoubtedly be adapted and subsequently expanded on.

5. The Strategic Control System

The strategic control system is comprised of three interlinked stages that are responsible for formulating the Critical Success Factors, Critical Business Processes and the Critical Control Variables. The Critical Success Factors are derived from either the feed forward or feedback approach to strategic control. The derivation of the Critical Business Processes and the Critical Control Variables subsequently follows. Refer to Figure 6-5 below for the case study roadmap and to the Strategic Control System Design section in Part 3 for further theoretical details.

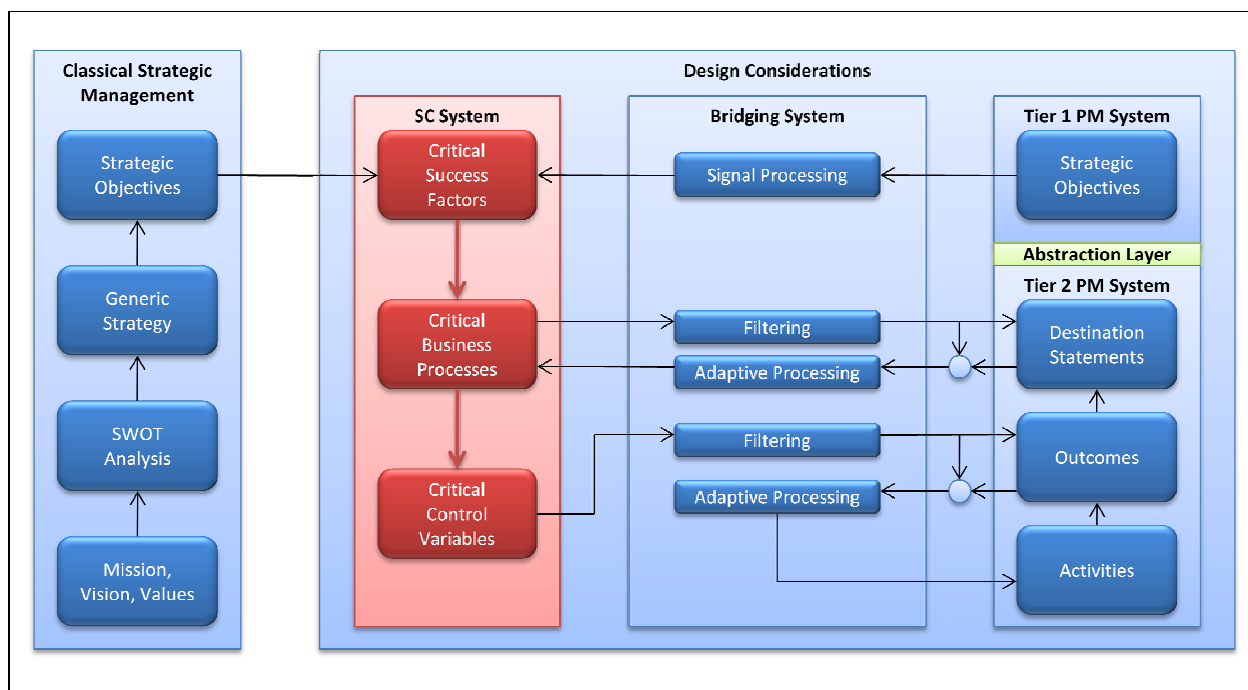


Figure 6-5: Case Study Roadmap - The Strategic Control System.

5.1. Critical Success Factor Identification

The first stage in the strategic control system deals with the identification of the Critical Success Factors. Critical Success Factors are seen as the factors on which a company can distinguish itself from its competition and serve as a basis for long term profitability. These Critical Success Factors are initially formulated based on the generic strategy and the related strategic objectives as defined in the classical strategic management process. This is in line with the feedback approach to strategic control, which views Critical Success Factors from a strategy implementation perspective. The Critical Success Factors are also formulated based on strategically controlled content from the signal processing chain. This is in accordance with the feed forward approach to strategic control, which views Critical Success Factors

from a strategy formulation perspective. The Critical Success Factors are therefore always relevant and will adapt as information about the competitive environment provided by the signal processing chain becomes available.

The growth strategy and the intention of the Mining Business Unit to increase turnover by selling more Movement and Surveying Radars to local and international markets has led to the formulation of the following Critical Success Factors:

- 1) Revenue growth.
- 2) Optimal manufacturing productivity.
- 3) Customer profitability.
- 4) Operational excellence.
- 5) Satisfied customers.
- 6) Innovative products.

Critical Success Factors that are not being excelled at will result in the organization not achieving its strategic objectives. It is therefore extremely important to break the Critical Success Factors down into more manageable processes and variables.

5.2. Critical Business Process Identification

The Critical Business Processes are those processes within an organization, that when executed well, will lead to the successful execution of the Critical Success Factors. The Critical Business Processes are thus derived from the Critical Success Factors. For brevity's sake, only the Critical Business Processes for revenue growth will be discussed in the paragraph below.

Revenue growth has been defined as a Critical Success Factors and in order to achieve distinguishable levels of revenue growth the Mining Business Unit needs to exploit new business opportunities by selling MSRs to both new markets and new customers. The up and cross selling of products will also help increase revenue growth. This is largely due to the fact that a single customer will not only buy an MSR but will also buy additional "add on" features (up selling) and extended product support packages (cross selling). The provision of product support is also seen as a Critical Business Process with regard to revenue growth, as a well supported product has a significant impact on whether a prospective client decides on whether or not to buy the product. Research and development is also seen as an additional

Critical Business Process, as technological enhancements ensure that the MSR remains competitive and relevant.

The critical success factor method for strategic control is used to determine the importance of the Critical Business Processes. This is especially useful in cases where there are numerous business processes to consider. Table 6-5 contains all of the Critical Success Factors and Critical Business Processes for the Mining Business Unit and demonstrates the critical success factor method for strategic control. For further theoretical background on this method refer to the Strategic Control System Design section in Part Three.

Table 6-5: Critical Success Factor Method for Strategic Control.

Critical Business Processes	Critical Success Factors						(A) Count.	(B) Process quality.
	1. Revenue growth.	2. Optimal manufacturing productivity.	3. Customer profitability.	4. Operational excellence.	5. Satisfied Customers.	6. Innovative products.		
1. Exploit new business opportunities.	X		X				2	D
2. Manage direct and indirect expenditures.		X					1	C
3. Up/Cross sell products.	X		X				2	C
4. Manage inventory performance.		X					1	B
5. Provide product support.	X			X	X		3	D
6. Research and development.	X				X	X	3	C

According to the results in Table 6-5 the Critical Business Processes for the Mining Business Unit should be ranked in the following order:

- 1) Provide product support.
- 2) Research and development.
- 3) Exploit new business opportunities.
- 4) Up/cross sell products.
- 5) Manage direct and indirect expenditures.

6) Manage inventory performance.

The true significance and value of this method is not really demonstrated in this case study, as there are too few Critical Business Processes in the Mining Business Unit. This method would however be a lot more useful in identifying the importance of Critical Business Processes in larger business units or organizations. Numerous Critical Business Processes may lead to an overload in the amount of data that is to be monitored and measured. This method will therefore provide management with a means to help identify which of the processes are important to monitor and measure and which of the processes are less important and should subsequently be ignored.

The direct link between the Critical Business Processes and the Critical Success Factors will therefore always ensure that the processes that the organization views as critical are adapted to the changes within the competitive environment. Corrections to underperforming Critical Business Processes can however be made by means of the adaptive processing chain. This however implies that the relevant Critical Business Processes are in a quantifiable state and the degree of deviation is known. Quantifying and determining the actual and desired levels of Critical Business Process performance is however accomplished by the bridging system and the performance measurement system.

5.3. Critical Control Variable Identification

The Critical Control Variables are those variables within the organization that should perform well in order to ensure that the Critical Business Processes are executed successfully. The Critical Control Variables are a direct product of the Critical Business Processes. Changes to the Critical Business Processes will therefore have a direct result on the Critical Control Variables.

For brevity's sake, only the Critical Control Variables related to the provision of product support are derived in the paragraph below. The purpose of the following discussion is to demonstrate the methodology behind deriving the Critical Success Factors from the Critical Business Processes.

Providing excellent product support has been defined as one of the Mining Business Unit's Critical Business Processes. Product support is crucial during system down times as it usually results in the mine stopping all operations. This is largely due to the fact that the safety of the miners and equipment cannot be guaranteed. Providing excellent product support therefore entails increasing the radar's

operational availability. The Critical Control Variables responsible for the operational availability of the radar system is the Mean-Time-To-Repair (MTTR) and the Mean-Time-Between-Failures (MTBF).

The complete list of Critical Control Variables for the Mining Business Unit is listed below:

- 1) Mean-Time-To-Repair (MTTR).
- 2) Mean-Time-Between-Failures (MTBF).
- 3) Research and development material expenditure.
- 4) Research and development labour expenditure.
- 5) Production material expenditure.
- 6) Production labour expenditure.
- 7) Number of mine visits.
- 8) Number of support calls.
- 9) Extended support sales.

When the performance of a critical control variable is not as desired the performance of the related Critical Business Process will undoubtedly suffer the consequences. The problem is however pin-pointed by identifying the underperforming Critical Control Variable. When related to the case study it means that if the Mining Business Unit's product support process is not as desired, the problem can be traced to either or both of the Mean-Time-To-Repair and Mean-Time-Between-Failure variables. As with the Critical Business Processes, the quantifying and establishing of the desired and actual levels of performance, is accomplished by the bridging and performance measurement systems.

6. The Bridging System: Filtering

The bridging system's goal is to achieve consistency between the strategic control system and the performance measurement system. Filtering forms part of the bridging system and is mainly responsible for ensuring that the Critical Business Processes and the Critical Control Variables of the strategic control system are consistently related to the Destination Statements and Outcomes of the performance measurement system. The filtering process can further be broken down into both the economic and contingency based filters as discussed in Part Five. Figure 6-6 on the following page shows how this section on filtering relates to the overall case study.

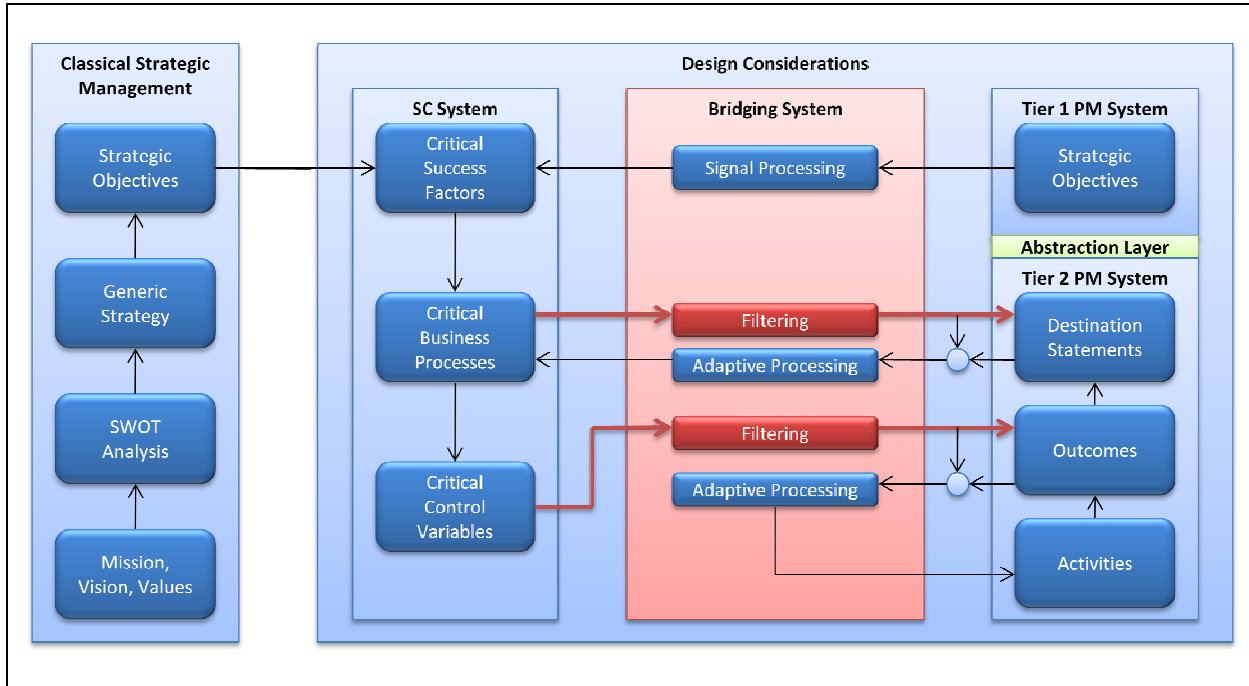


Figure 6-6: Case Study Roadmap – Filtering.

6.1. Filtering the Critical Business Processes

The economic and contingency based filters play an extremely important role in the overall effectiveness of the framework. The filters ensure that the Critical Business Processes measured by the performance measurement system are quantifiable, timely, congruent, verifiable, sensitive and relevant. Any of the Critical Business Processes that do not meet these requirements are filtered out. Filtering therefore helps to achieve an overall strategic framework that is consistent and dynamic. Figure 6-7 once again presents the six filters as discussed in Part Five.

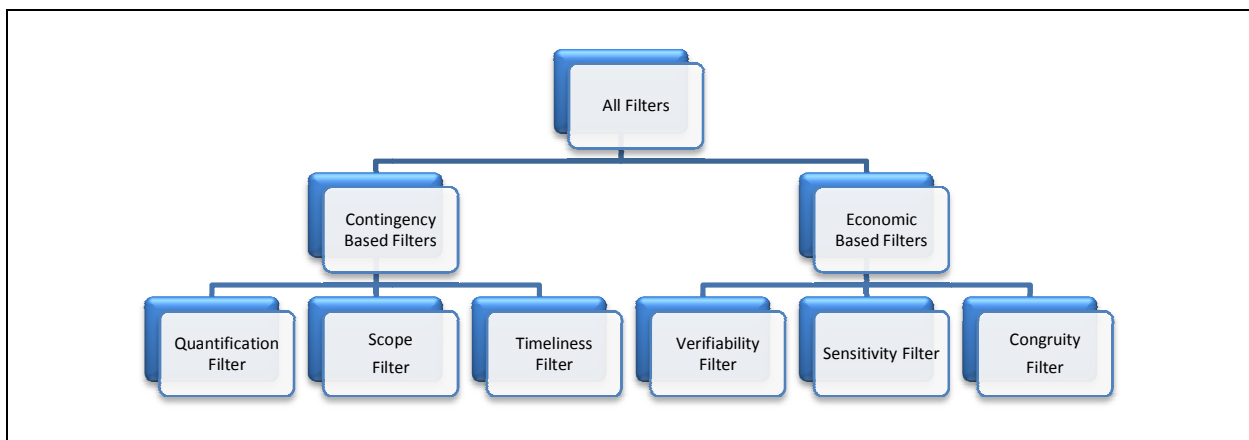


Figure 6-7: The Contingency and Economic Based Filters.

The quantification filter ensures that the Critical Business Processes are indeed quantifiable. If this is the case, the Critical Business Process is quantified and its desired level of performance is established. The desired levels of performance are expressed in either non financial or financial terms. The non financial quantification of a Critical Business Process entails that the given process either be expressed in physical or quantitative terms.

All the Critical Business Processes of the Mining Business Unit were found to be quantifiable when subjected to the quantification filter. It was therefore subsequently possible to determine the desired levels of performance of the Mining Business Unit's Critical Business Processes for the 2006, 2007 and 2008 financial years. The detailed results of the quantification filtering process, which includes the desired levels of performance, are depicted in Table B-1 of Addendum B.

The scope filter ensures that the Critical Business Processes are not too broadly or too narrowly focused. The scope filter is important in the greater strategic framework as it ensures that the Critical Business Processes of the Mining Business Unit can be used to reflect future feed forward strategic initiatives.

All of the Mining Business Unit's Critical Business Processes are characterised as having business unit level scope. If the scope was broader, in other words, if it was characterised by company or group level scope, it would not have been possible to base the Mining Business Unit's future strategic objectives on the performance of the Critical Business Processes. This same argument holds for Critical Business Processes that are too narrowly scoped. The results of the scope filter are summarised in Table 6 below.

The timeliness filter focuses on the timely and frequent acquisition of data. Data that are collected on an infrequent and untimely basis significantly decreases the consistency of strategic decision making and subsequent strategic action. Data and information regarding the Mining Business Unit's Critical Business Processes are currently available on an annual basis. This frequency might initially seem too low, but it is acceptable, given the fact that changes to business processes usually take years rather than months.

The data and information regarding the Critical Business Processes of the Mining Business Unit are deemed to be verifiable with little measurement spread and very little personal bias. This can largely be attributed to the fact that the quantified data and information regarding the business processes are gathered from independently audited sources (annual financial results, board reports, operational data, estimated cost to completion reports, etc). The verifiability filter, which ensures that the Critical Business Processes are indisputable and unambiguous, is provided with accurate and reliable data. All of

the Mining Business Unit's Critical Business Processes have been found to pass through the verifiability filter and these results are summarised in Table 6-6 below.

The sensitivity filter is concerned with the ability of a manager to influence and control strategic performance through direct actions. The sensitivity filter therefore outputs Critical Business Processes that when changed, will lead to a change in organization's strategic behaviour. The flat structure of the Mining Business Unit ensures that the Mining Business Unit Manager has direct influence and control over the Critical Business Processes which therefore results in all of the processes passing through the sensitivity filter. The results are summarised in Table 6-6 below.

The congruity filter has to do with the extent to which the priorities of the Mining Business Unit's strategy are reflected by the Critical Business Processes. The fact that the Mining Business Unit's Critical Business Processes have been derived from the Critical Success Factors, a direct result of the strategic objectives, warrants the congruity of the Critical Business Processes. The congruity filter may initially is an extremely important element, as its omission may lead to misalignment, inefficiency and inconsistency within the broader strategic system. The Critical Business Processes of the Mining Business Unit were all found to be congruent and the results are summarised in Table 6-6 below.

Table 6-6: Critical Business Processes Subjected To Filtering.

	Quantification Filter	Scope Filter	Timeliness Filter	Verifiability Filter	Sensitivity Filter	Congruity Filter
Exploit new market opportunities.	Number of new systems sold.	Mining Business Unit level.	Annually.	Yes, annual financial results.	Yes.	Yes.
Direct and indirect expenditures.	Operating profit margin.	Mining Business Unit level.	Annually.	Yes, annual financial results.	Yes.	Yes.
Up/cross sell products	Bundled sales results.	Mining Business Unit level.	Annually.	Yes, annual financial results.	Yes.	Yes.
Manage inventory performance.	Inventory turnover ratio.	Mining Business Unit level.	Annually.	Yes, annual financial results.	Yes.	Yes.
Product support.	Product availability percentage.	Mining Business Unit level.	Annually.	Yes, annual operational results.	Yes.	Yes.
Research and development	Number of functional enhancements.	Mining Business Unit level.	Annually.	Yes, annual operational results.	Yes.	Yes.

6.2. Filtering the Critical Control Variables

The Critical Control Variables are subjected to the same set of economic and contingency based filters as previously described. Arguments relating to the purpose and use of the various filters are therefore exactly the same and will, for brevity's sake, not be repeated.

All of the Mining Business Unit's Critical Control Variables were found to be quantifiable and it was subsequently possible to define the desired levels of performance. Table B-2, Table B-3 and Table B-4 of Addendum B provide detailed information on the desired performance levels for each of the Critical Control Variables. Table 6-7 on the following page provides a summary of the quantification filter results.

The Critical Control Variables of the Mining Business Unit are all deemed to have operational level scope. This is considered to be adequate, as broader or narrower scoped variables would render them obsolete in terms of uses for future feed forward strategic initiatives. All of the Critical Control Variables therefore pass through the scope filter and the results are depicted in Table 6-7.

The Critical Control Variables are subsequently subjected to both the timeliness and verifiability filters, with no variables being excluded by the respective filters. This is largely due to the fact that audited operational information (verifiable data) regarding the quantified Critical Control Variables are made available at internal "Estimated Cost to Completion" meetings which are held on a monthly basis (timely data). Refer to Table 6-7 for the results of the verifiability and timeliness filters.

The Critical Control Variables were lastly subjected to the sensitivity and congruity filters respectively. As with the Critical Business Processes, the Critical Control Variables were all found to be verifiable, which as previously mentioned is due to the flat structure of the Mining Business Unit. The Critical Control Variables are all congruent, which can largely be attributed to the relationship between the Critical Control Variables, the Critical Success Factors and the strategic objectives. The results of the sensitivity and congruity filters are depicted in Table 6-7 on the next page.

Table 6-7: Critical Control Variables Subjected to Filtering.

	Quantification Filter	Scope Filter	Timeliness Filter	Verifiability Filter	Sensitivity Filter	Congruity Filter
Mean-Time-Between Failures (MTBF)	MTBF per system.	MBU operational level.	Monthly.	Yes, call centre report.	Yes.	Yes.
Mean-Time-Between Repairs (MTBR)	MTBR per system.	MBU operational level.	Monthly.	Yes, call centre report.	Yes.	Yes.
Mining visits	Number of mining visits	MBU operational level.	Quarterly.	Yes, marketing report.	Yes.	Yes.
R&D materials expenditure	Cost of R&D materials.	MBU operational level.	Monthly.	Yes, ECC report.	Yes.	Yes.
R&D labour expenditure	Cost of R&D labour.	MBU operational level.	Monthly.	Yes, ECC report.	Yes.	Yes.
Production materials expenditure	Cost of production materials.	MBU operational level.	Monthly.	Yes, ECC report.	Yes.	Yes.
Production labour expenditure	Cost of production labour.	MBU operational level.	Monthly.	Yes, ECC report.	Yes.	Yes.
Support calls	Number of support calls.	MBU operational level.	Monthly.	Yes, call centre report.	Yes.	Yes.
Extended support contracts	Value of contract.	MBU operational level.	Monthly.	Yes, ECC report.	Yes.	Yes.

The results in Table 6-6 and in Table 6-7 above as well as in Table B-2, Table B-3 and Table B-4 of Appendix B clearly illustrate the advantages of the filtering process. Filtering ensures that the bridging system remains consistent and dynamic; this in turn leads to decreased strategic decision making time, better strategic alignment and an overall increase in strategic efficiency.

This section as well as the previous section of the case study therefore illustrated that the use of economic and contingency based filters ensured that all of the Mining Business Unit's *Critical Business Processes* and *Critical Control Variables*, which serve as inputs to the performance measurement system, are:

- Quantifiable and therefore able to be related to desired levels of performance.
- Available on a frequent and timely basis.
- Adequately scoped.
- Independently verifiable.
- Sensitive, so as to be influenced by a manager's direct actions.
- Congruent with the business unit's strategic objectives.

The filtering process in essence lays the foundation for interfacing with both the Destination Statements and the Outcomes of the performance measurement system.

7. The Second Tier Performance Measurement System

This second tier performance measurement system consists of the Destination Statements, Outcomes and Activities respectively. These three elements are interlinked and are ultimately responsible for providing the adaptive processing chain with information so that the deviation that exists between the actual and desired levels of both Critical Business Process and Critical Control Variable performance can be successfully determined. The causal relationship that exists between the Activities and Outcomes results in a strategic linkage model which makes it possible to correct for any Critical Control Variable deviation by making changes to the Activities. The case study roadmap in Figure 6-8 on the following page illustrates the relation of the second tier performance measurement system with the framework as a whole. Refer to the Second Tier Performance Measurement System Design in Part Four for further theoretical background.

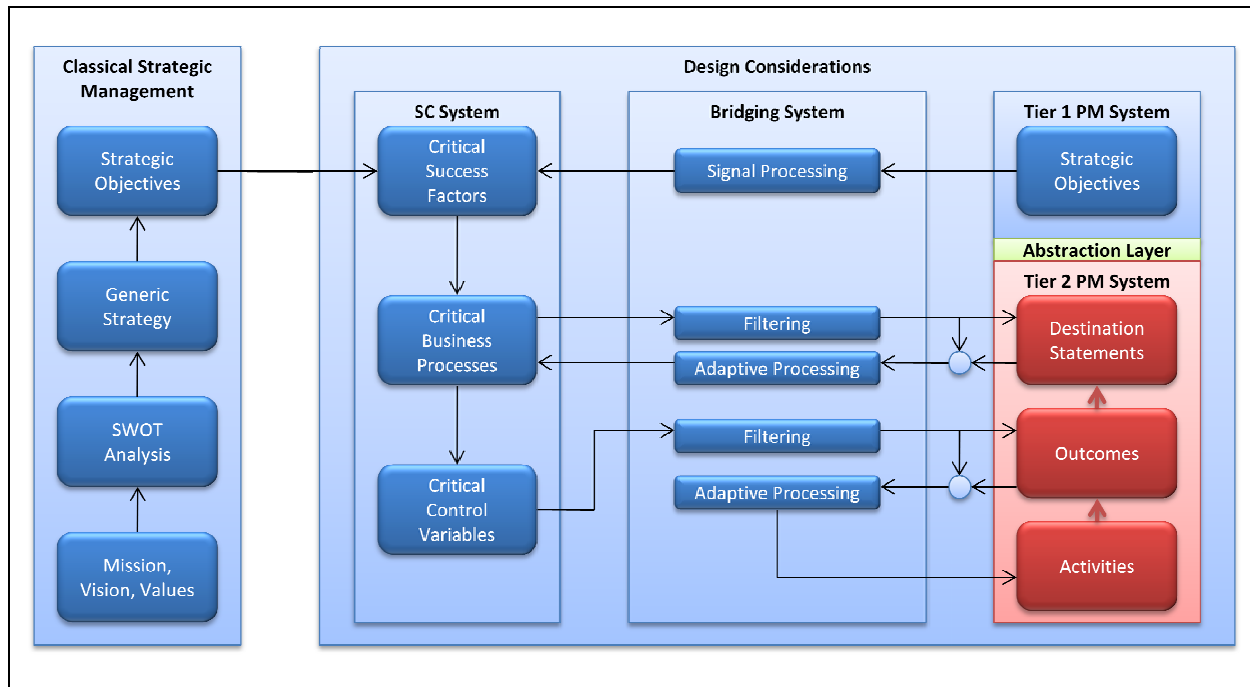


Figure 6-8: Case Study Roadmap - The Second Tier Performance Measurement System.

7.1. Destination Statements

The Destination Statement element aims to function as a broader target setting tool and additionally serves as a point of departure for the strategic objective selection, executed by the Strategic Objective element in the first tier performance measurement system. A definition provided in Part 3 by Lawrie and Cobbold defined a destination statement as:

“A description, ideally including quantitative detail, of what the organization, or part thereof is likely to look like at an agreed future date.”

The link between the Destination statements and the filtered Critical Business Processes therefore logically follows, as the filtered Critical Business Processes also function as a broader target setting tool. They additionally also include quantitative detail of what a part of the Mining Business Unit is likely to look like at an agreed future date, in other words the desired levels of performance.

The Destination Statement element is also responsible for gauging the actual levels of Critical Business Process performance. The actual levels of performance serve as input to the bridging system’s adaptive processing chain, which is in turn determines the deviation between the desired and actual levels of performance.

Within the context of this case study, the desired levels of Critical Business Process performance coupled with the Destination Statements, successfully provide a description of what the Mining Business Unit is likely to look like at an agreed future date. It also provides the Critical Business Processes of the Mining Business Unit with goals to continually strive for. The Critical Business Processes and related Destination Statements are summarized in Table 6-8 below.

Table 6-8: Critical Business Process Destination Statements.

Critical Business Process	Destination Statement
Exploit new market opportunities.	An increase in the number of systems sold annually.
Manage direct and indirect expenditures.	An increase in the annual operating profit margin.
Up/Cross sell products.	An increase in the annual sales revenue of bundled offerings.
Manage inventory performance.	An annual increase in inventory turnover.
Product support.	Excellent product availability on a yearly scale.
Research and development.	An annual increase in product enhancements that are implemented.

The Destination Statement element, as previously mentioned, is also responsible for determining the Mining Business Unit's actual levels of Critical Business Process performance. The information pertaining to the actual levels of performance, due to the overwhelming amount, is not presented in this part of the thesis, but is presented in Table C-1 of Addendum C.

7.2. Outcomes

The Outcomes are linked to Critical Control Variables by means of filtering in the same way as the Destination Statements are linked to the Critical Business Processes. The functional aspects of the performance measurement system's Outcomes are therefore in essence very similar to those of the Destination Statements.

The Outcomes, as the name suggests, provide the various Critical Control Variables with statements that describe their desired outcomes which ultimately also acts as goals to strive for. They are additionally also responsible for gauging actual Critical Control Variable performance, which serve as the input to the adaptive processing chain. A direct causal relationship between the Outcomes and Activities allows for the deviations in actual Critical Control Variable performance to be adapted for by means of changes to the Activities.

Within the context of this case study, the desired levels of Critical Control Variable performance coupled with the Outcomes, provides the Mining Business Unit's Critical Control Variables with a quantifiable goal to aim for. The Outcomes for the Mining Business Unit's Critical Control Variables have been defined in Table 6-9 below.

Table 6-9: Critical Control Variable Outcomes.

Critical Control Variable	Outcome
Mining visits.	An excellent relationship with the customer.
Mean-Time-Between Failures (MTBF).	Increase in MTBF per system.
Mean-Time-Between Repairs (MTBR).	Decrease in MTBR per system.
Support calls.	Less support calls per system.
R&D material expenditure.	Within budget.
R&D labour expenditure.	On time.
Production material expenditure.	Within budget.
Production labour expenditure.	On time.
Support sales.	Constant support sales.

Further information with regard to the actual performance of the Mining Business Unit's Critical Control Variables is depicted in Table C-2, Table C-3 and Table C-4 of Addendum C.

7.3. Activities

The Activities of the performance measurement system are related to the Outcomes by means of a simple causal relationship. The Activities therefore play a crucial role in stimulating continuous improvement within the performance measurement system, as subsequent changes in the Activities have a direct impact on the related Outcomes.

The causal relationship between the Activities and Outcomes of the Mining Business Unit are tabulated in Table 6-10 below.

Table 6-10: Activities of the Mining Business Unit Linked To the Outcomes.

Outcome	Activity
An excellent relationship with the customer.	<ul style="list-style-type: none"> Customer relationship management.
Increase MTBF per system.	<ul style="list-style-type: none"> Use continuous improvement and root cause analysis techniques such as the Failure Reporting and Corrective Action System (FRACAS). Continually involve the quality assurance department during the production phase. Focus on quality based initiatives, such as the First-Time-Right initiative, during the production phase.

Decrease MTBR per system.

- Optimise both local and international logistical processes.
- Excellent management of spare parts inventory.
- Excellent client/customer training programmes.

Less support calls per system.

- Establish contracts with local and international support partners.
- Build the required supply chain network.
- Provide excellent first time call centre support to customers.
- Well trained call centre operators.
- Use continuous improvement and root cause analysis techniques such as the Failure Reporting and Corrective Action System (FRACAS).

Within budget.

- Reduce costs by excellently managing projects.
- Reduce costs by making use of quantity benefits and optimal Minimum Order Quantities.
- Optimise the supply chain by leveraging existing relationships with suppliers.

On time.

- Excellent project management.
- Employee training and development programmes.

Constant support sales.

- Provide excellent product support.
- Establish contracts with local and international support partners.

The Activities receive inputs regarding the degree of deviation between the actual and desired Critical Control Variables by means of the adaptive processing chain. These deviations can be compensated for by making changes to existing Activities or by identifying additional operational Activities. Within the context of this case study it means that unacceptable deviations to, take as an example the Mean-Time-Between-Failure of a given system, can be corrected for by improving on activities that include but are not limited to:

- Continuous improvement and root cause analysis techniques (FRACAS).
- Involving the quality assurance department during the production phase.
- Quality based initiatives such as First-Time-Right during the production phase.

8. The Bridging System: Adaptive Processing

The primary objective of the adaptive processing system, as discussed in Part Five of this thesis, is to identify any deviations from the desired performance levels and to also compensate for possible errors by performing corrective actions. The ability to perform corrective actions is of the utmost importance as it is a key role player in promoting the consistency, agility and adaptability of the framework as a whole. The case study roadmap in Figure 6-9 below depicts the individual adaptive processing chains, which will subsequently be discussed, relative to the other elements within the larger framework.

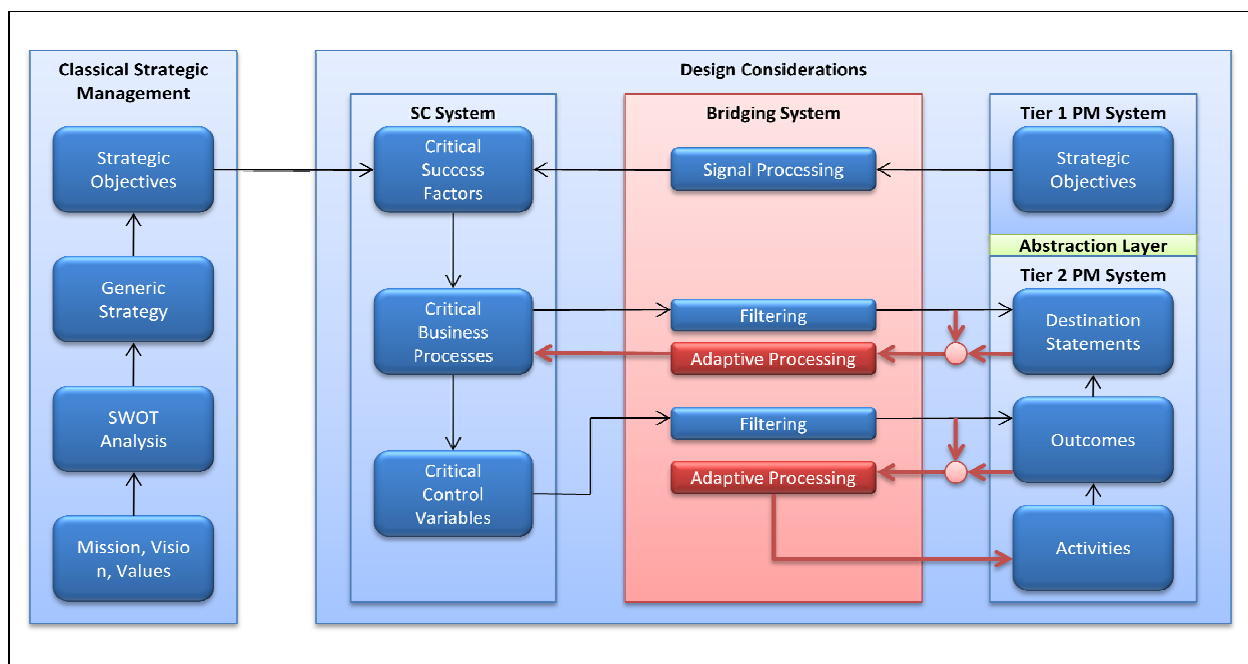


Figure 6-9: Case Study Roadmap - Adaptive Processing.

8.1. Identification of Adaptive Style Needed

In order to be in the position to take the needed corrective actions it is necessary to determine which if the four adaptive styles best suit the degree of turbulence within the Mining Business Unit's competitive environment. Refer to Adaptive Processing Concept in Part Three for further theoretical background regarding the different adaptive styles.

The Mining Business Unit operates within an extremely hostile environment; this can largely be attributed to the high degree of turbulence that is present in the competitive market environment as a

result of the commodity-based markets targeted by the Movement and Surveying Radar. With this in mind, the most suitable adaptive style is found to be either the **experimenter** or the **voyager** style.

The experimenter style incrementally modifies certain aspects of the existing processes and variables while the voyager style adopts an exploratory approach to change. Critical Business Processes or Critical Control Variables with medium to high degrees of deviation would therefore best be suited by the voyager approach, whereas the Critical Business Processes or Critical Control Variables with medium to low degrees of deviation would best be suited by the Experimenter approach.

The subsequent section verifies the functionality of the bridging system's adaptive processing chain by investigating certain interesting deviations in the actual and desired performance of both the Mining Business Unit's Critical Business Processes and Critical Control Variables. Refer to Addendum D for Critical Business Processes and Critical Control variables not discussed in this section.

8.2. Critical Business Process Deviations and Proposed Corrective Actions

8.2.1. Exploit New Business Opportunities

Contextual Background

The Mining Business Unit originally planned to only provide Movement and Surveying Radars to the metal and coal mining industry in South Africa, Namibia and Botswana for the 2006 financial year. Subsequent plans dealt with pushing the product into the South American and Australian markets during the 2007 and 2008 financial years.

The customer value proposition is based on customer intimacy and in particular after-sales support. Even though product features and competitive pricing are qualifiers to compete, the true differentiator will be the after-sales support.

Reutech Radar Systems as company has had no experience in after-sales support prior to 2006. The need to build up an efficient and sustainable support infrastructure led to very conservative sales targets for the 2006, 2007 and 2008 financial years (see "Desired MSR Sales", Figure 6-10).

Critical Business Process Performance

The exploitation of new business opportunities has previously been defined as one of the Mining Business Unit's Critical Business Processes. Table 6-11 below provides a brief summary of the Quantification and Destination statements that have been defined for this Critical Business Process.

Table 6-11: Exploit New Business Opportunities Process Summary.

Critical Business Process	Quantification	Destination Statement
Exploit new business opportunities.	Number of new systems sold.	An increase in the number of new systems sold annually.

The graph in Figure 6-10 below depicts the actual and desired performance of this Critical Business Process for the 2006, 2007 and 2008 financial years. There is a minimal deviation between the desired and actual number of new MSR's sold throughout the 2006, 2007 and 2008 financial years.

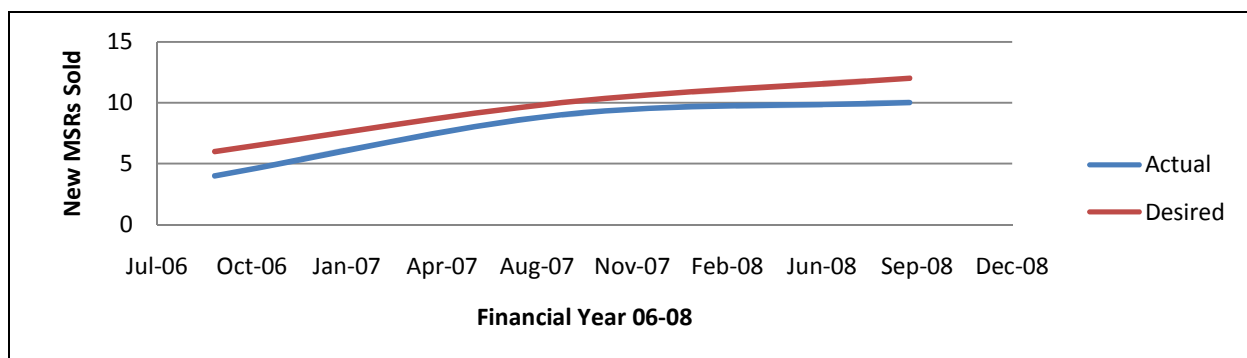


Figure 6-10: The Actual vs. Desired MSR Sales Figures.

Analysis and Relation to Adaptive Processing

The degree of deviation was generally found to be within acceptable limits, given the market conditions at the time. The fact that fewer MSR's were sold than what was originally projected is seen as a positive as it allows the Mining Business Unit to slowly and systematically expand its support infrastructure which is seen as a differentiating factor within the competitive environment. No immediate corrective action to this Critical Business Process is recommended.

8.2.2. *Manage Direct and Indirect Expenditures*

Contextual Background

Before October 2006 the need for immediate profit was not a major pressure as funding for the Mining Business Unit was provided by the development partner Anglo. Detailed business and marketing plans provided the financiers with enough security so as to secure a loan for the rest of 2006 as well as for the 2007 and 2008 years. The return on repayment on investment funding was fully guaranteed due to the fact that the first local client, Anglo Coal, was already secured.

The commencement of the MSR growth phase can be associated with the time after October 2006. The MSR started to become profitable as the loan repayments were settled in the first part of the 2007 financial year.

Critical Business Process Performance

The management of the direct and indirect expenditures have also been previously identified as a Critical Business Process. Table 6-12 below summarises the related quantification and Destination Statements.

Table 6-12: *Manage Direct and Indirect Expenditures Process Summary.*

Critical Business Process	Quantification	Destination Statement
Manage direct and indirect expenditures.	Operating profit margin.	An increase in the annual operating margin.

By referring to the graph in Figure 6-11, which depicts the operating profit margin performance, a noticeable degree of deviation from the desired operating profit margin can be noticed. The approximate 0.5 % month-on-month deviation first started occurring in earlier parts of the 2008 financial year.

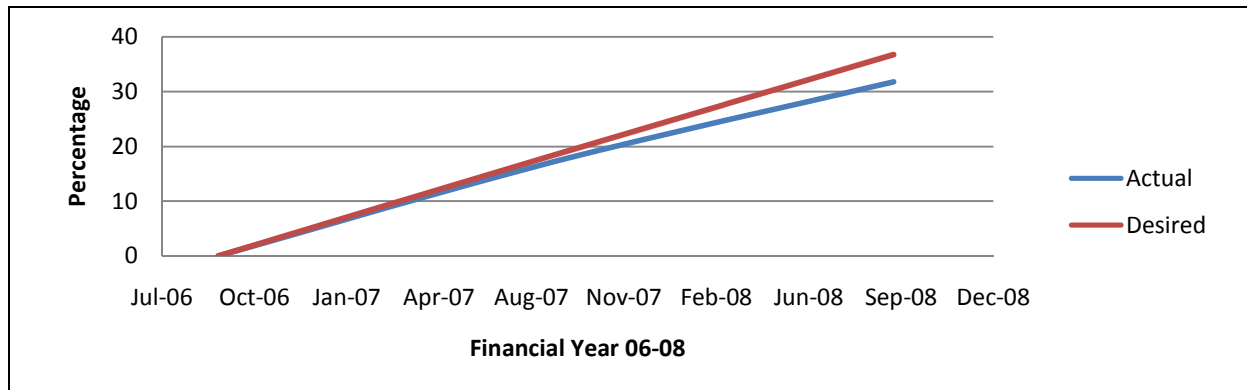


Figure 6-11: The Actual vs. Desired Operating Profit Margin.

Analysis and Relation to Adaptive Processing

The deviation can largely be attributed to higher than expected advertising costs as the focus was on aggressively building the MSR brand in the mining industry. Another reason for the deviation is increased activity from the established competition who is able to offer a similar product offerings.

The adaptive processing chain can compensate for this deviation by performing various corrective actions once the Reutech Radar Systems' market share has stabilised. Corrective action, with regard to the deviation between the actual and desired performance of this particular Critical Business Process, would therefore include, but not be limited to:

- Using the experimenter approach to initiate the incorporation of newer, more innovative concepts and ideas into the product allowing for the rejuvenation of exiting market interests while still capturing new markets.
- Using the experimenter approach to further investigate the detailed results from both indirect and direct expenditures which includes capital expenditure and operational expenditure.

8.2.3. Product Support

Contextual Background

Reutech Radar Systems believes that the availability and the level of support provided to clients is one of the keys to the overall success of the Mining Business Unit. Excellent product support is regarded as being just as important as pricing and product offering. Product availability (Ao) is calculated as the ratio between actual operational time divided by the required operation time in any calendar month. The

actual operational time is therefore equal to the required operational time less the unexpected down time. Issues and factors that were considered when deciding on the “desired” level of product availability are listed below:

- The inherent reliability of the system, Mean-Time-Between-Failure.
- The Mean-Time-To-Repair.
- The delay or time to move to the repair site.
- The remoteness of the service area.
- Built-In-Test features of the system.
- The capabilities of the operators and maintainers.
- The availability of maintenance partners.
- The environmental conditions of the operational site.
- The cost of call centres and service offerings.
- The levels-of-service and availability expected by the client.
- The cost of spares.
- The annuity cost of the maintenance crew or depot.

Critical Business Process Performance

Based on these considerations Reutech Radar Systems calculated that a 95% product availability would be a realistic target. This target has subsequently become a contractual obligation with Reutech Radar Systems being liable for penalties if the target is not met in a given calendar month. The product support process is quantified and related to the relevant Destination Statement as depicted in Table 6-13 on the following page.

Table 6-13: Product Support Process Summary.

Critical Business Process	Quantification	Destination Statement
Product Support.	Product availability percentage.	Excellent product availability on a yearly scale.

The graph in Figure 6-12 below shows the product availability performance for the 2006, 2007 and 2008 financial years. The availability percentage did vary on a month-to-month basis, but never fell below 96%.

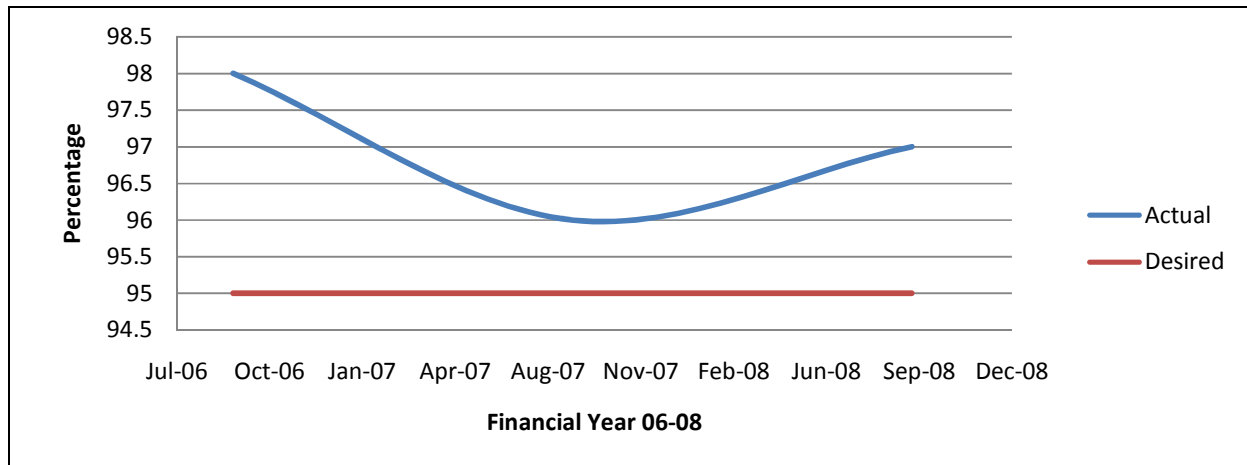


Figure 6-12: The Actual vs. Desired Product Availability.

Analysis and Relation to Adaptive Processing

Excellent product availability is seen as being strategically important for the future success of the Mining Business Unit. There are a variety of variables (as listed previously) that influences product availability. Changes within these variables are largely to blame for the fluctuation in product availability noticed in the period from October 2006 up until December 2008.

The deviation in actual versus desired levels of performance is acceptable and no corrective action is currently proposed. With regard to the fluctuation in the actual performance of this particular Critical Business Process, it would be beneficial to investigate so as to better understand which of the variables listed previously are responsible for the decline in product availability during the October 2006 to October 2007 time period. Gaining more insight into what caused this drop will help to avoid, and better compensate for, similar changes in the future.

8.3. Critical Control Variable Deviations and Proposed Corrective Actions

8.3.1. Mean-Time-Between-Failure

Contextual Background

The Mean-Time-Between-Failure of the Movement and Surveying radar refers to the inherent reliability of the system. The predicted Mean-Time-Between-Failure is estimated to be 2800 hours in a 24/7 operating environment. The biggest two factors that influence the MTBF of the radar system are the environmental conditions of the operational site and the inherent reliability of the subsystems that are procured as Commercially-Off-The-Shelf.

Critical Control Variable Performance

The quantification and related Outcomes of the Mean-Time-Between-Failure Critical Control Variable are summarised in Table 6-14 below. The actual and desired performance of the Mean-Time-Between-Failure of all of the deployed radar systems are depicted in Figure 6-13 below. A major drop in the actual Mean-Time-Between-Failure during January 2008 can be noticed as well as sub standard performance during the April 2008 to July 2008 time period.

Table 6-14: Mean-Time-Between-Failure Variable Summary.

Critical Control Variable	Quantification	Outcome
Mean-Time Between-Failure.	MTBF per system.	Increase in MTBF per system.

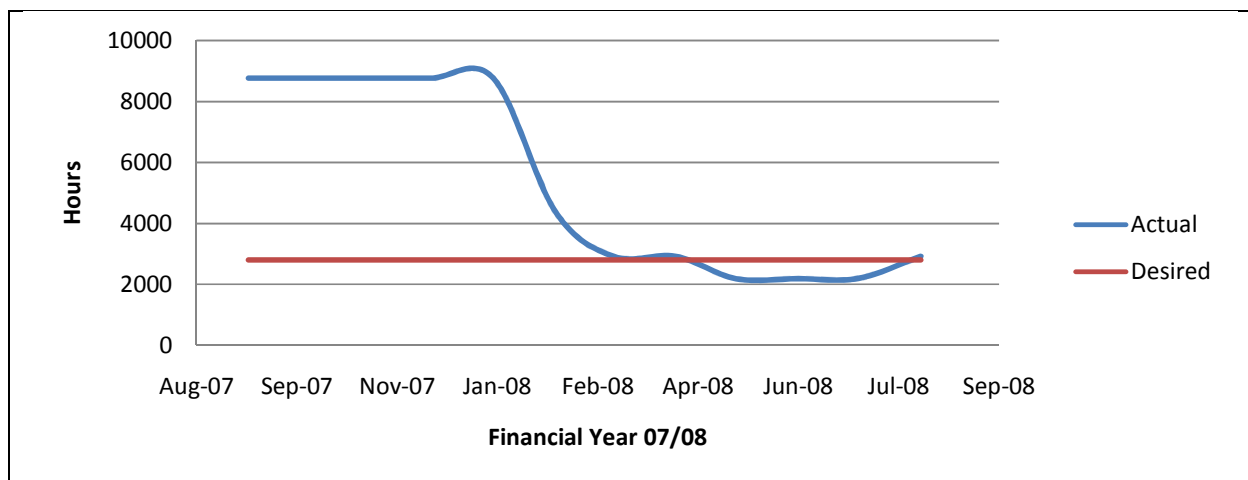


Figure 6-13: The Actual vs. Desired Mean-Time-Between-Failures.

Analysis and Relation to Adaptive Processing

The major drop in MTBF in January 2008 can largely be attributed to a combination of the two factors mentioned previously:

- Environmental conditions of the operational site: In January 2008 MSRs were for the first time commissioned in both Chile and Australia where they were operated in extremely harsh environmental conditions. Before this time MSRs were only deployed in relatively mild conditions on South African mines.
- Inherent reliability of Commercial-Of-The Shelf components: In December of 2007 the supplier of the onboard diesel generator was changed in favour of a supplier who was, at

the time, relatively inexpensive and who was able to provide better after-sales service due to a larger global support network. This proved to be a disastrous decision due to the poor inherent reliability of the generator subsystem and it was decided to revert back to the original supplier in June of 2008.

The strategic framework developed in this thesis can be used to prevent such future deviations by using the experimenter adaptive style to improve on activities that drive the Critical Control Variables. This includes:

- The optimised use of continuous improvement and root cause analysis techniques such as the Failure Reporting and Corrective Action System (FRACAS) so as to analyse the failures on the Movement and Surveying Radar.
- An increase focus on quality assurance by actively involving of the quality assurance department.
- Promotion of a supportive attitude by managers to initiatives such as “First Time Right”.
- Ensuring that suppliers of Commercially-Off-The-Shelf (COTS) components are properly vetted.

8.3.2. Mean-Time-To-Repair

Contextual Background

The Mean-Time-To-Repair of the Movement and Surveying radar refers to the length of time it takes to repair the radar after a failure occurred. There are various factors that influence the Mean-Time-To-Repair which includes the time it takes to move to the repair site, the built in test features of the system and the capabilities of the operators and maintainers.

Critical Control Variable Performance

The quantification and related Outcomes of the Mean-Time-To-Repair Critical Control Variable are summarised in Table 6-15 below. The actual and desired performance of the Mean-Time-To-Repair of all of the deployed radar systems are depicted in Figure 6-14 on the following page.

Table 6-15: Mean-Time-To-Repair Variable Summary.

Critical Control Variable	Quantification	Outcome
Mean-Time-To Repair.	MTBR per system.	Decrease in MTBR per system.

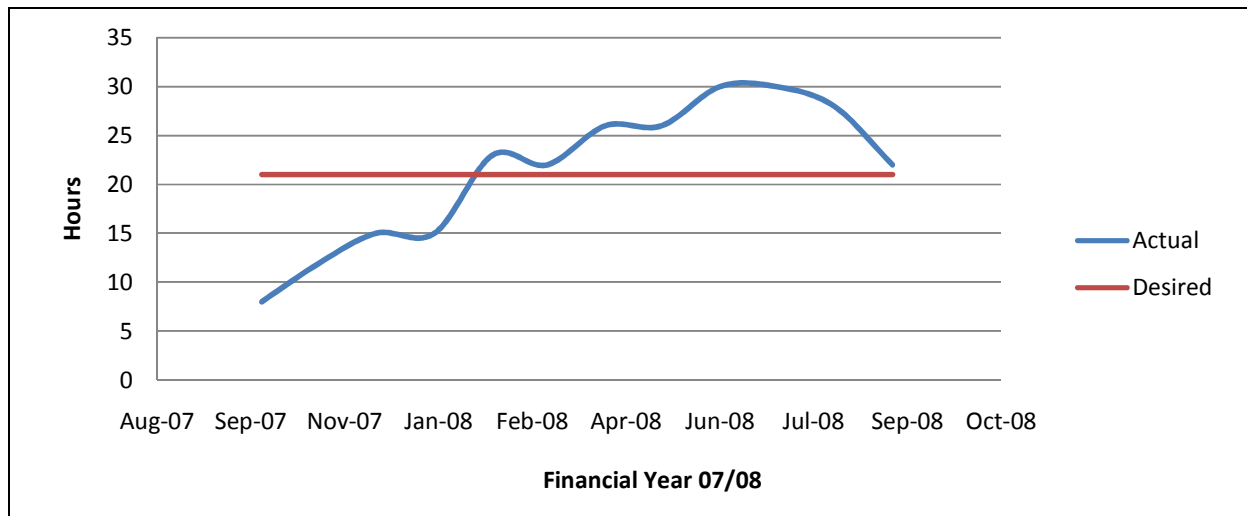


Figure 6-14: The Actual vs. Desired-Mean-Time-To-Repair.

It can be seen from Figure 6-14 that the actual MTTR started to deviate from the desired level in January of 2008 and did so at a fairly incremental pace until the end of June 2008, where after it gradually started declining. It should be noted that a qualitative relationship exists between the increased MTTR (Figure 6-14: January 2008) and the decrease in MTBF (Figure 6-13: January 2008).

Analysis and Relationship to Adaptive Processing

The major increase in MTTR in January 2008 can largely be attributed to a combination of the three factors mentioned previously:

- Time it takes to move to the repair site: In January 2008 MSRs were for the first time commissioned in both Chile and Australia which proved to be an obvious logistical challenge and therefore explains the sudden increase in MTTR.
- The built in test features of the system: In June of 2008 a new software version was released that contained a comprehensive set of built in test features. These features provided technicians with additional diagnostics which aided in fault finding.
- The capabilities of the operators in maintainers: In August of 2008 a comprehensive contract was negotiated with local support companies in both Chile and Australia. This contract ensures that local operators and maintainers are trained correctly and efficiently. The maintainers are also responsible for repairs which greatly reduce the MTTR.

The strategic framework developed in this thesis can be used to prevent such future deviations by using the experimenter adaptive style to improve on activities that drive the MTTR Critical Control Variable.

This includes:

- Optimising the logistical network and associated processes with respect to on site repair facilities, off site repair facilities and factory repair facilities.
- Excellent management of the spare parts inventory.
- Excellent customer and support partner training programmes as the customer's staff do many of the on-site repairs.
- Advanced training programmes for Reutech Radar Systems' technicians.
- Ensuring high standards of quality with respect to the servicing of deployed systems.

8.3.3. Support Calls Received

Contextual Background

The number of support calls received by the call centre is chosen as a Critical Control Variable as it provides a good indication of system reliability, overall availability and ultimately also customer satisfaction. The call centre functions on a 24/7 basis and "tickets" are logged from every single call received.

Critical Control Variable Performance

The quantification and related Outcomes of the support calls received Critical Control Variable are summarised in Table 6-16 below. The actual and desired performance of the support calls received is depicted in Figure 6-15 on the following page.

Table 6-16: Support Calls Variable Summary.

Critical Control Variable	Quantification	Outcome
Support calls.	Number of support calls received.	Less support calls per system.

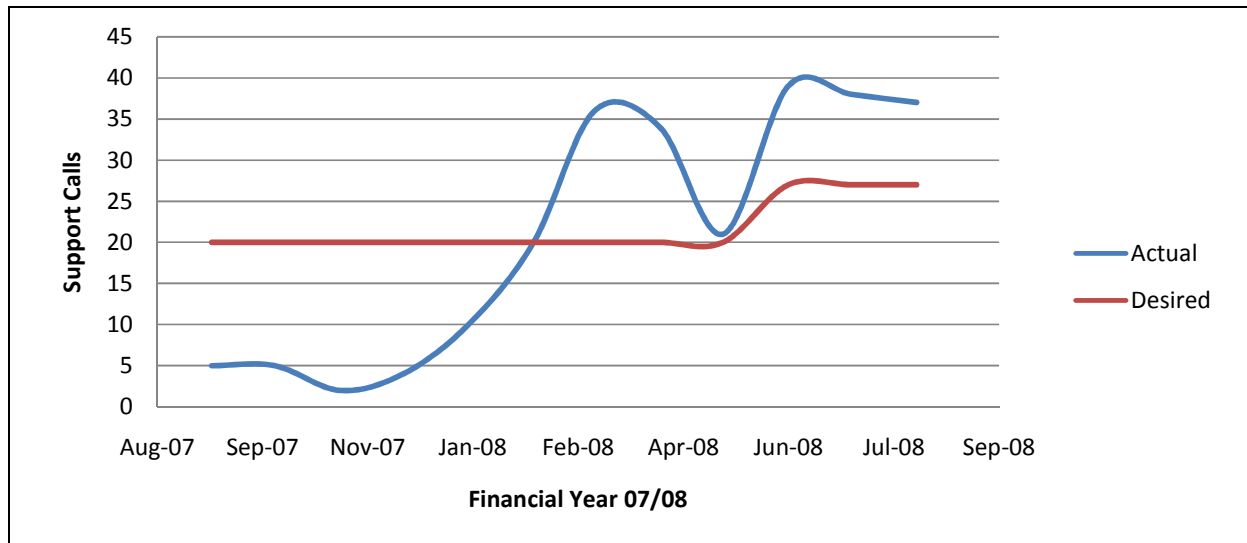


Figure 6-15: The Actual vs. Desired Number of Support Calls.

Figure 6-15 shows that the actual number of support calls increased dramatically in January of 2008. Once again note the qualitative correlation with the decrease in MTBF and the notable increase in the MTTR around the same time (refer to Figure 6-13 and Figure 6-14).

Analysis and Relation to Adaptive Processing

The strategic framework developed in this thesis can be used to prevent such future deviations by using the experimenter adaptive style to improve on activities that drive the support calls received Critical Control Variable. This includes:

- Further training of product support and call centre operators.
- Further optimisation of the supply chain network.
- Establishing of more contracts with local and international support partners so as to reduce dependency on Reutech's Radar System's support system.
- Increased customer, as the customers own onsite technicians do many of the repairs.
- Better use of continuous improvement and root cause analysis techniques such as the Failure Reporting and Corrective Action System (FRACAS) to analyse the failures on the Movement and Surveying Radar.

8.3.4. Production Labour and Material Expenditure

Contextual Background

The production strategy for the 2007 and 2008 financial years intended that the Mining Business Unit make use of Reutech Radar Systems production facilities and other services to execute the manufacturing and support of the project on a contractual basis. The Mining Business Unit therefore procures these services and in so doing avoids incurring initial set-up costs and major capital investments in infrastructure, business systems, personnel and training costs.

The production strategy up until December 2007 was accomplished by initially manufacturing complete and partially assembled systems for inventory. It was only possible to start optimising the supply chain in January of 2008 when production quantities started warranting effective and corresponding supplier investments in their inventory.

Critical Control Variable Performance

The quantification and Outcomes of the relevant Critical Control Variables are tabulated in Table 6-17 below. Figure 6-16 below and Figure 6-17 on the following page visually depicts the actual and desired levels of performance for the production material expenditure and the production labour expenditure respectively. Erratic and inconsistent behaviour can be noticed for the last quarter of the 2007 financial year.

Table 6-17: Production Material and Labour Variable Summary.

Critical Control Variable	Quantification	Outcome
Production material expenditure.	Cost of materials.	Within budget.
Production labour expenditure.	Cost of labour.	On time.

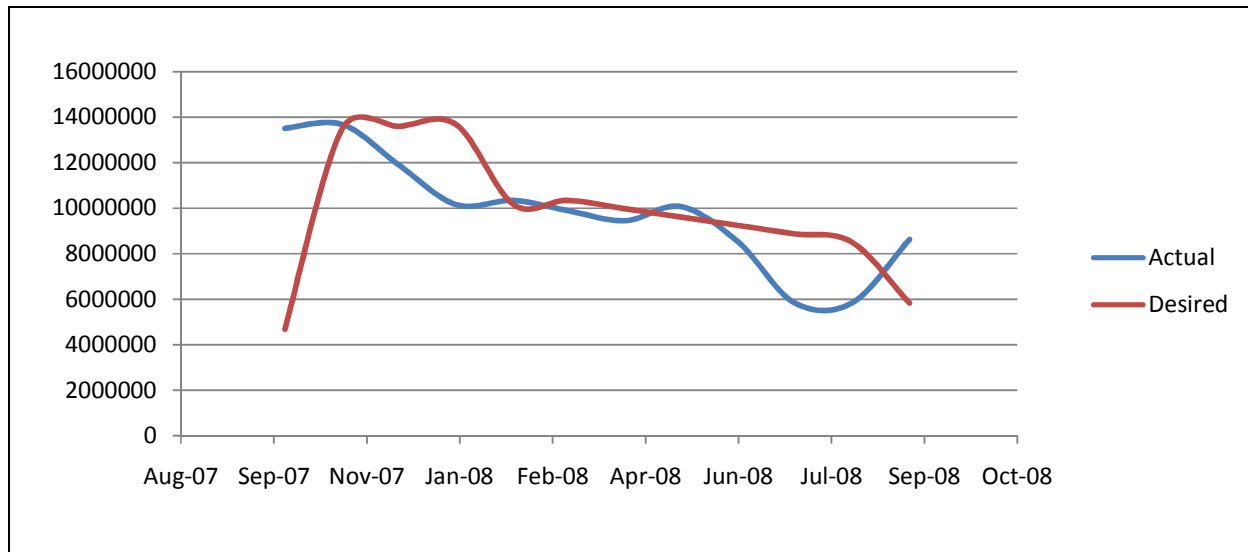


Figure 6-16: The Actual vs. Desired Production Material Expenditure.

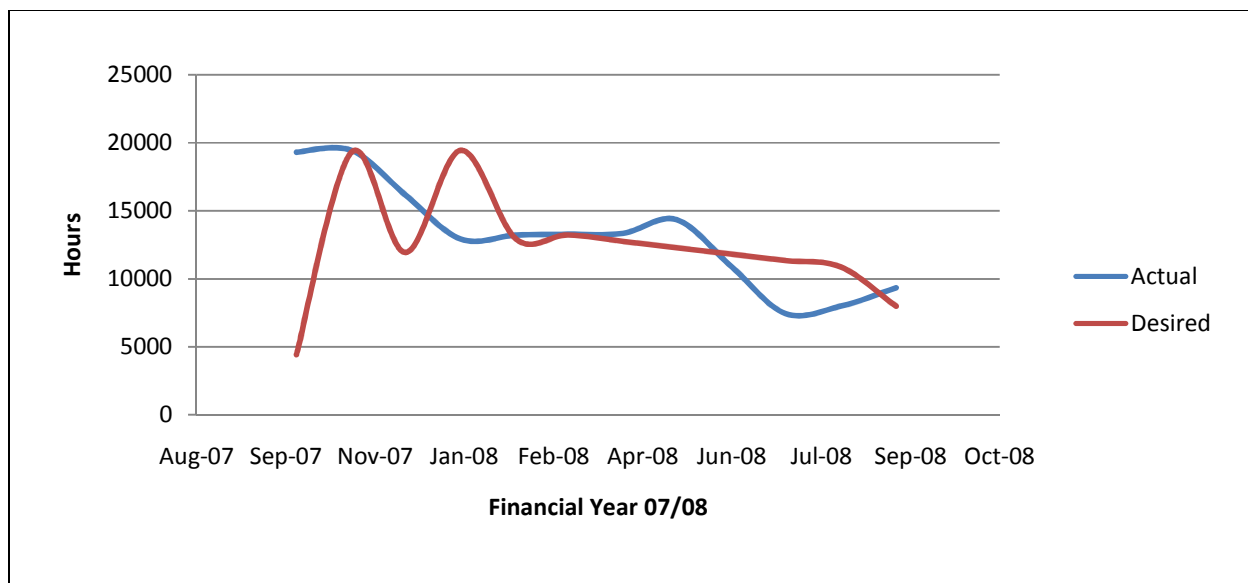


Figure 6-17: The Actual vs. Desired Production Labour Expenditure.

Analysis and Relation to Adaptive Processing

The deviation in the last quarter of the 2007 financial year points to a overloaded production line with a supply chain that is minimally optimised. The deviation became of an acceptable amount in the 2008 financial year as production quantities warranted corresponding supplier investments in their inventory which also resulted in various agreements and contracts between Reutech Radar Systems and its suppliers.

The strategic framework developed in this thesis can be used to prevent future deviations by using the experimenter adaptive style to improve on activities that drive the production material and labour expenditure Critical Control Variable. This includes:

- Better overall project management so as to optimally plan, load and organize resources.
- More accurate and frequent Estimated Cost to Completion meeting results.

9. The First Tier Performance Measurement System

The first tier performance measurement system is comprised of the Strategic Objective element, and is mainly responsible for driving the signal processing chain, and is therefore indirectly linked to control of strategic content. The abstraction layer acts as an interface between the first and second tier performance measurement systems, and allows for strategic objectives to be formulated based on data from the second tier performance measurement system as well as on a manager's experience or "gut feel". Figure 6-18 on the following page depicts the first tier performance measurement system and its relation with the larger framework. For further theoretical background refer to both the Performance Measurement System Design section in Part Three.

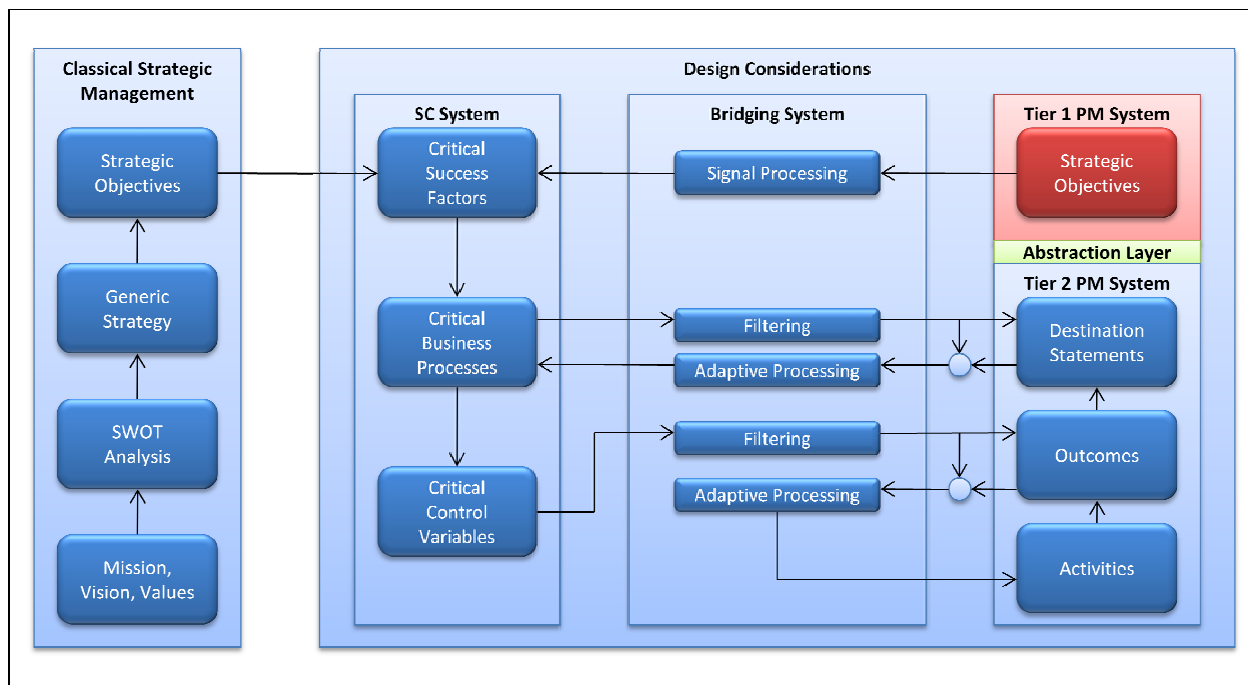


Figure 6-18: Case Study Roadmap -The First Tier Performance Measurement System.

9.1. Strategic Objectives

Strategic objectives are inherently associated with higher level strategic management. The identified strategic objectives serves as input to the signal processing chain as is, as mentioned previously, is indirectly responsible for the confirmation or reinvention of the Critical Success Factors. Strategic objectives can be based on a variety of information sources which include but are not limited to information from the second tier performance measurement system, the competitive environment, manager experience, and manager “gut feel”. This is largely due to the abstraction layer, which only accommodates the information imbalance that may exists, but which also provides a means to represent the “man in the loop”, an extremely important aspect of any business process.

At the time of this case study the Mining Business Unit’s strategic objective remains unchanged and thus still aims to increase turnover by selling Movement and Surveying Radars to both the South African and international markets.

10.The Bridging System: Signal Processing

The main aim of signal processing is to provide a feed forward information flow link between the performance measurement system and the strategic control system. This section deals with the signal processing chain that forms part of the bridging system, as discussed in Part Five of this thesis. The signal processing chain relative to the larger strategic framework is depicted in Figure 6-19 on the following page.

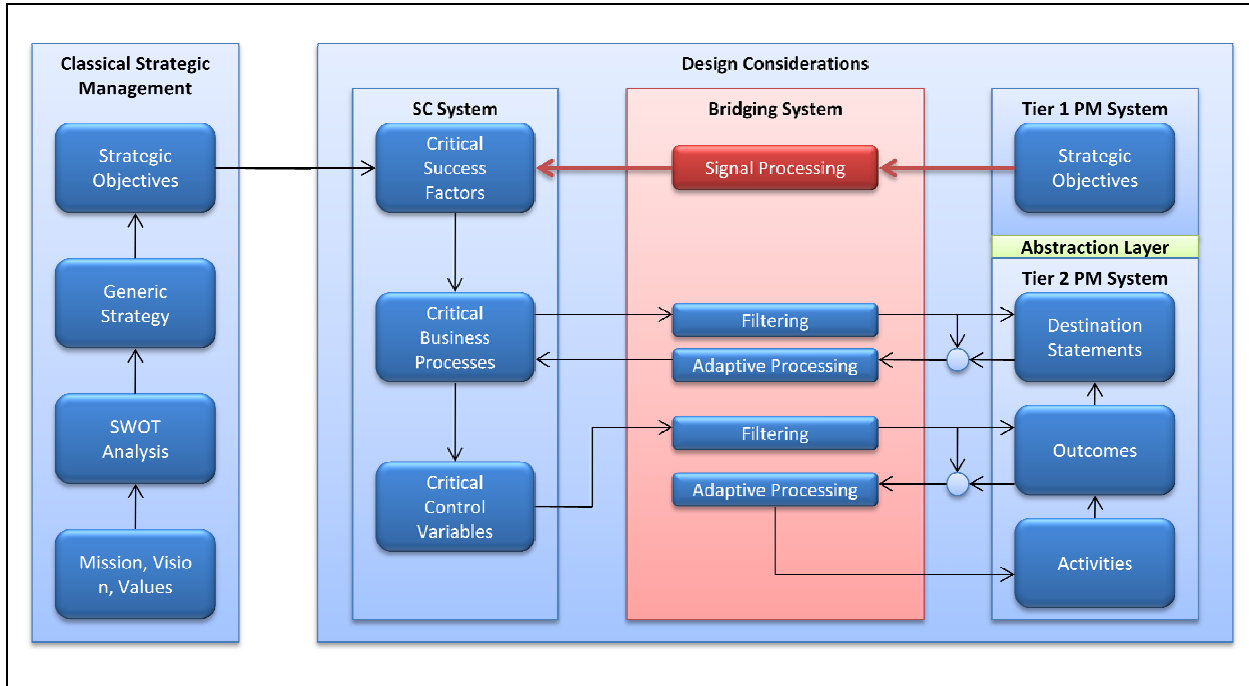


Figure 6-19: Case Study Roadmap - Signal Processing.

Signal processing consist of a chain of elements namely Data Acquisition, Pattern Recognition, Confirmation or Reinvention and Strategic Content Control. The signal processing chain allows the organization to exploit and identify valuable information patterns with specific reference to the strategic objectives. These identified information patterns allows the organization to better identify any emerging opportunities or threats and to in turn compensate the overall organization strategy by means of strategic content control. The entire signal processing chain, as described in Part Five is illustrated in Figure 6-20 on the following page. These individual elements are further discussed in the following sections.

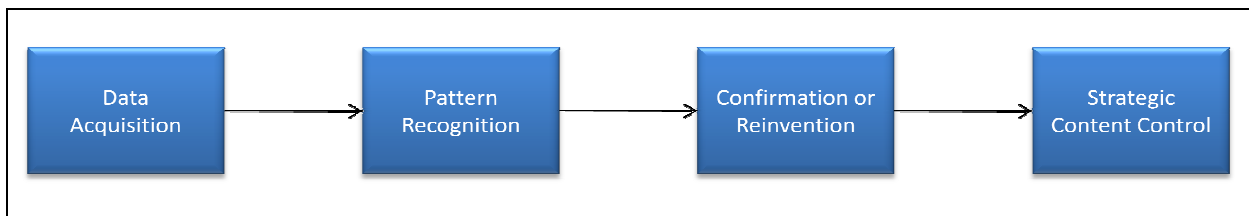


Figure 6-20: The Signal Processing Chain.

10.1. Data Acquisition and Pattern Recognition

Raw data that from the first tier performance measurement system is acquired and only the relevant signals are processed. Patterns within these relevant signals are recognized by means of the Pattern Recognition element so as to be able to more easily identify emerging opportunities and threats. Relevant signals for the Mining Business Unit have been defined as:

- Mining safety.
- Operational excellence.
- Mining productivity.
- Environmental issues.
- Supply and demand.
- Potential new clients.

10.1.1. Mining Safety

Research studies conducted by the Mining Health and Safety Inspectorate from 1989 to 2003 indicated that South African mines have the worst fatal injury frequency rate per million man hours relative to the United States of America, Canada and Australia. The research studies also found that the global fatal injury frequency rate is decreasing, therefore highlighting the increased focus on mining safety and the need for technology that ensures the safety of mine workers worldwide. Figure 6-21 on the next page presents a graph of the findings.

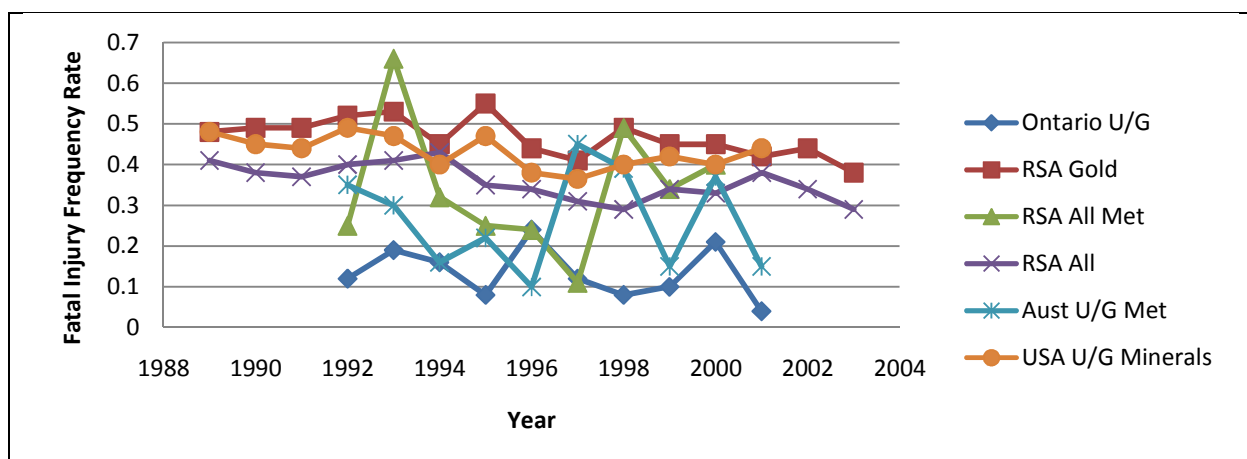


Figure 6-21: Fatal Injury Statistics for Mining (Department of Minerals and Energy 2003/2004).

10.1.2. Operational Excellence

The competitiveness of an open pit mine is directly proportional to operational excellence. This is largely due to the fact that mines deal with commodity products. An increase in the productivity and asset turnover of an open pit mine can therefore be achieved by (Girard, PE 2001)

- Accurate surveying methods, thus increasing the amount of product extracted.
- Optimised mining methods, thus being able to mine with steeper slopes.
- Improved asset utilization, thus using the product for both slope stability and surveying applications.

10.1.3. Mining Productivity

The primary focus of the mining industry is on operating efficiencies and on technological advances that improve productivity. There has been an ever present increase in competition in the global coal mining industry which has subsequently resulted in reduced production prices due to economies of scale and increased mining efficiency. Figure 6-22 on the following page presents a graph that depicts the percentage based increase in average mine production from 1990 to 2000 relative to percentage based decrease in labour hours for mines in the United States (World Coal Institute 2002).

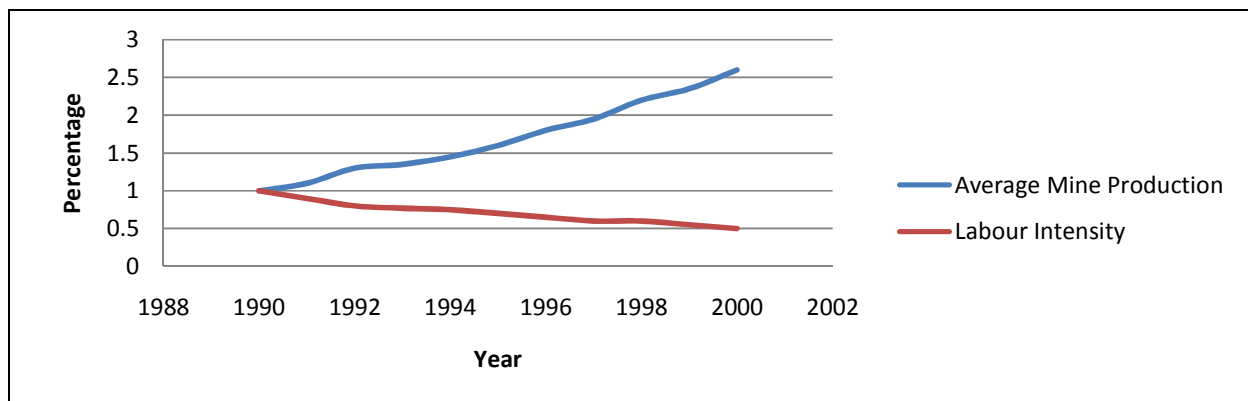


Figure 6-22: Average Mine Production Compared To Labour Intensity.

10.1.4. Environmental Issues

Increased environmental legislature is forcing mining companies to rehabilitate the mine after the mine has been decommissioned. Being able to mine with less earth removal significantly reduces rehabilitation costs.

10.1.5. Supply and Demand

The global supply from coal mines have been steadily increasing due to an increased global demand. This increase can largely be attributed to an upsurge in electricity demand mainly from Asian markets (World Coal Institute 2005). Table 6-18 below highlights the increase in international hard coal trade from 1995 to 2004.

Table 6-18: International Hard Coal Trade Growth.

	Steam	Coking	Total Trade
1995	295 Mt	196 Mt	494 Mt
2000	421 Mt	188 Mt	609 Mt
2004	541 Mt	214 Mt	755 Mt

Table 6-19 and Table 6-20 below provide summaries of countries that are both major exporters and importers of coal as of 2004 (World Coal Institute 2005).

Table 6-19: Major Coal Exporters.

	Total	Steam	Coking
Australia	219 Mt	107 Mt	112 Mt
Indonesia	107 Mt	90 Mt	17 Mt
PR China	86 Mt	80 Mt	6 Mt
South Africa	67 Mt	64 Mt	3 Mt
Russia	65 Mt	51 Mt	1 Mt
Colombia	52 Mt	51 Mt	1 Mt
USA	43 Mt	19 Mt	24 Mt
Canada	27 Mt	1 Mt	26 Mt
Kazakhstan	22 Mt	22 Mt	0 Mt

Table 6-20: Major Coal Importers.

	Total	Steam	Coking
Japan	183 Mt	97 Mt	86 Mt
Rep Korea	79 Mt	58 Mt	21 Mt
Chinese Taipei	60 Mt	53 Mt	7 Mt
Germany	39 Mt	32 Mt	7 Mt
UK	36 Mt	30 Mt	6 Mt

Energy consumption in developing countries such as China and India has been rapidly increasing. The world energy consumption is projected to increase by 54% by the year 2025 (Institute for the analysis of global security). Markets in Asia will be dominated by a demand for steaming coal that will mostly be used for the generation of electricity. The graph in Figure 6-23 below depicts the projected coal demand (Mimirot, Koizumi 2004).

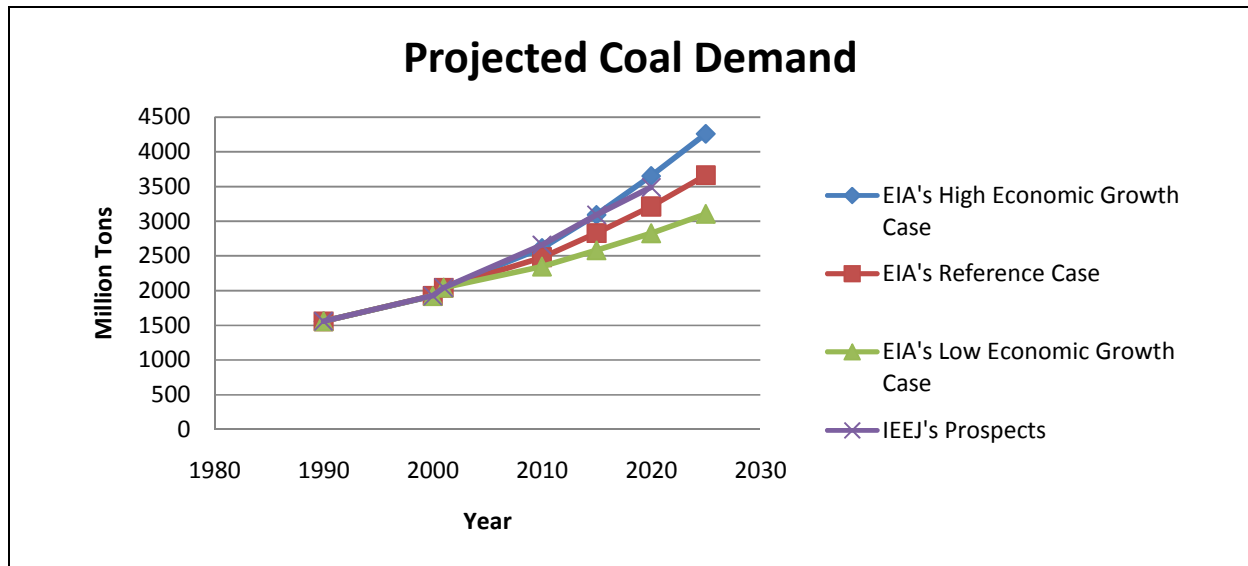


Figure 6-23: Projected Coal Demand Up To 2025.

The increase in global electricity demand and the falling price of coal (due to more productive mining) will result in a higher demand for coal. The energy outlook projects (Institute for the analysis of global security):

- An increase in high and medium sulphur coal production by 14% from 2002 to 2025.
- An increase in low sulphur coal production by 66% from 2002 to 2025.
- An increase in coal consumption for electricity by 66% from 2002 to 2025.
- A short term decrease in the price of coal due to increased mining productivity, decreased transportation costs, competitive labour costs and a shift to western production.
- An expected increase in the coal price in 2016 due to the costs of commissioning new mines and diminishing technological mining innovations.

10.1.6. Global Coal Suppliers

The ten most prominent mining companies with reference to open pit mining are depicted in Table 6-21 on the following page.

Table 6-21: Ten Most Prominent Mining Companies.

Company	Corporate Head Office	Subsidiaries
Anglo American.	London, England.	Anglo Coal SA. Anglo Coal Australia. Anglo South America. Ashanti Goldfield. Anglo Platinum.
Kumba Resources.	Pretoria, South Africa.	
DeBeers.	Johannesburg, South Africa.	NamDeb.
Rio Tinto PLC.	London, England.	Hunter Valley Energy Coal. Ingwe SA. New Mexico Coal.
Coal India.	Calcutta, India.	Central Coal Fields Ltd. Northern Coal Fields Ltd. South Eastern Coalfields Ltd.
Newmont Mining Corporation.	Denver, USA.	
Xstrata PLC.	Zug, Switzerland.	
Barrick Gold Corporation.	Toronto, Canada.	
Placer Dome.	Vancouver, Canada.	

Coal supplying countries and associated production capacity is depicted in Table 6-22 below.

Table 6-22: Planned World Coal Supply (Mimirot, Koizumi 2004).

	Production Capacity of Export Coal In 2002			Additional Production Capacity of Export Coal Expected To Be Achieved By 2007					Total Production Capacity of Export Coal
	Steaming Coal	Coking Coal	Total	Firm Commitment Existing Mines	Firm Commitment At New Mines	Planned Additional Mines	Planned New Mines	Total	
Australia	116.2	121.8	238.0	24.1	25.3	26.3	68.0	143.7	381.7
China	86.5	6.7	93.2	7.2	1.0	0.0	2.0	10.2	103.4
Indonesia	88.1	0.0	88.1	6.4	0.0	25.5	13.5	45.4	133.5
South Africa	72.5	4.6	77.1	14.1	0.0	2.8	13.9	30.8	107.9
Columbia	50.3	2.1	52.4	3.5	0.0	16.9	11.6	32.0	84.4
United States	20.7	19.5	40.2	2.0	4.0	0.0	0.0	6.0	46.2
Russia	33.4	6.8	40.2	-	-	-	-	-	40.2
Canada	7.7	26.0	33.7	3.1	2.0	0.0	9.0	14.1	47.8
Poland	14.0	3.0	17.0	-	-	-	-	-	17.0
Venezuela	6.1	2.3	8.4	0.0	2.5	3.4	10.0	15.9	24.3
Vietnam	5.5	0.0	5.5	0.0	0.0	0.0	2.0	2.0	7.5
Other	2.8	1.8	4.6	1.8	0.3	0.6	2.7	5.4	10.0
Total	503.8	194.6	698.4	62.2	35.1	75.5	132.7	305.5	1003.9
Total World Export	402.8	175.9	578.7	Production capacity of export coal assuming a 30% decrease due to closing of mines					794.4
Proportion Of Export Volume To Production Capacity of Export Coal	80%	90.4%	82.9%	The world's coal trade volume in 2010 predicted by the EIA					730.1 (91.9%)

10.2. Opportunities and Threats

Emerging opportunities and threats are identified based on the patterns that were recognized in the relevant signals. Such emerging opportunities for the Mining Business Unit are discussed in below. No threats different to those identified by the classical strategic management process have yet emerged.

10.2.1. Mining Safety

The downward trend in the fatal injury frequency rate highlights a focus on mining safety. This is largely due to union demands and the need for public transparency. There is a trend to replace the human component with mechanization and remote monitoring technologies.

- An opportunity exists to increase turnover by selling affordable Movement and Surveying Radars capable of remotely monitoring slope stability.

10.2.2. Operational Excellence

Operational excellence is the distinguishing factor when it comes to mining competitiveness.

- An opportunity exists to increase turnover by selling Movement and Surveying Radars able to perform slope stability monitoring in addition to performing surveying tasks.

10.2.3. Mining Productivity

Mining productivity is set to significantly increase coupled with a decrease in labour intensity.

- An opportunity exists to increase turnover by selling reliable Movement and Surveying Radars with a high operational availability (Ao).

10.2.4. Environmental

The environment is becoming and increasingly more important as pressure from governments and regulatory bodies pose great financial risks to mining companies.

- An opportunity exists to increase turnover by selling Movement and Surveying Radars capable of providing mining companies with a solution that will enable them to remove less material from the ground.

10.2.5. Supply and Demand

The major supplying countries have been identified.

- An opportunity exists to increase turnover by selling Movement and Surveying Radars to the major global coal suppliers including Australia, Indonesia, China and South Africa.

10.2.6. Global Coal Suppliers

The major coal mining companies have been identified.

- An opportunity exists to increase turnover by selling Movement and Surveying Radars to the major global coal suppliers. These mining companies have been identified as Anglo American PLC, Kumba Resources, DeBeers, Rio Tinto PLC, BHP Billiton, Coal India, Nemont Mining Corporation, Xstrata PLC, Barrick Gold Corporation and Placer Dome.

10.3. Strategic Content Control

Strategic content control ensures that the feed forward approach to strategic control is put into practice and successfully realized. The feed forward approach's main objective is to control the strategic content and it sees Critical Success Factors from a strategy implementation point of view. The main contribution of the feed forward approach is its ability to adjust the strategic content, thus adding and removing Critical Success Factors, by adapting to the emerging opportunities and threats.

The current Critical Success Factors are compared with the newly identified opportunities and threats. This process keeps the Mining Business Unit's strategy relevant, flexible and adaptive. The current Critical Success Factors which are in agreement with the emerging opportunities and threats are confirmed, while new Critical Success Factors may also be identified. The results are then fed back into the Strategic Control System, closing the loop, and thus providing the Mining Business Unit with the chance to identify new or discard old Critical Business Process or Critical Control Variables. Table 6-23 on the following page summarizes the results from the Mining Business Unit.

Table 6-23: Emerging Opportunity and the Relevant Critical Success Factors.

Opportunity	Critical Success Factor
<u>Mining safety</u> : Sell affordable MSRs capable of remotely monitoring slope stability.	<ul style="list-style-type: none"> • Revenue growth. • Innovative products.
<u>Operational excellence</u> : Sell MSRs able to perform slope stability monitoring in addition to performing surveying tasks.	<ul style="list-style-type: none"> • Revenue growth. • Customer profitability. • Innovative products.
<u>Mining productivity</u> : Sell reliable Movement and Surveying Radars with a high operational availability (Ao).	<ul style="list-style-type: none"> • Operational excellence. • Satisfied customers.
<u>Environmental issues</u> : Sell MSRs capable of providing mining companies with a solution that will enable them to remove less material from the ground.	<ul style="list-style-type: none"> • Innovative products.
<u>Supply and Demand</u> : Sell MSRs to the major global coal suppliers including Australia, Indonesia, China and South Africa.	<ul style="list-style-type: none"> • Revenue growth. • Innovative products. • Satisfied customers. • Operational excellence.
<u>Global coal suppliers</u> : Sell MSRs to the major global coal suppliers.	<ul style="list-style-type: none"> • Revenue growth. • Innovative products. • Satisfied customers. • Operational excellence.

11. Critical Design Review

The critical design review takes an in depth look at both the strong and the weak points of the strategic control system, the bridging system and the performance measurement system respectively. Conclusions are drawn based on the case study, and serves as a point of departure for subsequently identifying further areas of research within the context of the overall system design.

11.1. A Closer Look at the Strong Points

The following strong points with specific reference to the system design are listed below:

- 1) The strategic control system is able to take the strategic objectives and successfully break them down into Critical Success Factors, Critical Business Processes and Critical Control Variables. This process identifies the critical areas that have to perform well in order to ensure strategic success and increases the manageability and controllability of the organization's strategy. Critical Success Factors are broken down in such a manner so as to

provide all stakeholders within the organization with the ability to practically relate to the organization's strategic objectives.

- 2) The strategic control system allows for the use of both the feed forward and the feedback approaches to strategic control. This provides the overall system with more flexibility and agility. Strategic control decisions are therefore not purely based on the generic strategy and historical strategic analysis, but also on current objectives and newly emerging information patterns, as identified by the feed forward approach through the implementation of the bridging system.
- 3) The strategic control system is able to make use of both the strategic implementation view of Critical Success Factors as well as the strategic formulation view of Critical Success Factors. This leads to the implementation of strategic content control, as Critical Success Factors are identified based not only on past opportunities or threats, but also on current opportunities and threats.
- 4) The bridging system as a whole is able to successfully bridge the gap between economic based strategic control theory and contingency based performance measurement theory by making use of theoretical concepts such as filtering, signal processing and adaptive processing.
- 5) Filtering, one of the critical components of the bridging system, is able to consistently relate both business process and control variable metrics to the performance measurement system. Metrics that do not comply (i.e. unverifiable, unquantifiable, ambiguous, incongruent, etc) are filtered out with only relevant metrics passing on to the performance measurement system. The performance measurement system therefore only deals with quantified, relevant, timely, congruent, verifiable and sensitive measures. This undoubtedly promotes an overall dynamic system that decreases strategic decision making time.
- 6) Signal processing provides a way for the performance measurement system to be related back to the strategic control system by promoting the feed forward approach to strategic control, as well as the strategic formulation view of Critical Success Factors. Signal processing's strongest point is its ability to perform strategic content control. Data directly related to newly-formulated strategic objectives are used to identify patterns and are also subsequently used to identify newly emerging opportunities and threats. These opportunities and threats lead to the confirmation of existing Critical Success Factors or the

formulation of new Critical Success Factors; in essence promoting the concept of strategic control.

- 7) Adaptive processing is another crucial component of the bridging system. It is not only able to practically detect deviations in Destination Statements and Outcomes, but it also provides a means to correct for these deviations by performing corrective actions on the Activities and Critical Business Processes responsible for the deviation in performance.
- 8) The performance measurement system as a whole is able to successfully identify deviations in both Critical Business Processes and Critical Control Variables. This provides managers with diagnostic information and the errors in a quantified state. The performance measurement system makes it possible to identify errors in both the Critical Control Variables and Critical Business Processes.
- 9) The performance measurement system is able to make use of strategic linkage models to successfully identify activities and outcomes. Outcomes provide an efficient means to measure desired and actual levels of Critical Control Variable performance while the Activities are used to practically correct the error that may exist. The quantified error on a control variable level, as well as the actions required to correct for the error, is known to the manager.
- 10) The performance measurement system also formulates Destination Statements that act as desired levels of Critical Business Process performance. The Destination Statements also provide a means of measuring actual levels of performance and are additionally able to successfully feed the deviation back through the bridging system. The quantified error on a business process level, as well as the actions required to correct for the error, is known to the manager.
- 11) The performance measurement system is also able to successfully deal with the concept of information asymmetry by making use of a two tiered performance measurement system as well as an abstraction layer.

11.2. A Closer Look at the Weaker Points

The following strong points with specific reference to the system design are listed below:

- 1) The success of the system design ultimately lies with the stakeholders. The onus of whether the design is properly implemented, whether it receives the necessary stakeholder support and whether it is actively used rests with all levels of the organization.
- 2) Organizations may find it difficult to always be in the position to quantify the Critical Business Processes. Certain Critical Business Processes may be of such a nature that quantification skews the internal process operations, thus providing false feedback on actual performance.
- 3) The system design currently provides no means of defining acceptable limits of deviation with respect to the Destination Statements and Outcomes. This may potentially lead to ambiguity as some managers may believe that performance is acceptable while others may not. Defining acceptable limits, although it may initially seem so, is not a trivial task as it requires extensive scenario planning and a thorough investigation into the “knock-on” effect with respect to the other relevant performance measures.

12. Conclusion

The case study used a “post mortem” approach to verify the overall framework design based on Reutech Radar Systems’ Strategic Mining Business Unit’s plans, objectives and performance for the 2006, 2007 and 2008 financial years. It also demonstrated how the gap between strategic control and performance measurement is bridged by practically implementing the bridging system design. Identifying and formulating the Critical Success Factors with specific reference to Mining Business Unit’s generic strategy ensured that the Critical Success Factors were relevant and applicable.

The Critical Business Processes were derived from the Critical Success Factors by means of the critical success factor method of strategic control. The Critical Business Processes were subsequently further broken down into Critical Control Variables. This in essence ensured that the generic strategy and strategic objectives of the Mining Business Unit can be accomplished by excelling at every day business processes such as the provision of product support. The same can be said of every day operational variables such as the Mean-Time-Between-Failures. This ultimately transfers the responsibility of successfully executing the strategy from the boardroom to the production floor, call centre and

laboratory benches, as lower level managers and employees effectively gain direct control over strategy execution.

Knowing whether the generic strategy and related strategic objectives are actually being accomplished requires that the actual performance of the Critical Business Processes and Critical Control Variables be measured. This requires that business processes and control variables undergo filtering so as to ensure consistency. Filtering is an extremely important aspect of the overall framework as it is responsible for linking the strategic control and performance measurement systems and is thus solely responsible for translating the Critical Business Processes and Critical Control Variables into a quantifiable and measurable state. All the business processes and control variables that were identified in the Mining Business Unit's case were found to pass through all six of the filters.

The desired levels of performance, defined by means of the quantification filter, formed a crucial part of the Destination Statements and Outcomes of the second tier performance measurement system. The desired levels of performance were used to provide a benchmark to compare the actual performance to. Setting desired levels of performance promotes strategic alignment as well as strategy implementation. It also decreases the time it takes to make strategic decisions as managers have clearly defined levels of desired performance and can more easily predict the direct result of their decisions. The identification of deviations is also made simpler, as actual performance can accurately be compared to the quantified desired levels of performance. These deviations are used to perform corrective actions which ultimately ensure the successful strategic by making changes to the relevant Critical Business Processes and Activities. Changes to the Critical Business Processes not only influence the operation of the process itself, but it also indirectly influences the performance of the Critical Control Variables. Changes to the Activities have a direct influence on the Critical Control Variables and an indirect impact on the Critical Business Processes. This case study additionally also found several instances where early deviations in both the destination statements and outcomes could have been successfully compensated for.

The case study also focussed on the Strategic Objectives based on the competitive environment, the second tier performance measurement system, or manager experience. An example of a possible future strategic objective that may arise is related to the extended support sales. A high degree of deviation was noticed and can subsequently be translated into a strategic objective, as this is clearly one of the Mining Business Unit's strong points.

The signal processing chain provides a means for the data that is acquired, with respect to the Mining Business Unit's strategic objectives, to be translated into patterns and then into opportunities and threats. Emerging opportunities and threats are compared to existing Critical Success Factors, and misalignment leads to the identification of new Critical Success Factor. Signal processing is an extremely important aspect of the overall framework as it connects the strategic control and performance measurement systems by means of a feed forward link, as it is able to translate performance data back into strategy.

Part Seven - Conclusion

"I have walked that long road to freedom. I have tried not to falter; I have made missteps along the way. But I have discovered the secret that after climbing a great hill, one finds that there are many more hills to climb. I have taken a moment here to rest, to steal a view of the glorious vista that surrounds me, to look back on the distance that I have come. But I can rest only for moment, for with freedom come responsibilities, and I dare not linger, for my long walk is not yet ended."

Nelson Mandela in "Long Walk to Freedom"

1. Verifying the Research Methodology

In Part One of this thesis the hypothesis that was presented, stated that the gap between strategic control theory and performance measurement theory can be sufficiently addressed by means of a bridging system that links these two schools of thought. In order to be capable of sufficiently addressing the hypothesis the following research objectives were defined:

- Implement a bridging system so as to improve the understanding of how management behaviour can be influenced by performance measurement data to better facilitate management interventions by means of strategic control.
- Make use of a systems approach to design a strategic control framework, with the primary focus of being adaptive, and the secondary focus of operating within a process driven framework that acknowledges both the constraints and the structures of the organization.
- Make use of a systems approach to design a performance measurement framework, with the primary focus of being adaptive, and the secondary focus of operating within a process driven framework that acknowledges both the constraints and the structures of the organization.

The method used to achieve these research objectives was defined in the thesis research methodology that consisted of determining the state of the art, identifying opportunities, developing a framework and methodology, verifying and evaluating, and finally drawing research conclusions. The cross verification matrix in Table 7-1 on the following page summarises how the different stages of the research methodology, as defined in Part One, were addressed by comparing the methodology to the thesis roadmap.

Table 7-1: Cross Verification Matrix - Research Methodology vs. Thesis Roadmap.

	Introduction	Fundamentals	Strategic Control	Performance Measurement	Bridging The Gap	Case Study And Results	Conclusion
Determine State of The Art	✗	✗	✗	✗	✗		
Identify Opportunities			✗	✗	✗		
Framework and Methodology			✗	✗	✗		
Verify and Evaluate			✗	✗	✗	✗	
Research Conclusions						✗	✗

2. Achieving the Research Objectives

Successfully achieving the research objectives is the key to adequately substantiating the hypothesis. The research objectives focussed on the design of both a strategic control framework and a performance measurement framework that is adaptive and process driven. It also aimed to improve the understanding of the interactions between strategic control and performance measurements by means of successfully designing a bridging system. Detailed research conclusions with specific reference to the how the research objectives were met are presented below.

- Determine the Current State of the Art:** After an extensive review of relevant academic literature was completed, the following important points were noted.
 - ✓ There are two main approaches to *management control*, namely, diagnostic control and interactive control. To ensure success a control system should therefore make use of a hybrid of these two approaches.
 - ✓ There are two main views on *strategic control*, namely, strategic control as the control of strategy implementation and strategic control as the control of strategy content. To ensure success, a control system should make use of a hybrid of these two views.

- ✓ *Critical Success Factors* are a major driving force behind successfully implementing a given strategy. There are two main approaches to Critical Success Factors in the academic literature, namely, the feedback approach and the feed forward approach. To ensure the successful use of Critical Success Factors the given control system should implement a hybrid of these two approaches.
- ✓ Making use of a *balanced performance measurement system* that is able to deal with both financial and non financial measures is crucial in achieving success. The Balanced Scorecard technique was found to be the most suitable, with specific reference to the third generation Balanced Scorecards. Third generation Balanced Scorecards are more flexible as they only consist of destination statements and strategic linkage models.
- ✓ Very little academic literature that addresses the gap between strategic control and performance measurement exists. The literature does however confirm that the success of a bridging system is based upon its ability to promote quantification, timeliness, relevancy, verifiability, sensitivity and congruity.
- **Identify Opportunities:** Once the “landscape” was identified the following opportunities for potential improvement were noted.
 - ✓ An opportunity existed to design a strategic control system, by making use of a systems approach, that ensures Critical Success Factors are based on both the organization’s generic strategy as well as on emerging opportunities and threats, that determines desired levels of Critical Success Factor performance, that tracks the actual performance and that uses deviations so as to take corrective actions.
 - ✓ An opportunity existed to design a performance measurement system, by making use of a systems approach, that is derived from strategy, that links objectives to operations, that stimulates continuous improvement, that provides a link back to strategy and that provides fast and accurate feedback about actual levels of performance.
 - ✓ An opportunity existed to design a bridging system, by making use of a systems approach, which is able to consistently relate strategic control to performance measurement that evaluates both the strategic control and performance

measurements systems and that promotes strategic content control by means of a maintenance structure.

- **Framework and Methodology:** The identified opportunities were acted upon by means of designing a new framework and methodology, important points are discussed below.
 - ✓ The strategic control system, consisting of Critical Success Factors, Critical Business Processes and Critical Control Variables is nothing new, but the design of inputs and outputs that interface with a potential bridging system is.
 - ✓ Similarly, the performance measurement system, consisting of strategic linkage models, Destination Statements and Strategic Objectives is nothing new, but the design of inputs and outputs that interface with a potential bridging system is.
 - ✓ The development of the *signal processing chain*, adapted from the concept of signal advantage, with the primary goal of enabling strategic content control.
 - ✓ The development of both *contingency and economic based filters*, capable of promoting consistency and speeding up strategic decision making.
 - ✓ The development of the *adaptive processing chain*, adapted from the concept of adaptive advantage, with the primary goal of ensuring that deviations are used to perform corrective actions.
 - ✓ The development of the *abstraction layer*, that recognises the challenges posed by the imbalance of information (information asymmetry) and, which in turn, provides a means to alert an organization to the possible dangers and pitfalls.
- **Verify and Evaluate:** Following the design phase the framework was verified and subsequently evaluated by means of:
 - ✓ Cross verification matrices which successfully verified that each requirement was indeed met.
 - ✓ A case study, involving a real world strategic business unit, found that the framework and methodology is indeed viable. The case study specifically showed that the signal processing chain can be used to perform strategic control, that filtering promotes consistency and decreases strategic decision making time and that the adaptive processing chain can be successfully used to compensate for deviations. The case study also showed that an abstraction layer can be used to

informally connect the Strategic Objectives of the organization with the Destination Statements.

- **Research Conclusions:** The research objectives are regarded as being successfully achieved.. Relevant conclusions based on the verified and evaluated results and important points relating to the achieved research objectives are discussed below.

- ✓ *Implement a bridging system by making use of a systems approach, so as to improve the understanding of how management behaviour can be influenced by performance measurement data to better facilitate management interventions by means of strategic control.*

A bridging system was successfully implemented, capable of facilitating the consistent and dynamic flow of information between a strategic control and performance measurement system. Data provided by the performance measurement system and through the signal processing chain could successfully be used to influence management behaviour. Management intervention could also occur by means of the strategic control system as well as through adaptive processing.

- ✓ *Make use of a systems approach to design a strategic control framework, with the primary focus of being adaptive, and the secondary focus of operating within a process driven framework that acknowledges both the constraints and the structures of the organization.*

A strategic control framework was successfully implemented. The strategic control framework is regarded as being adaptive since it allows both the Critical Success Factors and the Critical Business Processes to be altered based on feedback from the signal processing and adaptive processing chains respectively. The systems approach resulted in the design of a generic strategic framework which is capable of acknowledging the constraints and structures of a given organization by means of the relevant initial design considerations.

- ✓ *Make use of a systems approach to design a performance measurement framework, with the primary focus of being adaptive, and the secondary focus of operating within a process driven framework that acknowledges both the constraints and the structures of the organization.*

A performance measurement framework was successfully implemented. The performance measurement framework is regarded as adaptive since strategic linkage models and Destination statements can be influenced by means of the adaptive processing and filtering chain respectively. The systems approach resulted in the design of a generic performance measurement framework, which is capable of acknowledging the constraints and structures of a given organization by means of the relevant initial design considerations.

3. Topics for Future Research

The research conducted in this thesis as well as the resulting framework forms the basis for further future studies with respect to:

- **Interfacing with an Integrated Knowledge Management Network:** The signal processing chain as well as the adaptive processing chain provides potential points for interfacing with an integrated knowledge management network. The data generated by these two chains can be used to build up a database of “strategic knowledge” that can potentially be used to decide on future strategies in environments characterized by uncertainty and irreversibility.
- **Interfacing with an Innovation Management Network:** The signal processing chain acquires relevant data, recognizes patterns and subsequently identifies emerging opportunities or threats. This provides an excellent point for interfacing with an innovation management network. Such a network can use the emerging opportunities and threats that are identified as inputs to subsequently stimulate creativity with reference to Research and Development, manufacturing, marketing, and other related business activities and processes.
- **Information Asymmetry:** Information asymmetry remains a possible stumbling block for successfully executing strategy on an operational level. Further research with specific reference to this imbalance of information may provide solutions that may potentially be able to adequately address this problem.

4. Concluding Remarks

The hypothesis made at the beginning of this thesis stated that the gap between strategic control theory and performance measurement theory can be sufficiently addressed by means of a bridging system that links these two schools of thought. This hypothesis was substantiated as the bridging system designed in this thesis provided a consistent and dynamic framework capable of successfully linking strategic control and performance measurement.

Research conducted increased the understanding of how management intervention, by means of strategic control, can be influenced by acquiring relevant performance measurement data. Research additionally resulted in an adaptive process driven framework, with properties and characteristics different from the properties and characteristics of the individual parts, capable of consistently and dynamically implementing an organization strategy.

This thesis formed the basis for future work with specific reference to interfacing with integrated knowledge and innovation management networks. The ultimate aim is to help organizations, in the words of Sun Tzu, avoid only being “fond of words” and not provide them with the ability to “carry them into deeds”.

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Addendum A – Functional Requirements

The following tables presented in this section provide the reader with all functional requirements that were developed in Part Three, Part Four and Part Five for the design of the Strategic Control, Performance Measurement and Bridging Systems respectively. The functional requirements were formulated based on opportunities for potential improvement that were identified. Table A-1 below presents the functional requirements for the strategic control system.

Table A-1: Functional Requirements for the Strategic Control System.

Requirement	Description
Requirement SC1.	The strategic control system should be able to define Critical Success Factors based on the organization’s generic strategy as derived from the mission, vision and environmental analysis (feedback approach to formulating Critical Success Factors).
Requirement SC2.	The strategic control system should be able to change the strategic content (Critical Success Factors) in light of invalid planning assumptions and emerging opportunities/threats in the competitive environment (feed forward approach to formulating Critical Success Factors).
Requirement SC3.	The strategic control system should be able to set standards of desired critical success factor performance, track actual performance and use deviations to take corrective action.
Requirement SC4.	The strategic control system should be able to collect data on the Critical Success Factors in order to monitor the validity of planning assumptions and to identify opportunities/threats, interpret the data and to respond to the information contained in the data.

Table A-2 below presents the functional requirements for the performance measurement system.

Table A-2: Functional Requirements for the Performance Measurement System.

Requirement	Description
Requirement PM1.	The performance measurement system should be derived from strategy so as to promote feed forward information flow.
Requirement PM2.	The performance measurement system should be able to link strategic objectives to operations.
Requirement PM3.	The performance measurement system should be able to stimulate continuous improvement.
Requirement PM4.	The performance measurement system should link back to strategy and promote feedback information flow.
Requirement PM5.	The performance measurement system should provide fast and accurate feedback concerning actual performance levels.

Table A-3 below presents the functional requirements for the bridging system.

Table A-3: Functional Requirements for the Bridging System.

Requirement	Description
Requirement BS1.	The strategic control system should be able to consistently relate the strategic control system to the performance measurement system and vice versa.
Requirement BS2.	The strategic control system should be able to evaluate the strategic control system, therefore ensuring that the right aspects are being strategically controlled.
Requirement BS3.	The strategic control system should be able to evaluate the performance measurement system, therefore ensuring that the right aspects are being measured.
Requirement BS4.	The strategic control system should promote the development of new performance measures based on changes within the competitive environment.
Requirement BS5.	The strategic control system should provide a maintenance structure whereby strategic control metrics can be consistently related to the performance measurement system.

This section also provides the reader with the cross verification matrices that were used to verify how and where the functional requirements were met. Table A-4 below presents the cross verification matrix for the strategic control system.

Table A-4: Cross Verification Matrix for the Strategic Control System.

Requirement	Where Was It Met	How Was It Met
<u>Requirement SC1:</u> The strategic control system should be able to (1) define Critical Success Factors based on the organization's generic strategy (2) as derived from the mission, vision and environmental analysis.	<ol style="list-style-type: none"> 1. System processes. 2. System inputs. 	<ol style="list-style-type: none"> 1. Define Critical Success Factors based on generic strategy. 2. Generic strategy serves as strategic control system input.
<u>Requirement SC2:</u> The strategic control system should be able to (1) change the strategic content in light of invalid planning assumptions and (2) emerging opportunities/threats in the competitive environment.	<ol style="list-style-type: none"> 1. System processes. 2. System inputs. 	<ol style="list-style-type: none"> 1. Strategic content control by making use of Critical Business Processes and Critical Control Variables. 2. Data collected from competitive environment serves as input.
<u>Requirement SC3:</u> The strategic control system should be able to	<ol style="list-style-type: none"> 1. System outputs. 	<ol style="list-style-type: none"> 1. Output desired levels of Critical Success Factor

(1) set standards of desired critical success factor performance, track actual performance and (2) use deviations to take corrective action.	2. System inputs.	performance. 2. Track actual performance by using deviations as inputs
<u>Requirement SC4</u> : The strategic control system should be able to (1) collect data on the Critical Success Factors in order to monitor the validity of planning assumptions and to (2) identify opportunities/threats, interpret the data and to respond to the information contained in the data.	1. System inputs. 2. System processes.	1. Data collected from competitive environment serves as input. 2. Strategic content control by using information from the system inputs.

Table A-5 below presents the cross verification matrix for the performance measurement system.

Table A-5: Cross Verification Matrix for the Performance Measurement System.

Requirement	Where Was It Met	How Was It Met
<u>Requirement PM1</u> : The performance measurement system should be (1) derived from strategy.	1. System inputs.	1. By using feed forward strategic information as input.
<u>Requirement PM2</u> : The performance measurement system should be able to (1) link strategic objectives to operations.	1. System processes.	1. By making use of strategic linkage models and destination statements.
<u>Requirement PM3</u> : The performance measurement system should be able to (1) stimulate continuous improvement.	1. System inputs.	1. By continually making changes to internal process by using corrective actions as input.
<u>Requirement PM4</u> : The performance measurement system should (1) link back to strategy.	1. System outputs.	1. By feeding back strategic information about the organization's objectives.
<u>Requirement PM5</u> : The performance measurement system should provide fast and accurate feedback concerning actual performance levels.	1. System outputs.	1. By providing accurate feedback with specific reference to the performance measures.

Table A-6 below presents the cross verification matrix for the bridging system.

Table A-6: Cross Verification Matrix for the Bridging System.

Requirement	Where Was It Met	How Was It Met
<u>Requirement BS1</u> : The strategic control system should be able to (1) consistently relate the strategic control system to the performance measurement system and vice versa.	<ol style="list-style-type: none"> System inputs. System outputs. 	<ol style="list-style-type: none"> By using strategic control and performance measurement system outputs as inputs. By using strategic control and performance measurement system inputs as outputs.
<u>Requirement BS2</u> : The strategic control system should be able to (1) evaluate the strategic control system, therefore ensuring that the right aspects are being strategically controlled.	<ol style="list-style-type: none"> System processes. 	<ol style="list-style-type: none"> By implementing an adaptive processing chain.
<u>Requirement BS3</u> : The strategic control system should be able to (1) evaluate the performance measurement system, therefore ensuring that the right aspects are being measured.	<ol style="list-style-type: none"> System processes. 	<ol style="list-style-type: none"> By implementing an adaptive processing chain.
<u>Requirement BS4</u> : The strategic control system should (1) promote the development of new measures based on changes within the competitive environment.	<ol style="list-style-type: none"> System processes. 	<ol style="list-style-type: none"> Strategic content control by means of successfully implementing the signal processing chain.
<u>Requirement BS5</u> : The strategic control system should (1) provide a maintenance structure whereby strategic control metrics can be consistently related to the performance measurement system.	<ol style="list-style-type: none"> System processes. 	<ol style="list-style-type: none"> By successfully implementing both contingency and economic based filters.

Addendum B – Desired Levels of Performance

This section presents the reader with the desired levels of Critical Business Process and Critical Control Variable Performance for Reutech Radar Systems' Mining Business Unit. This is as result of the filtering process that forms part of the overall bridging system discussed in Part Five of this thesis. The filtering process consists of both economic and contingency based filtering.

The results tabulated in Table B-1 below depict the desired levels of Critical Business Process performance for the 2006, 2007 and 2008 financial years.

Table B-1: Desired Levels of Critical Business Process Performance (Annually: Sep 06' – Sep 08').

Critical Business Process	Quantification	Sep 06'	Sep 07'	Sep 08'
Exploit new market opportunities.	Number of new systems sold.	6	10	12
Direct and indirect expenditures.	Operating profit margin.	-0.67%	18.50%	36.73%
Up/cross sell products	Bundled sales.	0	R 3,388,936	R 7,600,208
Manage inventory performance.	Inventory turnover.	2.22 times	3.09 times	4.12 times
Product support.	Product availability.	95 %	95%	95%
Research and development.	Functional enhancements.	3	9	12

The results tabulated in Table B-2 below depict the desired monthly levels of Critical Control Variable performance for September 2007 up to, and including, December 2007.

Table B-2: Desired Levels of Critical Control Variable Performance (Monthly: Sep 07' - Dec 07').

Critical Control Variable	Quantification	Sep 07'	Oct 07'	Nov 07'	Dec 07'
Mean-Time-Between-Failures (MTBF).	MTBF per system.	2800 hours	2800 hours	2800 hours	2800 hours
Mean-Time-To-Repair (MTBR).	MTBR per system.	21 hours	21 hours	21 hours	21 hours
Mining visits.	Number of mining visits.	1	1	1	1
R&D materials expenditure.	Cost of R&D materials.	R 8,752,815	R 8,800,799	R 8,800,799	No Data
R&D labour expenditure.	Cost of R&D labour.	23,420	23,478	23,478	No Data
Production materials expenditure.	Cost of production materials.	R 4,679,073	R 4,679,073	R 4,679,073	No Data
Production labour expenditure.	Cost of production labour.	4,424	19,308	19,430	No Data

Support calls.	Number of support calls.	20	20	20	20
Extended support contracts.	Value of contract.	No Data	R 14,900	R 16,200	R 16,200

The results tabulated in Table B-3 below depict the desired monthly levels of Critical Control Variable performance for January 2008 up to, and including, April 2008.

Table B-3: Desired Levels of Critical Control Variable Performance (Monthly: Jan 08' - Apr 08').

Critical Control Variable	Quantification	Jan 08'	Feb 08'	Mar 08'	Apr 08'
Mean-Time-Between-Failures (MTBF).	MTBF per system.	2800 hours	2800 hours	2800 hours	2800 hours
Mean-Time-To-Repair (MTBR).	MTBR per system.	21 hours	21 hours	21 hours	21 hours
Mining visits.	Number of mining visits.	1	1	1	1
R&D materials expenditure.	Cost of R&D materials.	No Data	No Data	R 8,183,581	R 8,098,267
R&D labour expenditure.	Cost of R&D labour.	No Data	No Data	22,371	22,188
Production materials expenditure.	Cost of production materials.	R13,677,415	R10,156,104	R10,339,404	R 9,971,933
Production labour expenditure.	Cost of production labour.	12,919	13,212	13,340	14,344
Support calls.	Number of support calls.	20	20	20	20
Extended support contracts.	Value of contract.	R 16,200	R 16,200	R 16,200	R 16,200

The results tabulated in Table B-4 below depict the desired monthly levels of Critical Control Variable performance for May 2008 up to, and including, Aug 2008.

Table B-4: Desired Levels of Critical Control Variable Performance (Monthly: May 08' - Aug 08').

Critical Control Variable	Quantification	May 08'	Jun 08'	Jul 08'	Aug 08'
Mean-Time-Between-Failures (MTBF).	MTBF per system.	2800 hours	2800 hours	2800 hours	2800 hours
Mean-Time-To-Repair (MTBR).	MTBR per system.	21 hours	21 hours	21 hours	21 hours
Mining visits.	Number of mining visits.	1	1	1	2
R&D materials expenditure.	Cost of R&D materials.	R 8,057,840	N/A	N/A	N/A
R&D labour expenditure.	Cost of R&D labour.	21,885	N/A	N/A	N/A

Production materials expenditure.	Cost of production materials.	R 9,604,462	R 9,236,991	R 8,869,520	R 8,502,048
Production labour expenditure.	Cost of production labour.	10,862	7,455	7,988	9,338
Support calls.	Number of support calls.	20	27	27	27
Extended support contracts.	Value of contract.	R 16,200	R 16,200	R 16,200	R23,700

Addendum C – Actual Levels of Performance

This section presents the reader with the actual levels of Critical Business Process and Critical Control Variable Performance for Reutech Radar Systems' Mining Business Unit. The Destination Statements that were identified in Part Six represent the quantified desired levels of Critical Business Process Performance. The filtered Critical Business Processes will in reality therefore always strive towards a steady-state condition by continually minimising the error between the actual and desired levels of performance. Actual levels of performance for the Mining Business Unit's Critical Business Processes for the 2006, 2007 and 2008 financial years are presented in Table C-1 below.

Table C-1: Destination Statements and Actual Levels of Performance for the Critical Business Processes.

Critical Business Process	Destination	Sep 06'	Sep 07'	Sep 08'
Exploit new market opportunities.	Number of new systems sold.	4	9	10
Direct and indirect expenditures.	Operating profit margin.	-0.80 %	17,28 %	31.8 %
Up/cross sell products	Bundled sales.	R 0	R 2,100,142	R 5,432,021
Manage inventory performance.	Inventory turnover.	1.23 times	2,59 times	3,85 times
Product support.	Product availability.	98 %	96%	97%
Research and development.	Functional enhancements.	4	10	14

The Outcomes that were identified in Part Six represent the quantified, desired levels of Critical Control Variable performance. The filtered Critical Control variables will in reality therefore always strive towards a steady-state condition by continually minimizing the error between the actual and desired levels of performance. The results tabulated in Table C-2 below depict the actual monthly levels of Critical Control Variable performance for September 2007 up to, and including, Dec 2007.

Table C-2: Outcomes and Actual Levels of Critical Control Variable Performance (Jan 07' - Dec 07').

Critical Control Variable	Outcome	Sep 07'	Oct 07'	Nov 07'	Dec 07'
Mean-Time-Between-Failures (MTBF).	Better MTBF per system.	8760 hours	8760 hours	8760 hours	8760 hours
Mean-Time-To-Repair (MTBR).	Better MTBR per system.	8 hours	12 hours	15 hours	15 hours
Mining visits.	More mining visits.	1	1	2	1
R&D materials expenditure.	Within budget.	R8,800,779	R 8,934,025	R 8,183,852	No Data
R&D labour expenditure.	On time.	23,478 hours	23,997 hours	22,371 hours	No Data

Production materials expenditure.	Within budget.	R 4,679,073	R13,511,938	R 13,677,415	No Data
Production labour expenditure.	On time.	4,424 hours	19,308 hours	19,430 hours	No Data
Support calls.	Lower support calls per system.	5 calls	5 calls	2 calls	4 calls
Extended support contracts.	Increased extended support sales.	R 14,900	R 31,100	R 47,400	R 63,600

The results tabulated in Table C-3 below depict the desired monthly levels of Critical Control Variable performance for January 2008 up to, and including, April 2008.

Table C-3: Outcomes and Actual Levels of Critical Control Variable Performance (Jan 08' - Apr 08').

Critical Control Variable	Outcome	Jan 08'	Feb 08'	Mar 08'	Apr 08'
Mean-Time-Between-Failures (MTBF).	Better MTBF per system.	8760 hours	4380 hours	2920 hours	2920 hours
Mean-Time-To-Repair (MTBR).	Better MTBR per system.	23 hours	22 hours	26 hours	26 hours
Mining visits.	More mining visits.	2	1	2	1
R&D materials expenditure.	Within budget.	No Data	No Data	R 8,454,694	R 8,057,840
R&D labour expenditure.	On time.	No Data	No Data	22,386	21,885
Production materials expenditure.	Within budget.	R 10,156,104	R10,339,404	No Data	R 9,447,042
Production labour expenditure.	On time.	12,919 hours	13,212 hours	No Data	13,340 hours
Support calls.	Lower support calls per system.	10 calls	20 calls	36 calls	34 calls
Extended support contracts.	Increased extended support sales.	R 79,900	R96,100	R112,300	R 128,600

The results tabulated in Table B-4 below depict the desired monthly levels of Critical Control Variable performance for May 2008 up to, and including, Aug 2008.

Table C-4: Outcomes and Actual Levels of Critical Control Variable Performance (May 08' - Aug 08').

Critical Control Variable	Outcome	May 08'	Jun 08'	Jul 08'	Aug 08'
Mean-Time-Between-Failures (MTBF).	Better MTBF per system.	2190 hours	2920 hours	2920 hours	2920 hours
Mean-Time-To-Repair (MTBR).	Better MTBR per system.	30 hours	30 hours	28 hours	22 hours
Mining visits.	More mining visits.	2	2	1	2
R&D materials	Within budget.	R 7,993,169	N/A	N/A	N/A

expenditure.					
R&D labour expenditure.	On time.	21,908	N/A	N/A	N/A
Production materials expenditure.	Within budget.	R10,069,271	R8,502,028	R5,843,663	R5,826,998
Production labour expenditure.	On time.	14,344 hours	10,862 hours	7,445 hours	7,988 hours
Support calls.	Lower support calls per system.	21 calls	39 calls	38 calls	37 calls
Extended support contracts.	Increased extended support sales.	R 144,800	R 161,100	R184,800	R201,000

Addendum D - Actual vs. Desired Levels of Performance

This section presents the results from the adaptive processing chain as discussed in Part Five. The adaptive processing chain is responsible for using the deviation due actual and desired levels of performance to perform corrective action. The up and cross selling of products was identified as a Critical Business Process and was quantified by means of the bundled sales results. Desired levels of performance are based on a list of prospective clients who possibly interested in bundled sales packages. Figure D-1 below presents a graph of the actual versus desired levels of bundled sales performance.

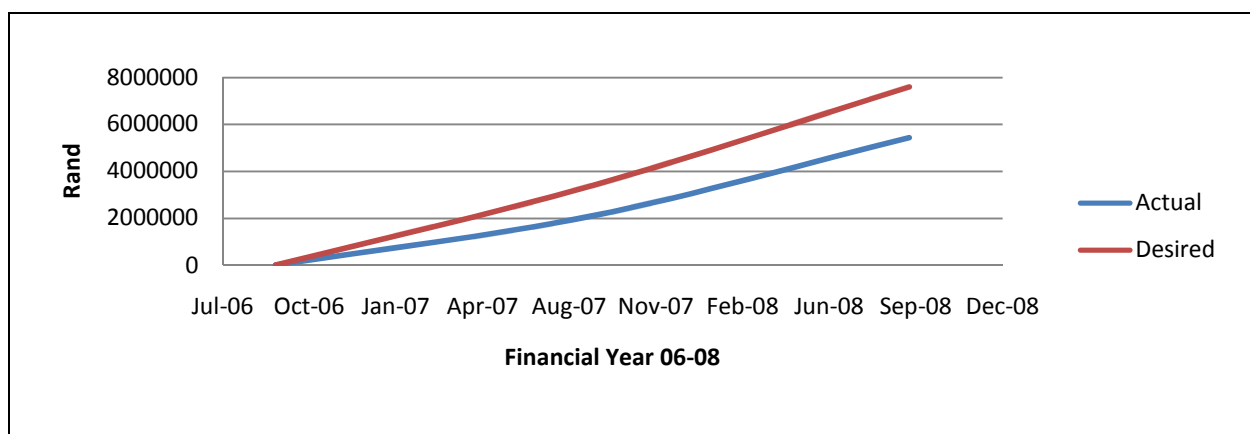


Figure D-1: The Actual vs. Desired Bundled Sales.

The management of inventory was also defined as Critical Business Processes and was quantified by means of the inventory turnover. Figure D-2 below presents a graph of the actual versus desired levels of inventory turnover performance.

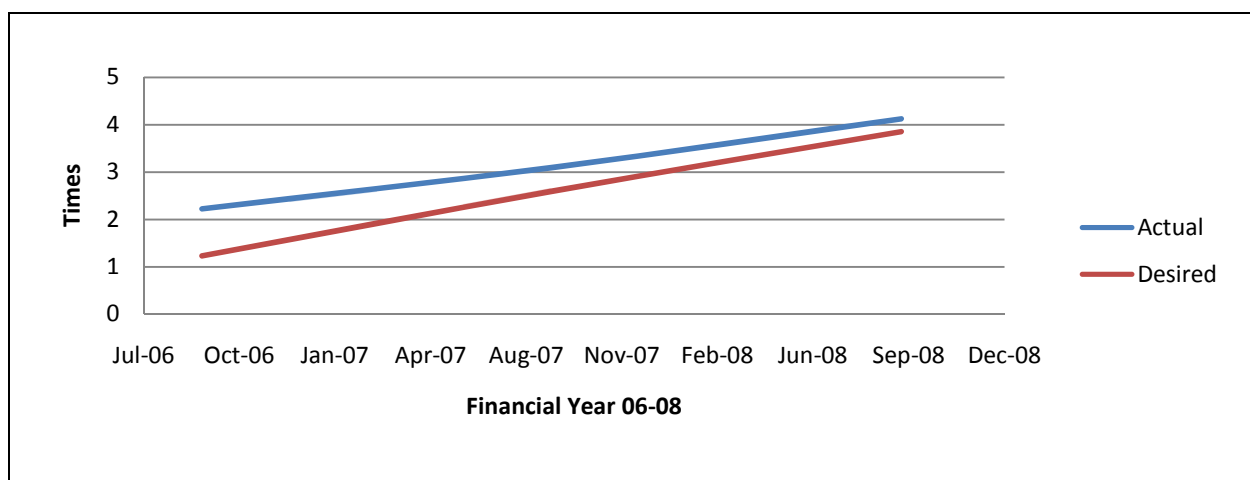


Figure D-2: The Actual vs. Desired Inventory Turnover.

Research and development was also defined as a Critical Business Process and was subsequently quantified by means of the number of functional enhancements that are implemented. Figure D-3 below presents a graph of the actual versus desired levels of functional enhancements implemented.

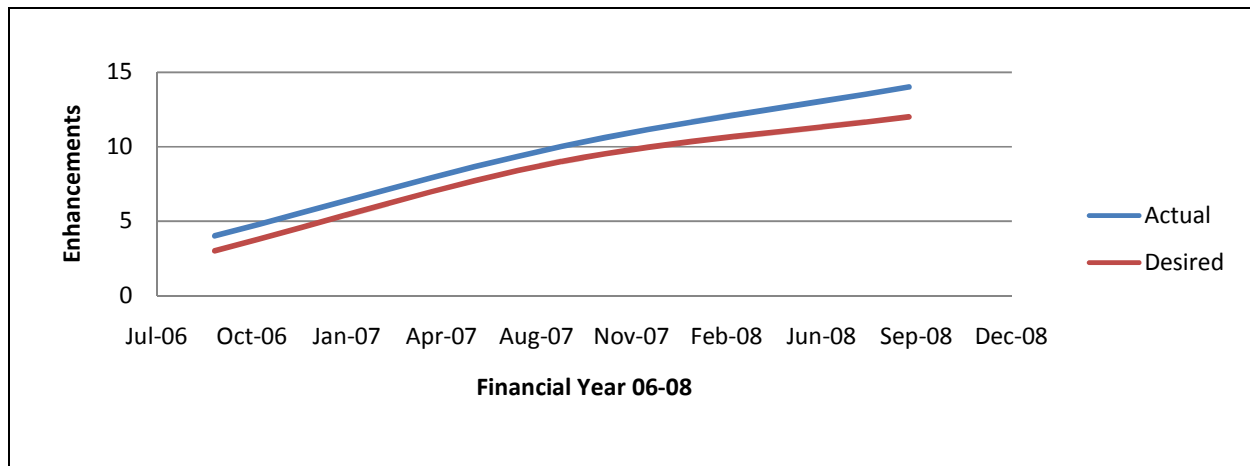


Figure D-3: The Actual vs. Desired Number of Functional Enhancements Implemented.

Research and development material as well as research and development labour expenditure has been identified as a Critical Control Variables with Outcomes aimed at being within budget and on time respectively. There is a definite deviation between the actual and desired levels of performance of the Mining Business Unit’s research and development expenditures and this can largely be attributed to poor cash flow management and inefficient project management. Figure D-4 and Figure D-5 below clearly depict this deviation.

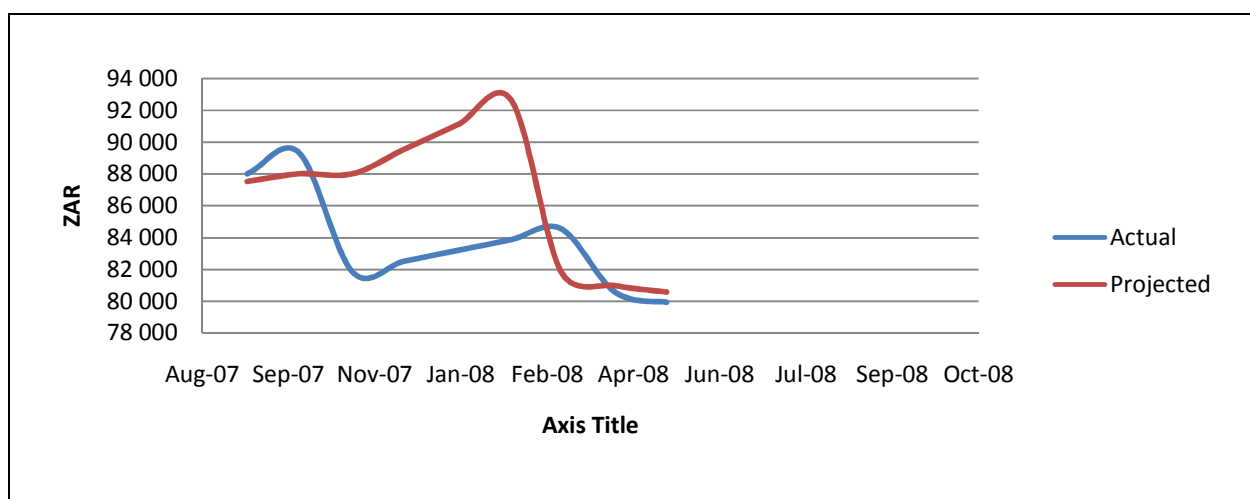


Figure D-4: The Actual vs. Desired R&D Materials Expenditure.

This situation might seem acceptable, as the actual expenditure is below the desired expenditure, but in this case the error is simply too large and is mostly due to poor planning and inefficient project management. Such a large deviation makes proper project management within the Mining Business Unit extremely challenging. The optimal planning, loading and organizing of research and development resources can therefore only happen when the error is minimised.

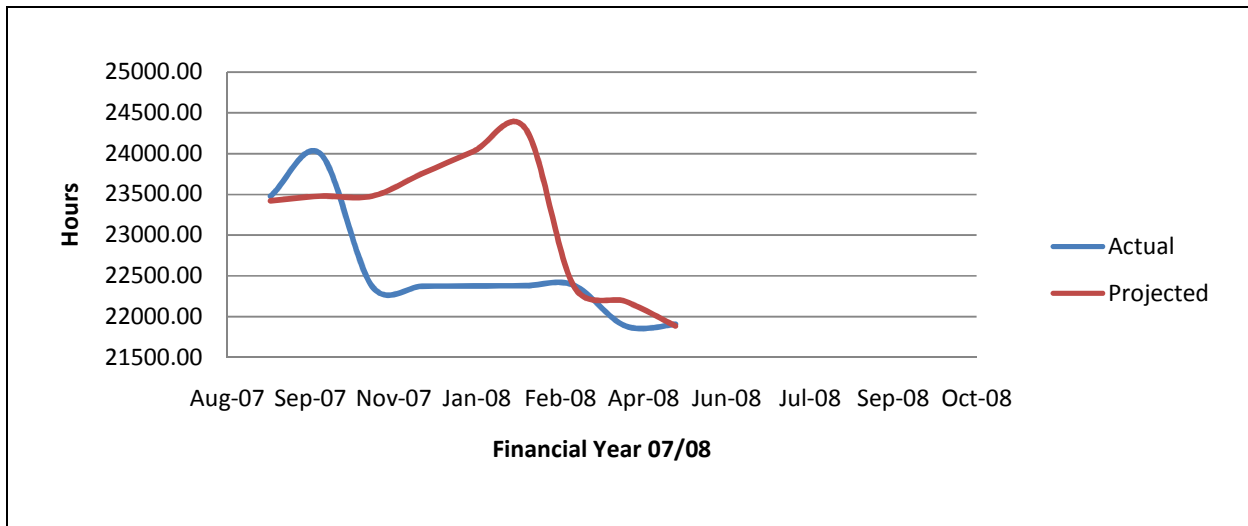


Figure D-5: The Actual vs. Desired R&D Labour Expenditure.

Corrective action with regard to the following Activities may possibly have decreased the error:

- Better project management so as to optimally plan, load and organise resources.
- Present valid data at every Estimated Cost to Completion meeting so as to more accurately project estimated cost and labour totals.

Extended support sales were also identified as a Critical Control Variable and were quantified by looking as the extended support contract sales figures. Figure D-6 below presents a graph of the actual versus desired extended support contract sales.

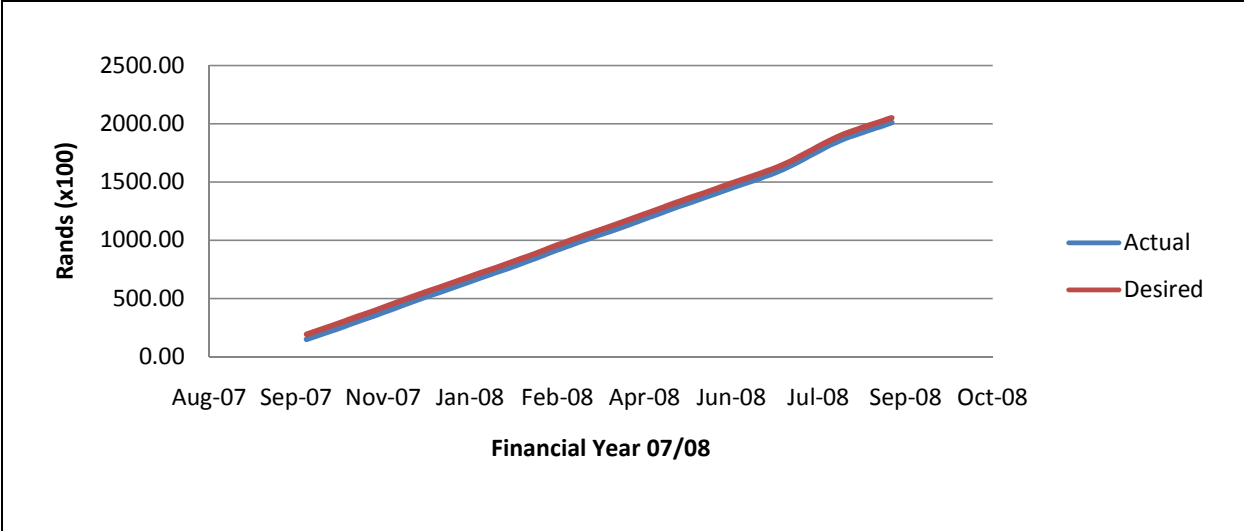


Figure D-6: The Actual Vs. Extended Support Contract Sales.

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