AN INDUSTRIAL ENGINEERING PERSPECTIVE OF BUSINESS INTELLIGENCE

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ABSTRACT

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Key words:

Business intelligence, strategy alignment, Balanced Scorecard, strategy map, enterprise modelling, business process management, performance management, value chain, data warehouse, dimensional modelling, key performance indicators.

Summary:

In this thesis the candidate explores the apparent gaps between strategy development and strategy implementation (the strategy alignment question), and between business end-user needs and the suppliers of information technology (IT) related products and services. With business intelligence (BI) emerging as one of the fastest growing fields in IT, the candidate develops a conceptual model in which BI is placed into context with other relevant subjects such as strategy development, enterprise architecture and modelling and performance measurement.

The emphasis is on the development of processes and templates that support a closed loop control system with the following process steps:

- A business strategy is defined.
- The implication of the strategy on business processes, supporting IT resources and organizational structure is formally documented according to enterprise architecture principles.
- This documented blueprint of the organization helps to implement the selected business strategy.
- A performance measurement system is developed and supported by a well-designed data warehouse.
- On a regular basis the measurements that were defined to support the implementation of the strategy, together with information from the external environment are interpreted and this analysis leads to either a new strategy, or refinement of the implementation of the existing strategy. Both options may lead to changes in the enterprise architecture, the execution of business processes and/or the performance measurement system.

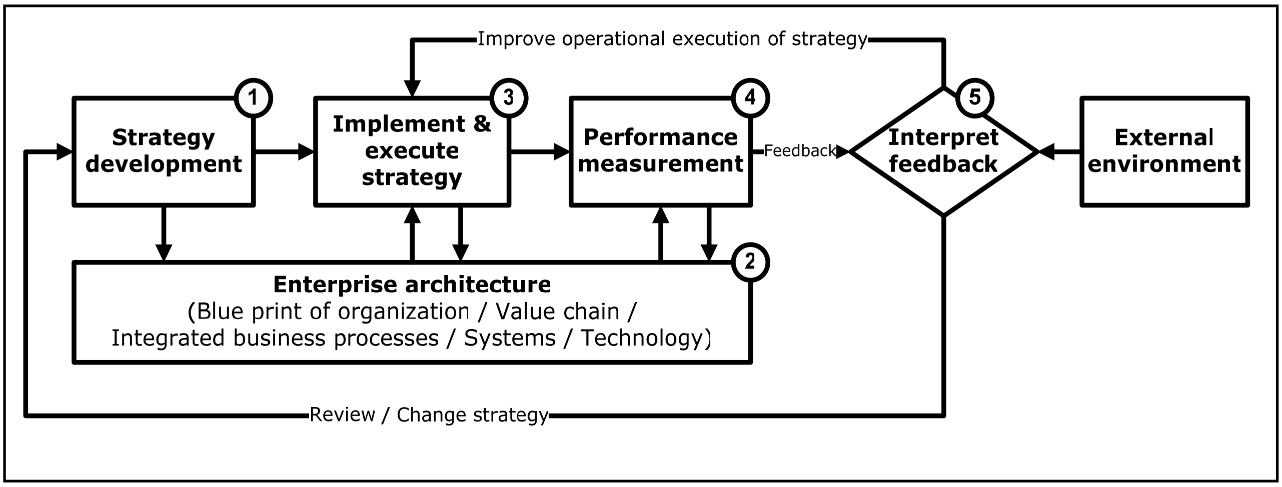
Some of the individual components of the model are supported by existing theories, for example the Zachman Framework for enterprise architecture and the Balanced Scorecard from Kaplan and Norton. The contribution of the author was to position them in the bigger picture to indicate how they can add value with regard to the establishment of business

intelligence in organizations. Instead of packaging existing ideas slightly differently under a new name, the author intentionally searched for existing theories to fulfil certain requirements in the Bigger Picture BI Context Model.

Apart from a set of templates that were adapted from various other sources and packaged into practical formats that can be used during facilitation sessions, the author has also developed and described the Fourier Model and the Pots of Money Model. The Fourier Model is a powerful conceptual model that helps a business to package solutions for market related requirements through selections of previously defined building blocks (technical components) that can be delivered through various business entities, depending on the requirements of the opportunity. The Pots of Money Model is a quantitative model embedded in a spreadsheet format to illustrate and communicate the effect of spending decisions in one area of the business on other areas.

The candidate demonstrates the Bigger Picture BI Context Model in several case studies. The thesis is accompanied by a CD ROM, which contains over 700 references to relevant literature (most of them available in full text) and links to internet web sites, as well as examples of the software templates that support some of the steps in the context model.

The following figure depicts the conceptual model in schematic format:



acknowledgements

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an **industrial engineering** perspective
of business intelligence

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acronyms

AIM	Absolute information management
B2B	Business to business
BAM	Business activity monitoring
BP	Business process
BPM	Business performance management
BPM	Business performance measurement
BPM	Business process management
BI	Business intelligence
BSC	Balanced scorecard
CD	Compact disk
CD ROM	Compact disk read only memory
CIF	Corporate information factory
CIM	Computer integrated manufacturing
CORS	Cognitive, operit, revit and synit
CRM	Customer relationship management
CSF	Critical success factor
CuTS	Culture, technology and skills
DSS	Decision support system
DW	Data warehouse
EA	Enterprise architecture
EAI	Enterprise application integration
EBIS	Enterprise business intelligence suite
EDW	Enterprise data warehouse
EII	Enterprise information integration
ER	Entity relationship
ERP	Enterprise resource planning
ETL	Extraction, transformation, loading
FK	Foreign key
GERAM	Generalized enterprise reference architecture and methodology
IE	Information ecosystem
IS	Information system
I and T Layer	Integration and transformation layer
IT	Information technology
ICT	Information and communication technology
JIT	Just in time
KM	Knowledge management
KPI	Key performance indicator
MBO	Management by objectives
MIS	Management information system
MOLAP	Multidimensional OLAP
OLAP	Online analytical processing
OLTP	Online transactional processing
ODS	Operational data store
PERA	Purdue enterprise reference architecture
PK	Primary key
ROLAP	Relational OLAP
RSA	Republic of South Africa
SCM	Supply chain management
SIG	Swanborough information grid
SWOT	Strengths, weaknesses, opportunities and threats
TQM	Total quality management
UI	User interface

1 Introduction

"To win without fighting is best" – Sun Tzu

1.1 Background

During the last number of centuries wars have been fought not only on the battlegrounds, but also in the boardrooms and corridors of businesses. Long before the term business intelligence became fashionable, the military world was talking about military intelligence (even though there are people who refer to it – tongue in cheek – as an example of a contradiction in terms!)

Just as the military realised that pertinent, actionable information is necessary to be successful, businesses also need information to base their decisions on. Just as military generals need to develop and implement strategies to survive, the long-term survival of businesses depends on the way in which they strategise and adapt to changing business environments. Many of the principles and guidelines that are discussed in *The Art of War*, by Sun Tzu (1991), are used successfully by business leaders in their handling of organizations in conflict – the analogy between martial art and business success is therefore not that far fetched.

Business intelligence (BI), according to the definition by Kimball and Ross (2002), is a generic term to describe leveraging the internal and external information assets of the organization to make better business decisions. Inmon, Imhoff and Sousa (Inmon et al. 2001) see BI as representing those systems that help companies understand what makes the wheels of the corporation turn and help predict the future impact of current decisions. They also add that these systems play a key role in the strategic planning process of the corporation.

Although the definitions will be further explored later on in the study, it is clear that BI has to do with **information** and **decision support.**

1.2 Major role players

1.2.1 Industrial engineers

Traditionally, industrial engineers have been involved in decision support at various levels in the organization. At first they focussed on the production function of organizations, but during the last number of decades they have also played an important role in the improvement of business processes in other business functions, such as human resource management, financial management, procurement and marketing. They are also playing an increasing role in the streamlining of transactions between businesses. The process approach that industrial engineers bring into the environment often enables different disciplines in an organization to see their role in context of the bigger business picture for the first time.

The deserved attention that supply chain management (SCM) has been receiving since 1990 is proof of the potential value that can be unlocked by improving inter-company activities and information flow – managing an even bigger picture of interdependent businesses.

Other typical industrial engineering activities such as quality management, simulation modelling, systems engineering and integration and enterprise architecture also play a role in helping businesses to clarify their information system needs.

Industrial engineers are, however, not the only players in the field. Various other disciplines are also playing their parts and bringing specific expertise to the table. Management science and information and communication technology (ICT) are two other major players that are also involved.

1.2.2 Management science

Concepts like Management by Objectives (MBO), Total Quality Management (TQM), Balanced Scorecard (BSC) and many more were originally developed by people that entered the arena from the business management and operations research point of view. These concepts are often qualitative of nature and need some kind of quantitative support foundation to become practically usable.

Buys (2002) points out:

> *What managers need are new and improved theories and models (tools) that can be applied in practice. Theories should be embodied in conceptual models (graphical, mathematical or schematic descriptions or analogies) or practical methods (procedures or techniques).*

Currently, in the so-called "information era", the necessary quantitative support foundation for these theories very often involves information and communication technology.

1.2.3 Information and communication technology

People operating in the ICT environment are producing enabling tools that are potentially capable of supporting almost any conceptual curveball that the management science people can throw at them through sophisticated hardware and software products. The speed at which generic products are developed and introduced into the market is extremely fast and provides in itself a challenge to decide what to select and when to use it.

The reason why generic products are often developed instead of user specific solutions is obvious – the potential market is much bigger and the development cost can be recovered from various parties, making the tools also more affordable to the buyers.

The implementation of acquired tools in the existing environment and circumstances of a specific organization often proves to be a task beyond the IT product/service provider (because of a lack of business knowledge), as well as the business user (because of a lack of knowledge of the system and the way systems are integrated).

1.3 The gap between different worlds

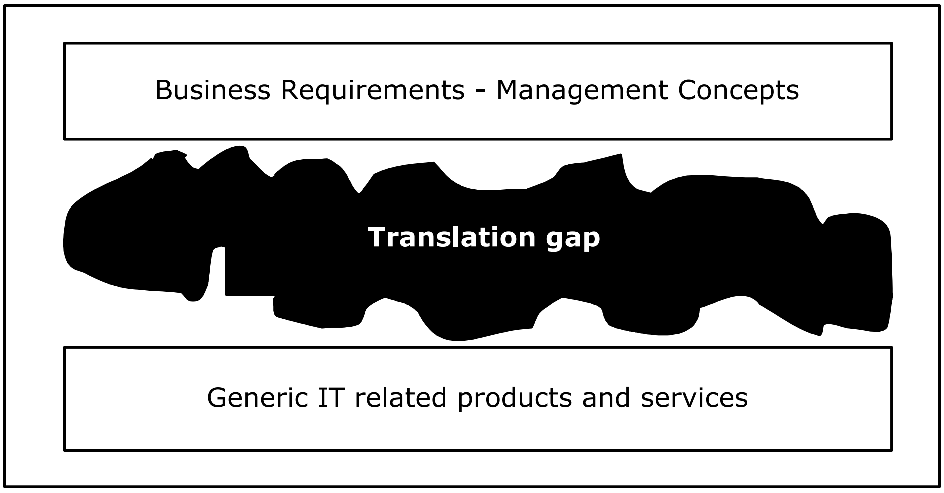


Figure 1. Translation gap between IT and business

Given this background, it can be stated that various gaps still exist in the ideal picture. First of all, there is the gap between business end-users and information technology. As Jim Kanzler (2003) summarizes the situation in the title of one of his internet articles, *"IT is from Mars, End-Users are from Venus"*. The struggle between end-users and IT over reporting and data responsibility is far from over, and each party has a valid case. Business intelligence tools have progressed over time to empower end-users to generate their own reports, but they often still need bits of data that are not provided for in the Enterprise Data Warehouse (EDW). This leads to cutting and pasting into spreadsheets – a manual process prone to error and open to criticism when the business user, who comes up with a figure, cannot answer the common question: How did you get that number?

The traditional management gap between strategic planning and operational execution (the strategic alignment question) is still haunting most organizations. Various management models have been developed to address this issue, but they are not always successfully implemented.

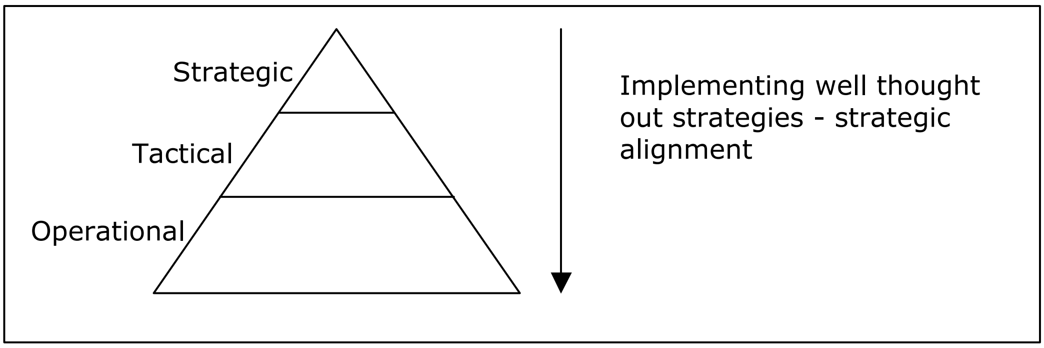


Figure 2. Strategic alignment

The concept of identifying key performance indicators (KPIs) to guide people's efforts in the right direction (strategically speaking) is an old technique, dating back to the early days of Peter Drucker's concept of Management by Objectives (MBO). Combined with performance measurement, it can be a powerful instrument. However, people often find it difficult to define the right KPIs and to get objective measurements from the existing information sources.

The use of a Balanced Scorecard approach, as proposed by Kaplan and Norton *(1996)*, goes a long way to ensure that the right KPIs are identified (instead of just a list of measurements that sound good or are easy to measure). It also links measurements from various business perspectives in a cause-and-effect manner that supports the selected business strategy.

Various other less traditional approaches to identify innovative products, services and total solutions (such as the "*Lessons in radical Innovation*" by Wolfgang Grulke, 2001), and structured methods to do scenario planning that will give strategic direction (such as the *Foxy Matrix* by Illbury and Sunter, 2001) will have to find a place in the bigger picture framework.

1.4 Problem statement

This thesis explores the important role that industrial engineers may play in the selection, implementation and integration of relevant IT solutions to meet business requirements, when they position themselves on the side of businesses instead of products and specific IT solutions. The goal is to develop a bigger picture model, or framework, that will put a number of the existing theoretical models into context and will provide a generic process for implementing BI in organizations.

The roles of change agent, translator of user requirements into functional specifications and integrator of various components in a total solution are not really new to industrial engineers. The focus of this study, however, is on bridging the gap between business requirements and the suppliers of ICT products and services with special attention to

- a structured approach to link business strategy to an information technology strategy in such a way that the value stream and underlying business processes of the organization are supported by appropriate transactional and business intelligence information systems, which are in turn supported by appropriate and flexible IT infrastructure;
- data warehousing as the foundation for information needs;
- performance measurement to support strategic, tactical and operational goals;
- management information systems (MIS) for decision support – the delivery mechanisms of relevant information at the right time.

Having stated where the emphasis of the thesis lies, it is also appropriate to state what is not included in the study:

- Purely technical issues in the information technology arena such as specific differences between various databases (e.g. SQL Server and Oracle, or the differences between various versions of Oracle).
- The differences between and detail algorithms used by various data mining methods.
- Detail comparisons between various BI related tools – for example Cognos vs. Business Objects, or Datastage vs. Sagent. One reason for excluding such comparisons is the fact that it is almost impossible to have thorough enough knowledge of all the products at a certain point in time to compare them effectively. Furthermore, all the products are constantly in a mode of development with enhancement releases at least once a year and from time to time products are acquired and packaged differently with other new or existing products.

1.5 Research methodology

Buys (2002) clearly distinguishes between pure management practice and research. "To qualify as a research project, there must also be some generation of new knowledge." This new knowledge can be demonstrated in three different ways:

- Application of existing theories, models and methods to a new problem.
- Testing of existing theories, models and methods.
- Building of new or improved theories, models and methods.

The research methodology followed in this case was the following:

- The identification of relevant existing theories, models and methods in the fields of strategic management, enterprise architecture, performance management, data warehousing and knowledge management through literature studies, internet searches and practical exposure.
- Critical testing and comparison of a number of these theories, models and methods.
- The integration of a number of these theories, models and methods into a new framework of integrated theories, models and methods that can assist businesses in bridging the gap between their requirements and information technology offerings.
- Testing the new integrated framework and parts thereof in a limited number of case studies, which have led to further refinements of the framework and supporting templates.

What makes the work different from pure management practice is the **integration** of the various existing theories, models and methods and the development of **supporting templates** to assist the user in various steps within the bigger framework. The **design of a set of data marts** that support the value chain of a typical consulting firm is a further deliverable that should have reusability in similar environments.

1.6 Organization of this thesis

1.6.1 Document structure

Chapter 2, a literature study, provides insight into a number of subjects that form the foundation for the bigger picture model that is later developed. The literature study is presented along a number of themes:

- Strategic positioning and scenario planning
- Frameworks for enterprise architecture
- Data warehousing
- Knowledge management
- Performance measurement
- Business intelligence and technology tools

In Chapter 3 the various theories and conceptual models are analyzed and a new contextual framework is developed where the existing theories, together with some new inputs, are integrated in the Bigger Picture BI Context Model. Practical and simplistic templates are developed and discussed.

In Chapter 4 this contextual framework is applied to a consulting company and the results are discussed. Other case studies where elements of the framework were used are also discussed, as well as situations that were handled without the framework.

Chapter 5 summarizes the thesis and evaluates the study. Various recommendations regarding further enhancements are made.

1.6.2 CD-ROM

In addition to the thesis document a CD-ROM is provided with a rich collection of current literature (mostly dated from 1999 to 2004), as well as electronic versions of the templates that were developed. Many of the sources that are on the CD have not been referenced directly in the document and do therefore not appear in the bibliography.

Numerous references to web sites of relevant service providers are also included. Some of the electronic articles on the CD have links to the internet and it is recommended that one should be linked to the internet while browsing the CD. However, since many of the internet links change sooner or later, the majority of articles were captured in such a way that they will be usable off line.

2 Literature study

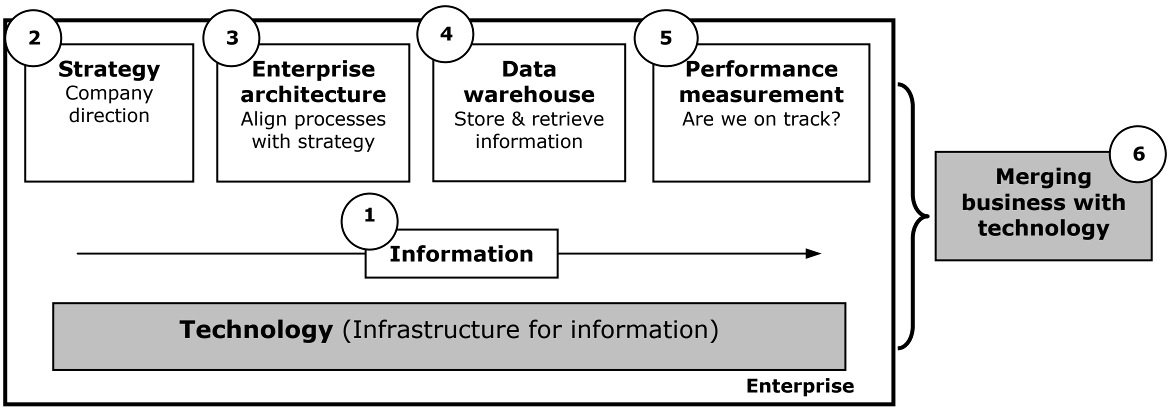
2.1 Introduction

The challenging (and frustrating) part of a literature study is the decision what to include in the final presentation and also in what manner or structure. During the whole journey of discovery, which stretched over four to five years and included literally hundreds of books, journal articles, white papers and internet articles, many detours were taken on interesting, albeit slightly unrelated, paths.

Also, with the problem statement to develop a **bigger picture** framework, one is tempted to try and accommodate everything. The main focus, however, is on business intelligence (BI) and the process orientation that the industrial engineer can offer to make the process of extracting BI from data more practical. It is clear that business intelligence does not stand on its own – the what, why, who, when, how, where and other relevant questions put it in a certain context. To understand BI in this context it is necessary to explore a number of related subjects.

The following figure illustrates the components of this literature study within the context of an enterprise. It takes into account all aspects that influence business intelligence in the author’s view.

The numbers indicate the section headings that will follow and the order in which they will be addressed.



1. Information

Defining information and its generic role in the enterprise.

2. Strategy and scenario planning

Establishing the mission and the strategy to accomplish the mission.

3. Enterprise architecture

Creating a blue print of all relevant aspects in the organization, linking strategic direction to organizational structure, business processes, systems and technological infrastructure.

4. Data warehousing

Providing a central repository where various knowledge workers can extract information in a user-friendly and consistent manner.

5. Utilizing information to measure performance

Identifying KPIs and measuring company performance to aid in decision-making.

6. Merging business with technology

This section explores other theories that seek to bring together all (or some) of the above mentioned components. It aims to bring understanding of the relationship between the above-mentioned topics and to align the utilization of information with the company strategy.

2.2 Information

It is common knowledge that the amount of information accessible to people has increased enormously since the industrial age. The problem is no longer a lack of information, but how to utilize that information effectively to aid in decision-making. Business intelligence aims to achieve just that. However, merely transforming information into knowledge, to aid decisions, is not the only purpose of BI. To illustrate, consider the following example: If a business is focused on the wrong processes, those that do not drive profit and strategy, information will be gathered on how to improve those processes. The decisions made will at best achieve only improvement of the current processes. Thus, the company will remain on the wrong road. Also, if the company does have the right processes, but the information gathered does not support the selected strategy, then the decisions made will not necessarily support the successful implementation of the strategy.

To be successful a company first has to establish a business strategy to accomplish its mission. Then it must determine the processes required to support the strategy and decide what information is required for the processes to run smoothly. As soon as the processes are aligned the company can establish what information is required to measure performance against the strategic objectives. Finally the company must decide how to manage the information, perhaps through a data warehouse, and how to retrieve it effectively. All of these actions together help a company to be an intelligent business.

It is evident that information plays a major role within all activities of an organization. But before the company can optimise the utilization of that information, it must first understand what information is and in what forms it manifests itself within the company. *"The starting point for successful information systems is not the definition of information needs, it is the definition of information."* (Absolute Information 2001) The following section will address this issue.

2.2.1 Defining information

A typical dictionary definition of information would be "knowledge acquired through experience or study; the meaning given to data by the way it is interpreted". (*The Collins Concise Dictionary, 21st Century edition* 2004) Often the distinction between data and information is stated in the phrase that information is processed data.

English (1999) also puts the relationship between data, information, knowledge and wisdom into context by defining it as follows:

- *Simply stated, **data** are the representation of facts about things. Data are only the raw material from which information may be produced.*

- ***Information** is data in context. Information quality requires quality of three components: clear definition or meaning of data, correct value(s), and understandable presentation (the format represented to a knowledge worker).*

  Information = f(Data + Definition + Presentation)

- ***Knowledge** is not just information known - it is information in context. Knowledge means understanding the significance of the information. Knowledge is applied information and may be represented as a formula:*

Knowledge = f(People + Information + Significance)

- ***Wisdom** is applied knowledge and may be expressed in the formula:*
  Wisdom = f(People + Knowledge + Action)

According to English (1999) *"… it is in wisdom, or applied knowledge, that information is exploited, and its value is realized".*

Swanborough (2002) pays a lot more attention to definitions. He argues that very often objects or concepts are defined in terms of their uses and not their actual characteristics. This narrows the perception of the subject. To introduce his (somewhat eccentric) definition of information he starts off with the following analogy: If a person were asked to define a chair, the answer would probably be that it is something you sit on. This is true, but it does not answer the question. The person's answer states what a chair is *used for*, not what a chair *is*.

This analogy can be applied to information as well. The answer to the question "What is information?" would probably be "Information is something I use that tells me what happened, or what I should do, or what I base my decisions on." Again the answer is true, but still it addresses only what information is *used for* and not what it *is*.

According to Swanborough (2002) the correct answer should be *"Information is signals of coherent content that pass within or between* orgs". He then further explains the semantic content:

- *"Signals" means light-signals, sound-signals, flavour-signals, smell-signals, or tactile-signals for humans and other living things, and additionally electronic-signals or mechanical signals for machinery and other non-living things (and thus being tangible and measurable in terms of magnitude, time and/or direction), making a maximum of seven signal types thereof.*

- *"Coherent content" means "not noise" and therefore means four-, three-, two- or one- dimensional content or abstract content relating to the width, depth, height, time (including magnitudes) or the names of things, or any combination thereof, making a maximum of five coherencies thereof.*

- *"Occur" means manifesting in one or more of the four linguistic contextual constructs of "synit" (expectation), "revit" (reflection), "operit" (instruction) or "cognitive" (identification) information, making a maximum of four contexts thereof.*

- *"Within" means not leaving the org, such as a stored memory, a personal thought (organism) or an internal memo (organization).*

- *"Orgs" means structured complexity in the form of "organizations" (non-living) or "organisms" (living); organism or organization being two destination types thereof.*

- *"Between" means leaving one org and entering another org, such as a verbal communication (organism to organism) or a personal invoice (organization to organism) or an attention signal (organization to organization).*

Figure **3** shows the attributes of information in a schematic manner.

Knowing / Amplification				Getting / Movement				
CONTENT 4 Dimensional 3 Dimensional 2 Dimensional 1 Dimensional Abstract	**X**	**CONTEXT** Expectational Reflectional Instructional Identificational	**>**	Sight Sound Smell Taste Touch Mechanical Electrical	**X**	**INTERNAL** **EXTERNAL**	**X**	**ORGANISM** **ORGANI-ZATION**
Information as intelligence, knowledge and strategy - "THING"				**Information as communication - "FLOW"**				

Figure 3. Attributes of information. (Adapted from Swanborough 2002)

2.2.2 Types of information

Swanborough bases his classification of information types on the principles of financial management. A financial transaction is described by three absolutes, being a Debit, Credit and the description of the content as in **Figure 4**.

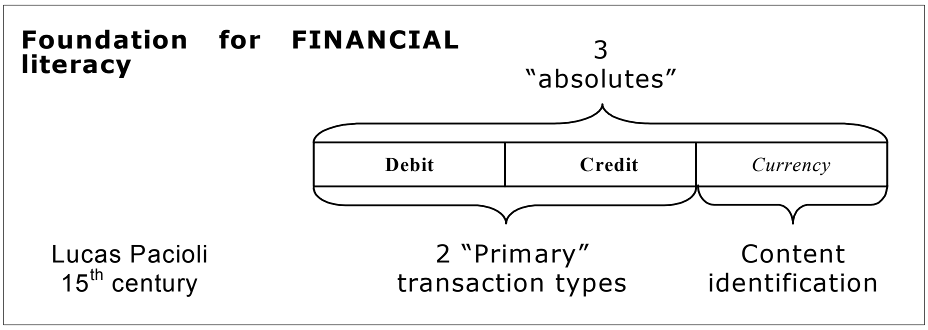


Figure 4. The three financial management "absolutes"
(Absolute Information 2001)

For information, using the same concept as for financial management, Swanborough introduces four absolutes, "Synoptic", "Review", "Operative" and "Cognitive". See **Figure 5**.

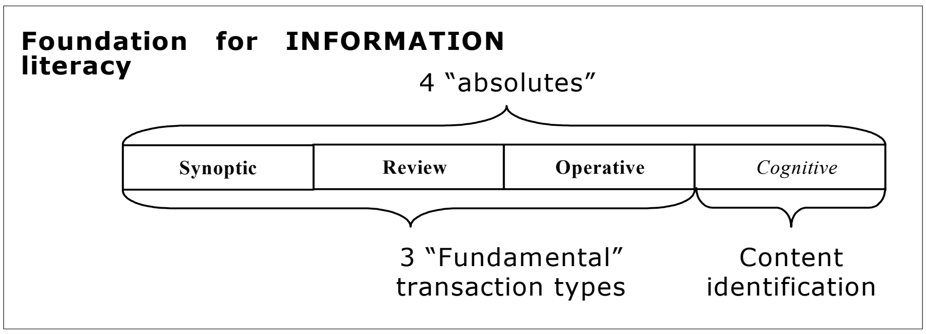


Figure 5. The four informational management "absolutes"
(Absolute Information 2001)

Cognitive information has no time content and simply provides descriptive information. The other three information types, in short Synit, Revit and Operit, do have time-content and apply to processes and the management of processes.

For simplicity and easy visual identification, each information type is denoted with an arrow as indicated in **Table 1**. The table summarizes the types with their description and shows which arrow represents it.

Table 1. Types of Information (Absolute Information 2001)

Type	Arrow	Description
Synit	↑	Long range forecasting information
Revit	←	Summarized past performance
Operit	→	Short range instructions and decisions made
Cognitive	↓	Description

2.2.3 Information in organizations

2.2.3.1 Sophistication of use of information

Information can be utilized at various levels of sophistication. Absolute Information *(*2001*)* identified seven levels of sophistication of use of which companies must aim to achieve the highest level possible. These levels are shown in **Table 2**.

Table 2. The sophistication of use of information
(Absolute Information 2001)

Levels of sophistication					
	Level	**To Address**	**Derive**	**Use**	
High	7	Wisdom	MAs	Learning algorithms	Management advices
	6	Knowledge	MDs	Rules/Policies	Management decisions
	5	Effectiveness	MIs	SMIs	Management indicators, synoptic
	4	Efficiency	MIs	OMIs	Management indicators, operative
	3	Effort	MIs	RMIs	Management indicators, review
	2	Activity	PIs	RPIs	Process indicators, review
Low	1	Description	Detail	Data	Description

> *Many technologies address levels 1 to 5, but it is not common knowledge that knowledge based systems or expert systems that aim to address levels 6 and 7 have been implemented successfully. Knowledge based systems combine the indicators of levels 3 to 5, policies and rules to deliver management decisions (MDs). By learning from these MDs, the system can automatically generate management advices (MAs). (*Absolute Information 2001*)*

2.2.3.2 Levels of corporate information focus

It is clear that information is utilized throughout the organization, the distinction being in the different levels of sophistication. To visualize the different levels, Absolute Information (2001) introduces the following "logical levels of corporate information focus":

- Communication
- System
- Enterprise

Communication level

The communication level represents the infrastructure by which information is collected, processed, stored and distributed.

Systems level

The systems level represents the processes within the enterprise and their relationships in order to establish the flow of information.

Enterprise level

This level represents the core level of functioning of the organization, encompassing all systems and processes. Absolute Information (2001) identifies four business domains:

- Manpower
- Money
- Machinery
- Material

The different information types (see **Table 1**) related to the four domains above could be utilized to establish the required information content and attributes. The three levels are illustrated in **Figure 6**. Note that the closer to the middle an item is, the more closely it is related to the core business issues.

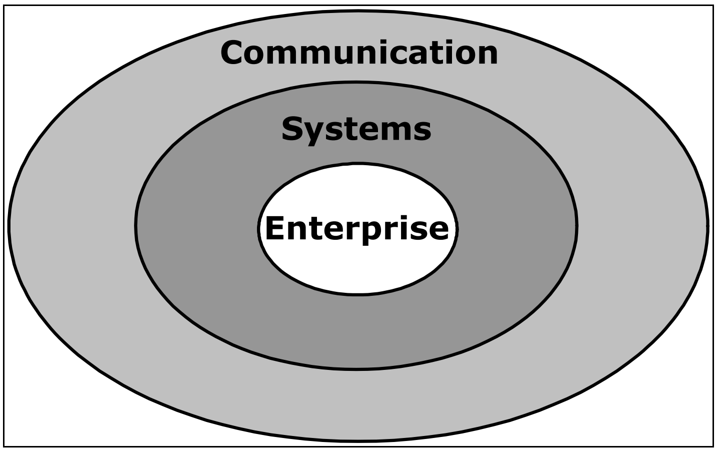


Figure 6. Levels of corporate information focus
(As adapted from Absolute Information 2001)

This concludes the literature section on information. Although there are many other sources (perhaps with more of an information technology undertone), it is felt that this slightly unorthodox view of information and the way in which it can be defined is sufficient for purposes of this study. The classification of information in an organization using the different types, levels of sophistication and business domains will be discussed later.

2.3 Business strategy and scenario planning

"Life is what happens when you're busy making other plans" – John Lennon

Even though the reader may wonder why the literature journey of a thesis on business intelligence incorporates business strategy, the motivation is found in the following reasons:

- Business intelligence implemented by an enterprise must support the strategy to be effectively utilized.
- The output from BI may improve or influence the business strategy process when BI is effectively in place in an organization.
- For organizations that are new in BI, the business strategy process may provide some valuable pointers on how to start the BI implementation process and what to concentrate on.

As it is (or should be) the aim of the industrial engineer to improve and streamline **all** processes in an organization to add value in the long run, it would be foolish to skip what should be the first and most important process of all organizations, namely that of strategic management.

The popular view of business strategy is that it is an annual exercise done by top management (preferably in the bush somewhere) where they take a long term view of where the business is headed, do some SWOT (strengths, weaknesses, opportunities and threats) analysis, reconfirm the vision, mission and values of the organization and create an action plan.

Tony Manning (2001) puts it this way: "*Strategy, it seems, is something that a few smart and powerful people think about. Then they pass their wisdom down the line in the form of instructions, and the drones get busy.*"

During the early 1980s the process of strategic management was fairly sorted out and various versions with approximately the same content were taught at business schools. They all had the following elements:

- Define the vision of the organization.
- Define the mission (what do we do, for whom, with what technology).
- Examine the macro environment (state of the economy, politics, legal issues, demographics, and so forth).
- Do the SWOT analysis – examining the microenvironment within the organization, as well as the competition.
- Derive a grand strategy (select from a number of options like high volume, low price).
- Develop a specific strategy with long-term goals, as well as tactical plans.
- Pass this enterprise strategy on to the various lower levels in the organizational hierarchy and let them develop divisional and departmental strategies that are in line with the overall strategy, as well as tactical and operational plans.

However, according to Manning (2001), "*A lot (of corporate evolution) happens way out at the edges, far from the planners, the scenarios, and the spreadsheets, where 'low-level people' serve customers, make stuff, fix things, punch buttons, sign documents, interpret events, and otherwise do their own thing. People at the top don't have 'line of sight' to the real world. The rest don't have 'line of sight' to the reasoning behind their organizations strategy. This blindness makes both groups less effective than they might be.*" Even in a large and diverse academic institution like the University of Pretoria, it is evident that aligning the activities of the operational and academic staff with the vision of top management is a challenging task.

To add to this dilemma of a gap between the strategy planners and the strategy executers, the business world early in the twenty first century is a world of accelerating change and increasing discontinuity. Thus, the processes and methods that were used with some degree of success in the second half of the previous century are not necessarily wrong – they are simply incomplete and insufficient. The managers that were trained in that era are not necessarily inefficient and incapable – they are unequipped to deal with the changed business scenario.

To put the changing world in perspective, the following section will address the all too familiar subject of life cycles. It is followed by a discussion on innovation and scenario planning and the section concludes with the concise and "no-nonsense" approach of Manning towards strategy.

2.3.1 Life cycles

Everything in life goes through cycles – people, weather patterns, the seasons, economies, products and projects - even fashion. If one could anticipate the next phase in a cycle you would definitely have a competitive advantage. Business intelligence includes the identification of trends over time and therefore this brief study of life cycles.

Wolfgang Grulke (2001) distinguishes between small cycles and big cycles. The big cycles refer to long economic cycles as defined in 1922 by Kondratieff (who was unpopular with his superiors and had to spend the rest of his life in Siberian exile). His identified turning points are shown in **Figure 7**:

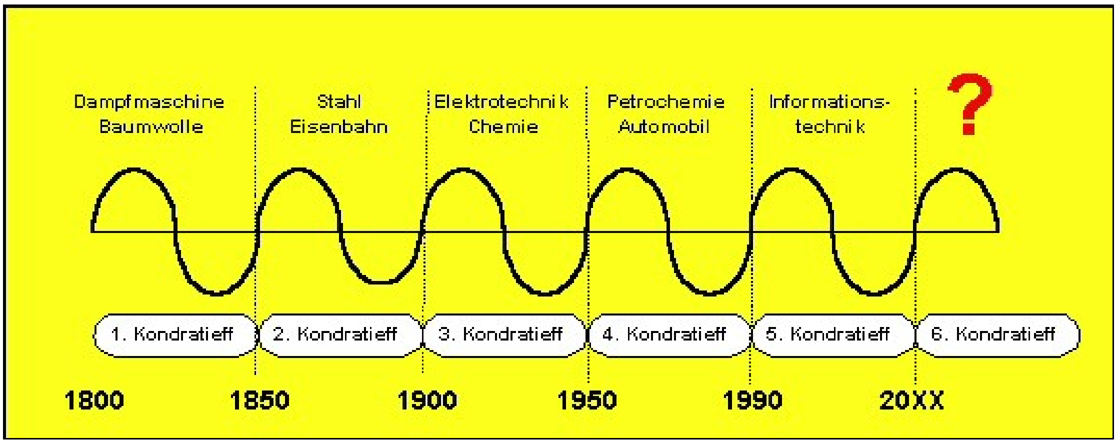


Figure 7. Economic cycles (Kondratieff, as referred to by Grulke 2001)

In 1939 Joseph Schumpeter published a book, *Business Cycles,* in which he associated each of Kondratieff's long waves with specific innovations in technology and commerce. He believed that the driving force behind the waves was innovation – not only new inventions, but also any change in the method of supplying commodities. See **Figure 8** for a chart that was taken from "*The Economist"* of February 1999 (referred to by Grulke 2001) and that shows how the waves accelerate.

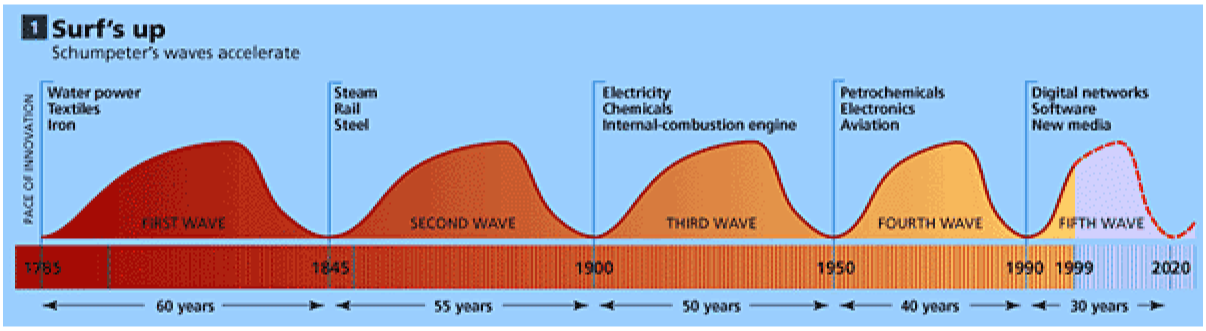


Figure 8. Schumpeter's waves (as referred to by Grulke 2001)

Schumpeter also coined the phrase "creative destruction" to describe the effect of true innovation. **Table 3** (data supplied by the US Bureau of Census) illustrates the effect of creative destruction on job opportunities:

Table 3. Creative destruction of job opportunities (Grulke 2001)

Destruction!	**Today**	**Yesterday**	
Railroad employees	231000	2076000	1920
Carriage, harness makers	<5000	109000	1900
Telegraph operators	8000	75000	1920
Boilermakers	<5000	74000	1920
Cobblers	25000	102000	1900
Blacksmiths	<5000	238000	1910
Watchmakers	<5000	101000	1920
Switchboard operators	213000	421000	1970
Farm workers	851000	11500000	1910
Total	**1,328,000**	**14,396,000**	

Creation!	**Today**	**Yesterday**	
Pilots, mechanics	232000	0	1900
Medical technicians	1380000	0	1900
Engineers	1850000	38000	1900
Computer programmers	1290000	<5000	1960
Fax machine workers	699000	0	1980
Car mechanics	864000	0	1900
Truck/Bus/Taxi drivers	3330000	0	1900
Professional athletes	77000	0	1920
TV and radio announcers	30000	<5000	1930
Electricians / electronic eq.	711000	51000	1900
Optometrists	62000	<5000	1910
Total	**10,525,000**	**<100000**	

From **Table 3** it is clear that as innovation causes job losses, it in turn also creates new jobs. That is the beauty of innovation.

Grulke (2001) comments: "*Any business leader who seriously wants to lead a truly innovative company has to be ready to manage the creative side of innovation, as well as the rather more difficult destructive consequences of innovation.*"

The life cycle of a typical business falls into the category of smaller cycles. According to Grulke there is a distinct difference between the first and second half of the business cycle. In the first half of the life cycle, all business thinking is based on the customers and their needs. All products and processes are focused on adding value to these customers.

In the second half of the life cycle, successful companies need to compete with other competitors who differentiate themselves in existing markets by cutting the price. Products become increasingly commodities and the focus on price differentiation leads to an internal emphasis on cost cutting and operational efficiency, especially for the market leaders that established the market in the first place. See **Figure 9**.

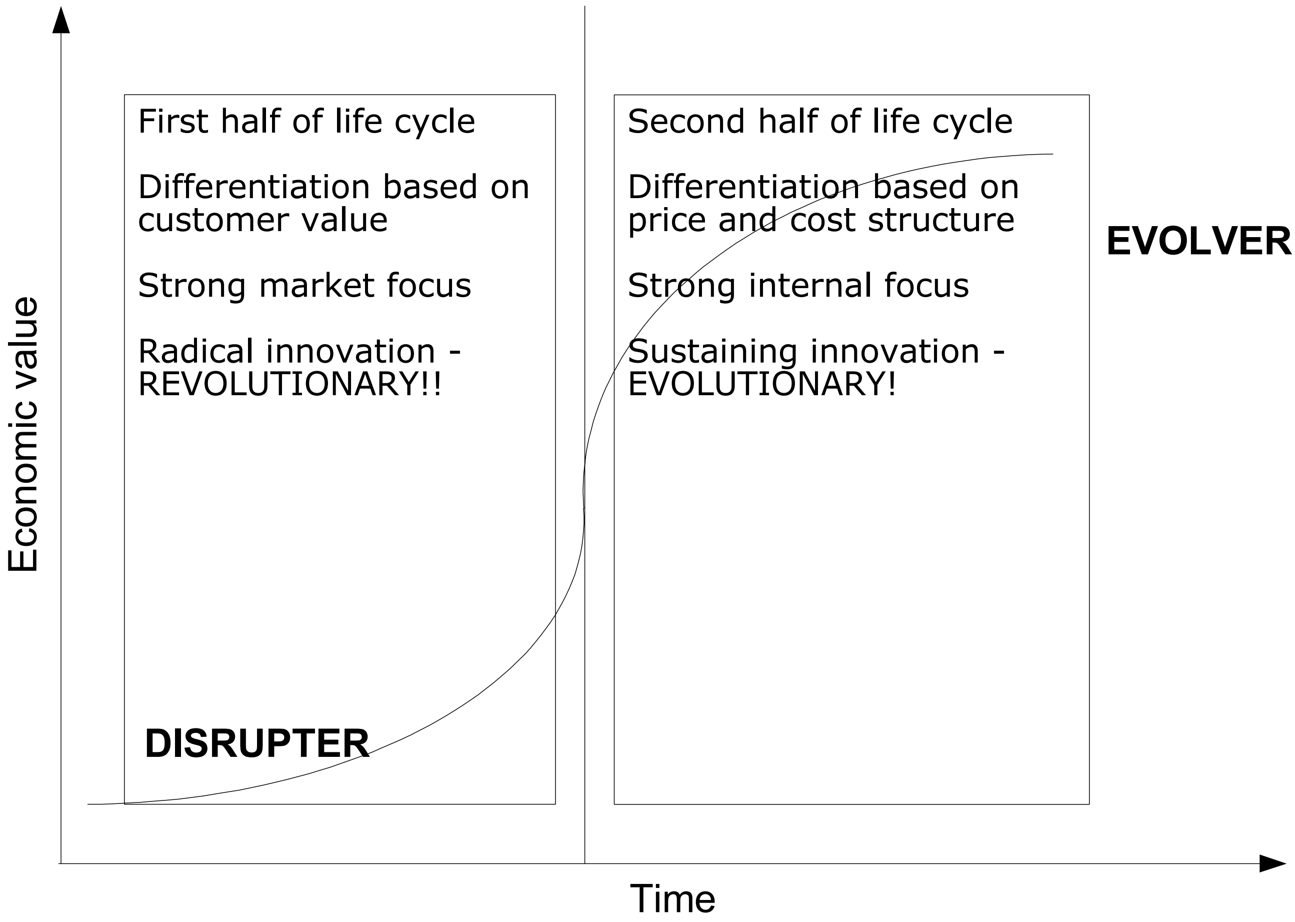


Figure 9. Business cycle (Grulke 2001)

In the second half of the business cycle the *organization* can become more important than the *business.* In the words of Grulke (2001):

> *You can sense the character of these companies in the second half of their life cycle when you deal with them as a customer. The top people in the organization are in staff and management jobs. Those positions with direct customer contact are now held by the lowest-paid people in the business – mostly clerks.*

(That is if the clerks have not been replaced by electronic hot line voices in the name of improved efficiency!)

It is important to note that only the successful businesses reach the second half of their cycle with the consequences mentioned – the failed companies have already left the scene before they have had the chance to lose sight of the customer and become obsessed with efficiency. Grulke is therefore not advocating that businesses should rather fail before the start of their second half in the life cycle – they should be aware of the typical cycle and take some deliberate action and a quantum shift in corporate thinking to handle this constant shift from innovation to evolution.

In terms of the bigger economic cycles, it is clear that we are in the last phases of the industrial economy and that a new economy has already started. For many this new economy is the Information Economy. Grulke (2001) suggests in his book *Lessons from the future* that the new economy might actually be called the Bio-economy and that the information advances of the last few decades are only the first phase, or foundation, of the bigger biotechnology wave.

It is clear, however, that innovation will play an important role in the business strategies of the future and therefore the next section covers one of many techniques in innovation. The intelligent business should have information available that will assist managers to identify the effect of innovative changes in and around them.

2.3.2 Innovation Matrix

Grulke puts forward a matrix (see **Figure 10**) that consists of two axes that indicate the relative levels of creative destruction in two dimensions:

- **Technology linkages**: The new innovation either enhances the existing technology usage, skills, platforms and investments or destroys them.
- **Market linkage**: The new innovation either enhances existing market linkages, channels, business partners and processes or threatens to destroy them.

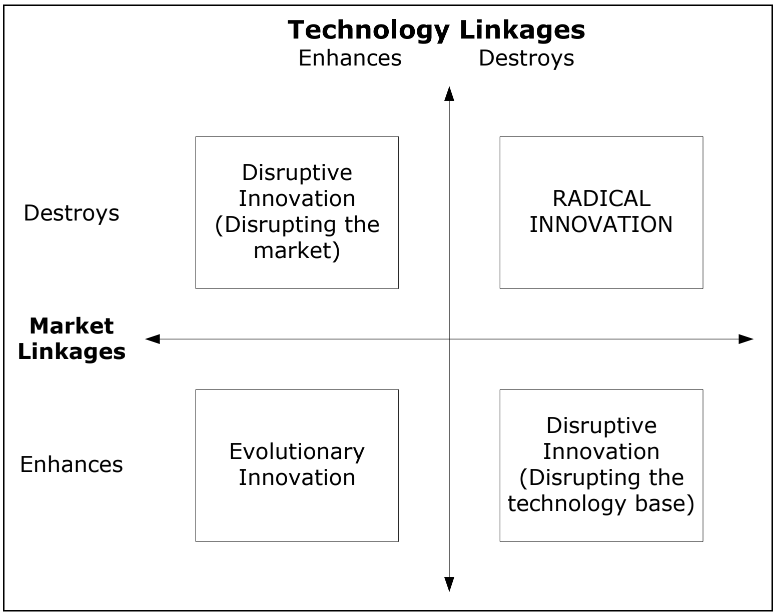


Figure 10. Innovation Matrix (Grulke 2001)

Grulke illustrates the application of the matrix by means of a fictitious example:

> *A large airline company is contemplating certain innovative proposals to improve its current reservation system (a system which is supported by*

thousands of technical people and has more than a decade of investment).

Evolutionary innovation (bottom left corner of the matrix), for example, would be an enhanced system that would give the travel agents significant benefits and ease of use, and that would be supported by the existing technicians with their existing expertise. This approach is a very low risk option creating incremental benefits without disrupting either the current market channels or the existing technology.

If the reservation system is judged to be at the end of its useful life and should be replaced by a new internet-based reservation system that will have to be developed and supported by a new (and younger) team of programmers, the disruption starts on the technology side. Even though the travel agents would have significant improvement, the whole technical department of the organization will be disrupted. (Bottom right corner of the matrix)

If someone would suggest that they enhance this internet-based system to give end-users direct access to the reservation system through the internet (cutting out the travel agents) and offer discount for booking and paying on-line, it would potentially create an extremely negative response from the travel agents and therefore disrupt the market linkages. (Top left corner of the matrix)

Now, if a young executive suggests that they should get really radical and replace the existing system with cell phones based access to the reservation system (since most clients have cell phones), it would almost destroy the market linkages with travel agents and will definitely destroy the current technology base. (Top right corner of the matrix) But just consider the business potential of such a venture!

Grulke explains further that they use the matrix to create an innovation profile for a business by doing the following:

- Identify ten top activities in which resources are focused in the business.
- Represent each activity by a bubble that represents the size of the investment and position each bubble in a quadrant on the matrix, based on the degree to which they potentially enhance or destroy the current market linkages and technology.
- Evaluate the matrix. If all the bubbles are in the bottom left corner, the business might be a cash-cow business for the moment, but their future is bleak in terms of future success. Similarly, if all bubbles are in the top right corner, the business is most likely new with a lot of great ideas and great innovators, but will be regarded as a very risky enterprise and based on experience of the past decade only 5-10% of these companies will ever make it to profitability. The ideal is a good spread between the quadrants with 10-20% of its revenue being invested in carefully selected radical projects.

Grulke also makes the following comments on the Innovation Matrix:

- *Risk increases exponentially from bottom left to top right.*
- *Potential returns from successful radical innovations far outweigh those from evolutionary innovation (in line with the risk distribution!).*
- *It does not take more effort or energy to be radical than to be evolutionary.*
- *Map your innovation strategy with the right people – do not expect a person who is risk averse to be your radical innovation champion!*
- *Radical innovation is time-bound – all radical ideas in the top-right will*

eventually become the norm and any new innovations on this "old" idea will at best be considered evolutionary.

(An adapted template on the CD can be used to evaluate a business in terms of its innovation profile.)

2.3.3 Innovation in strategic planning

From an innovation point of view, Grulke (2001) provides a strategic thinking and strategic action process that in many instances overlaps with the step-by-step approach of Manning that will be discussed in the next section. His basic point of departure is that your thoughts about your existing business should not be the departure point – rather focus on "What do I want my business to be in the future?"

Normally one could describe your present business, markets and environment by learning from experience and inside-out thinking. This may be a good way of running the business on a day-to-day basis, but according to Grulke it is not a good place to start thinking about the future.

Grulke suggests that one should start with strategic inputs as the first step in the process. These inputs are key factors that the team believes will shape their business environment in the future. It could typically include the following:

Technologies that will

- change production processes;
- change consumer behaviour;
- open new markets;
- increase life span;
- dramatically cut costs of food, drugs, etc..

Political and regulatory actions that will

- change employment practices;
- raise operating costs;
- open markets to competition.

Social trends that will

- create pressure on global companies;
- build resistance to global brands;
- give preference to organic or "green" products;
- cause consumers to exercise their individual and group power.

The process is graphically presented in **Figure 11**.

After creating the ideal future of choice, based on first divergent thinking about the future environment and the future market, followed by convergent thinking to define the future business, the strategic team is faced with the task of "looking back from the future" and identifying the sequence of actions that will be taken to get there. Even though the approach seems a little unorthodox, it prevents the strategic process from being an annual ritual where the same old issues are reiterated because the starting point is always the same – the current business environment!

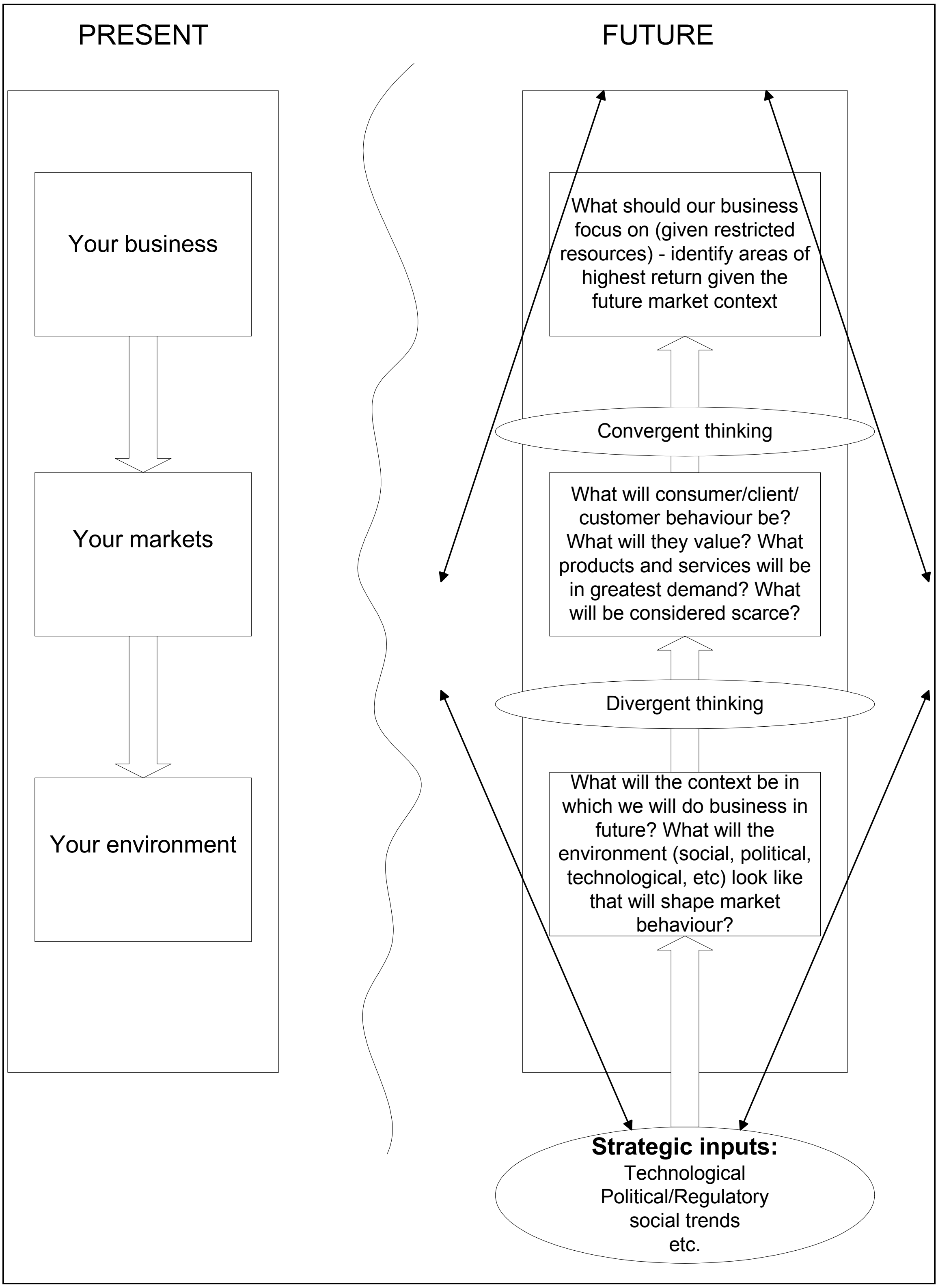


Figure 11. Learning from the future (As adapted from Grulke 2001)

2.3.4 Strategy – an ongoing conversation

Tony Manning has a "no-nonsense" approach to strategic management that is based on a number of principles. In one key principle, Manning (2001) states: "*Strategic management is **conversation**. It informs, focuses attention and effort, triggers fresh insights, lights up the imagination, energizes people and inspires performance.*"

2.3.4.1 Creating the right context

First of all a certain context or "mental space" should be created where people can perform at their full potential. This context is a product of conversation and leads to many other conversations in and outside the business. "*If the right people are involved and these conversations are open, honest, constructive and positive, good things happen. But if key people are left out, and if the conversation is blocked, devious, destructive, or negative, trouble is assured.*" (Manning 2001)

In shaping the context, the strategist must

- **make choices** regarding which customers and markets to chase, what products or services to offer and how to apply their resources;
- **win "votes"** – exist in harmony with various stakeholders and persuade them to volunteer their imagination and spirit to their case;
- **build capacity** – develop the strategic IQ of the organization so that their people can think and act appropriately.

With the context in place, a leader should provide a clear point of view: "*There is the hill we're aiming at … these are the results we want … this is how we should conduct ourselves … here are our priorities … this is what we'll do to get where we want to go*." Depending on the specific person, more or less detail will be necessary. The ongoing task is to focus and inspire them - once again through conversation, because "*what is spoken about – constantly, passionately, consistently – that will be … measured and managed*".

Manning (2001) also refers to the life cycle of organizations and points out that the only way to extend the time between birth and death of an organization is to continually reinvent the organization so that it "fits" the conditions emerging around it. Survival and success depend on innovation, and strategy should therefore be about

- being alert to change – **anticipation**;
- seeing opportunities to offer something different or new – **insight**;
- dreaming up new ways of doing it – **imagination**;
- doing it consistently and to the highest standards – **execution**.

W*hen* and *what* to change, and how (through radical change or continuous improvement) depends on circumstances. There should be a business case for each change and if the case is clear, there should be no hesitation.

Manning is much more pragmatic about the future than Grulke. "*Business is always a gamble … There are few certainties and many possibilities. While there's plenty of information about most things today, the future is a mystery … The best you can do is make some assumptions based on what is already going on.*"

He shares the concern of Grulke that experience, even though it hones judgement, may just prevent you from taking a lot of chances that might have paid off. His experience is that in most cases organizations *"… fall (and fail) their way into the future. Action is a surer way to the future than endless analysis."* Although every company would prefer to identify and ride a big and lengthy S-curve and follow it up with another big and lengthy S-curve, *"…for most companies the way to win is by trying more things faster – by hustling with a purpose. By laying lots of small bets, you can afford the losses and learn from the wins."* See **Figure 12**.

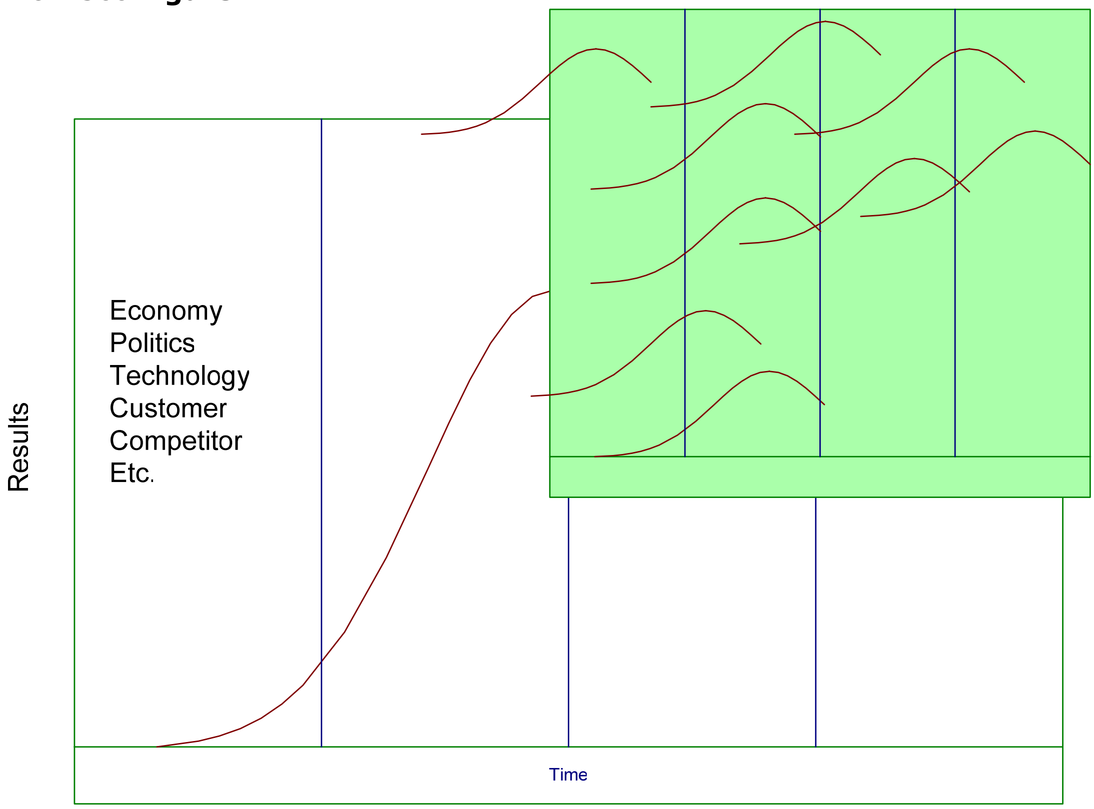


Figure 12. Hustling with a purpose (Manning 2001)

Manning (2001) is also quite outspoken about arguments on the difference between *strategy* and *tactics*, *radical change* versus *constant improvement*. His advice: *"Do whatever is necessary and appropriate in your circumstances and don't be too worried about the semantics."* According to him, *"… strategic management is an ongoing process. It needs daily attention."* One should be in constant conversation about what lies ahead, what it means and what one should do about it.

2.3.4.2 Important business concepts

After setting the context in which strategic planning should take place, Manning (2001) clarifies a number of business concepts. He emphasizes that **growth** should be at the top of the responsibility list of executives for the following reasons:

- *It makes an organization fit for the future.*
- *It motivates and inspires employees.*
- *It impresses customers.*
- *It satisfies investors.*

It does not necessarily mean growth in numbers of employees, but could also imply growth in their skills and knowledge, growth in terms of replacing or upgrading resources that have become inappropriate over time, growth in profitability, growth in customer satisfaction and so forth. "*Strategy is a means to make growth happen and to make more money than you use. Talk about growth and money should be central to your strategic conversation*." (Manning 2001)

A second concept that is often misunderstood is the importance of shareholders as a group of stakeholders. Manning (2001) explains why this is so important:

> *The fashionable notion that all stakeholders rank equally is not grounded in reality. Firms that balance the demands of shareholders, customers and their own people tend to outperform others. But let's be clear: the reason to care for customers is because they're the source of economic profit – the indicator that investors care most about. The reason to care for employees is that they produce the products and services and drive sales. Both groups, in other words, serve the investor.*

Obviously, companies should strive for win-win relationships with all there stakeholders and "*… be good citizens, do good works, and to care for everything from their own people to spotted owls"*, but when faced with trade-offs, the long-term survival of the organization should be their first responsibility.

A third concept is that "*making a difference makes the difference"*. Your value proposition should be different in reality (not only in terms of a marketing campaign!) to encourage customers to buy from you.

The fourth important concept that is highlighted by Manning (2001) is what he calls "*The first principles of business competition"*. Although different companies have different business models to make them unique in the customer's mind (and to fit their specific industry), the three basic and generic principles are:

- ***Focus*** *resources where you'll get the most for them.*
- *Continually drive up your customer's perception of* ***value.***
- *Simultaneously drive down the* ***cost*** *of doing it.*

Even though the leadership of the organization might decide on the focus and should ensure that the ship stays on the selected course, the other two principles (drive value up and cost down) are very much the responsibility of everyone in the organization.

Manning (2001) supports the idea of scenario planning (having to think about several futures), but as a fifth concept points out that you have to commit a critical mass of resources (mostly money and minds, which are always limited) to getting what you want. This concept is not in contrast with the discussion earlier on the context of betting on a number of smaller S-curves, rather than waiting for the one big and lengthy S-curve to come along. It merely states that "*you can't cover yourself by betting on everything – you have to bet on something".* This *something* might be a carefully selected number of smaller investment opportunities to pursue.

As a sixth concept Manning (2001) explores the implementation of strategy and the help one needs from all stakeholders – "winning votes" for the selected strategy. He identifies six groups of stakeholders:

- **Company** - all insiders (shareholders, employees, management)
- **Customers** – those who buy the company's products or services
- **Competitors** – "natural" ones who are in the same business and others who

compete for the same customer expenditure

- **Suppliers** – who provide whatever the firm needs to function, including finance, services, supplies, components and utilities
- **Influencers** – people or organizations who can make life easier or harder, such as activists, lobbyists, industry associations, the media, environmentalists and trade unions
- **Facilitators** – those who make it possible to carry on the business, such as government, regulators, licensing agencies and standards authorities

The aim should be to align all stakeholders in the same direction – *"… to get all that stakeholder energy focused on the same objectives"*. See **Figures 13** and **14**.

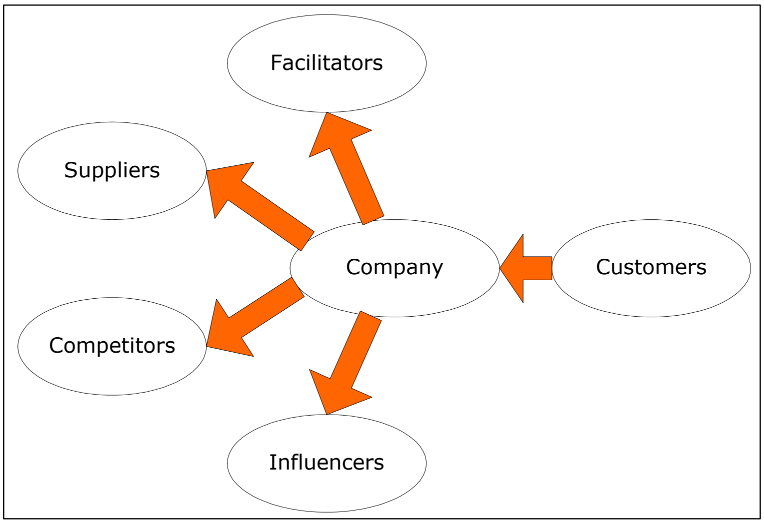


Figure 13. Unaligned stakeholders (Manning 2001)

Moving from this ……

To this!

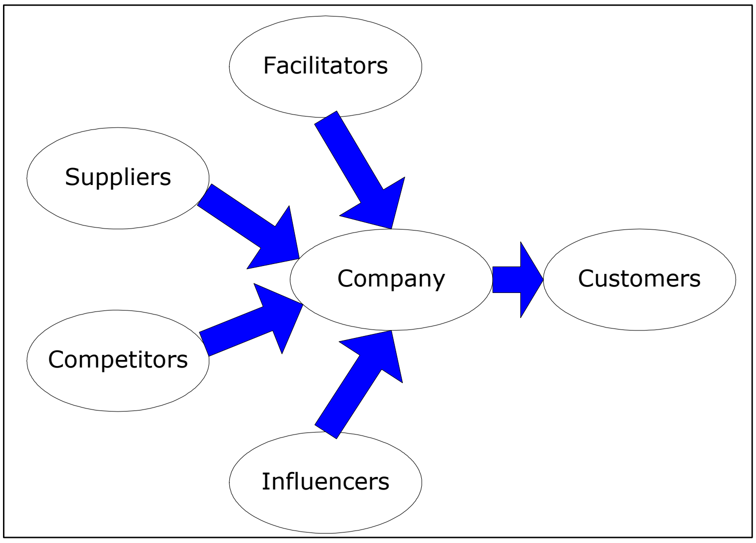


Figure 14. Aligned stakeholders (Manning 2001)

Getting all stakeholders involved in the strategic process is not always possible. However, clear communication between the stakeholders is essential if you hope to align their efforts. The participation of all the role players in the company equips them to perform and understand the process.

As a seventh concept Manning (2001) provides a systems view of value delivery, identifying five generic activities that all companies should be involved in, regardless of their purpose:

- **Sensing** – to be alert to what is going on outside as well as inside the business that can be an opportunity or a handicap.
- **Sourcing** – to acquire or build key resources such as cash, raw materials, components as well as skills, knowledge and reputation.
- **Serving** – to create and deliver value to customers.
- **Symbiosis** – to maintain win-win relationships and thus live in harmony with a wide range of stakeholders.
- **Synthesis –** to pull it all together into a cohesive whole that is more than the sum of the parts.

The synthesis part is obviously the most important and challenging.

Effective implementation of strategy is very much a *human spirit* thing. It requires of all people in the organization to be passionate and enthusiastic about where they are heading and how they are "*racing up the value path and down the cost path*", even though work is not all a breeze – much of it is chore and bore.

Manning (2001) illustrates this eighth concept by using a matrix with strategy and spirit as the axes. See **Figure 15**.

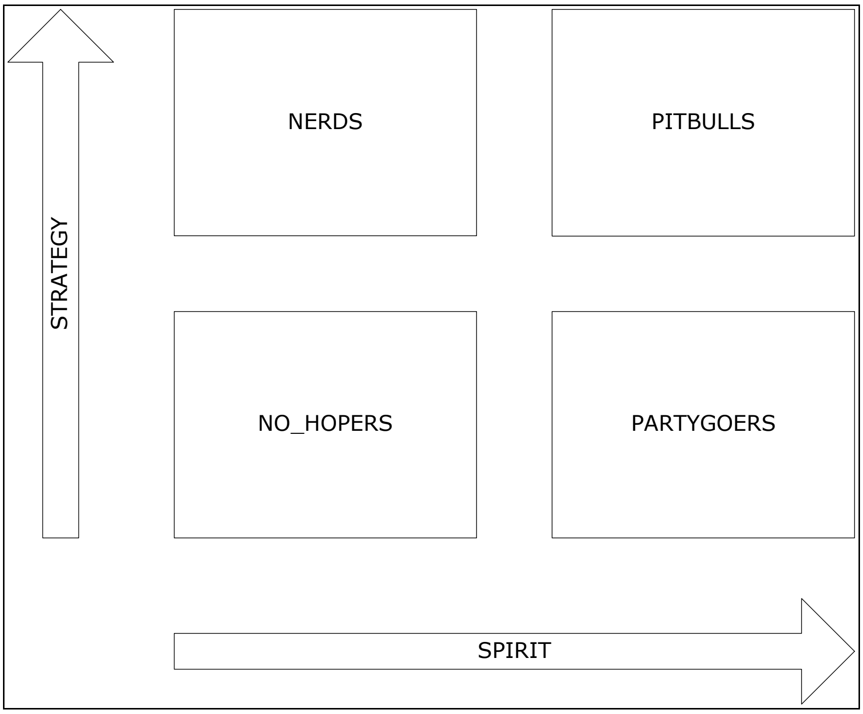


Figure 15. Effect of human spirit on strategy (Manning 2001)

Manning (2001) gives a clear description of each of the human types mentioned in **Figure 15**:

- *The No-Hopers either have no strategy, or it is a lousy one, and their spirit* *is weak.*

- *The Nerds apply their minds to creating a strategy that is precise and detailed, but they do not have the spirit to drive it and therefore it does not deliver the expected results.*
- *The Partygoers are hugely spirited, but lacks strategy. They are busy, busy, busy, but because they are directionless they flap around and go nowhere.*
- *The Pitbulls are clear about where they're headed and ferocious about getting there. They don't mess around, call for more research or another meeting – they just fix on target and go for it! Obviously the kind of crowd you want to be surrounded by.*

Since strategy implementation often leads to change, Manning equates strategy to change management. As a ninth concept he strongly suggests that the gap between strategy (as the job of thinkers in the ivory tower) and strategy implementation (as the job of the doers in the dirt and dust), should be eliminated. He points out four steps to make things change:

- ***Step 1****: Create dissatisfaction with the status quo by flooding people with information; exposing them to reality; involving them in the "big" conversations about what is going on inside and outside the organization and what it means, as well as asking them how they see things.*
- ***Step 2****: Debate possible futures so that people know what they are changing to and are familiar with the options that were considered.*
- ***Step 3****: Act to learn. By snapping into action and trying something, you quickly learn what works and what does not and you lay the foundation for future progress.*
- ***Step 4****: Review and revise deliberately. From time to time it is important to pause and reflect on where you have been, what happened, and what might have been. It makes your tacit knowledge explicit and it makes the knowledge of individuals available to everyone.*

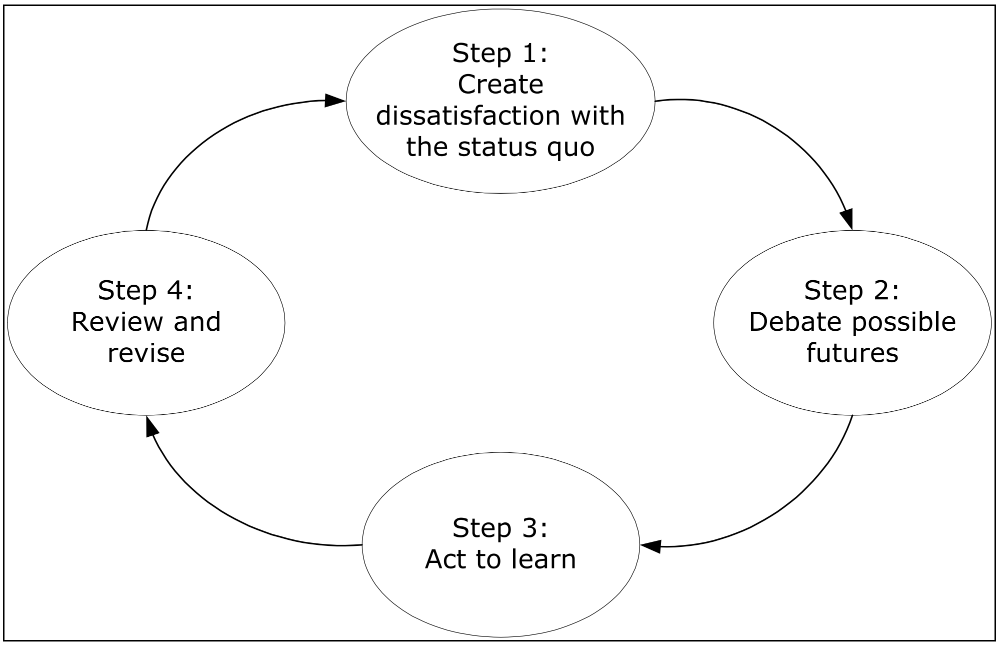


Figure 16. Four steps to implement change (Manning 2001)

The change cycle is a self-fuelling engine in the sense that each step drives the next and during the fourth step you are likely to identify new gaps or reasons for dissatisfaction with the status quo, which will drive the next cycle of change.

Throughout his discussion of the concepts of strategy, Manning emphasizes the point that strategic conversation should be kept alive on a continual basis among all members of an organization. If the corporate climate is based on trust people share ideas, listen to each other and rely on one another. Trust takes time to build and can unfortunately be destroyed in an instant. Nourishing conversation makes people feel good, and when they feel good they want to contribute. The opposite is true of toxic conversation. By involving people in all the strategic discussions (big and small) and creating a trusting climate, the "strategic IQ" of the whole organization increases, making it more competitive.

As a final concept Manning (2001) addresses incentive schemes. According to him you first need to manage people correctly before you can be concerned about how you reward them. He points out that for people to be effective in any job (and more so if you expect them to be exceptional at it), they need to know five things:

- ***What*** *to do – the task*
- ***Why*** *to do it – the context, the reason, the implications*
- ***How*** *to do it – the method*
- ***How well*** *to do it – standards*
- ***How well they are doing –*** *results*

In most organizations attention is given to the "what", often to the "how" and sometimes to the standards. Much improvement is needed, however, in the field of "why", as well as feedback on how well people are performing. Performance measurement, as an aspect of business intelligence, can play an important role to fill this gap.

2.3.4.3 A strategy creating process

After stating the context of strategic management and discussing a number of key concepts, Manning (2001) provides a pragmatic process to create and evaluate strategies. In essence strategy is about asking questions - rigorous probing into what the organization does, why and how.

He starts with naming six abilities that are needed to make a success of the integrated and ongoing process of strategic management, among them creative thinking, designing, taking action, fast learning and adjusting:

- ***Strategy making*** *– "Do we understand our challenges and do we have a clear view of how we must respond?"*
- ***Possibility thinking*** *– "Do we think 'out of the box' about what could be, rather than what is, or what is impossible?"*
- ***Winning stakeholder support*** *– "Do we actively seek to win 'votes' through strategic conversation?"*
- ***Business model design*** *– "Have we designed our organization to deliver the results we want?"*
- ***Implementation*** *– "Do we have what it takes to meet our ambition, and will our practices deliver the results we expect?"*
- ***Learning and change*** *– "Are we alert to what's happening around us and do we learn and change fast enough?"*

Apart from the questions above, he has another set of critical questions that should be answered to ensure that the **business logic** adds up. The context of the questions is graphically presented in **Figure 17**.

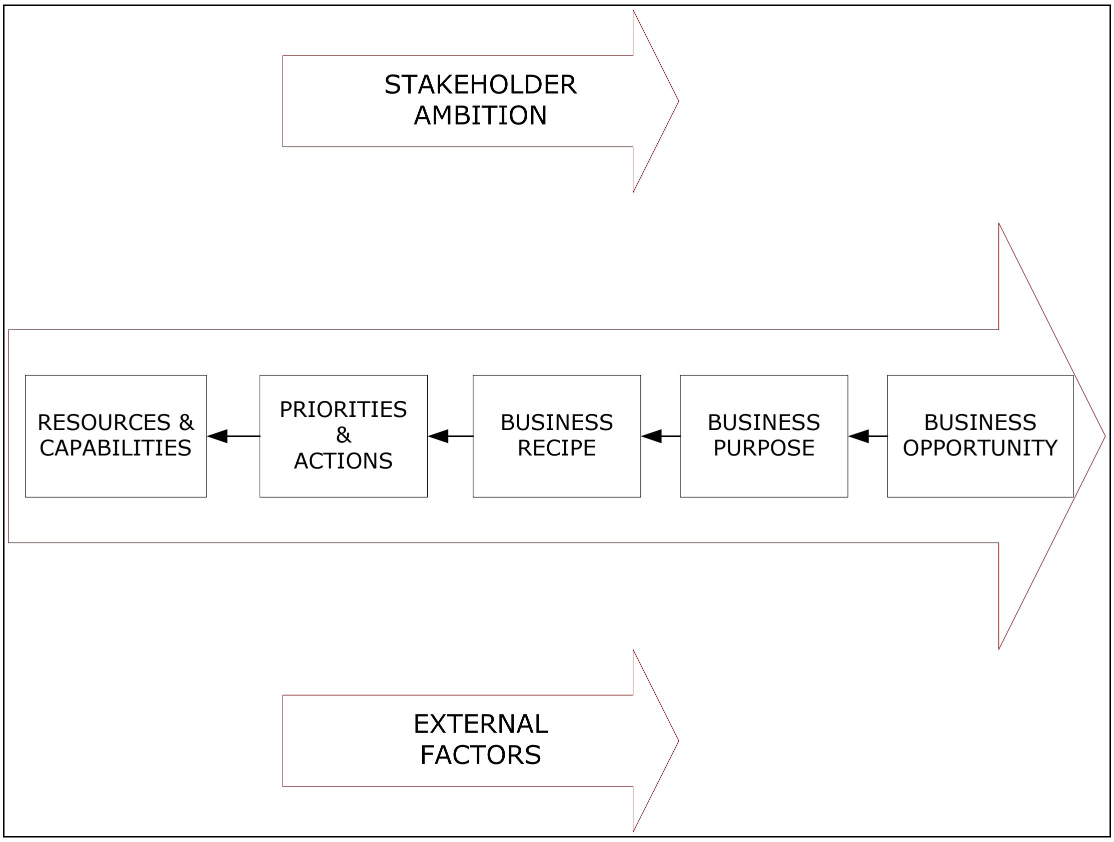


Figure 17. Does the business logic add up? (Manning 2001)

The specific questions are:

1. *Is there a real – and exploitable – business opportunity for this organization?*
2. *Is the business purpose clear and worth supporting?*
3. *Is there a "business recipe", is it spelled out and is it likely to deliver the intended results?*
4. *Have hard choices and trade-offs been made about priorities and actions?*
5. *Are essential resources and capabilities available, or can they be acquired or built?*
6. *Does the organization satisfy the ambitions of key stakeholders?*
7. *Does its strategy take into account external forces that may affect it?*

When answering the questions one must be sure that the answers are based on facts and not perception, guessing or over-enthusiastic feelings. Therefore, the last underpinning question that must be answered is the following:

On what assumptions do you base your thinking?

Naturally, there is no way to have all information or to be sure about everything. The future will always be the greatest mystery of all.

Manning (2001) presents two frameworks to bring order and discipline to knowing the environment in which one operates. The first one focuses on the drivers of competitive hostility in the domain, and the second one helps you to develop a detailed picture of your world and the players and forces at work in it. See **Figure 18**.

Before answering the questions in the two frameworks, one needs to draw a line around the business area in which one operates:

- Industry (e.g. steel, telecommunication, bulk chemicals)
- Geography (countries, regions, cities/towns, communities)
- Product/Customer category (e.g. accounting software to small businesses, electronic components to the automotive industry; where are you on the price scale, do you provide just the basic product, or are there levels of sophistication?)
- Purchase and usage occasion (When do customers buy and use your offering - distinguish if the buyer and end-user are not the same entity.)
- Distribution channels (What channels are used and who controls them?)

After clarifying the above environmental issues, one is ready to tackle the two frameworks in **Figure 18**. The purpose of the "background" information is to help one to focus on the relevant factors. *"No company can compete everywhere or be everything to everybody. You need to understand your territory, not the whole map. You have to balance where you are now, with where you want to be in future."* (Manning 2001)

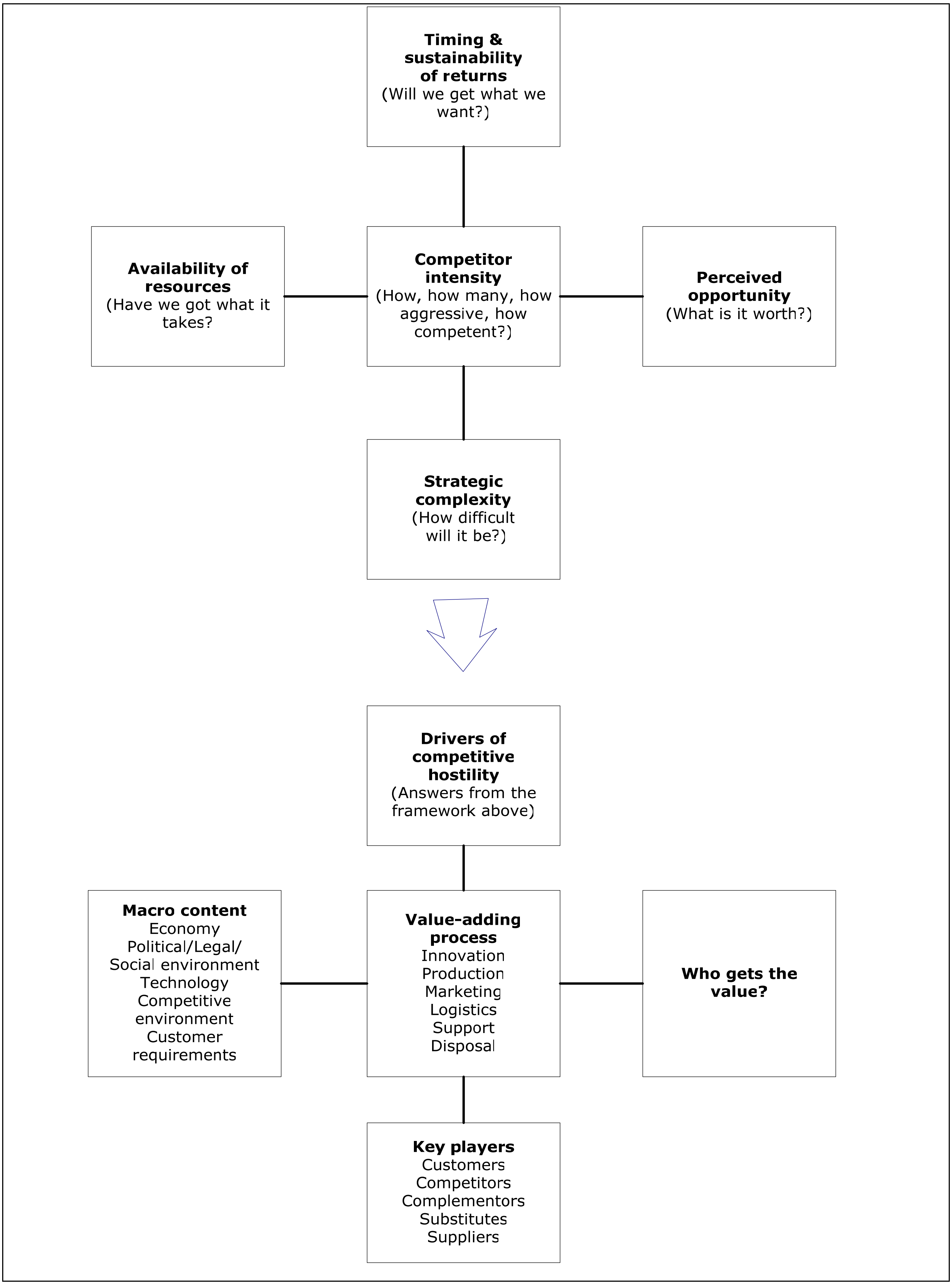


Figure 18. Two frameworks to explore your business environment
(Adapted from Manning 2001)

After the preparation phase, one should be ready to complete the systematic approach to derive a strategic plan, as proposed by Manning (2001). He based this approach on five building blocks. See **Figure 19**.

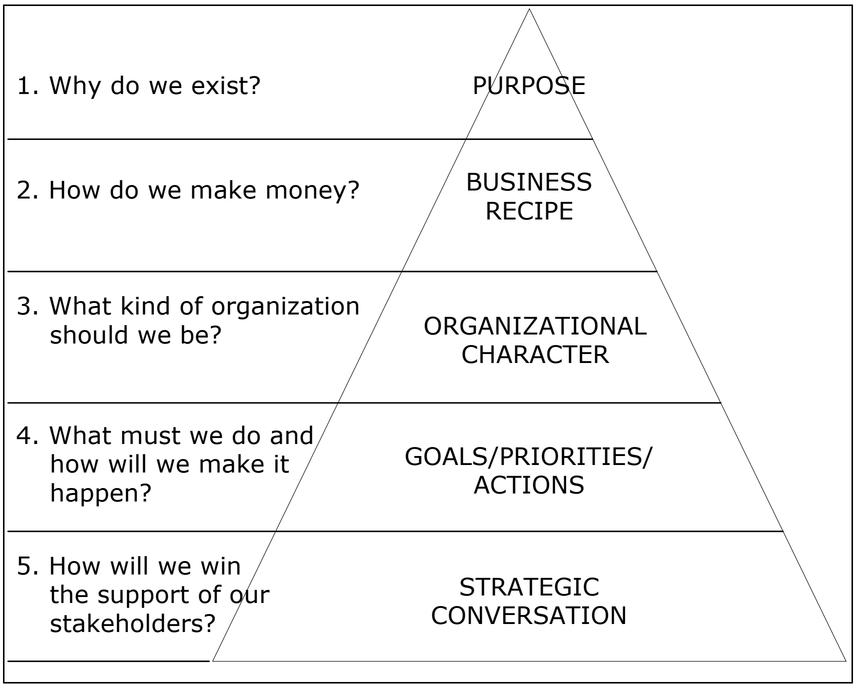


Figure 19. Five building blocks of a strategic plan (Manning 2001)

Each of the five levels is further explored through more specific questions. The complete set of 20 questions is the following:

- ***Why do we exist? (purpose)***

  Whom do we serve?
  What value do we deliver?
  Why do we matter?
  What is our ambition?

- ***How do we make money? (business recipe)***

  What is our "difference"? (value proposition)
  How do we deliver our value proposition? (business model)
  What makes our strategy superior?
  How will it evolve?

- ***What kind of organization should we be? (organizational character)***

  What assumptions guide us?
  What turns us on?
  What is not negotiable?
  How do we behave?

- ***What must we do and how will we make it happen? (goals/priorities/actions)***

  What results do we seek? (goals)
  On which few high impact issues must we concentrate our resources? (priorities – see the Strategy Wheel)

What must we do about them? (actions)
What must we do in the next 30 days and who is responsible?

- ***How will we win the support of our stakeholders? (strategic conversation)***

  Whom must we talk to? (who must be addressed, persuaded, informed)
  What do they need to know?
  How can we reach them? (customize your message)
  How should they respond? (be clear on how you want them to respond – it will influence your message)

According to Manning (2001) *"the race for the future will be a race between competing business models".* To clarify the business model (level 2) Manning proposes a 7 Ps framework. The seven Ps are Purpose, Philosophies, Products, People, Processes, Partners and Positioning. See **Figure 20**.

Manning proposes the Strategy Wheel to assist in prioritising issues (level 4). It highlights the major (maximum 8-10) issues in the organization that should be managed. It also shows that while some issues may be in conflict with others, you have to balance them and manage all of them. The list is naturally compiled as part of the strategic conversation. See **Figure 21**. Innovation will be used to address each of the issues and will therefore not be presented as an issue.

The action plan with goals, priorities, specific actions, responsible person and target date flows directly from the strategic wheel issues. What is interesting is the 30-day time slot that is allocated between review sessions. Manning suggests this to put some real "heat" into the system and to move forward aggressively in small, measurable steps.

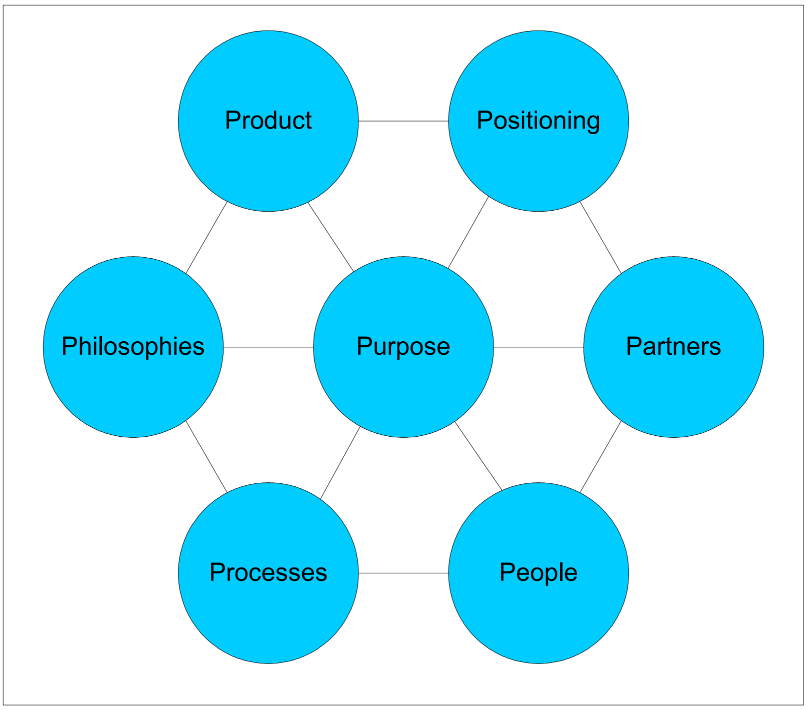


Figure 20. The 7 Ps Model (Manning 2001)

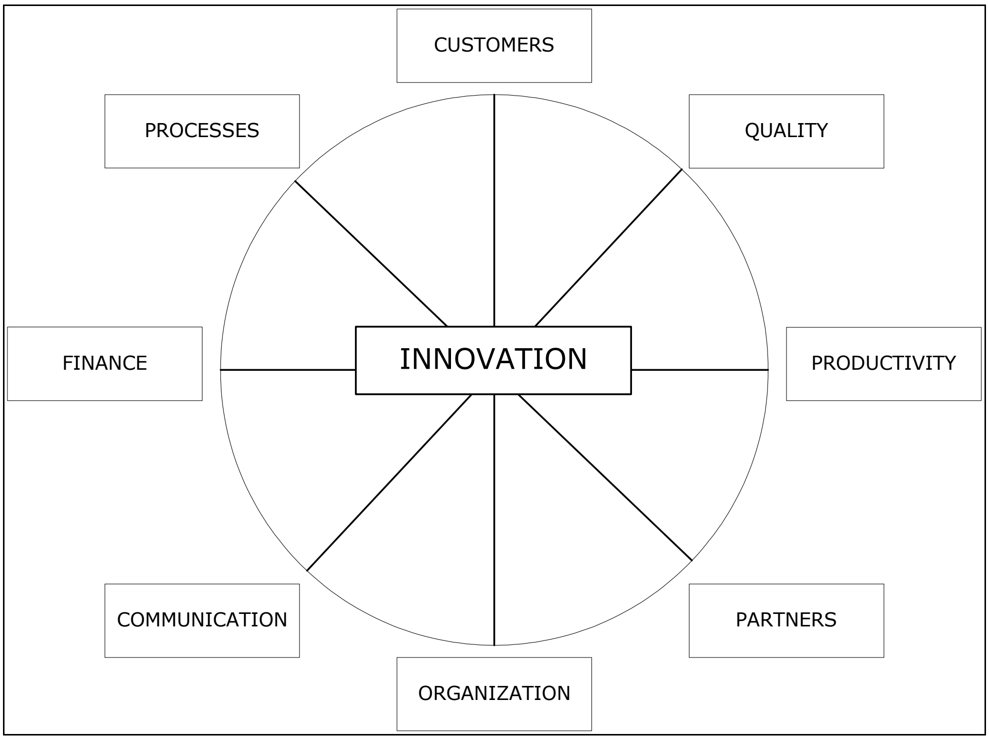


Figure 21. The Strategy Wheel to identify top priority issues
(Adapted from Manning 2001)

To conclude the literature section on business strategy and scenario planning, the next section will briefly explain the Foxy Matrix as developed by Ilbury and Sunter (2001).

2.3.5 Scenario planning

Manning (2001) made the following comment: "In the sixties and seventies, long-range planners bet the farm on precise predictions of future outcomes. They got it wrong so often that scenario planning found a welcome audience in the next two decades."

During the mid-1980s Clem Sunter, an employee of Anglo American Corporation since 1966, became famous for the "High Road" and "Low Road" scenarios they had drawn up at Anglo during a scenario exercise concerning the political and economic paths that South Africa might have taken into the 1990s. The remarkable political transformation in South Africa, based on the "High Road" scenario is now history, but at the time nobody was brave enough to forecast what actually happened. Some people were, however, comfortable enough to discuss it as a possibility – a possibility that became a probability and a probability that became a reality.

In June 2001, less than three months before the tragic events of September 11, Chantell Ilbury and Clem Sunter published the book *The Mind of a Fox.* It included an open letter to President Bush warning him that the key uncertainty during his tenure was nuclear terrorism, more specifically the possibility of terrorists planting a nuclear device in a western city. Ilbury and Sunter (2001) state in the foreword of the October 2001 impression of the book: "Nothing could have demonstrated the power of scenario planning more effectively than this terrible tragedy. We could never have captured it in a forecast, but it was possible to provide a warning in the form of a scenario."

Obviously, if you can do effective scenario planning in your business as part of the strategic management process, it could help you to focus on a few possible scenarios. Ilbury and Sunter (2001) describe a simple matrix method that can be used to identify possible scenarios and make decisions based on them. The matrix has two axes:

- the horizontal one portrays certainty and uncertainty; and
- the vertical one portrays control and absence of control.

The two axes provide four quadrants. The bottom right-hand one represents things that are certain, but outside your control. The bottom left-hand one include things that are both uncertain and outside your control. The top left-hand one contains things that are uncertain, but within your control and the top right-hand one things that are certain and within your control.

Although people have a preferred quadrant (e.g. control freaks would occupy the top right-hand quadrant because they know exactly what is going to happen since they believe they are totally in control), the authors suggest a more foxy approach. "You can't box a fox!" The foxy behaviour would therefore be to move around through all the quadrants. As part of the methodology, the matrix provides the framework for a four-step process. See **Figure 22**.

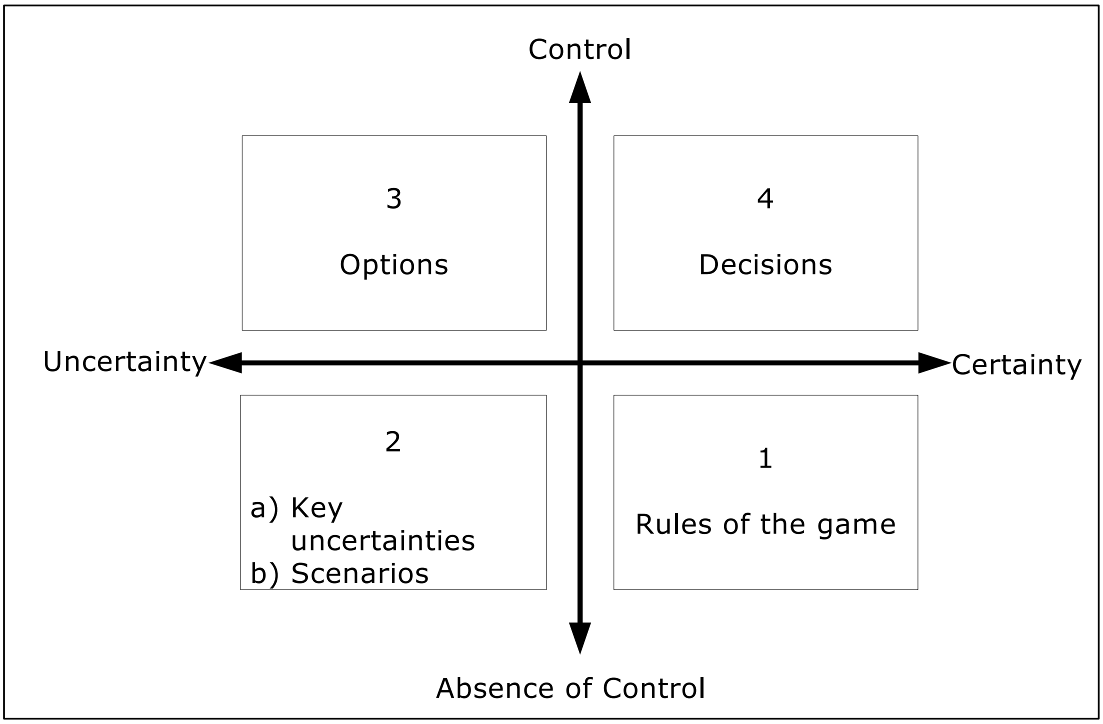


Figure 22. Foxy Matrix (Ilbury and Sunter 2001)

To illustrate the process, Ilbury and Sunter use the following scenario:

> *You are driving down a main road and there is a crossroad ahead. You are on the main road and logic and law dictate that you have the right of way. This can be referred to as the rule of the game. However, on the minor road travelling at right angles to you and in the direction of the intersection is another vehicle that, theoretically, should stop. This action is out of your control, cannot be guaranteed and is, therefore, uncertain. This is a key uncertainty. In your mind you play out different scenarios:*

1. *The driver of the other car sees you and slows to a halt, allowing you to travel through safely.*
2. *The driver of the other car does not see you, drives through the intersection and you have a near miss.*
3. *Same as 2., but you crash.*

Based on the scenarios, you have a number of options:

1. *Maintain your speed on the assumption that the driver is eventually going to see you.*
2. *Slow down because you worry that the driver is not going to see you.*
3. *Speed up in the hope that you may get through the intersection before the other car arrives.*

Options 1 and 3 may result in a crash, whereas option 2 won't. These options will influence your decision.

It is clear that the process does not make the decisions for you – it merely takes you through a thought process that may improve the final decision and also helps you to identify a number of possible options. Ilbury and Sunter also suggest that graphic names for the scenarios are very helpful, because they become part of the vocabulary when the future of the organization is discussed. The names are not always positive vs. negative as in the case of "High Road" and "Low Road". For the world scenario planning exercise that was directed to President Bush, they came up with two scenarios called *"Friendly Planet"* and *"Gilded Cage"*. For the situation on HIV/AIDS, they came up with three scenarios, "*Denial*", "*Business as Usual*" and "*Total Onslaught*".

This concludes the literature study regarding business strategy and scenario planning. Although not in depth, it provides enough guidelines to incorporate some of the ideas and methods in the bigger picture of business intelligence. The author's view of business intelligence, which will be elaborated on in the next chapter, is that BI should be driven from a strategy support angle. Therefore the discussion of existing methods to derive and implement a business strategy is relevant.

"If you come to a fork in the road - take it!" – Yogi Berra

2.4 Enterprise integration and architecture

2.4.1 Overview

Absolute Information (2001) noted, "Speeding up bad systems just makes *fast* bad systems". In order to have an intelligent enterprise, information technology should never be applied to existing information systems and structures before it has been established that the existing systems and structures are aligned to the enterprise strategy.

This section discusses a wide range of architectures and frameworks that assist in the process of planning and implementing enterprise architecture. The various architectures and frameworks are not compared, only discussed individually. The reader is required to recognize the necessity of following a structured design approach when establishing the enterprise architecture and then to select a framework that applies to his organization.

Enterprise integration is analogous to enterprise architecture. Williams and Li (1998) define enterprise integration as: *"the coordination of the operation of all elements of the enterprise working together in order to achieve the optimal fulfilment of the mission of that enterprise as defined by enterprise management"*.

Note the emphasis on *all* and on *optimal*. All elements means

- all equipment providing the product and/or service to the customers of the enterprise;
- all control and information processing equipment;
- all humans involved in the enterprise.

Enterprise engineering covers a wide range of subjects, which are outlined below as identified by Whitman (1999). The third category of the outline shows that enterprise reference architectures form only a part of enterprise engineering, but it is the only part that will be discussed in more detail in the following paragraphs:

1. *Enterprise modelling languages and meta-models:*
   - *IDEF - The IDEF family of languages*
   - *ARPA Knowledge sharing information – ontologies*
   - *STEP - Product model exchange using STEP*
   - *Express - Information modelling*
   - *Petri Nets - The "World of petri nets" at the computer science department, University of Aarhus, Denmark*
2. *Enterprise engineering tools:*
   - *IDEF tools*
   - *FirstStep*
   - *ARIS toolset*
   - *METIS - Web services for METIS solutions*
   - *Information engineering*
3. *Enterprise reference architectures (enterprise life-cycle models):*
   - *GRAI*
   - *PERA*
   - *GERAM*
   - *C4ISR*
   - *CIMOSA*
   - *Zachman Framework*
   - ARIS

4. *Enterprise reference models (enterprise specific models):*
   - *IAA - The IBM insurance application architecture*
   - *SEI Quality models - Software engineering institute capability maturity models*
   - *ARRI/EEG - Various enterprise models at ARRI in IDEF format*
5. *Infrastructures for enterprise integration (enterprise modules):*
   - *IBM Open Blue – IBM's integration architecture*
   - *MAP and MMS – Manufacturing automation protocol and Manufacturing message specification*
   - *Workflow management coalition*
   - *Workflows at U Twente*

The terms "architectures" and "frameworks" are very commonly used in defining the various enterprise reference architectures as outlined in part 3 of the Whitman outline above. These two terms are quite ambiguous and are often used incorrectly, according to Whitman. For purposes of this thesis, however, the distinction will not be discussed any further.

A system can be formally described by using a framework or architecture. An architecture is made up of smaller blocks that define the complete system. Zachman (1992) defines architecture as *"a set of design artefacts, or descriptive representations, that are relevant for describing an object such that it can be produced to requirements, as well as maintained to the period of its useful life"*.

In the following paragraphs a number of the more popular and better-known architectures are discussed in general.

2.4.2 PERA

PERA (Purdue Enterprise Reference Architecture) was developed at the Purdue University. According to the PERA Enterprise Integration Web Site (2000), "it provides a life cycle model which demonstrates how to integrate Enterprise Systems, Physical Plant Engineering (because the method originally focused on manufacturing organizations) and Organizational Development, from enterprise concept to dissolution".

Theodore Williams of the Purdue University and Hong Li, a consultant, (1998) did some extensive work on the Purdue methodology and their work is summarised in **Figure 23**.

As can be seen from the figure, the main focus of PERA is to separate human based functions in an enterprise from those with a manufacturing or information perspective. PERA takes an enterprise integration task and puts it into one of three categories:

- Information system tasks
- Manufacturing system tasks
- Human based (organizational) tasks

From the architecture two streams can be identified, namely the information and manufacturing streams. On a functional level the information stream consists of planning, scheduling, control and data management functions whereas the manufacturing stream consists of physical production functions.

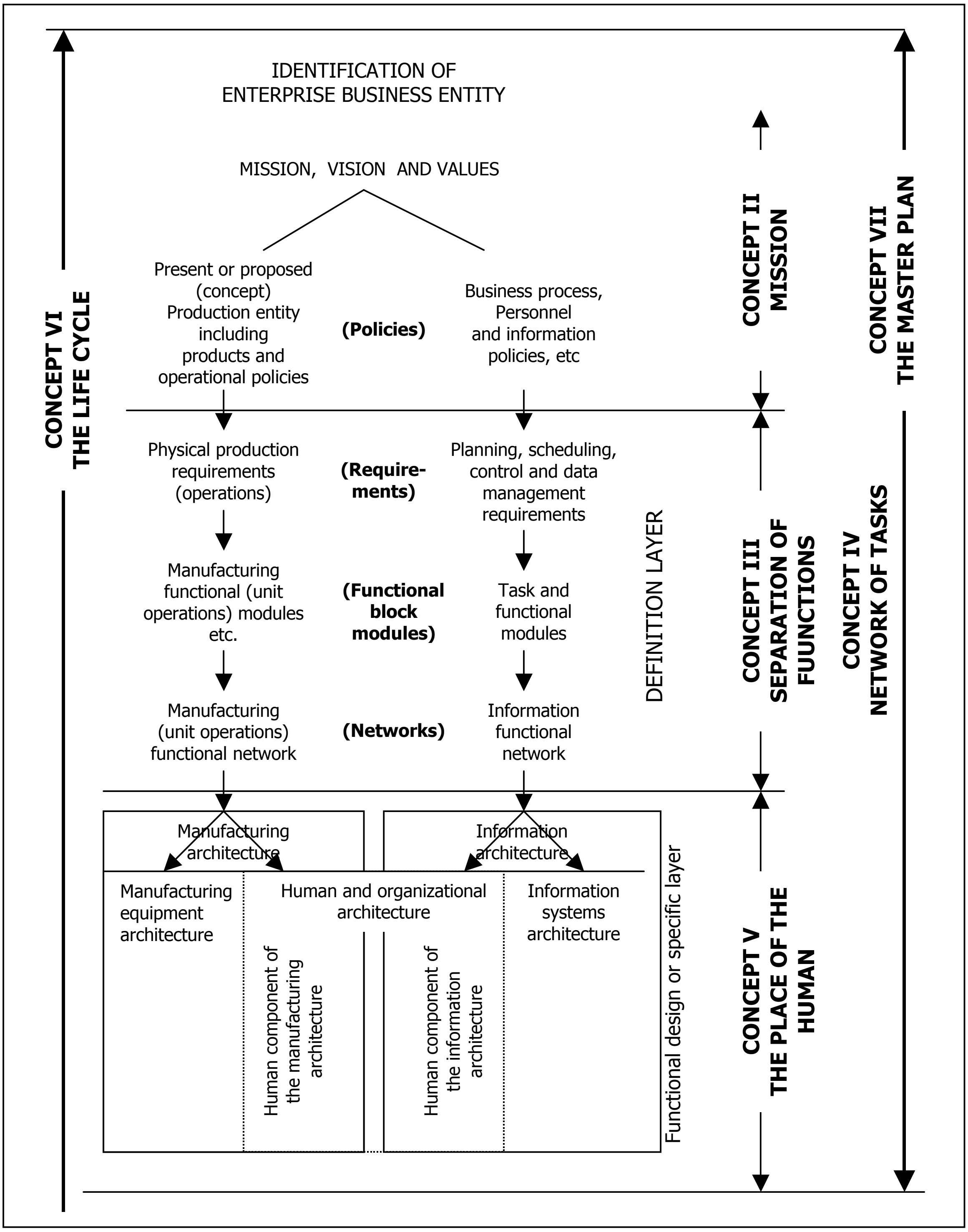


Figure 23. Purdue Enterprise Reference Architecture
(Adapted from Williams and Li 1998)

Table 4 depicts the enterprise entity life cycle as described by Williams and Li (1998).

Table 4. Enterprise entity life cycle (Adapted from Williams and Li 1998)

Phase	Title	Brief description
1	*Identification of the Enterprise Business Entity*	Establishment of identity and boundaries of the enterprise entity being considered.
2	*Concept of the project*	Mission, vision and values of the enterprise entity, operational policies to be followed.
3	*Definition of the project*	Identity requirements, tasks and modules and develop flow diagram or other models of the enterprise entity.
4	*Specification of preliminary design of project*	Identify human tasks, initial choice and specification of human organization and of information and control equipment and mission fulfilment equipment.
	Note (1) The master plan involves all of the above information	
5	*Detailed design of human and organizational, information, control, customer, product and service components of the enterprise*.	Completion of all design in detail needed for construction phase.
	Note (2) Phases 4 and 5 are often combined as one design phase. However, the differences in effort level and the need for master plan completion at the end of phase 4 indicates their desirable separation into two phases.	
6	*Implementation or construction, test and commissioning phase*	Conversion of detailed design to actual plant elements, their testing, operational trials and acceptance or commissioning
7	*Operations phase*	The period of time while the enterprise entity is carrying out its mission as prescribed by management.
8	*Decommissioning*	The enterprise entity has come to the end of its economic life, must be renovated or dismantled.

On an implementation level, the information architecture is broken down into information systems architecture and human and organizational architecture. The manufacturing architecture on the other hand is divided into manufacturing equipment architecture and human and organizational architecture. In fact, the latter forms the link between the information architecture and the manufacturing architecture.

Even though the methodology focuses on manufacturing organizations, its principles can be applied generically across different types of organizations.

2.4.3 GERAM

According to Williams and Li (1998) GERAM (Generalized Enterprise Reference Architecture and Methodology) was developed by evaluating existing enterprise integration architectures, such as CIMOSA (see par. 2.4.6.2), GRAI/GIM (see par. 2.4.6.1) and PERA and defining a new generalised architecture. This methodology was developed by the IFAC/IFIP (The International Federation of Automatic Control and the International Federation for Information Processing) task force for enterprise integration.

The methodology was also designed with the purpose of being applied to all types of enterprises. GERAM acts as a toolkit for designing and maintaining enterprises across their entire lifespan.

The developers of this methodology, the IFIP-IFAC Task Force (1999), had a truly holistic vision in developing the methodology. GERAM also intends to merge the methods of various disciplines in the change process. These methods include those of industrial engineering, management science, control engineering, communication and information technology.

Williams and Li (1998) state that GERAM defines the criteria that must be satisfied in designing and maintaining the enterprise. The design descriptions utilized in the process of design are referred to as models. These models are essential components of enterprise engineering and integration and these components are illustrated in **Figure 24**.

The most important component of GERAM is GERA. This component identifies the basic concepts to be used in enterprise engineering and integration. Firstly, it distinguishes between methodologies for enterprise engineering (EEMs) and languages for modelling (EMLs). The methodologies use the languages to define the model, structure and behaviour of the enterprise entities.

The result of the modelling process is enterprise models (EMs) that represent all the operations of the enterprise or part of them. This will include manufacturing or service operations, organizational and management operations and control and information systems. These models provide guidance for the implementation of the enterprise operational system (EOSs), but also for evaluating operational or organizational alternatives.

Enterprise engineering tools (EETs) support the process of enterprise modelling. The semantics such as ontologies, meta models and glossaries are collectively called generic enterprise modelling concepts (GEMCs). Partial enterprise models (PEMs) are reusable models of human roles, processes and technologies that enhance the modelling process.

Specific modules (EMOs) support the operational use of enterprise models. They include, amongst others, prefabricated products like human skill profiles, common business procedures and IT infrastructures.

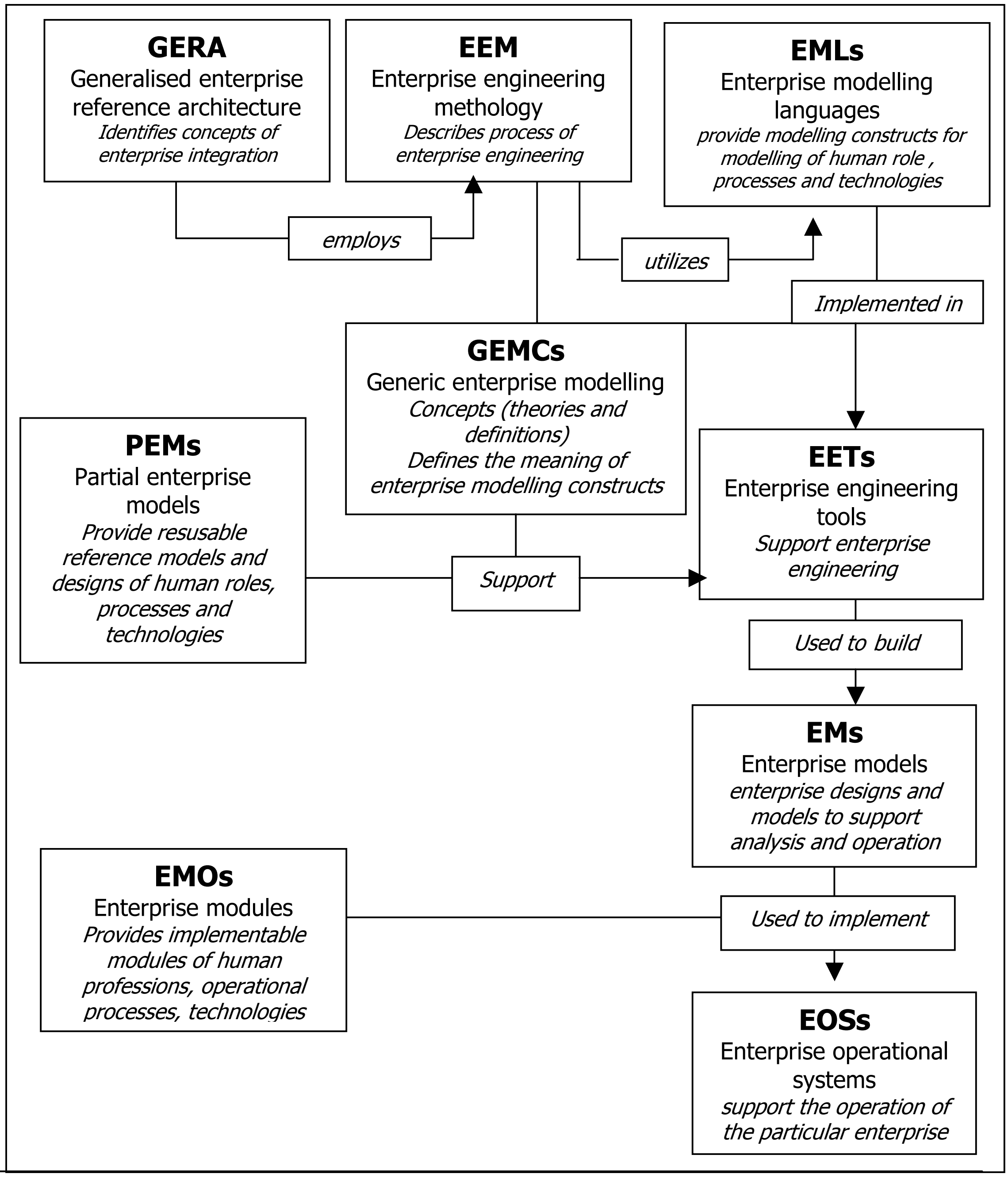


Figure 24. GERAM framework components (Adapted from Williams and Li 1998)

By characterizing proposed reference architectures and methodologies in GERAM, the IFIP-IFAC task force states that users of these architectures would benefit from GERAM as they will be able to identify what they could (and could not) expect from any chosen particular architecture in connection with an enterprise integration methodology and its proposed supporting components. This will eliminate the need to rewrite documents to comply with GERAM.

2.4.4 The Zachman Framework

The Zachman Framework provides a way of viewing a system, such as an enterprise, from many different perspectives as well as showing the relationships between the different perspectives. It provides a systematic way of relating the components of an enterprise, such as business entities, processes, locations, people, times and purposes, to the representations in the computer in terms of bits, bytes, numbers and programmes.

According to Popkin Software, *"the framework can contain global plans, as well as technical details, lists and charts. Any appropriate approach, standard, role, method or technique may be placed in it."*

1987 Version

In 1987 John Zachman, an employee of IBM at that stage, published the first version of his now popular framework for information system architecture. The basic concepts are illustrated in **Figure 25**.

	A - Data (What)	B - Function (How)	C - Network (Where)
1 Scope Planner	List of things important to the enterprise	List of processes the enterprise performs	List of locations where the enterprise operates
2 Enterprise Model Owner	Entity relationship diagram (including m:m, n-ary, attributed relationships)	Business process model (physical data flow diagram)	Logistics network (nodes and links)
3 System Model Designer	Data model (converged entities, fully normalized)	Essential data flow diagram; application architecture	Distributed system architecture
4 Technology Model Builder	Data architecture (tables and columns); map to legacy data	System design: structure chart, pseudo-code	System architecture (hardware, software types)
5 Components Sub-Contractor	Data design (denormalized), physical storage design	Detailed program design	Network architecture
Functioning system	E.g. Data	E.g. Functions	E.g. Network

Figure 25. Zachman Framework for enterprise architecture (Zachman 1987)

The three columns in **Figure 25** represent the data, function and network of an information system. For each of the five rows, column A shows which entities are involved, column B shows the functions performed and column C shows the locations and interconnections. Each row also represents a specific perspective such as the planner, owner or designer. If the physical processes within architecture or engineering were analysed, column A would represent material, column B functions and column C location.

Sowa and Zachman (1992) listed the rules of the framework which are outlined below:

- ***Rule 1. The columns have no order.*** *Order implies priorities. It creates* *a bias toward one aspect at the expense of others. All columns are equally important, for all are abstractions of the same enterprise.*

- ***Rule 2. Each column has a simple basic model.*** *Each column represents an abstraction from the real world enterprise for convenience of design. These abstractions correspond to a classification scheme suggested by the English interrogatives,* ***what****,* ***how****,* ***where****,* ***who****,* ***when*** *and* ***why****. The answers to these six questions are the basic entities or columnar variables: entities, functions, locations, people, times and motivations. But in addition, the connections between them are also important for the design.*
- ***Rule 3. The basic model of each column must be unique.*** *No entity or connecter in the basic columnar model is repeated either in name or in concept. They may all be related to one other, but they are all separate and unique concepts.*
- ***Rule 4. Each row represents a distinct, unique perspective.*** *For example:*
    - *Row 2: Owner. Deals with usability constraints, both aesthetic and utilitarian in the conceptual view of the end product.*
    - *Row 3: Designer. Deals with the design constraints – the laws of physics or nature in the logical view of the end product.*
    - *Row 4: Builder. Deals with the construction constraints – the state of the art in methods and technologies in the physical view of the end product.*
- ***Rule 5. Each cell is unique.*** *No meta entity can show up in more than one cell. For example:*
    - *Business entity can only be found in cell A2.*
    - *Data entity can only be found in cell A3.*
    - *Business process can only be found in cell B2.*
    - *Application function can only be found in cell B3.*
- ***Rule 6. The composite or integration of all cell models in one row constitutes a complete model from the perspective of that row.*** *The sum of all cells in a given row is the most complete depiction of reality from the perspective of that row. At a minimum each cell is related to every other cell in the same row. In some cases there may even be a dependence upon other cells in the row and thus a change in one cell may have some effect on another cell. This also holds true for cells in the same column.*
- ***Rule 7. The logic is recursive.*** *The framework logic can be used for describing virtually anything, certainly anything that has an owner, designer and builder who makes use of material, function and geometry.*

1992 Enhancement

In 1992, Sowa and Zachman published the extended information system architecture to include three more columns to cater for the other three exploratory questions: **who**, **when** and **why**. These words introduce a different, but needed focus on each of the five rows: who works with the system, when do events occur and why do these activities take place.

The extended architecture shows thirty different perspectives of an information system and therefore helps the user to understand the enterprise in a holistic way. (The 6th row does not represent further perspectives – it shows component examples of the functioning system that was analysed.) The extended version of the architecture is illustrated in **Figure 26**.

	A - Data (What)	B - Function (How)	C - Network (Where)	D - People (Who)	E - Time (When)	F - Motivation (Why)
1 Scope Planner	List of things important to the enterprise	List of processes the enterprise performs	List of locations where the enterprise operates	List of organizational units	List of business events / cycles	List of business goals / strategies
2 Enterprise Model Owner	Entity relationship diagram (including m:m, n-ary, attributed relationships)	Business process model (physical data flow diagram)	Logistics network (nodes and links)	Organization chart, with roles; skill sets; security issues.	Business master schedule	Business plan
3 System Model Designer	Data model (converged entities, fully normalized)	Essential data flow diagram; application architecture	Distributed system architecture	Human interface architecture (roles, data, access)	Dependency diagram, entity life history (process structure)	Business rule model
4 Technology Model Builder	Data architecture (tables and columns); map to legacy data	System design: structure chart, pseudo-code	System architecture (hardware, software types)	User interface (how the system will behave); security design	"Control flow" diagram (control structure)	Business rule design
5 Components Sub-Contractor	Data design (denormalized) physical storage design	Detailed program design	Network architecture	Screens, security architecture (who can see what?)	Timing definitions	Rule specification in program logic
Functioning system	Converted data	Executable programs	Communica-tions facilities	Trained people	Business events	Enforced rules

Figure 26. Zachman Framework for enterprise architecture (Zachman and Sowa 1992)

Because the three added columns are less pragmatic and more theoretical, Sowa and Zachman highlight the fact that it is crucial to *"understand and to rigorously abide by the rules of the framework while hypothesizing the contents of the cells of the (last) three columns".*

Koorts (2002) identifies the fact that even though the architecture acts as a comprehensive checklist to follow during business analysis or enterprise architecture design and implementation, the architecture requires a large amount of detail and depth of analysis.

2.4.5 CuTS (culture, technology and skills)

Before Absolute Information (2001) enter into the information analysis process, they start with an analysis of the corporate culture, technology and skills, utilizing the CuTS approach.

This approach takes into consideration all the factors affecting the re-engineering of an organization. The purpose of this approach is to apply improved information flows to an infrastructure that supports the corporate direction.

The CuTS approach is illustrated in **Figure 27** and discussed below.

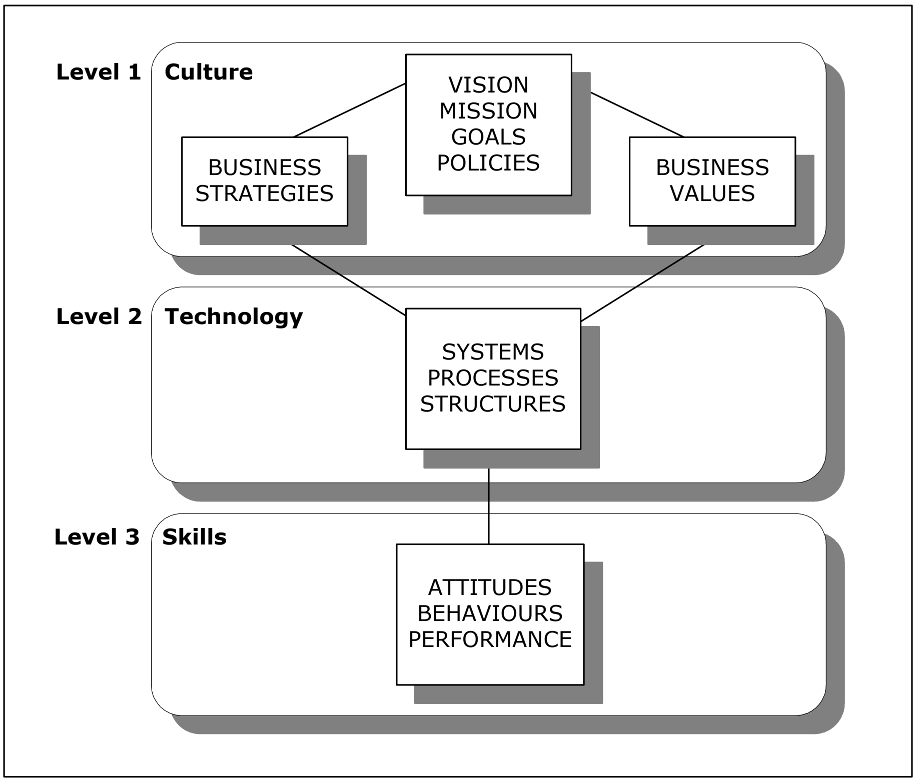


Figure 27. The CuTS model (Absolute Information 2001)

Level 1

In level 1, the corporate mission, vision and goals are translated into a set of business strategy requirements and value statements.

Level 2

Level 2 represents the systems, processes and structures that require focus and change to support the corporate strategy. They constitute the logical infrastructure by which information will flow.

Level 3

This level represents the human attributes that may have to be modified to ensure that the change that will take place will be effectively implemented and managed after implementation.

Implementation of change

To be successful in the process of re-engineering an organization, it is imperative that all three levels, culture, technology and skills, be addressed simultaneously. For example, changing the mission and strategy, but not the processes and structures to effectively support the new mission and strategy, is a sure recipe for failure.

The AIM approach continually monitors the information and infrastructure changes to ensure that change is initiated and maintained at all three levels simultaneously. This can be done by identifying critical success factors (CSFs) for each level. Absolute Information introduce their approach to realising CSFs and compares it to the traditional approach as illustrated in **Figure 28**.

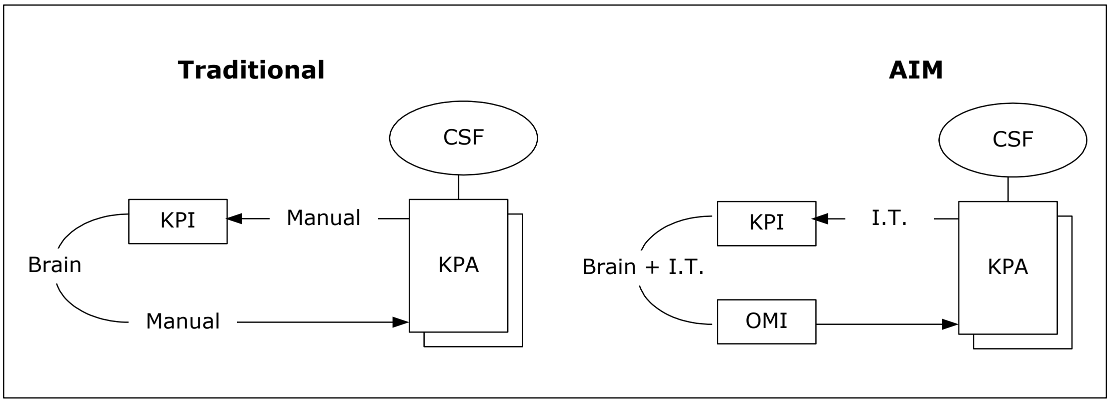


Figure 28. Defining information needs (Absolute Information 2001)

The traditional approach defines only Revit information (as defined in par. 2.2.2), such as a traditional KPI (key performance indicator) to measure the success of a KPA (key performance area). The AIM approach utilizes technology to automatically supply RMIs (revit management indicators, see par. 2.7.6.2), which are more focused. Then, based on the RMI, it automatically generates OMIs (operit management indicators, see par. 2.7.6.2). The interrelationship between the measurements at different levels results in more effective decision-making.

2.4.6 Other architectures

Without discussing them in detail, a number of other enterprise architecture methodologies are briefly mentioned in the following sections.

2.4.6.1 GRAI-GIM

The GRAI integrated methodology was developed by the Grai laboratory of the University of Bordeaux. (Koorts 2002) This GRAI-GIM Architecture represents four co-operating systems, according to which an organization is modelled:

- Decision system
- Information system
- Operating system
- Physical system

The integration and functioning of this architecture is shown in **Figure 29**. The most important difference and contribution in the GRAI-GIM Architecture is its decision modelling technique. According to this architecture the main task of the organization is to make decisions. The decision system is the company's brain, and to achieve an awareness conscious enterprise a good decision system is needed.

The decision system congregates from decision centres. These centres originate in the top management structure, where strategic decision-making takes place, and decompose down to operational decisions. The operational and physical systems are utilized as tools by the decision system to manufacture products or deliver services. The information system then acts as the feedback of operational data to the decision system. Thus a closed-loop enterprise is created.

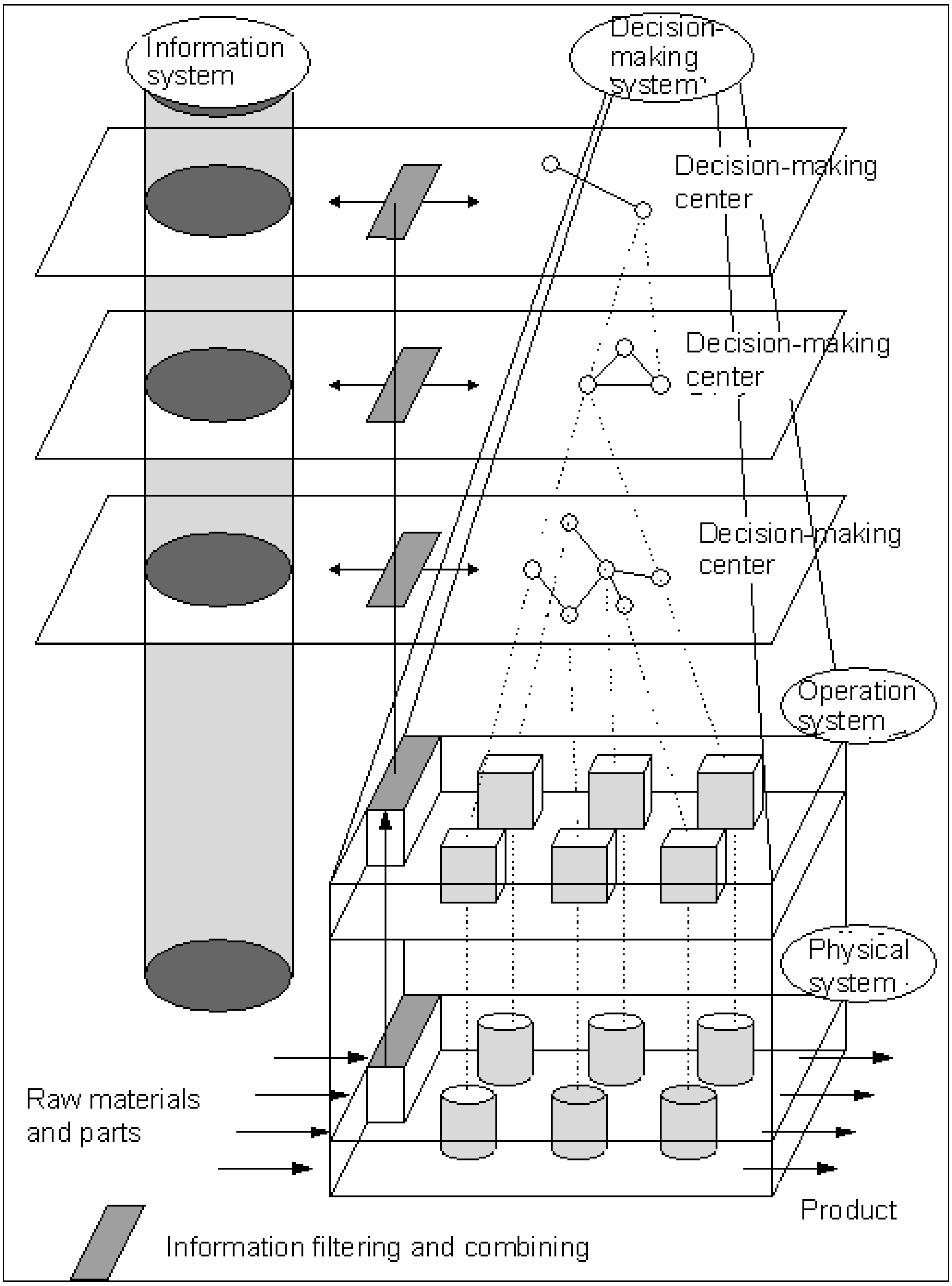


Figure 29. GRAI Global Model *(http://www.atb-bremen.de/projects/prosme/Doku/oqim/GRAI.htm)*

Figure 30 shows the structured procedure of enterprise design according to GRAI-GIM. Analysis and design are done in terms of the four co-operating systems.

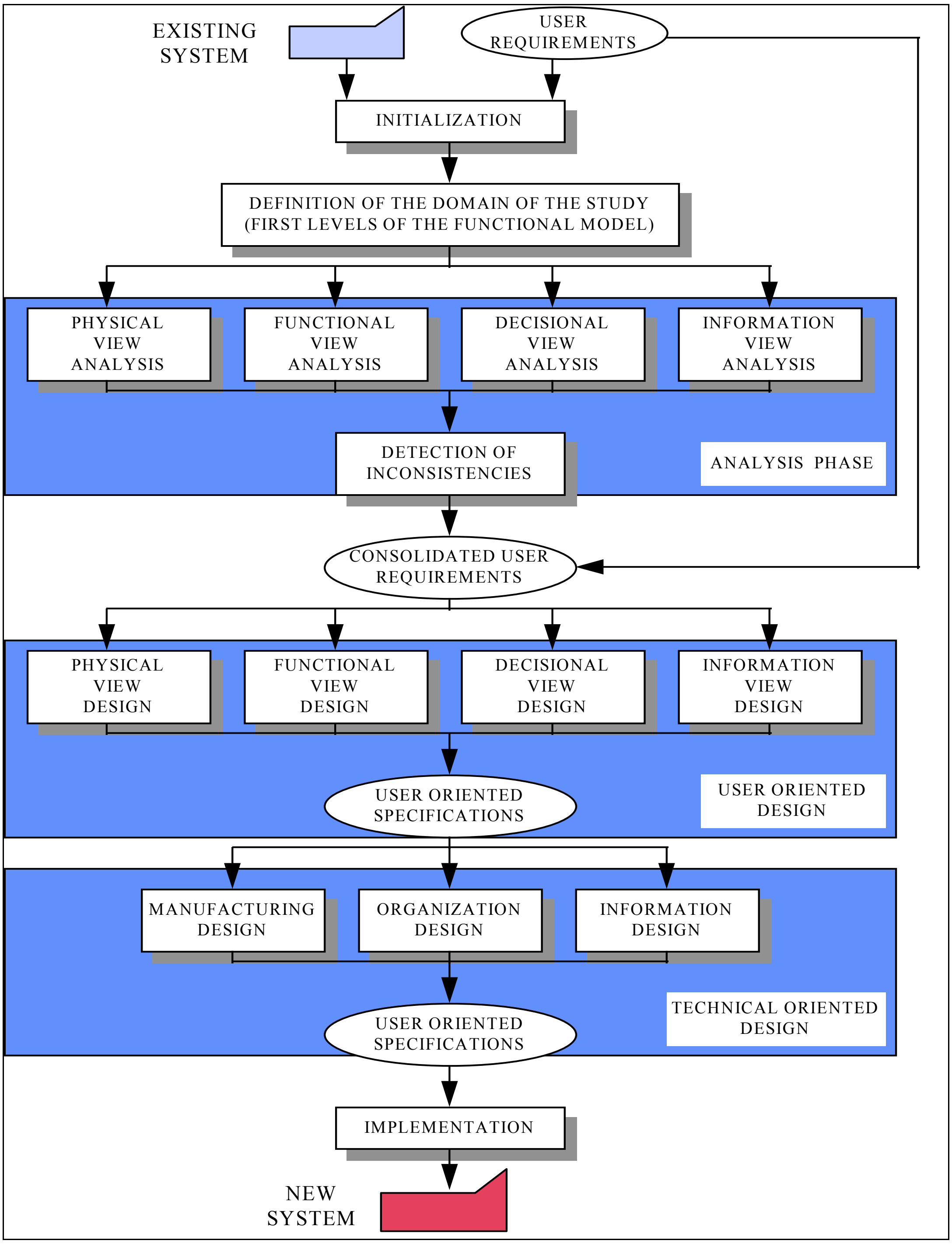


Figure 30. GRAI-GIM Enterprise Life Cycle (Adapted from Koorts 2000)

Koorts (2000) made the following comments regarding the GRAI-GIM Architecture and also points out the useful link to the Balanced Scorecard concept:

> *The Grai-Gim methodology is useful in defining a hierarchy for decision-making and control within an enterprise, especially in already existing organizations. Using the Grai-grid with its corresponding decision centres, would describe all the relevant decision roles in an enterprise. When a proper model of the necessary systems is built, it is easy to define the communication links between the components.*
>
> *This GRAI-GIM architecture can also be used in conjunction with the Balanced Scorecard, in which a set of measurements are defined for the*

Balanced Scorecard and the GRAI-GIM Architecture is used to define the measurement and control tree down into the enterprise.

2.4.6.2 CIMOSA

CIMOSA objectives

Computer integrated manufacturing (CIM) should provide the industry opportunities to streamline production flows, to reduce lead times and to increase overall quality while adapting the enterprise fully to the market needs. Adaptability and flexibility in a turbulent environment are key issues.

Computer integrated manufacturing open systems architecture (CIMOSA) provides a widely accepted CIM concept with an adequate set of architectural constructs to structure CIM systems. This concept is based on an unambiguous terminology in order to serve as a common technical base for CIM system users, CIM system developers and CIM component suppliers.
(http://www.rgcp.com/cimosa.htm)

The primary objective of CIMOSA is to provide a framework for analyzing the evolving requirements of an enterprise and translating these into a system that enables and integrates the functions, thus satisfying the original requirements. The CIMOSA reference architecture contains a limited set of architectural constructs to describe the requirement of, and the solutions for, a particular enterprise completely.

The CIMOSA architectural principles are based on the generalized concept of isolation:

- **Isolation between the user representation and the system representation**, which restricts the impact of changes and provides ability to modify the enterprise behaviour in order to cope with market changes (organizational flexibility).
- **Isolation between control and functions** making it possible to revise the enterprise behaviour, in order to meet changing circumstances, without altering the installed functionality.
- **Isolation between functions and information** to facilitate integration, application portability, inter-operability and maintainability.

CIMOSA framework

The CIMOSA modelling framework (*CIMOSA cube*) is based upon:

- A dimension of genericity (three architectural levels). See **Table 5**.
- A dimension of model (three modelling levels). See **Table 6**.
- A dimension of view (to describe the model according to its four integrated aspects). See **Table 7**.
  (http://www.rgcp.com/cimosa.htm)

Table 5. CIMOSA - Dimension of genericity

Generic level	catalogue of basic building blocks
Partial level	library of partial models applicable to particular purposes
Particular level	model of a particular enterprise built from building blocks and partial models

Table 6. CIMOSA - Dimension of model

Requirements modelling	for gathering business requirements	Business user
Design modelling	for specifying optimized and system-oriented representation of the business requirements	System designer
Implementation modelling	for describing a complete CIM system and all its implemented components	System developer

Table 7. CIMOSA - Dimension of view

Function view	for describing the expected behaviour and functionality of the enterprise
Information view	for describing the integrated information objects of the enterprise
Resource view	for describing the resource objects of the enterprise
Organization view	for describing the organization of the enterprise

2.4.6.3 ARIS

The framework of architecture of integrated information systems (ARIS) has four views and three levels.

The four views are:

- Organization
- Data
- Control
- Function

The three levels are:

- Requirements definition
- Design specification
- Implementation description

To a certain degree the structure correlates with the dimensions of view and model that were discussed in the previous section on CIMOSA.

2.4.7 Summary

Enterprise architecture is a growing field of interest, not only from an academic point of view, but also from a business perspective. More and more organizations realise that they need to define the various aspects of their enterprises through the complete life cycle to truly understand the interaction between business functions. For purposes of this thesis it is not necessary to go into a detailed comparison between the different methodologies and architectures – the main point is to acknowledge the existence of these architectures and to put them into context with other management support tools.

The aim of all the enterprise architecture models is to define an enterprise from various perspectives (from conceptual to physical systems) and to show the interrelationships between data, business processes, network of locations, people, time and motivation for activities that take place in an organization. Although these frameworks are useful when new organizations are started, their value is also evident when changes to existing enterprises are considered and the associations between the different perspectives can be checked to evaluate their impact.

2.5 Data warehousing

Businesses are realising more and more that simply improving and automating manual processes is not the only requirement to survive and thrive in the long run. Businesses need to be customer focused. With all the information available to companies today, it is imperative that the information be utilized to the advantage of the client. A company does not want to waste time on improving and automating internal processes, if the improvements do not bring value to the client. It requires customer focused processes and applications that can leverage its potential to satisfy customer requirements far beyond their expectations.

The demand to manage and deliver information more effectively has led to an enormous need for a single version of the truth that can be provided to the right people at the right time. Various concepts have emerged from the information technology arena to support this quest:

- Data warehousing
- The operational data store
- Data marts
- Data mining
- Internet and intranet
- Multidimensional and relational databases
- Online analytical processing (OLAP)

Although many of these concepts provide part of the answer, it is also true that a combination of concepts in the right context can very often provide a better solution. As business intelligence and data warehousing are relatively new disciplines, it is understandable that various viewpoints exist. Without understating the role that many other people are playing in this field, it is felt that the work of Bill Inmon and Ralph Kimball stands out. In this literature theme on data warehousing their views are primarily discussed and compared. These two gentlemen and their co-authors have been involved in data warehousing since the early 1980s and during that time they have refined and reviewed their conceptual models to adapt to technological changes.

Bill Inmon is referred to by many people as the father of data warehousing and has popularized the concept of a Corporate Information Factory (CIF). His viewpoints are strongly rooted in the information technology arena. Ralph Kimball, being an electrical engineer, approaches the subject from a different angle and also concentrates more on dimensional modelling and the links to business requirements and project management.

2.5.1 The Corporate Information Factory (CIF) - Inmon

2.5.1.1 Information ecosystem

"An information ecosystem is a system with different components, each serving a community directly while working in concert with other components to produce a cohesive, balanced information environment." (Inmon et al. 2001) Like nature's ecosystem, the environment constantly changes and the entities within the system also change and adapt to remain in balance with each other. Adaptability and transformation are also vital within an information ecosystem.

According to Inmon et al. (2001) the Corporate Information Factory (CIF) represents the physical version of the information ecosystem. As an example consider the components of the CIF, including amongst others applications, the integration and transformation layer, the data warehouse and the data marts working together to deliver business intelligence capabilities to the organization. Inmon et al. (2001) also suggest that to deliver support for real-time tactical decisions one requires an operational data store (ODS).

The following is a summary of the work of Inmon, which will later be compared to the viewpoints of Kimball.

2.5.1.2 Visualizing the CIF

The CIF, as illustrated in **Figure 31**, has the following components:

- **External world**
  This is where the data used within the CIF originates. Businesses and people interact with the interface to the CIF and the transactions and data are captured in the system.

- **Applications**
  These are the applications that the company uses to capture the data into the CIF. They drive the day-to-day business processes such as order processing and accounts payable.

- **Operational data store**
  Inmon describes the ODS as *"a subject-oriented, integrated, current-valued and volatile collection of detailed data used to support the up-to-the-second collective tactical decision-making process for the enterprise".*

- **Integration and transformation layer**
  The data captured by transactional applications are now integrated and transformed into a "*corporate structure*" that supports the company's functions.

- **Data warehouse**
  As opposed to the ODS, the data warehouse is "*a subject-oriented, integrated, time-variant (temporal) and non-volatile collection of summary and detailed data used to support the strategic decision-making process for the enterprise*".

- **Data mart(s)**
  Data marts are a customized subset of data withdrawn from the data warehouse, that aims to support the specific needs of a given business unit.

- **Internet/Intranet**
  These are the lines of communication between different components that interact with each other.

- **Meta data**
  Meta data provides the necessary detail to promote data legibility, use and administration.

- **Exploration and data mining warehouse**
  Instead of occupying the data warehouse resources, the explorer can go to a separate area to perform analyses on data.

- **Alternative storage**
  In time, data is moved to alternative storage to improve performance and to extend the warehouse to infinity.

- **Decision support systems**
  These systems produce the end product of the data warehouse, gathering data from the data warehouse and packaging it to support strategic decision-making through analytical tools.

  Data enters the CIF as detailed, raw data collected by the transactional applications. The raw, detailed data is passed to the integration and transformation layer where functional data is transformed into corporate data. From here the data is passed to the operational data store and/or the warehouse. From here data is queried, analysed and structured into data marts and decision support systems for various purposes.

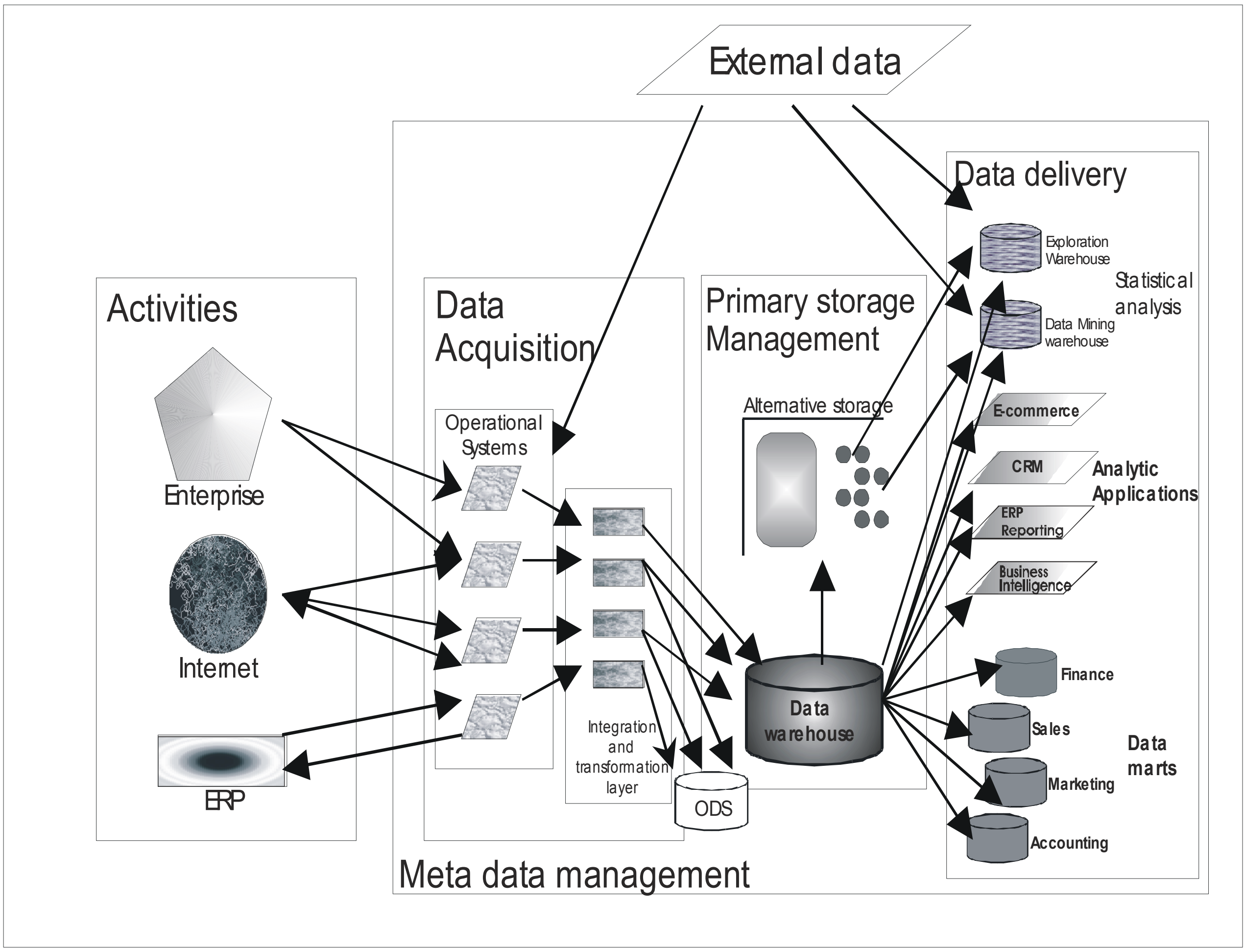


Figure 31. The Corporate Information Factory (Inmon et al. 2001)

2.5.1.3 Components of the CIF

External world component

The participants of the external world such as individuals, employees, partners, and vendors capture data used in the Corporate Information Factory. They supply the raw material and services, execute the tasks, direct the machinery and consume the final product. Without these participants there would be no data for the CIF to utilize and thus no need for the CIF to exist.

Application component (Data acquisition)

The application component of the CIF is the part that captures the transaction data either directly from the consumer/client (e.g. an ATM) or indirectly (e.g. an employee enters the data received from the consumer/client). Normally different applications emerge in time. Some are bought off the shelf, while others are developed and customized and thus these applications are often not integrated. This lack of integration shows up in many places such as the key structure of data; definition of the data; data layout; encoding structure of the data and the use of reference tables.

Transaction response time during data capturing must be excellent as this may concern customers directly and because decisions have to be made on constantly changing information. If the application systems have already been built and installed, the process of integrating the applications is a long and challenging effort.

After data acquisition, data leaves the application layer and is fed into the I and T (integration and transformation) layer.

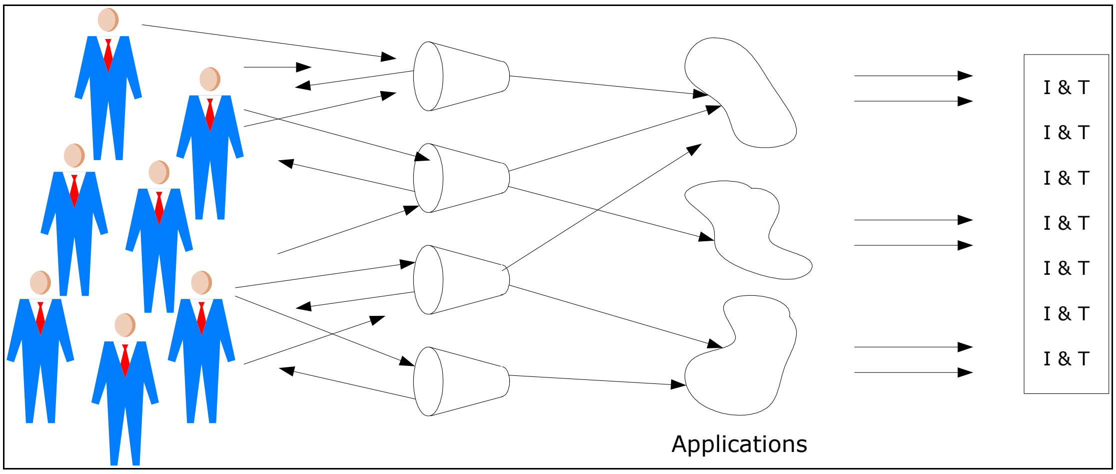


Figure 32. Applications feed data into the I and T layer (Inmon et al. 2001)

The integration and transformation (I and T) layer component

The I and T layer represents a number of programmes that integrate and transform the data from the applications into a corporate asset as illustrated in **Figure 32**. In turn they pass data from the applications environment to the ODS or the data warehouse environment shown in **Figure 33**. The many different variations of data that are fed into the I and T layer require a complex process and this process needs to be rigorously monitored and updated as the data and process in the information ecosystem change. The integration process includes the following activities:

- Key resolution
- Re-sequencing data
- Restructuring of data layouts
- Merging of data
- Aggregation of data
- Summarization of data

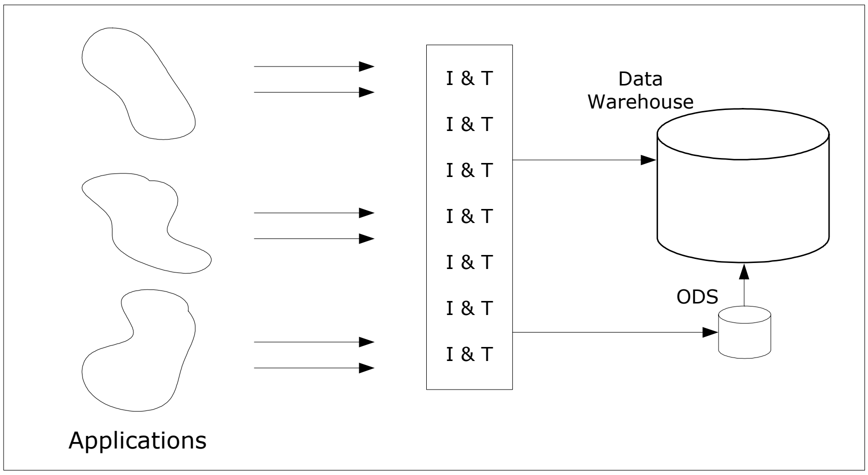


Figure 33. The feeds into and out of the I and T layer (Inmon et al. 2001)

The data model heavily influences the structure of the I and T layer. It serves as the conceptual road map for the work that is accomplished by the I and T programmes. Reference tables are a standard part of the I and T interface.

The meta data repository also plays an important role in the processes of transformation. A description of these processes should be placed inside the meta data repository to keep track of how data was transformed and integrated. "*The information that is captured is technically not meta data, but meta process information*", according to Inmon et al. (2001).

The operational data store component

The operational data store (ODS) is a complex "*architectural construct*" that combines some elements of data warehousing and some application characteristics. A mixed load passes through the I and T layer and into the ODS. Inmon et al. (2001) assert that it is easily the most difficult component of the CIF to construct and operate.

The ODS is subject-oriented, integrated, volatile, current-valued and detailed. According to the first two characteristics, the ODS is very much like the data warehouse. But they differ in that the ODS is volatile and current-valued and contains only detailed data.

Being volatile means that the ODS can be updated normally as opposed to a data warehouse that (according to the Inmon definition) contains snapshots that are created whenever a change needs to be reflected in the data warehouse.

Inmon et al. (2001) also state that the ODS is current-valued. It typically contains daily, weekly, or maybe even monthly data. The data warehouse, in contrast, may contain five or even ten years of data.

The third difference between an ODS and a data warehouse is that the ODS contains detailed data only, while a data warehouse contains both detailed and aggregated data.

Four types of an ODS exist: Class I, Class II, Class III and Class IV. These types are classed according to the speed with which data passes from the I and T layer.

As the ODS operates on a severely mixed workload, an ODS operational day is divided into time slices, namely the OLTP (online transactional processing) time slice, the batch and the DSS time slices.

In essence, the ODS provides a platform for integrating detail data for operational reporting. As the data is transformed and passed by the I and T layer to the ODS, the corporate asset is made available for tactical decision-making.

The data warehouse component (primary data management)

The data warehouse is the primary architectural component of the Corporate Information Factory. From here all DSS systems gather information for strategic DSS processing. According to Inmon et al. (2001) the data warehouse is the first place where integration of data is achieved anywhere in the entire environment. Much historical processing is also done here. See **Figure 34**.

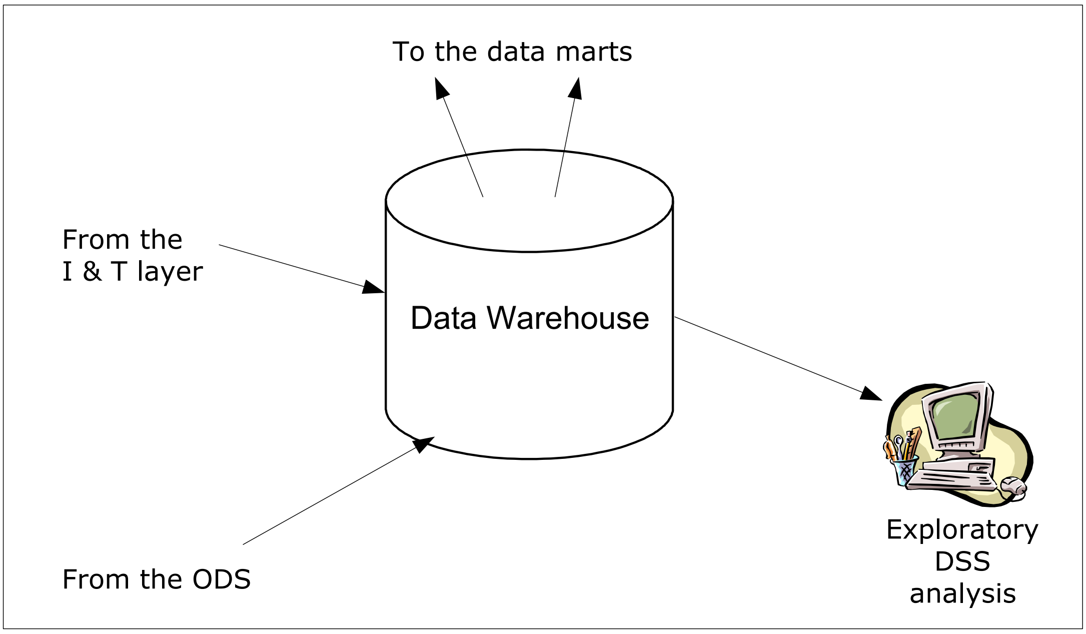


Figure 34. A data warehouse in the context of the CIF (Inmon et al. 2001)

The data warehouse is fed by the ODS and the I and T layer and, in turn, feeds the data marts. Some direct analysis may also be done at the data warehouse itself. It is significantly larger than other components of the CIF. Its size is determined by the amount of information stored within the warehouse and by the level of detail of the data.

The data warehouse is an architectural structure that is:

- **Subject-oriented**
  Subject-oriented refers to data that is structured into a corporate structure. The data is organized along the lines of the major entities of the corporation, such as customers, products, vendors and accounts.

- **Integrated**
  As raw data passes through the I and T layer, it undergoes a fundamental alteration to achieve an integrated structure. Integration covers many aspects of the warehouse, including common key structures, definitions of data, data layouts, data relationships and naming conventions. Inmon et al. (2001) emphasize that the design for the data found in the data warehouse is dominated by a **normalized** design. He states that this design technique strives to eliminate data redundancy and to produce a stable database design. (This is one of the primary differences between Inmon and Kimball.)

- **Time-variant**
  Any record in the data warehouse environment is accurate relative to some moment in time. Usually this is achieved by creating snapshot records. Keep in mind that a snapshot must refer to reference data that is accurate as per the date that the snapshot was taken. In other words, a record must be kept of the reference data for the time the snapshot was taken. A data warehouse is often said to contain nothing but a massive series of snapshot records. Thus, it can contain data over a lengthy period of time. It is common for a data warehouse to hold detailed data that is five to ten years old.

- **Non-volatile**
  Non-volatility refers to the fact that updates to a record are not normally made within a data warehouse. If a change occurs that should be recorded a snapshot is taken of that data and added to the data warehouse.

- **Comprised of both summarized and detailed data**
  According to Inmon et al. (2001) this is one of the major differences between a data warehouse and an ODS. The data warehouse contains both detailed and summarized data.

As the data warehouse grows, the demands for information and analysis of data start to utilize the warehouse resources. A new information construct is needed that can turn the integrated data provided by the data warehouse into information. This component of the CIF is called the data mart.

The data mart component

A data mart is a subset of data gathered from the data warehouse to address the specific DSS processing needs of a business unit. According to Inmon et al. (2001) data found in the data marts are **denormalized**, pruned and summarized as it passes from the data warehouse to the data mart as illustrated in **Figure 35**.

According to the Inmon definition, a data mart contains mainly summarized data and only a small amount of detailed data. It contains a limited amount of history, significantly less history than what may be found in the data warehouse. Unlike Kimball, Inmon et al. (2001) do not utilize the data mart within the data warehouse, but outside, as a decision support system for each department.

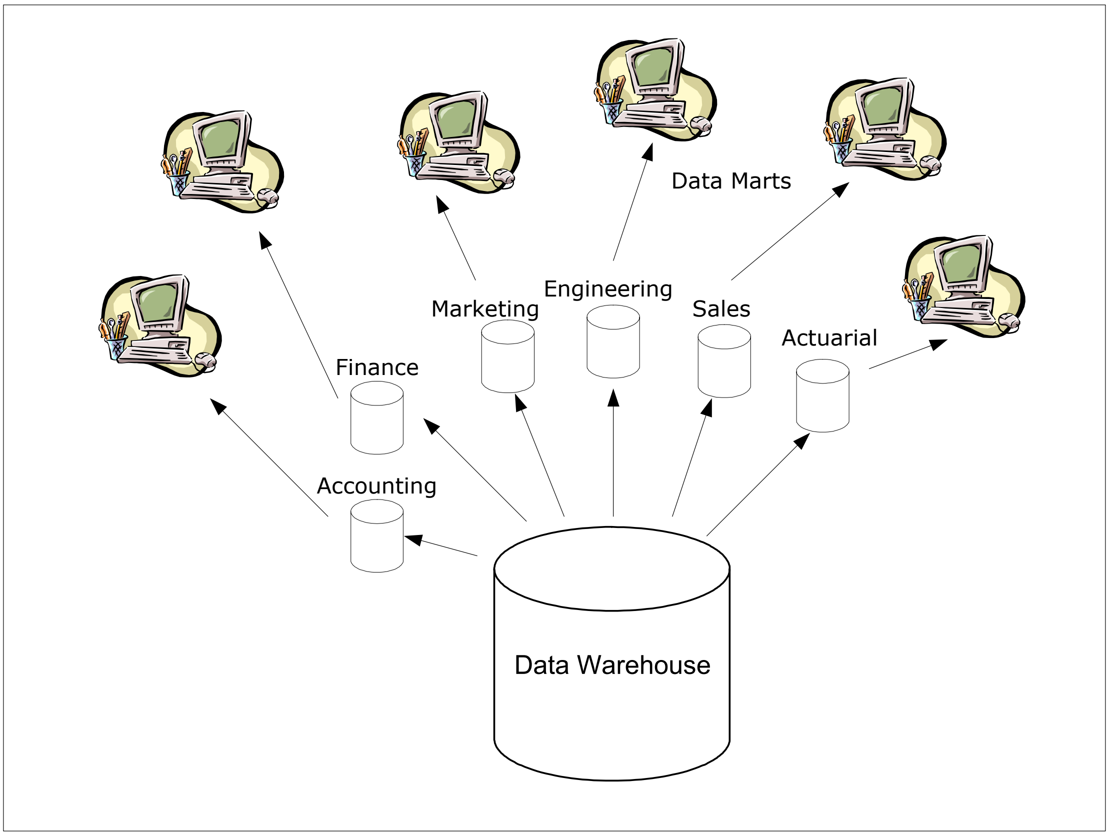


Figure 35. The data warehouse feeds to the data marts (Inmon et al. 2001)

Inmon et al. (2001) identify the following advantages of utilizing data marts that are managed by individual departments outside the data warehouse:

- **Control**
  The data and processing that occurs inside a data mart can be controlled completely by a department.

- **Cost**
  Because the department wants to analyse only a subset of data found in the data warehouse, the cost of storage and processing is substantially less when the department transfers the desired data to a departmental machine.

- **Customization**
  As data passes into the data mart from the data warehouse, it is customized to suit the peculiar needs of the specific department.

Data marts are fed only from the data warehouse. The flow occurs as and when needed or requested. After the initial load has been made to the data mart, the volume of the incremental loads to refresh the data is minimal.

Decision support capabilities

The data warehouse and data marts are excellent tools to support the specific analytical requirements of a given business unit or business function. There are different types of data marts for different decision support analytical processes. These data mart types, as defined by Inmon et al. (2001), are now examined in more detail.

- **Departmental**

  A departmental data mart supports decision-making tailored for a specific department or division within the organization. For example, the sales department may want to create a decision support database containing sales data specifically. Departmental data marts are therefore fairly generic in functionality and store historical data for use by the personnel of that department only.

  - Advantages:
    - One has a good chance of delivering what the department wants.
    - One can get good funding since the department owns this mart.
    - The department controls the mart and therefore can make it perform almost all of the department's proprietary analyses.

  - Disadvantages:
    - Performance issues can arise because the data mart is not being optimized for any set of queries – or worse, being optimized for some queries that cause performance problems for others.
    - Redundant queries can run on different data marts throughout the organization even though the result sets from these may not be consistent, due to different refresh rates, for example.
    - A minimal sharing of findings between departments can occur.

- **Decision support (DSS) application**

  According to Inmon et al. (2001), DSS application data marts focus on a particular decision support process such as risk management, campaign analysis, or head count analysis, rather than generic utilization. Because of their universal appeal in the company, these marts are also seen as an enterprise resource. They are used by anyone in the organization who may find a need for their analytical capability. *"DSS application data marts have a narrow focus, but a broad user community usage,"* according to Inmon et al. (2001).

  - Advantages:
    - DSS applications have an enterprise wide appeal and reusability.
    - It is possible to create standard analyses and reports from these marts.
    - The data mart is easy to optimize and the capacity is predictable.

  - Disadvantages:
    - It may be difficult to customize the views or queries in the data mart so that the diverse set of users is satisfied.
    - Funding must come from an enterprise source rather than a single department.
    - It can be hard to get the business community to agree on the overall design of this application.

- **ERP analytical applications**

  To support minute-by-minute tactical decisions ERP analytical applications act as an excellent tool. ERP activity begins in the transaction application environment.

  ERP transaction data is stored in one or more ERP application databases. As the data ages, it is pulled from the ERP transaction database into the data warehouse. Once again it may be required to integrate the data with other sources of data into meaningful units.

  Once inside the data warehouse, the ERP data is available for DSS analytical processing and reporting. Inmon et al. (2001) identified the following kinds of reporting that are typically done by a DSS analysis application:

  - Simple reporting
  - Key performance monitoring
  - Checkpoint monitoring
  - Summary reporting
  - Exception reporting

- **E-Business analytic applications**

  According to Inmon et al. (2001), e-business is not a DSS application, but many aspects of e-business relate to a DSS analysis. Common in today's economy is the relationship that exists between the web site (which supports e-business) and the Corporate Information Factory. See **Figure 36**.

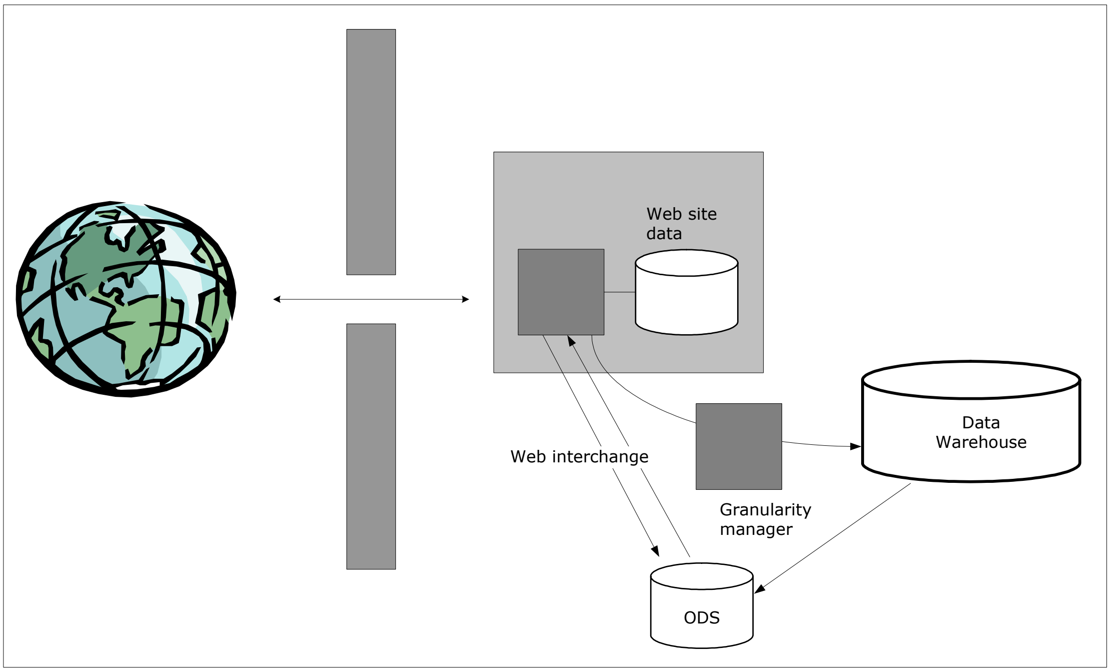


Figure 36. The essential components of the web and the CIF (Inmon et al. 2001)

As illustrated in Figure 36, data passes from the web site to the data warehouse through a "*granularity manager*". The granularity manager reduces, aggregates and organizes very low-level detail, created in the web site as the data passes into the Corporate Information Factory. In turn, the web site may receive small amounts of aggregated, analysed data originating from the data warehouse and fed into an ODS. The last direct interface that the web site has with the CIF is through the fulfilment process, which is the order-processing component of the CIF. When the web site captures an order, the order information is passed directly into the operational systems of the corporation.

2.5.1.4 Migrating to the CIF

Inmon et al. (2001) suggests a "step-at-a-time" approach in migrating to the Corporate Information Factory. Its size and complexity already suggest that this is the way to go. Inmon et al. (2001) identify the following reasons to support this approach:

- **Cost**
  The cost of the infrastructure and the cost of development simply discourage organizations to consider building the CIF at anything but a step at a time.

- **Complexity**
  The CIF entails the usage of many different kinds of technologies. An organization can absorb only a limited number of technologies at once.

- **Nature of the environment**
  The DSS portion of the environment is built iteratively in any case. It does not make sense to build the DSS environment in a "big bang" approach.

- **Value**
  Above all else, the implementation of the Corporate Information Factory must demonstrate incremental value to the business. This is best accomplished through a series of iterations, say every three to six months.

The typical progression of such a task is depicted in **Figure 37** and **Figure 38**.

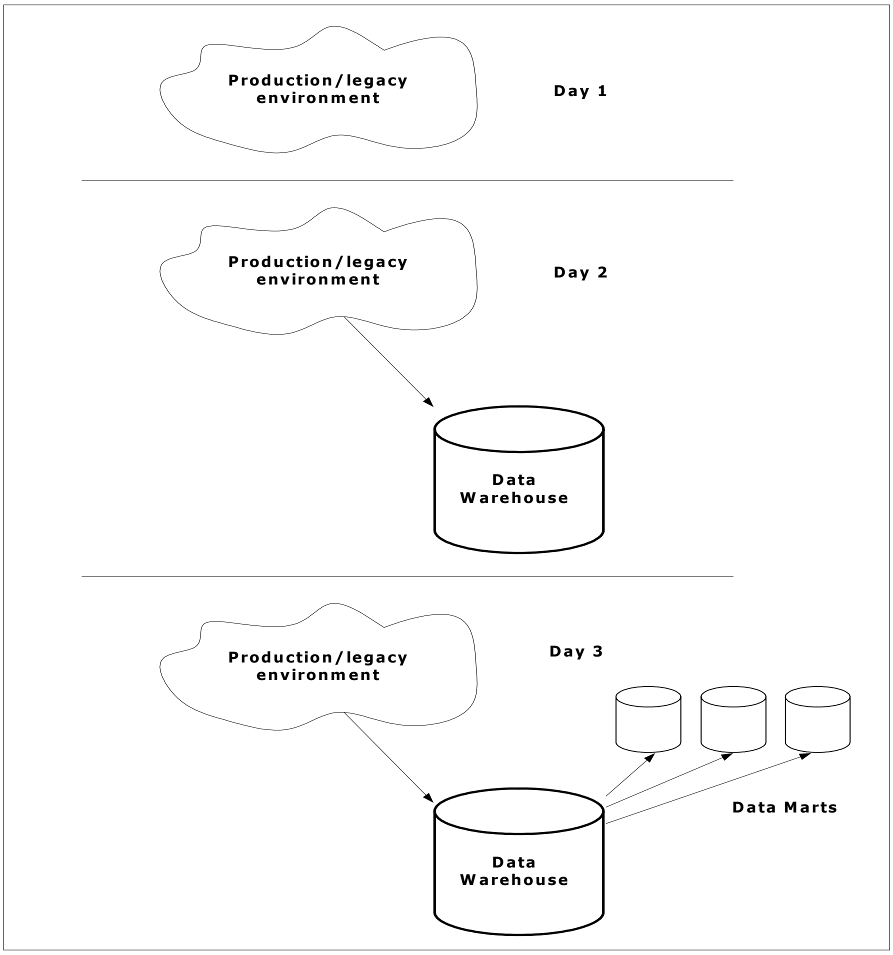


Figure 37. First three steps to building the CIF (Inmon et al. 2001)

At first the information systems are not integrated and non-standardized. Then the data warehouse starts to emerge and grows incrementally. As the warehouse advances, that data is removed from the unstructured information systems environment and loaded into the new normalized data warehouse structure.

When the data warehouse reaches a sufficient size, data marts start to grow from the data warehouse as the distinctive business units identify their needs. Again, as the CIF grows, more processing and data are removed from the transactional IS environment as different departments begin to rely on their data marts for DSS processing.

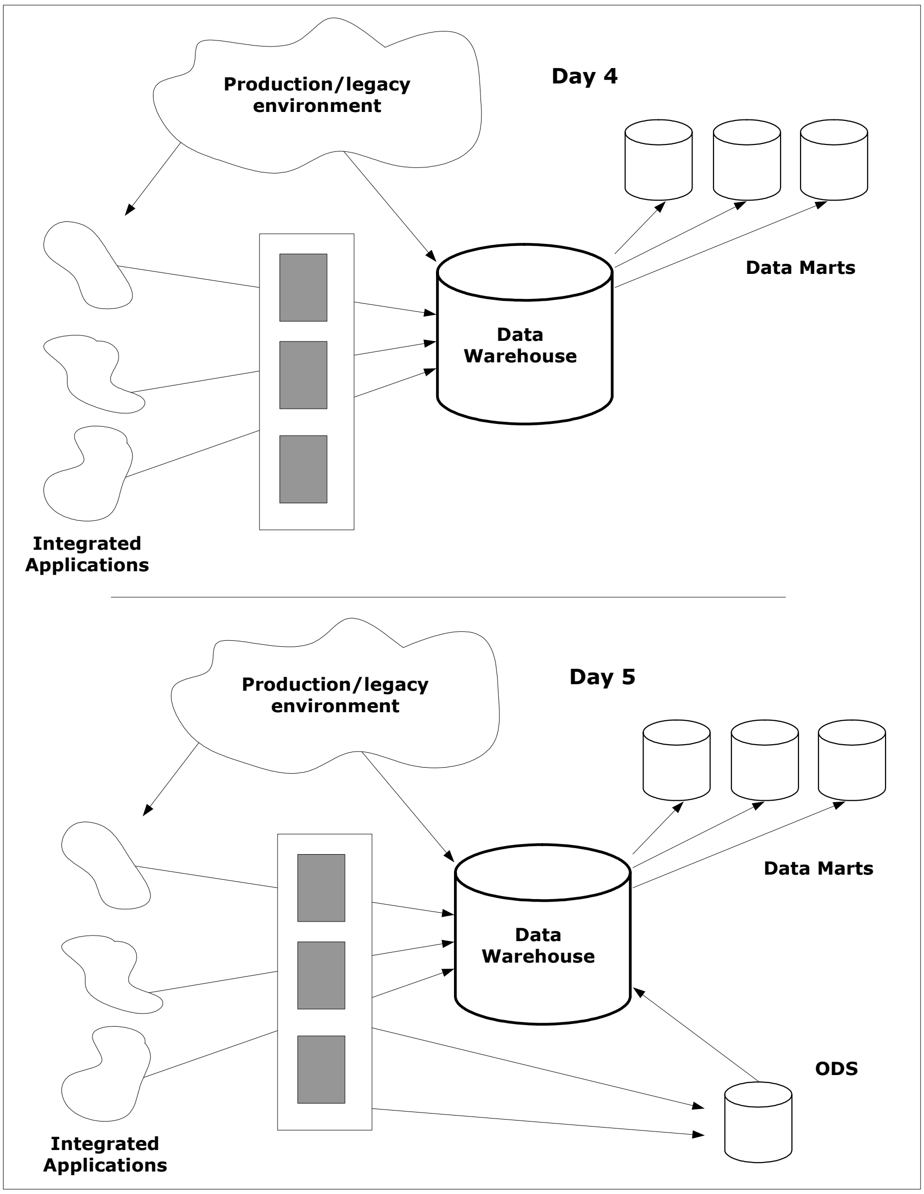


Figure 38. The next steps to building the CIF (Inmon et al. 2001)

As the integrated applications start to appear at this stage and to pass their information to the data warehouse, an integration and transformation (I and T) layer is required. This addition is illustrated in **Figure 38**.

Finally the ODS is constructed, which is fed from the I and T layer and, in turn, feeds its data to the data warehouse. By this time the systems that were once known as the production systems environment have almost disappeared.

Also note that this path is seldom linear. Different parts of the Corporate Information Factory are being built simultaneously and independently.

2.5.1.5 Enhanced CIF picture

Figure 39 shows an updated picture of the CIF with interfaces to the internet/web environment.

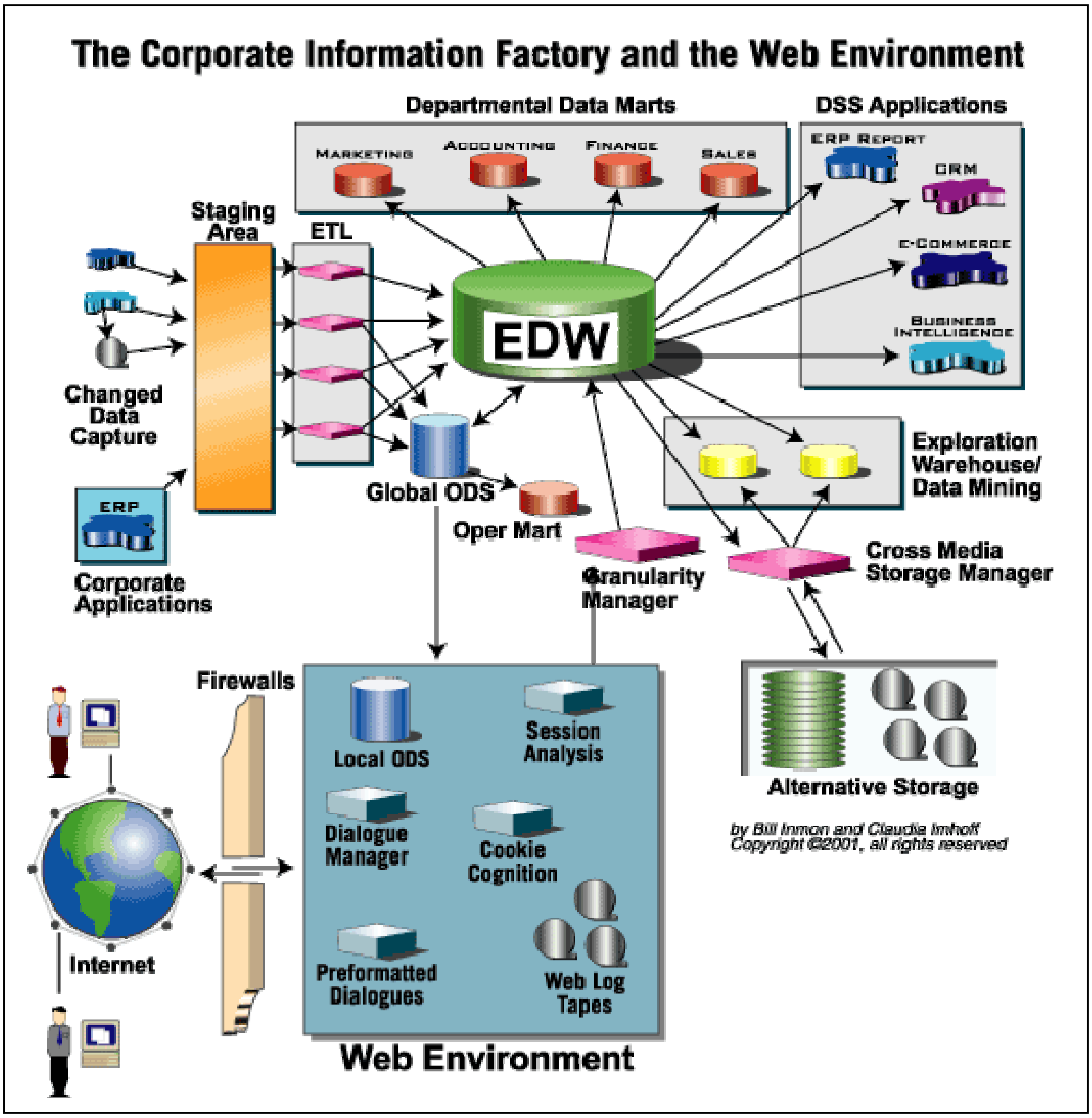


Figure 39. Enhanced CIF picture (Inmon and Imhoff 2001)

It is clear from the picture that the CIF concept has grown over time and is now also addressing issues like alternative storage, firewall protection and analysis of access to the CIF environment. Although not shown in this picture, Inmon always propagates the importance of meta data throughout the environment – from the source systems, to the data warehouse, and all the way to the end-user applications via data marts and DSS applications.

2.5.2 The data warehouse - Kimball

Ralph Kimball presents a view of the data warehouse that differs slightly from that of Bill Inmon. The main difference is the structure of the data warehouse. In this section the components and views of Kimball are discussed. The two different viewpoints will then be compared in a summarized manner.

2.5.2.1 Components of a data warehouse

The following components of a data warehouse as described by Kimball et al. (1998) are presented in **Figure 40**.

Source systems

The source systems of the enterprise represent the operational systems that capture the transactions of the business. In the mainframe environment one may find that people refer to it as "*legacy systems*". As these systems are used to run minute-by-minute transactions, they require a very quick response time. For this reason management reporting is not supported by the source system as large queries will only be a burden and will slow down performance. Queries on the source system are "narrow" and normally form part of the day-to-day transaction flow. It also maintains little historical data in order to speed up performance.

Data staging area

Within the data staging area the source data is prepared for the data warehouse. Data is received from the source system, then cleaned and transformed to be fit for the presentation area. Although data is stored here, it does not provide query and presentation services. One key reason for this stems from the fact that the data must be transformed to be fit for the presentation area. For example, data format differences from different source systems must be resolved. Queries will only slow down this process. According to Kimball et al. (1998) the staging area does not need to be based on 3NF (third normalized form) relational modelling, it could just be flat files (typically .csv files) that normally increase performance. However, this decision is subject to the requirements of the data staging area managers.

Data staging is a major process that includes some sub processes, being extracting, transforming, loading, indexing and quality assurance checking. In the *extracting* process source data is taken from the source systems. The data is read, understood and copied into the staging area, awaiting transformation. After the data has been extracted, it is transformed and prepared for loading into the data warehouse. These transforming activities may include the cleaning up and combining of data. The transformed data is then loaded into the data warehouse database on the presentation server.

Presentation area/server

The presentation server is the target *machine* onto which the transformed data is loaded for direct querying by end-users and other applications. Kimball et al. (1998) insist that the data in the presentation server should be presented and stored in a dimensional framework. If based on a relational database, the tables will be organized into star schemas. If the presentation area is based on a multidimensional database or online analytical processing (OLAP) technology, the data will be stored in cubes.

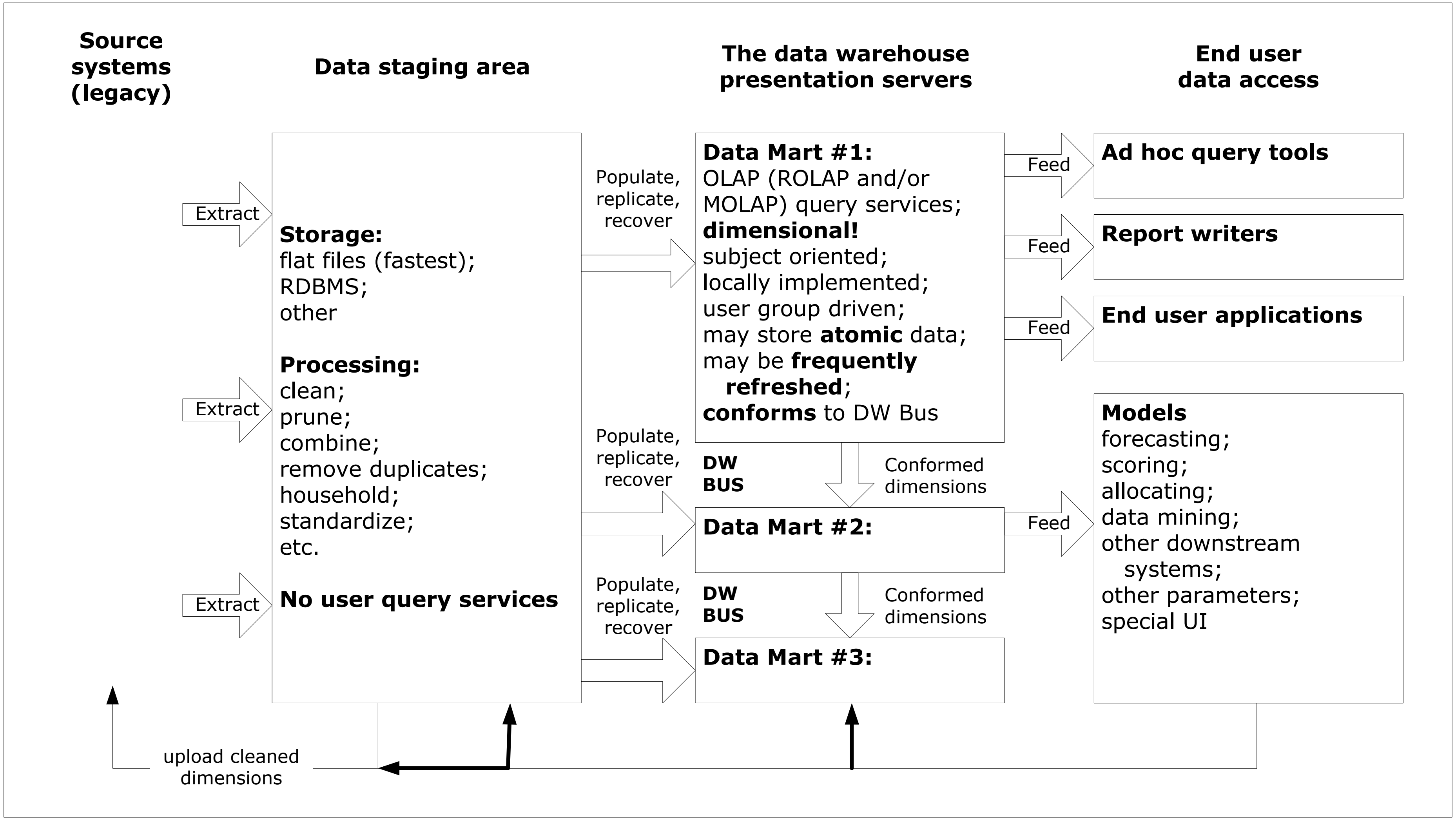


Figure 40. The basic elements of the data warehouse (Kimball et al. 1998)

Dimensional model

Kimball et al. (1998) utilize dimensional modelling for the structure of the data warehouse. This is an alternative to normalized entity relationship (3NF E/R) modelling, as proposed by Inmon. A dimensional model contains the same information as a normalized E/R model, but the data is structured in such a way that it is easier to understand, knowing that all users (especially business users) do not have knowledge of normalized database design. It also aims to improve query performance and to be resilient to change.

Although some people in industry refer to 3NF entity relational data modelling as only E/R (an acronym for entity relationship) modelling, it should be clear that dimensional modelling is also based on entity relationships – it is just the degree of normalization that differs. (Normalization is a logical modelling technique that removes data redundancy by separating the data into many discrete entities, each of which becomes a table in a relational database.)

The relationship between a dimension and the fact table is always one-to-zero/many, indicating that a record in the fact table will always be linked to one record in the dimension table and that a record in the dimension table may be linked to zero or many records in the fact table.

The main components of a dimensional model are the central fact table and the dimension tables around it, as illustrated in **Figure 41**.

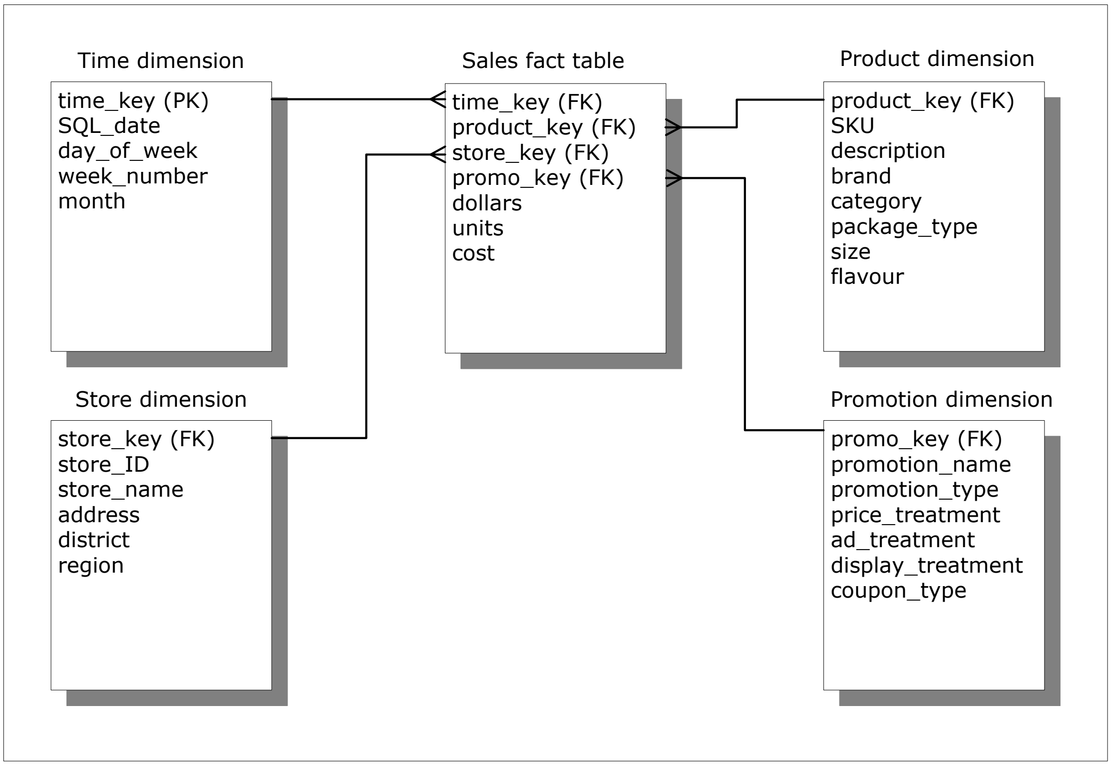


Figure 41. Star schema (Kimball et al. 1998)

Kimball et al. (1998) describes a fact table as the primary table in each star schema that contains measurements of the business. The values are usually not known in advance and they are normally numeric, although one may find a few text values as facts. Each record in the fact table also contains foreign keys (FKs) that are the primary keys (PKs) of the dimension tables, which are joined to the fact table.

A dimension table is a companion to one or more fact tables and contain mostly text fields. Each fact table is surrounded by a number of dimension tables that represent the attributes of the "measures" in the fact table. This design is also called a *star schema*, for obvious reasons. Conformed dimensions are those dimensions that act as a companion for more than one fact table and are therefore shared between data marts.

Corr and Kimball (2001) suggest that the classical 5 Ws (When, Where, Why, What, Who) should be hints to suggest the dimensions that will possibly surround any fact table, while the classical "How" questions (how much, how many, how often) will be addressed in the fact table.

Data mart

A data mart is a logical and physical subset of the presentaion area of the data warehouse. It is a flexible set of data, ideally based on the most atomic, granular, detailed data that can be extracted from an operational source. It is presented in a symmetric (dimensional) model that is most resilient when faced with unexpected user queries. Each data mart is therefore represented by a star schema that is usually built and organized around a single business process.

Data warehouse

This is the "*queryable source of data in an enterprise",* according to Kimball et al. (1998). It consists of the union of all the data marts. The advantage of this approach is the fact that the data warehouse is not seen as a gigantic project that will never end, but as a series of data mart projects that will come to completion and that can be utilized when finished. The data marts are tied together by shared or conformed dimensions and drill-across between data marts on the same granularity is therefore possible.

Operational data store (ODS)

Kimball et al. (1998) encourage enterprises to consider carefully whether they really need an ODS. The ODS acts as a data store, structured to meet operational needs and performance requirements. If it will be utilized for operational and real-time queries, then it truly is an operational data store and should be separated from the data warehouse. But, if it will only be utilized to provide reporting and decision support, Kimball et al. (1998) encourage the enterprise to skip the ODS and meet these needs directly from the detailed level of the data warehouse.

OLAP (On-line analytic processing)

Kimball et al. (1998) define OLAP as "*the general activity of querying and presenting text and number data from data warehouses, as well as specifically dimensional style of querying and presenting that is exemplified by a number of OLAP vendors"*. With ROLAP (relational OLAP), user interfaces and applications are used, to give a relational database a dimensional flavour. MOLAP (multidimensional OLAP) represents those interfaces, applications and database technologies that are purely multidimensional. Hybrid approaches can also be used, where multidimensional cubes may be used with drill down capabilities that are based on ROLAP.

End-user applications

These applications are the tools that query, analyze and present the information within the data warehouse for decision support.

Ad hoc query tool

As opposed to the normal end-user applications that are structured and usually limited to a list of predefined reports and analysis possibilities, ad hoc query tools provide the more knowledgeable users with a way to directly manipulate relational databases and the joins between tables in a specific query.

Modelling applications

These sophisticated applications with analytical capabilities are mostly reserved for power users of the data warehouse. Amongst others, it will include most data mining tools and forecasting models.

2.5.2.2 Implementing the components of the data warehouse

Mainly two methods can be utilized in constructing the data warehouse. The first method builds the entire data warehouse all at once from a central, planned perspective. With the second method, separate subject areas are built whenever the team is up to it. But according to Kimball et al. (1998) these two methods are seldom used, but rather some kind of architected step-by-step approach. Kimball et al. (1998) describe a variation on that step-by-step approach and calls it the "*Data Warehouse Bus Architecture".*

The Warehouse Bus Architecture identifies all data marts and the business processes that they support. In matrix format each data mart is also linked to its relevant dimensions – indicating clearly the dimensions that are shared between data marts. See **Figure 42** for an example.

Data Mart	Transaction date	Billing date	Customer	Product	Pricing package	Vendor	Purchased product	GL account	Organization	Employee
Vendor contracts	X					X	X			
Purchase orders	X					X	X		X	
Marketing promotions	X		X	X	X					
Labour and payroll	X							X	X	X
Customer inquiries	X		X	X						
Account receivables	X	X	X	X						
Account payables	X					X	X			
General ledger	X							X	X	

Figure 42. The data mart matrix showing the Data Warehouse Bus Architecture (Adapted from Kimball et al. 1998)

With this method the data warehouse is first planned "*with a short overall data* *architecture phase that has very finite and specific goals".* This surrounding architecture defines the scope and implementation of the complete data warehouse. This architecture phase is followed by a step-by-step implementation of separate data marts. The overall data architecture provides guidelines that the separate data mart development teams must follow, but these teams can work fairly independently and asynchronously. As the data marts are completed they are fitted together like the pieces of a puzzle.

2.5.2.3 Business Dimensional Lifecycle

Kimball et al. (1998) provide the Business Dimensional Lifecycle framework for development of the data warehouse environment (see **Figure 43**) that includes the following aspects:

- Project management
- Business requirement definition
- Three development areas of technical architecture and product selection, dimensional modelling of the data warehouse and the data staging processes, as well as the end-user application specification and development
- Deployment
- Maintenance and growth

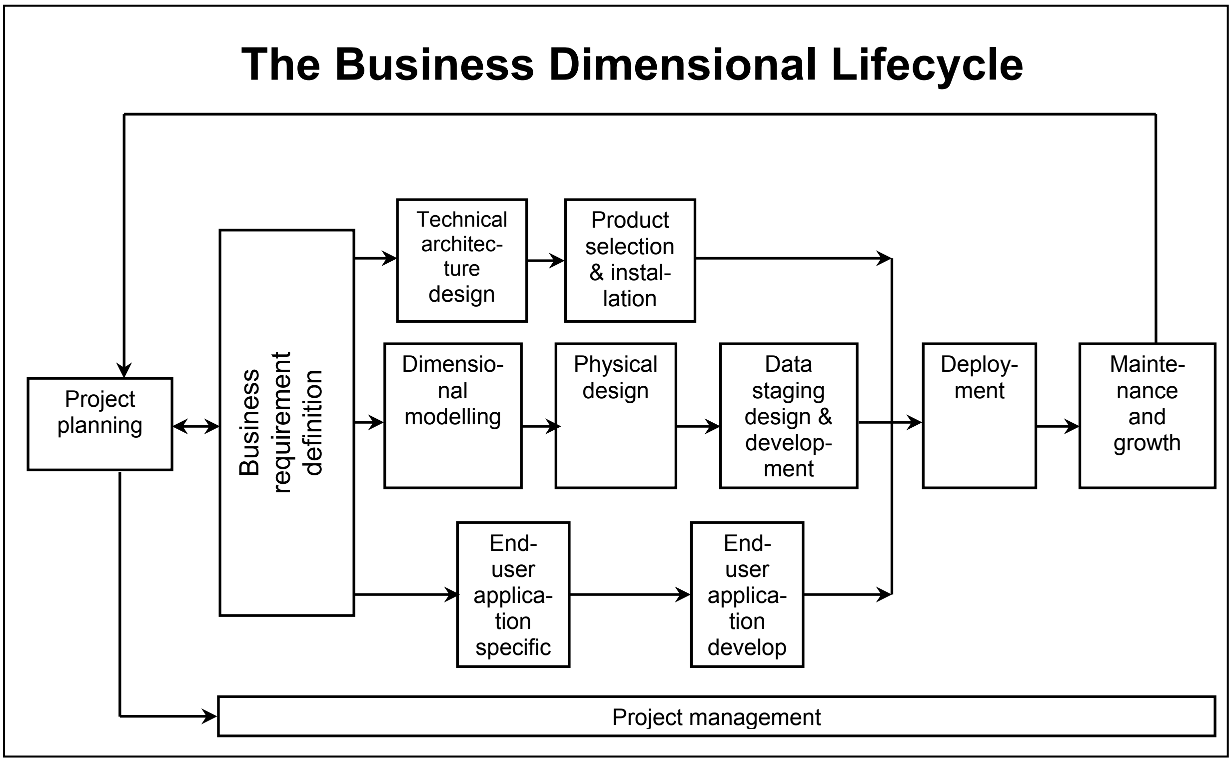


Figure 43. Business Dimensional Lifecycle diagram (Kimball et al. 1998)

The emphasis on business requirements early on in the lifecycle ensures that all three development areas are focussed on those requirements only, instead of building a warehouse that might be too extensive for the requirements of the business at that stage. The maintenance and growth step ensures that the warehouse environment stays in synchronization with any relevant changes in the source systems and that new data marts are introduced as new business requirements are defined. The whole process is governed by normal project management principles.

2.5.2.4 Handling changes to dimensions

Kimball and Ross (2002) have introduced the concept of surrogate keys that should be used as the primary keys in all dimension tables. By using surrogate keys instead of the natural keys (actually in addition to the natural keys) that are used in the transactional systems, it is possible, for example, to have many records for a person in the employee dimension, based on changes to certain attributes of that person. Say for instance that an employee with natural employee code "007" joins the firm as an unmarried person. After a while he gets married and (unfortunately!) two years later he gets divorced. In the data warehouse it could be possible to have three different records that will all have the same employee code of "007", but they will all have different surrogate keys. Since the surrogate keys are linked to the fact tables, it will be possible to group records in the fact table based on the surrogate keys, which may lead to interesting analysis. Very often those changes are made in the transactional system by overwriting the previous value to reflect the most current value, making it impossible to track behaviour for the periods separately.

Kimball and Ross (2002) have identified three primary types of changes that can be applied to records in a dimension. Type 1 overwrites the value with the most recent value and is typically used when corrections are made to obvious errors. It is easy to implement, but does not maintain any history of the previous attribute values.

Type 2 changes require the addition of a dimension row, as explained in the example above. This is the correct type to use in situations where accurate tracking of slowly changing dimension attributes is required. It is very powerful, because it automatically partitions the history in the fact tables. The negative side is that the dimension table can grow rapidly if there are many records in the dimension and/or many attributes in the dimension are tracked according to Type 2 changes and/or those attributes change frequently.

Type 3 changes require the addition of a dimension column for each attribute that you want to handle in this way. The additional column is used to show the previous attribute value. This technique allows one to see new and historical fact data by either the new or prior attribute values (or "*alternate reality*", as it is called by some designers). A good example may be when the district boundaries have been redrawn for a sales force and some users may still want to see today's sales in terms of the previous district boundaries. It should be noted that this technique only shows the most recent and prior value (or in hybrid use of the technique the original value), and not the full history of changes to an attribute as would be possible with Type 2 changes.

Various hybrid combinations of the primary three types are also possible. It is important to realise from a design point of view that each attribute in each dimension should be allocated a change type. Careful consideration should be given to each decision, since it can have a major impact on the size of the data warehouse, as well as the complexity of the ETL processes. One should always strive to arrive at a reasonable balance between flexibility and complexity.

2.5.2.5 Fact table types

As opposed to the idea of Inmon that the data warehouse mostly consist of a large series of snapshots, Kimball and Ross (2002) have identified three types of fact tables that enable them to capture any level of detail in a data mart:

- Transaction grain
- Periodic snapshot grain
- Accummulating snapshot grain

A comparison of the three types is given in **Table 8**.

Table 8. Fact table type comparison (Adapted from Kimball and Ross 2002)

Characteristic	Transaction grain	Periodic snapshot grain	Accumulating snapshot grain
Time period represented	Point in time	Regular, predictable intervals (E.g. monthly)	Undetermined time span; typically short-lived
Grain	One row per transaction	One row per period	One row per life
Fact table loads	Insert	Insert	Insert and update
Fact row updates	Not revisited	Not revisited	Revisited whenever there is activity (E.g. reaching next milestone)
Date dimension	Transaction date	End-of-period date	Multiple dates for standard milestones
Facts	Transaction activity	Performance for predefined time interval	Performance over finite lifetime

Transaction fact tables represent the most fundamental view of the operations of the business at the individual transaction level, for example an invoice line item on an invoice.

Periodic snapshot fact tables are needed to see the cumulative performance of the business at regular, predictable time intervals. The periodic snapshots are stacked consecutively into the fact table and make it easy to retrieve a regular, predictable trend of the key business performance metrics, for example monthly sales figures per region.

Accumulating snapshot fact tables normally have multiple date stamps, representing the predictable major events or phases that take place during the course of a lifetime, for example a project or an application for a home loan. At the start of a new lifetime a record is inserted into the table, although many of the facts are not available yet. Whenever there is activity on that project or home loan application, the record will be revisited and additional fields will be captured.

By using combinations of these fact table types, different perspectives on the same story can be provided. One should also keep in mind that these fact tables share certain dimensions and by drilling across fact tables on the same grain (via the shared or conformed dimensions) new insights into the story may be gained.

2.5.3 Comparing Inmon and Kimball

Both Inmon and Kimball have contributed a lot to the field of data warehousing. Both have realised that transactional system data cannot form the foundation for effective, consistent enterprise-wide reporting and analysis. Neither can "stove pipe" departmental databases that are maintained in isolation. Both value the role of meta data management, although Inmon elaborates a lot more on the autonomy of the end-user versus the sharability of meta data across the CIF (Inmon et al. 2001), and even refers to meta data as the "glue" that keeps the CIF together.

Both make provision for an integration and transformation step in the process following the extraction process, although Kimball just calls it a data staging phase. They differ slightly in terms of the format of the tables in the data staging area – Inmon promotes a normalized relational model, while Kimball leaves it to the preference of the DW team, but suggests that flat files will have a performance advantage.

They differ, however, on a few critical points:

- The design architecture of the data warehouse
- The role of the ODS
- The definition of data marts

Inmon feels very strongly that the data warehouse component of the CIF should be designed as a normalized E/R model. From there, additional data marts can be extracted for use by departments or DSS analysts and these data marts may be based on star-joined, denormalized dimensional modelling principles. Kimball, on the other hand, insists on a data warehouse architecture that is based on dimensional modelling principles with the Bus Architecture to identify shared or conformed dimensions. The dimensions are denormalized by nature and "snowflaking" (where a single-table dimension is decomposed into a tree structure with potentially many nesting levels) is strongly discouraged.

For Inmon the ODS (operational data store) is a compulsory component of the CIF to support detailed, operational queries. Kimball questions the justification of an ODS based on his view that the data warehouse can also contain the transactional level data that is normally associated with the ODS. The only time when a separate ODS can be justified, according to Kimball, is when real-time data is necessary for the operational queries (and with more and more pressure for near real-time updates of the DW, this reason also falls away). In the Kimball approach many of the transactional fact tables will also be aggregated to periodic snapshot fact tables to cater for business users that are only interested in the summarized view.

Kimball sees each data mart as a building block for the larger data warehouse, while Inmon sees the normalized data warehouse as the source for separate, smaller data marts that are built and distributed to specific user groups. The concern of many Inmon supporters is that the mere grouping of a number of data marts can not constitute a data warehouse, based on the old idea of "stove pipe", or isolated, functional data marts. The Kimball counter argument is that his Bus Architecture where all data marts are described in terms of their dimensions during the initial planning phase, ensures that integration takes place and the building blocks fit neatly together through the conformed dimensions.

The name that Inmon gives to his model, "Corporate Information Factory", sounds very good to the ear of an industrial engineer. The concept of a processing plant where raw material (data) is sourced from various suppliers (captured through transactional systems and other sources), transformed into usable products (information in various formats) by well defined processes (ETL) and according to specifications (user requirements and functional specifications) that are under configuration management (meta data), using carefully selected resources (BI tools, servers, trained people) for production, quality assurance, packaging (e.g. robot logic, OLAP cubes, static intranet reports) and distribution (e.g. via client/server, web services, PDA devices, cell phones), are all too familiar concepts to the industrial engineering discipline.

However, although the author fully supports the concept of a corporate information factory where industrial engineering principles can be applied, the Kimball approach to the design of the data warehouse (simple data mart by data mart, driven by specific business needs and glued together by the Bus Architecture of conformed dimensions), leads the author to lean towards the Kimball approach when developing the Bigger Picture BI Context Model in the next chapter. The idea to accommodate the detailed transactional data requirements in a detailed data mart as part of the data warehouse (instead of a separate ODS), is a further plus point for the Kimball approach.

2.6 Knowledge management

It would be difficult to ignore the subject of knowledge management (KM) while trying to establish a bigger picture framework for business intelligence in organizations. More and more organizations are realising the value of knowledge captured in the minds of their employees and they also fear the risk of losing that knowledge when losing the employee. On a more positive note, they also anticipate that a lot more value can be unlocked when this knowledge is shared in the organization.

Swanepoel (2001) mentions, "knowledge management, like most other management philosophies, means many things to many people". He then refers to Davenport and Prusak, who support the concept that data, information and knowledge are the three basic entities of which knowledge is the broadest, deepest and richest. They give the following definition of knowledge:

> *Knowledge is a fluid mix of framed experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations it often becomes embedded not only in documents or repositories, but also in organizational routines, processes, practices and norms.*

Swanepoel (2001) also refers to Takeuchi and Nonaka who define knowledge management as follows:

> *KM is about capturing knowledge gained by individuals and spreading it to others in the organization.*

It is well known in knowledge management circles that knowledge can be classified as either explicit or tacit. Swanepoel (2001) points out that in practice these two concepts are not complete opposites, but rather a spectrum. Explicit knowledge at the one extreme is stating something in exact terms, not merely implying things. It is easier to identify and is reusable in a consistent and repeatable manner. On the other extreme, tacit knowledge is implied or understood without being put into words. Human beings are the storage medium of tacit knowledge, while explicit knowledge can be stored in computer systems, for example.

Swanepoel (2001) points out a number of knowledge management technologies (after commenting that these technologies often become the drivers, instead of the supporting tools of any knowledge management initiative):

- *Messaging and collaboration (such as e-mail, groupware, calendaring, workflow and document management).*
- *Data based technologies (such as data warehouses, data mining tools, predictive modelling and analytical tools such as OLAP that performs online analytical processing of multi-dimensional data cubes).*
- *Web based solutions (such as web publishing and content management, extranets, personalised information delivery and portals).*

Even though knowledge management does not feature as a separate building block in the Bigger Picture BI Context Model that is developed in the next chapter, the whole context diagram is developed with knowledge management as an underlying philosophy.

2.7 Performance measurement

2.7.1 Why do we need to measure performance?

How does one support a manager's claim "We did well last quarter"? The normal follow-up question is, "How do you know?"

Despite massive amounts of information, organizations still struggle to gain insight into this topic. When the manager just referred to, states that "we did well", how does the organization determine if the entire enterprise benefited from whatever that department did when they supposedly did well? One way to know is to improve the organization's measurement system. It is also evident that to answer another follow-up question "How well?" a process of measurement, preferably in quantitative terms, is required.

A major frustration of executives is to get employees to execute the strategy, be it the current one, or a change in strategy. CEOs and MDs are usually blamed if the company fails to do so.

When a strategy is changed, the massive inertia of the existing measures keeps employees at doing what they have been doing and a change in course may not come as quickly as the executives may have hoped (if ever!). Executives are more concerned with the fact that employees focus on what is important than on improving in what they have always done. How the employees are measured, plays a major role in this regard. "You get what you measure", according to Cokins (2002).

2.7.2 Performance measurement or management?

To determine if a business is successful, or if it is achieving its goals, one has to measure activities and compare them to future targets or goals. In other words, it is a process of measurement. Henry Morris (DMReview 2002), vice president of Applications and Information Access Software Research for IDC, states that in the process of business performance ***measurement***, data is analysed by dimensions and key performance indicators (KPIs).

Taking those measurements and analysing them to impact decision-making, is referred to as business performance ***management***. Thus, according to Morris (2002), "*Business Performance Management can be differentiated because it builds predictive models for leading performance indicators for enterprise optimisation and develops actionable information*".

Performance measurement is therefore a sub-set of the broader subject of performance management.

2.7.3 Link between strategic management and performance management.

It has become evident ever since the early 1990s that most economies no longer focus on physical workers, but on knowledge workers. For a company to achieve its goals, the drivers of the non-financial performance measures have to be exploited, as they are the major drivers of the success of the company. Kaplan and Norton (1996) identified some of the functions of intangible assets, which enable an organization to be successful:

- Develop customer relationships that retain the loyalty of existing customers and enable new customer segments and market areas to be served effectively and efficiently.
- Introduce innovative products and services desired by targeted customer segments.
- Produce customized high-quality products and services at low cost and with short lead times.
- Mobilize employee skills and motivation for continuous improvements in process capabilities, quality and response times.
- Deploy information technology, databases and systems.

Placing a reliable financial value on such assets as the new product pipeline, employee skills, motivation, customer loyalty, databases and systems is a difficult job, yet these are the very assets and capabilities that drive success in the 21st century company.

This thesis emphasizes the need that the processes yielding these intangible assets must be aligned with the company strategy to achieve the company mission and goals. In turn, the performance measures of the intangible assets must provide information that will either confirm that the company is moving in the right direction, or indicate that the strategy that is currently followed is not providing the expected results.

2.7.4 Cross-functional management

Traditionally businesses are generally divided into departments, e.g. Research and Development (R and D), Manufacturing and Marketing and Sales. A problem that may arise from viewing an organization vertically and functionally as in **Figure 44**, is the fact that managers also tend to manage the organization vertically and functionally.

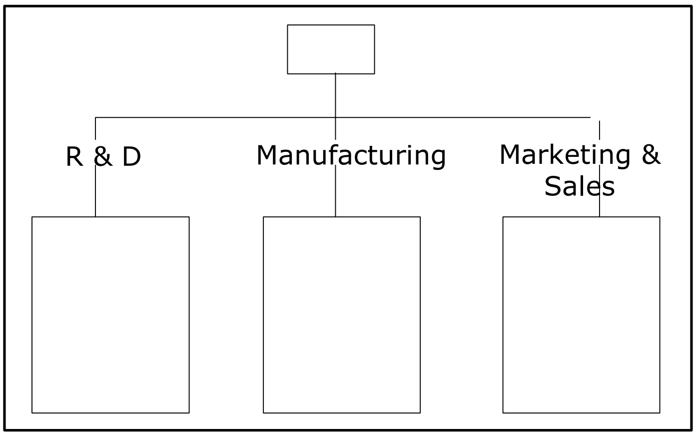


Figure 44. Traditional (vertical) view of an organization
(Rummler and Brache 1995)

This fact was identified by Rummler and Brache (1995) and formed the basis for their book: *Improving Performance, How to Manage the White Space on the Organization Chart*. (The white space refers to the areas between the blocks that normally indicate departments for which responsible persons are identified.) They identify three critical variables that influence effective performance management: the organization level, the process level and the job/performer level. The overall performance of an organization is a result of effectively applying good goals, structures and management actions at all three levels.

2.7.4.1 The organization level (I)

If a traditional view of an organization is taken, a common phenomenon that may arise is that "silos" (tall, thick, windowless structures as illustrated in **Figure 45**) are built around the individual departments that prevent interdepartmental communication. Because of bad communication cross-functional issues are often escalated to the top for managers to resolve instead of the problem being addressed among peers at the required level.

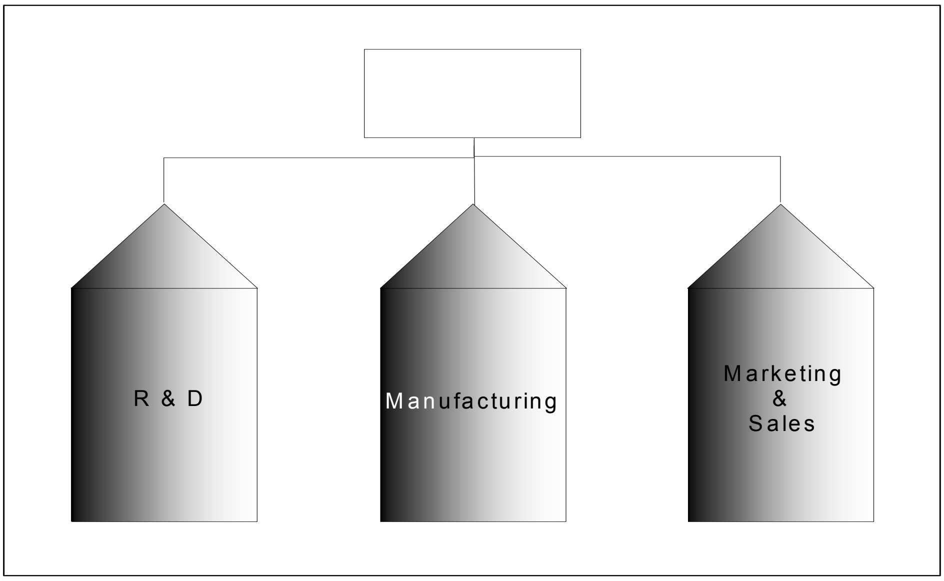


Figure 45. The "silo" phenomenon (Rummler and Brache 1995)

> *The silo culture forces managers to resolve lower-level issues, taking their time away from higher-priority customer and competitor concerns. Lower–level employees, who could be resolving these issues, take less responsibility for results and perceive themselves as mere implementers and information providers.* (Rummler and Brache 1995)

An organization does not exist only of independent, individual functions, but of functions that form a process. If one function excels but it does not improve the process as a whole, the performance of the organization as a whole will deteriorate. For example, if R & D looks good by designing a technically sophisticated product, but Marketing cannot sell the product, then it is not necessarily only Marketing's problem. What should first be considered is whether R & D and Marketing had effective communication beforehand to determine if a market existed for the product that they were designing.

Often function heads are so at odds that cross-functional issues are not even addressed. These are the handover problems (or white spaces) so often heard of where things "fall into the cracks" or "disappear into a black hole".

These facts require that organizations are viewed and managed in a different way so that the gaps (or the white space, as Rummler and Brache call it) are also managed.

The systems (horizontal) view of an organization

Rummler and Brache (1995) introduced a different perspective on this scenario and called it the horizontal or systems view of an organization, illustrated in **Figure 46**.

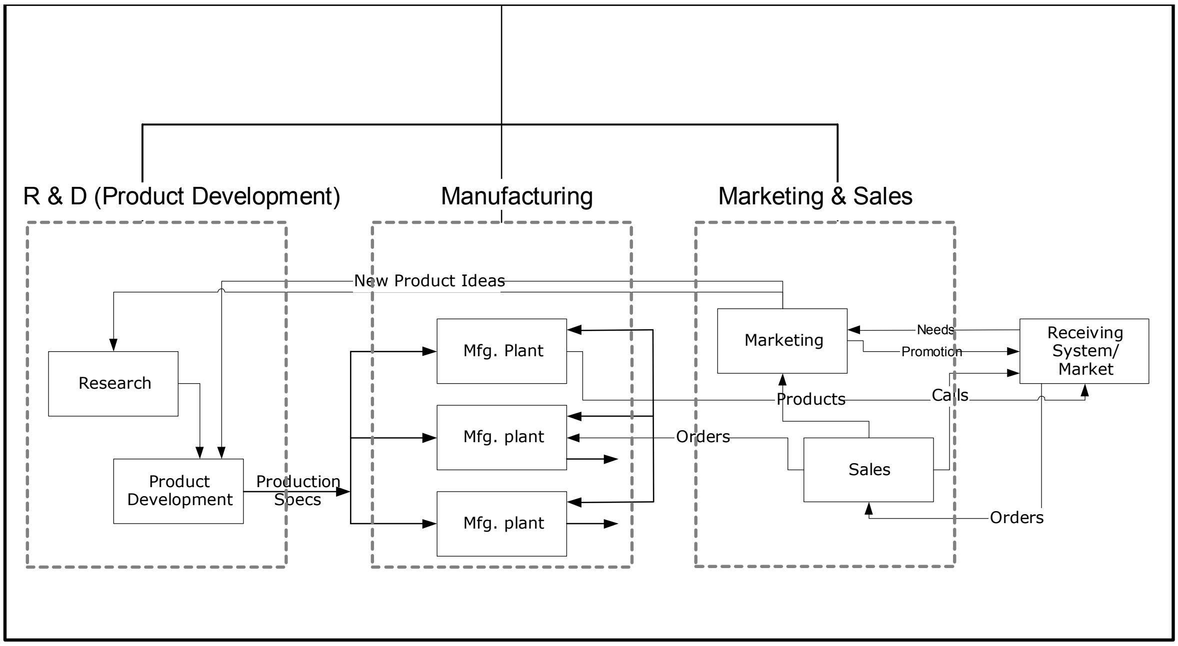


Figure 46. Systems (horizontal) view of an organization
(Rummler and Brache 1995)

This perspective includes three key ingredients: the customer, the product and the flow of work. The flow of work enables one to see how the work actually gets done, which is through processes that cut across functions. The internal customer-supplier relationship is also clearly understood from this perspective. For example, manufacturing is provided with the production specifications from R & D and thus manufacturing is an internal client of R & D. Rummler and Brache (1995) believe that the greatest opportunities for performance improvement lie within the interfaces between the functions.

According to the traditional view of an organization as shown in **Figure 44**, managers tend to manage the organization chart rather than the business. It is general practice that individual functions of an organization do have managers. A higher-level manager should not only manage say manufacturing *and* R & D *and* marketing, but also the interfaces between these functions.

The organization as an adaptive system

It is evident that ever since the 1990s, (some might even argue it was earlier) a major requirement of any organization is pro-change, i.e. adaptability. The systems perspective of an organization claims to support the need for adaptability and provides managers with the ability to predict and proactively cope with change. **Figure 47** presents the organization as an adaptive system.

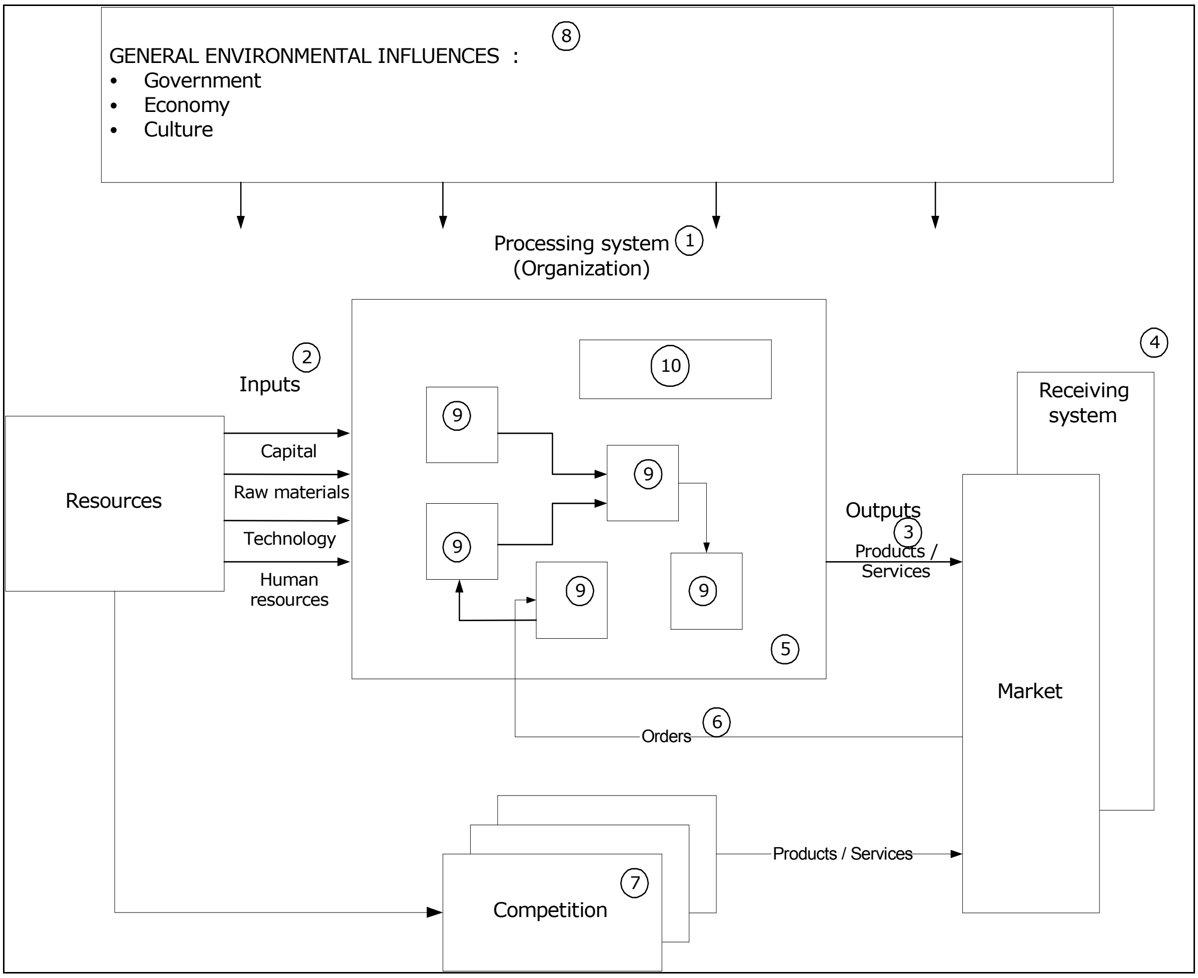


Figure 47. An organization as an adaptive system
(Rummler and Brache 1995)

Looking at **Figure 47** an organization is presented as a processing system (1) that converts inputs (2) into products or service outputs (3), which it provides to receiving systems or markets (4). The organization is guided by its own internal criteria and feedback (5), but is ultimately driven by the feedback from its market (6). The competition (7) may also utilize the same resources and provide products or services to the market. This scenario plays out in a social, economic and political environment (8).

Inside the organization various functions and systems exist that convert the inputs into products or services (9). Finally the organization has a control mechanism called management (10).

A common method to be pro-change is to use what-if scenarios to determine possible changes in the market and assess their impact on every component of the organization. The results will help establish the rate and direction of change required within the organization and this can be incorporated into its strategy.

2.7.4.2 The process level (II)

When looking at an organization, Rummler and Brache (1995) refer to Level I, the organization level, as the skeleton (**Figure 48**) and Level II (**Figure 49**), the process level, as the "*musculature of the cross-functional processes".*

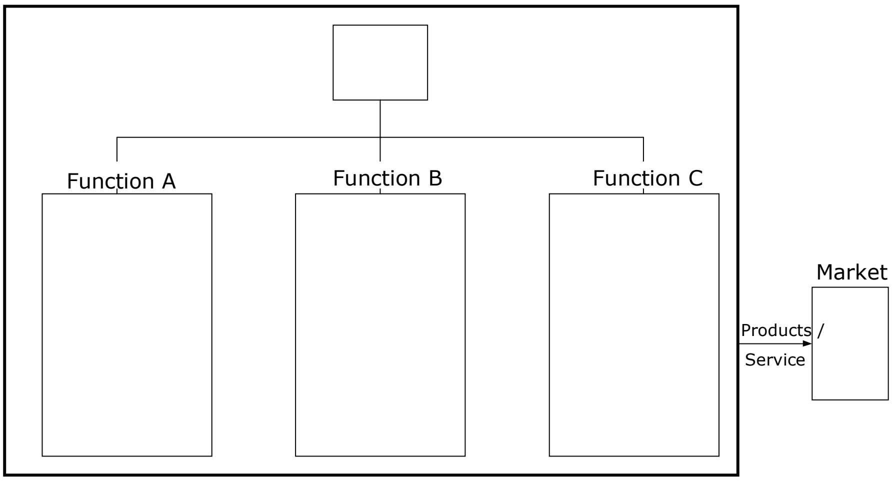


Figure 48. The organization level of performance
(Rummler and Brache 1995)

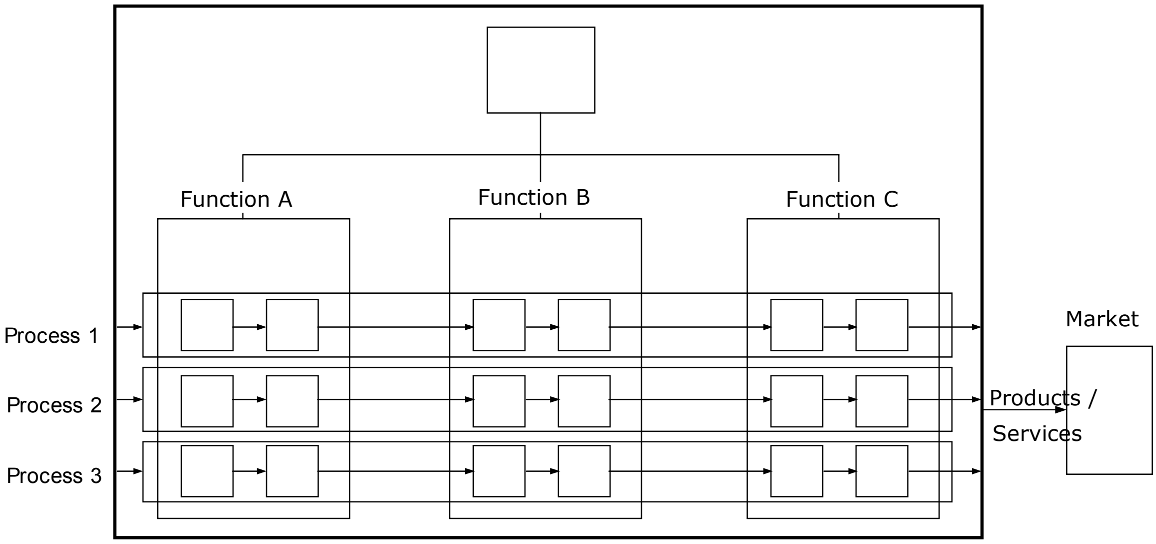


Figure 49. The process level of performance
(Rummler and Brache 1995)

"*An organization is only as good as its processes"* (Rummler and Brache 1995). By looking one level deeper, at the processes, one can see the workflow. **Figure 49** illustrates that these processes are cross-functional and thus require cross-functional management. Examples of such processes would include the new-product design process, the production process and the sales process, to name but a few. To manage the performance variables at the process level, the organization has to ensure that the processes are aligned with the customer needs and that these processes work effectively and efficiently. The process goals and measures can also be aligned with customer and organization requirements.

Process design

Process mapping is illustrated (**Figure 50**) by using an example of Rummler and Brache (1995). The mapping process starts by first identifying the functions, departments or disciplines involved with the process, listing them on the left-hand axis and drawing a horizontal "swim-lane" for each. The team traces the process of converting the input through each intervening step, until the final output is produced. The map provides critical information on interfaces, overlays and disconnects within the process.

After the current situation has been mapped, the team creates a "to be" process map that addresses all the problems identified in the current situation, using a similar swim-lane diagram.

The swim-lane diagram can also be used as an effective process flow diagram in preparation of a simulation model, should the process require to be simulated. It already indicates all the resources and activities and it should not be difficult to add expected process times, resource capacities, probabilities where the work flow split up and any other required input parameters. Having an overview of the process, it should also be possible to identify relevant output parameters, such as time intervals between various points, throughput and utilization of various resources.

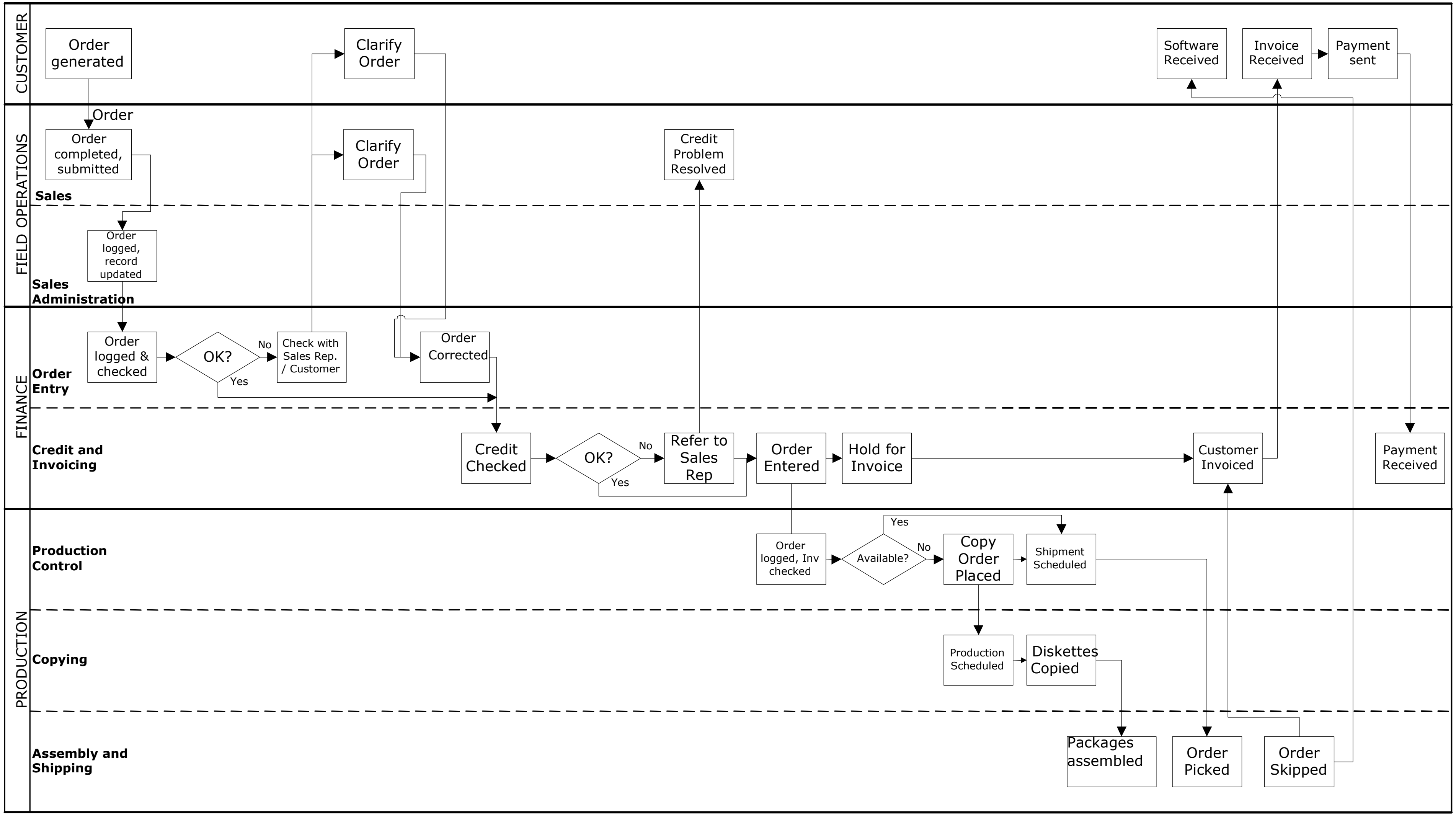


Figure 50. Computec order filling: "As-is" process map (Rummler and Brache 1995)

2.7.4.3 The job/performer Level (III)

Organization outputs are produced through processes of which the process steps in turn are performed and managed by individuals. See **Figure 51**.

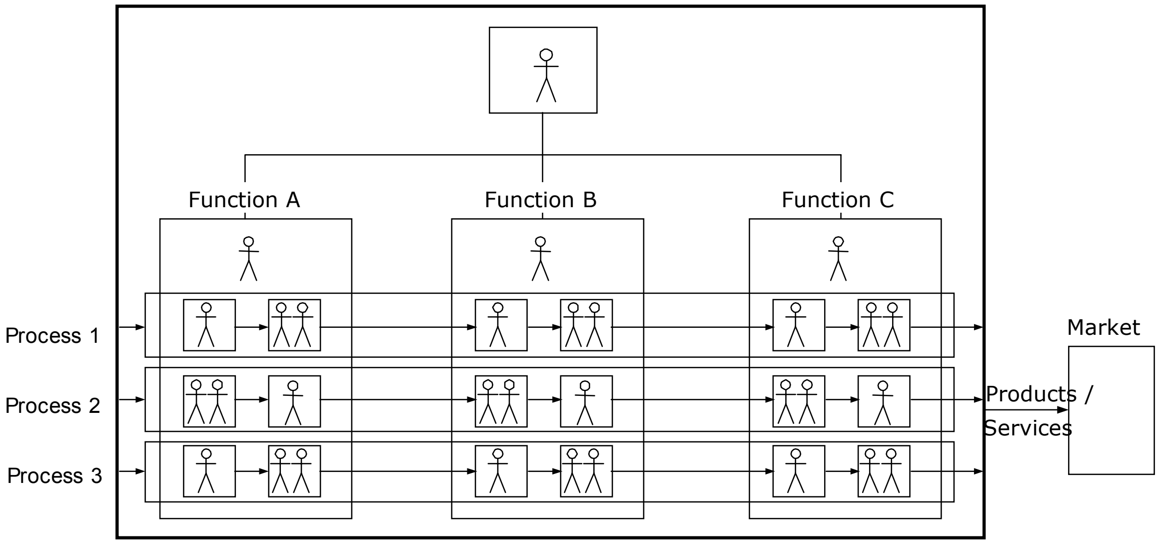


Figure 51. The job/performer level of performance
(Rummler and Brache 1995)

The individuals represent the cells of the body and they perform the actual process steps and then pass their completed work on to the following performer. Typical performance variables that must be managed at this level include hiring and promotion, job responsibilities and standards, feedback, rewards and training.

2.7.4.4 A holistic view of performance

Table 9 presents Nine Performance Variables, as introduced by Rummler and Brache (1995), in terms of questions. Two conclusions were drawn based on the systems view of performance:

- To manage the performance of an organization effectively requires goal setting, structuring and managing at each of the three levels.
- The three levels are interdependent. For example, any organizational goals that are set will fail if processes and individual performance systems do not support these goals.

Shortcomings of many attempts to change and improve an organization are a common result of failing to consider all three levels of the framework.

Table 9. The Nine Performance Variables with questions (Rummler and Brache 1995)

Performance Needs

Performance Levels	GOALS	DESIGN	MANAGEMENT
ORGANIZATION LEVEL	ORGANIZATION GOALS ▪ Has the organization strategy/direction been articulated and communicated? ▪ Does this strategy make sense, in terms of the external threats and opportunities and the internal strengths and weaknesses? ▪ Given this strategy, have the required outputs of the organization and the level of performance expected from each output been determined and communicated?	ORGANIZATION DESIGN ▪ Are all relevant functions in place? ▪ Are there unnecessary functions? ▪ Is the current flow of inputs and outputs between functions appropriate? ▪ Does the formal organization structure support the strategy and enhance the efficiency of the system?	ORGANIZATION MANAGEMENT ▪ Have appropriate function goals been set? ▪ Is relevant performance measured? ▪ Are resources appropriately allocated? ▪ Are the interfaces between functions being managed?
PROCESS LEVEL	PROCESS GOALS ▪ Are goals for key processes linked to customer / organization requirements?	PROCESS DESIGN ▪ Is this the most efficient/effective process for accomplishing the process goals?	PROCESS MANAGEMENT ▪ Have appropriate process sub-goals been set? ▪ Is process performance managed? ▪ Are sufficient resources allocated to each process? ▪ Are the interfaces between process steps being managed?
JOB / PERFORMER LEVEL	JOB / PERFORMER GOALS ▪ Are job outputs and standards linked to process requirements (which are in turn linked to customer and organization requirements)?	JOB DESIGN ▪ Are process requirements reflected in the appropriate jobs? ▪ Are job steps in a logical sequence? ▪ Have supportive policies and procedures been developed? ▪ Is the job environment ergonomically sound?	JOB/PERFORMER MANAGEMENT ▪ Do the performers understand the job goals? ▪ Do the performers have sufficient resources, clear signals and priorities and a logical job design? ▪ Are the performers rewarded for achieving the job goals? ▪ Do the performers know if they are meeting the job goals? ▪ Do the performers have the necessary knowledge/skill to achieve the job goals? ▪ If the performers were in an environment in which the five questions listed above were answered, "yes", would they have the physical, mental and emotional capacity to achieve the job goals?

Table 10 shows how measures or KPIs are to be defined in order to incorporate specific aspects of a process. Notice the goals that reveal whether the organization is on target and whether everyone has the same perception of what good achievement is.

Table 10. Selected functional goals based on Computec order-filling process goals (Rummler and Brache 1995)

FUNCTION	Functional Goals Summary (Measures & Goals)							
	Timeliness		Quality		Budget		Other	
	Measures	Goals	Measures	Goals	Measures	Goals	Measures	Goals
TOTAL PROCESS	% Orders received by customer within 72 hours of company receipt	95	% Orders correct	100	Avg. handling cost/order	$3.50	% Bad debts Inventory Turns	0.01 60
SALES	% Orders entered within 10 hours of receipt	100	% Orders correct	100				
SALES ADMINISTRATION								
CREDIT & INVOICING	% Credit checks done within 24 hours of order receipt	100			Processing cost per order	$.50	% Bad debt	0.01
PRODUCTION CONTROL					Processing cost per order	$.50	Inventory turns	60
COPYING			# Of scheduling errors	2				
ASSEMBLY & SHIPPING	% Orders shipped within 4 hours of receipt	100	% Accurate orders	100	Processing cost per order	$2.50		

In summarising this section it can be said that the swim-lane approach of Rummler and Brache (1995), together with their identification of the three performance measurement levels (organization, process and individual) forms a cornerstone of the Bigger Picture BI Context Model that will be developed in the next chapter.

2.7.5 The Balanced Scorecard (BSC)

> *The Balanced Scorecard (BSC) translates an organization's mission and strategy into a comprehensive set of performance measures that provides the framework for a strategic measurement and management system.* (Kaplan and Norton 1996)

The scorecard measures organizational performance across four perspectives:

- Finance
- Customers
- Internal business processes
- Learning and growth

Evident from these four perspectives is the fact that financial indicators are not the only measures taken into consideration. The financial measures are complemented with measures of the drivers of future performance.

The objectives and measures of the scorecard are derived from an organization's vision and strategy and it thus enables executives to visualize the performance of the company in terms of the vision and strategy.

The following paragraphs cover the fundamentals for building objectives and measures in each of the four scorecard perspectives, as defined by Kaplan and Norton (1996).

2.7.5.1 Financial perspective

The financial perspective represents the long-term goal of a company - being able to achieve superior returns on the capital invested. Executives can specify the metrics by which the long-term success of a company will be evaluated. The most important variables that drive the long-term success can also be identified and chosen to serve as a measurement.

Kaplan and Norton (1996) identify three stages by which any company can be categorized in order to present a framework from which companies can select financial objectives:

- Grow
- Sustain
- Harvest

Growing businesses are at the early stages of their life-cycle. These companies focus mostly on the customer instead of internal processes, and on increasing their market share. The company makes investments for the future that may consume more cash than can currently be generated by the limited base of existing products, services and customers. They may even operate with a negative cash flow and low current returns on invested capital that will cause their financial measures to be quite different from those of more established businesses.

The majority of business units in a company will be in the **sustaining** stage. These units still attract investment and reinvestment, but excellent returns are required for the invested capital. Their financial objectives are focused on profitability and can be expressed by using measures related to accounting income, such as operating income and gross margin.

Some business units will have reached a phase where they want to **harvest** the investments made in the two earlier stages. These units have reached a mature phase of their life cycle. The main financial goals of the business units will be to maximize cash flow back to the corporation; it will therefore focus on operating cash flow and reductions in working capital requirements.

Generally, three financial themes drive the business strategy, according to Kaplan and Norton (1996):

- **Revenue growth and mix**
  These strategies will focus on expanding product and service offerings, as well as reaching new customers and markets.

- **Cost reduction/productivity improvement**
  These strategies will focus on lowering the direct costs of products and services, reducing indirect costs and sharing common resources with other business units.

- **Asset utilization/investment strategy**
  These strategies will focus on reducing working capital levels required to support a given volume and mix of business and obtaining greater utilization of their fixed asset base.

These themes, which correlate strongly with the views of Tony Manning (2001) on growth, cost reduction and increasing the customers' perception of value (see par. 2.3.4.2), are illustrated in **Table 11**, which acts as a classification scheme from which businesses can choose financial objectives relating to these themes.

Table 11. Measuring strategic financial themes (Kaplan and Norton 1996)

		Strategic themes		
		Revenue growth and mix	**Cost reduction/ Productivity improvement**	**Asset utilization**
Business unit strategy	**Growth**	Sales growth rate by segment Percentage revenue from new products, services, customers	Revenue/Employee	Investment (percentage of sales) R&D (percentage of sales)
	Sustain	Share of targeted customers and accounts Cross-selling Percentage revenues from new applications Customer and product line profitability	Cost vs. competitors' cost Cost reduction rates Indirect expenses (percentage of sales)	Working capital ratios (cash-to-cash cycle) ROCE by key asset categories Asset utilization rates
	Harvest	Customer and product line profitability Percentage unprofitable customers	Unit costs (per unit of output, per transaction)	Payback Throughput

2.7.5.2 Customer perspective

In the customer perspective, according to Kaplan and Norton (1996), companies identify their target market, which are the customers that will deliver the revenue component of the company's financial objectives. Companies also establish the value propositions they will deliver to their customers. These include product or service attributes, customer relationships, image and reputation.

The customer core measurements are generic across all kinds of organizations. They include:

- Market share
- Customer retention
- Customer acquisition
- Customer satisfaction
- Customer profitability

These core measures can be grouped in a causal chain of relationships as shown in **Figure 52**.

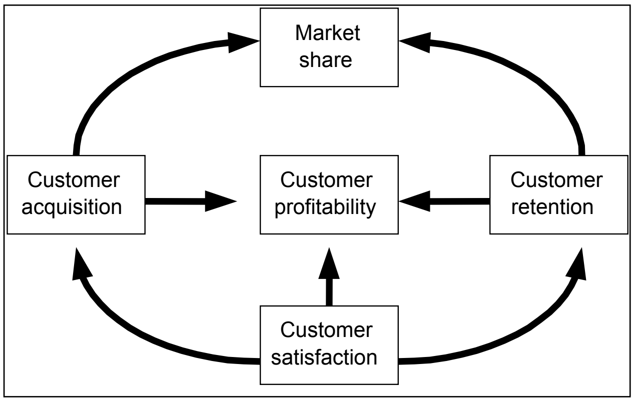


Figure 52. The customer perspective
(Kaplan and Norton 1996)

Kaplan and Norton (1996) define these core measures as follows:

> ***Market share***
> *reflects the proportion of business in a given market (in terms of number of customers, dollars spent or unit volume sold) that a business unit sells.*
>
> ***Customer acquisition***
> *measures, in absolute or relative terms, the rate at which a business unit attracts or wins new customers or business.*
>
> ***Customer retention***
> *tracks, in absolute or relative terms, the rate at which a business unit retains or maintains ongoing relationships with its customers.*
>
> ***Customer satisfaction***
> *assesses the satisfaction level of customers along specific performance criteria within the value proposition.*
>
> ***Customer profitability***
> *measures the net profit of a customer, or a segment, after allowing for the unique expenses required to support that customer.*

It should be clear that these core measures should be in balance in the long run, although some might have a higher priority during a certain stage in the life cycle of the business. For example, if market share and customer acquisition is growing, while customer profitability is decreasing (perhaps because of too low prices), it will not be a sustainable business.

2.7.5.3 The internal business process perspective

Kaplan and Norton (1996) explain what this perspective entails:

> *This perspective represents the internal business processes of the company that create value for the customer and in turn produce financial results. It is important that companies need to reconsider their current operations to ensure that the internal processes meet shareholder and targeted customer expectations. If the processes do not support the company strategy, then the objectives and measures for the internal-business-process perspective will not produce information that can lead decisions in the direction of the strategy. Decisions will only be made to improve the current processes, which already do not support the processes and hence, the*

improvements cannot produce the ultimate results desired.

Kaplan and Norton (1996) identified a generic value-chain model (**Figure 53**) that acts as a customisable template for companies in preparing their internal business process perspective.

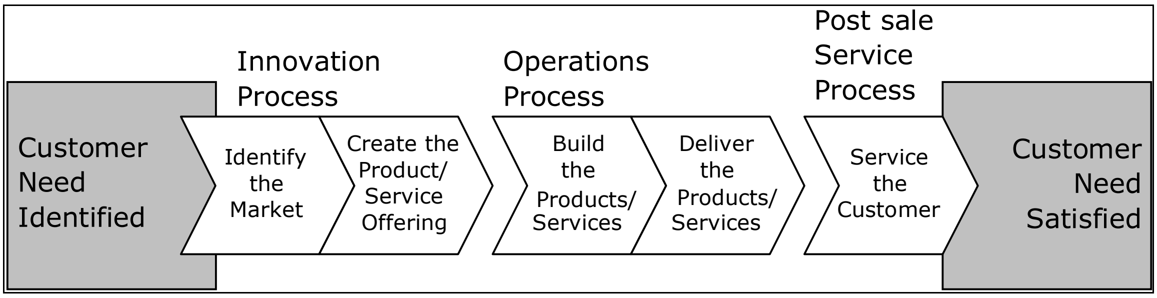


Figure 53. The generic value model (Kaplan and Norton 1996)

In the innovation process, the market is analysed and the customer needs are identified. Then the products and services are created that will satisfy these needs. Within the Operations Process existing products and services are produced and delivered to customers. At the start of the 21st century, the final step is probably the most important as this after sale service may determine whether a company will retain a customer or not.

2.7.5.4 The learning and growth perspective

> *The Balanced Scorecard stresses the fact that companies need to be pro-change and should not just adapt to change, but create change. The Learning and Growth Perspective develops objectives and measures that stimulate and drive organizational learning and growth. These objectives and measures enable ambitious objectives in the other three perspectives to be achieved.* (Kaplan and Norton 1996)

Kaplan and Norton (1996) further identified three principal categories for the learning and growth perspective:

- Employee capabilities
- Information systems capabilities
- Motivation, empowerment and alignment

Organizational capabilities are built by significant investments in people, systems and processes. Outcome measures from investments in employee, systems and organizational alignment can be obtained from measures such as the satisfaction, productivity and retention of employees.

2.7.5.5 Linking BSC measures to the business strategy

It is imperative that all managers will be able to implement the strategy decided upon by the business unit. If they can translate their strategy into a measurement system, they are already one step ahead, because they will be able to measure their performance against the objectives of the strategy and thus determine if they are executing the strategy successfully.

This requires that organizations link the Balanced Scorecard to their business strategy. One way of doing this is by establishing cause-and-effect relationships for each measurement thus linking all the measures with each other to tell a short story (or define a hypothesis).

Cause-and-effect relationships can be expressed by means of if-then statements. Kaplan and Norton (1996) used the following example to illustrate:

> If *we increase employee training about products,* then *they will become more knowledgeable about the full range of products they can sell;* if *employees are more knowledgeable about products,* then *their sales effectiveness will improve.* If *their sales effectiveness improves, then the average margins of the products they sell will increase.*

It can also be illustrated as in **Figure 54**.

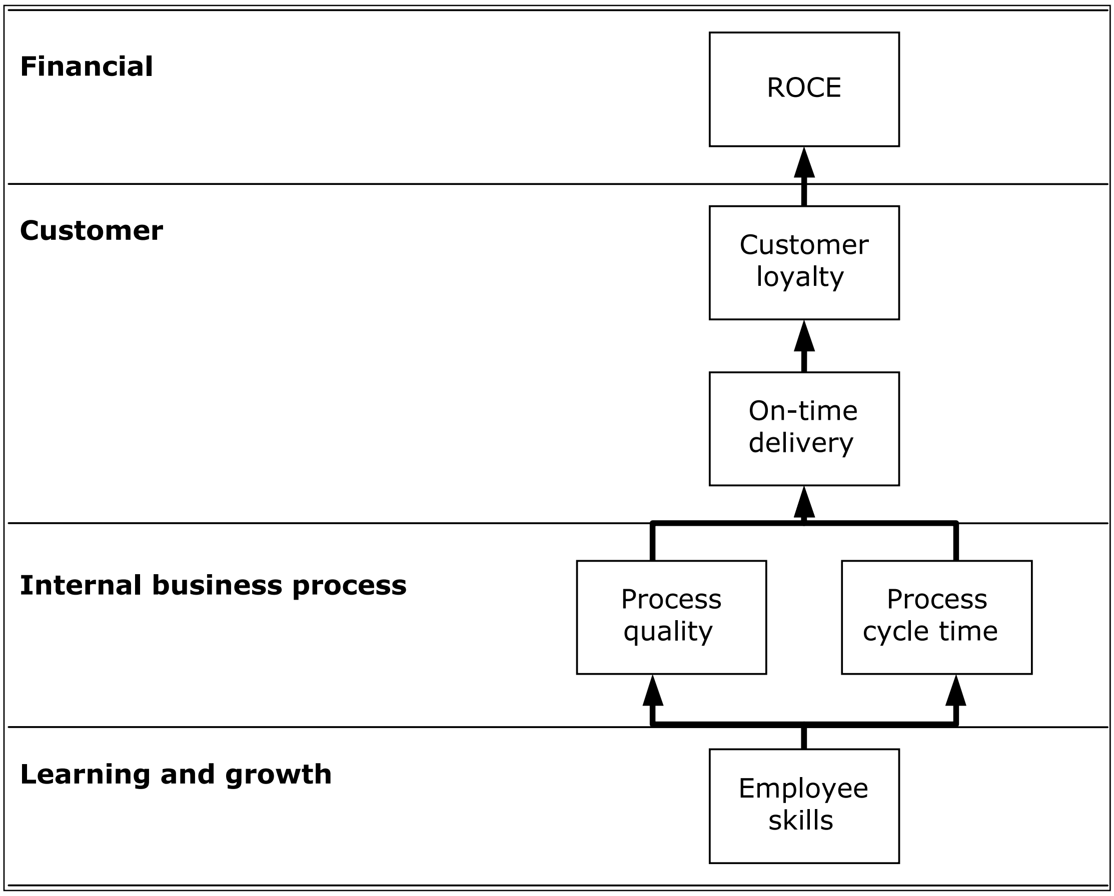


Figure 54. Cause-and-effect example (Kaplan and Norton 1996)

Thus, a properly constructed Balanced Scorecard should clearly communicate the story of the business unit's strategy.

The cause-and-effect relationships correlate strongly with similar diagrams and logic that are promoted by Goldratt (1992) in his theory of constraints (TOC) with which engineering students may be more familiar. The interested reader may want to explore the TOC principles further, because there are a number of powerful techniques that may help to establish a more feasible measurement hierarchy of cause-and-effect measures. One such a technique is the Evaporating Cloud, which is a thinking process that enables a person to present the conflict that is sometimes present in our cause-and-effect reasoning very accurately. The technique then directs the search for a solution by challenging the assumptions underlying the conflict.

2.7.6 Key performance indicators (KPIs)

This section explores different methods for an organization to establish its key performance indicators (KPIs). One way to identify KPIs has already been examined in the discussion of the work done by Rummler and Brache (1995), as well as the Balanced Scorecard.

In his interesting article "*Data warehousing: It's not about data, it's about measuring performance*", Lawrence Corr (2003) describes the differences between facts, measures and KPIs and the impact they have on data warehouse development. He defines KPIs as high level measurements that offer a rapid assessment of the current state of the organization and answer the "How are we doing?" type of question. If only these high level indicators are available, without the detailed operational facts behind the KPIs, it is not possible to answer the "Why is this happening?" type of question. *"KPIs without the detail and the detailed atomic facts without the KPIs don't work well."* (Corr, 2003)

According to Corr (2003) facts are the raw numeric values that are captured in each transaction by the operational systems – they exist in millions and are ideally additive. Measures are *"best described as facts summarized or aggregated to a common level of summarization suitable for comparison."* They are typically what business users ask for. *"KPIs are measures expressed as self-contained ratios or percentages … users can gain understanding from viewing a single figure without having knowledge of previous values or performing further analysis in conjunction with other measures."* This is what business users really need and include time comparisons, target/budget comparisons, competition comparisons and other ratios.

Corr (2003) further notes that KPIs do not exist in large quantities and by understanding which measures and KPIs are most valuable, one can accelerate the requirement definition process and prioritize important requirements – helping the data warehouse team to control the scope since they do not have to pull in all data from all data sources to decide what is important.

There are, however, generic functions in all businesses and one can also identify a number of relevant KPIs by working through an existing checklist of typical ones.

2.7.6.1 24 Ways by Richard Connelly et al.

Connelly et al. (1999) suggest 24 Ways, which cover a variety of information "sweet spots" in which KPIs can be identified. They are typical measurements in a manufacturing organization that wants to excel in the new business models where the emphasis moves away from products and revenue to customer and profit-centric organizations. Information "sweet spots" are defined as a relatively small number of positions in the information flow through an organization that contain the most valuable information for corporate decision-making.

Even though the 24 Ways are identified for the most general type of business, namely manufacturing, where they are strongly identified with the flow of products and services across the supply chain, the underlying business issues also apply to any corporation or governmental organization. The 24 Ways are grouped into eight areas, which are normally organized into separate departments. They are briefly discussed in the following paragraphs and mapped to the BSC perspectives as identified by Kaplan and Norton.

Finance

1. Multidimensional income statement
2. Profit drill-down analysis

3. Multidimensional balance sheet
4. Key financial ratios
5. Cash flow analysis

These ways can strongly be identified with the financial perspective of the BSC. Typical dimensions include time period, organizational department, income statement lines and balance sheet lines. The typical measures compare actual figures with planned or budget figures.

Sales

6. Sales analysis
7. Customer and product profitability
8. Sales plan vs. forecast
9. Sales pipeline

These four ways are shared between the BSC perspectives of finance and internal business processes (of marketing and sales). Additional dimensions include product, customer and sale type.

Marketing

10. Strategic marketing analysis
11. Tactical marketing analysis

These ways are associated with the BSC perspective of internal business process (of marketing). Additional dimensions could include marketing channel, marketing campaigns, market segment and in certain circumstances, product attributes.

Purchasing

12. Inventory turnover
13. Supplier scorecard

These ways are associated with the BSC perspective of internal business process (of purchasing). Additional dimensions include supplier, terms, delivery performance category and inventory location.

Production

14. Capacity management
15. Standard product cost and quality
16. Cause of poor quality

These ways are associated with the BSC perspectives of internal business process (of production scheduling and quality assurance), as well as the financial perspective. Additional dimensions include work stage (e.g. set-up, assembly, inspection and packaging), production run and reject reasons.

Distribution

17. Carrier scorecard

This way is associated with the BSC perspective of internal business process (of distribution). Additional dimensions include carrier, destination, distance category and customer type (e.g. JIT, buy and hold).

Customer service

18. On-time delivery
19. Complaints, returns and claims
20. Cost of service relationship

These ways are associated with the customer perspective of the BSC. Additional dimensions include lead-time categories (e.g. >30 days, 6-30 days, 1-5 days), % late categories (on time/early, 1-2 days late, 3-7 days late) and reasons for complaints/returns/ claims.

HR/IT

21. HR administration
22. Core competence inventory
23. BI deployment
24. ROI of the 24 Ways

These ways are associated with the learning and growth perspective of the BSC. Additional dimensions include job group, salary grade, status (e.g. full time, part time), length of service category, performance, core skill and rating.

Although these 24 ways are by no means applicable to all organizations and there might be other relevant KPIs in specific industries, they do provide a valid starting point for the identification of KPIs and help to determine whether there is a healthy mix of KPIs between the different business functions.

2.7.6.2 PIs and MIs by Absolute Information

Something worth noting about the work of Absolute Information is the ability they have to classify and define each element with the aim to simplify the concept of information. Before performance indicators (PIs) and management indicators (MIs) are described, it is appropriate to revise the four information types identified by Absolute Information (2001).

Type	Arrow	Description
Synit	↑	Long range forecasting information
Revit	←	Summarized past performance
Operit	→	Short range instructions and decisions
Cognitive	↓	Description

Absolute Information (2001) categorizes indicators into two groups, namely indicators (Revit) and factors (Synit or Operit). (Note that a management indicator (MI) in their terminology is the same thing as a key performance indicator.)

Indicators

Indicators are further classified into either "simple" or "compound" types. Both refer only to *Revit* information. Process indicators would be classified as "simple" (RPIs) and management indicators as "compound" (RMIs.)

Factors

Factors are also classified into two types, but in a different manner. They exist for the two future-based information types, Synit and Operit. They are known as Synit management indicators (SMIs) and Operit management indicators (OMIs).

Indicators (RPIs and RMIs) by themselves are usually not sufficiently sophisticated for decision-making. A factor is based on **Operit** information as it assists in short term decision-making. Thus an RMI requires some form of calculation or comparison in order to derive OMI factors.

Process indicators

As previously stated, PIs are simple indicators. They are "raw" basic data elements, supplied directly from a process and have not been combined with any other indicators or factors.

An RPI, such as the reading from a counter, is usually not good for management, since it cannot support decision-making. It needs to be combined with something else, such as elapsed time, to give an RMI. Thus the difference between an RPI and an RMI lies only in their degrees of complexity.

Three types of process indicators are identified by Absolute Information (2001):

1. ***Revit process indicators (RPIs)***

RPIs are variable and represent only actual historical occurrences:

- *Number of new staff hires*
- *Amount of cash spent*
- *Count of breakdowns experienced*
- *Quantity of product sold*

2. ***Operit process indicators (OPIs)***

OPIs are variable and represent required instruction capabilities:

- *Number of new staff required*
- *Amount of cash to be spent*

3. ***Synit process indicators (SPIs)***

SPIs are relatively fixed and represent design capabilities:

- *Number of staff expected to be required*
- *Amount of cash spent required in the long term*
- *Expected life span of a vehicle in kilometres*

Management indicators

Management indicators are compound indicators. They are the result of combining, or comparing, PIs with defined time frames. This is a mathematical and/or Boolean process. Thus, they are of higher sophistication than PIs. This concept is illustrated by the following example:

First RPI = Quantity of product sold: 80
Second RPI = Number of days that product was sold: 5
Combined RMI = Average daily sales: 80/5=16 per day

Three types of management indicators are identified by Absolute Information (2001):

1. ***Revit management indicators (RMIs)***

RMIs are variable and represent only actual historical occurrences:

- *Number of new staff hires this month*
- *Amount of cash spent this week*
- *Count of breakdowns experienced over the last 30 days*
- *Quantity of product sold this year*

The information may have been collected from various PIs, but should be delivered in the form of RMIs.

2. ***Operit* management indicators (OMIs)**

OMIs are variable and represent required instruction capabilities:

- *Number of new staff required this month*
- *Amount of cash to be spent this week*

3. ***Synit* management indicators (SMIs)**

SMIs are relatively fixed and represent design capabilities:

- *Number of staff expected to be required next year*
- *Amount of cash required for next year's budget*

It is necessary to understand the distinction between basic data elements (process indicators) and the more sophisticated compound indicators (management indicators), because this clearly influences the design of the data warehouse from where these KPIs are normally reported.

2.7.7 Summary

This section on performance management has covered the motivation for performance measurement, the framework for measurement at the different levels as defined by Rummler and Brache (1995) - organization, process and individual levels, as well as the need to align measurements with strategy as proposed by the Balanced Scorecard methodology of Kaplan and Norton (1996).

The differences between facts, measures and KPIs as seen by Corr (2003) have been addressed. Typical KPIs as proposed in the 24 Ways of Connelly et al. (1999) and the clear distinction between basic data elements and the more sophisticated management indicators (MIs) as explained by Absolute Information (2001) were also dealt with. This section laid an important foundation for the performance management component of the bigger picture context diagram that will be developed in the next chapter.

2.8 Merging business intelligence (BI) with technology

2.8.1 Business intelligence

Business intelligence (BI), according to the definition by Kimball and Ross (2002) is "*a generic term to describe leveraging the organization's internal and external information assets for making better business decisions*".

Inmon et al. (2001) see BI as *"representing those systems that help companies understand what makes the wheels of the corporation turn and to help predict the future impact of current decisions. These systems play a key role in the strategic planning process of the corporation."*

Both definitions refer to improved decision-making by using information assets in a specific way. Inmon et al. (2001) go further and point out the value for strategic planning, but it is probably also implied by Kimball and Ross (2002) under the broader term of "business decisions". The author agrees with both definitions and would like to stress the goal of BI – namely to make better business decisions. BI should never be implemented for any other reason.

The systems that Inmon et al. (2001) refer to include transactional databases and applications, the data warehouse database, staging processes (extraction/ transformation/loading) to cater for integration of disparate systems, end-user applications that may include ad hoc query tools, standard reports on an intranet, dashboard / robot systems, sophisticated data mining tools, data quality tools, meta data repository and many other technologically advanced tools. However, it should always be understood that these systems that represent BI are only in place to support better business decisions.

To elaborate on the decision-making theme, the next section will define a decision and discuss a few aspects regarding decisions.

2.8.2 The decision-making process

Gore et al. (1992) provide a number of definitions for a decision from other sources. For example, Mintzberg defines a decision as "*a specific commitment to action*" and implied by that also a commitment of resources. Harrison defines it as "*simply a moment in an ongoing process of evaluating alternatives for meeting an objective".* It assumes that there is a decision-making cycle with a distinct number of stages and that the decision is just the moment of choice.

Gore et al. (1992) also point out levels of decisions by referring to the classifications of a number of other sources. Simon has categorized them into two groups, namely "programmed" and "non-programmed" decisions. Drucker has suggested the names "generic" and "unique" for these two categories, where the generic decisions are routine, deal with predictable cause and effect relationships, use defined information channels and have definite decision criteria. This type of decision is often handled by rules and procedures and is normally taken by middle and lower management. Unique decisions on the other hand, require judgement and creativity, because they are complex and characterized by incomplete information and uncertainty, and are normally taken by top management.

After listing a number of sources (Simon, Schrenck, Janis, Mintzberg, Witte, Harrison, Bridge, Hill and a few more) that have mentioned different stages in a decision-making process, Gore et al. (1992) conclude with the following steps in a generic decision process:

- *Set objectives.*
- *Problem recognition (Identify a need for a decision based on internal or external changes).*
- *Define the problem.*
- *Search inside and outside for solutions.*
- *Develop alternatives.*
- *Evaluate alternatives.*
- *Make the actual choice.*
- *Implement decision.*
- *Monitor the effect of the decision.*

This is a generic process that has been advocated in a similar manner by a number of sources, but it is shown here to point out that BI plays an important role in a number of these steps. Based on existing historic information, it can help to set realistic objectives. Trend analysis could identify that problems exist in certain areas. It cannot automatically define the problem or search for solutions, but it can provide information for "what if"-analysis to develop and evaluate alternatives. After a choice has been made and implemented, the effects can be monitored by BI systems, if relevant measurements have been defined.

To demonstrate further what type of decisions BI should support, the following illustration from Absolute Information (2001), to distinguish between precision and accuracy, is included.

An organization may find itself at a point where its strategy, quality, productivity and information technology are in need of focus. The current situation of the organization can be illustrated as in **Figure 55**.

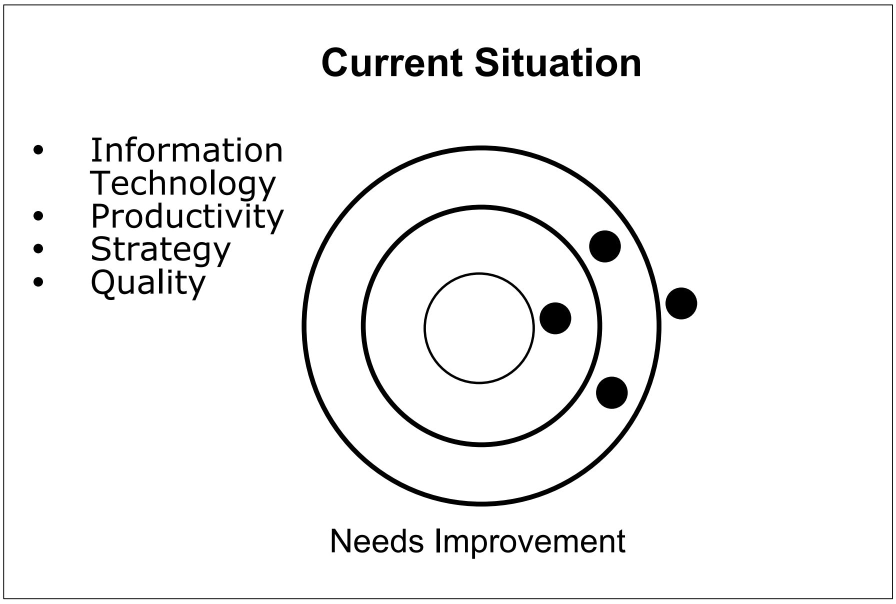


Figure 55. Typical current situation - old focus
(Absolute Information 2001)

The traditional approach would be to synchronize and improve the current processes. The problem with this approach is that it only leads to improved precision as illustrated in **Figure 56**.

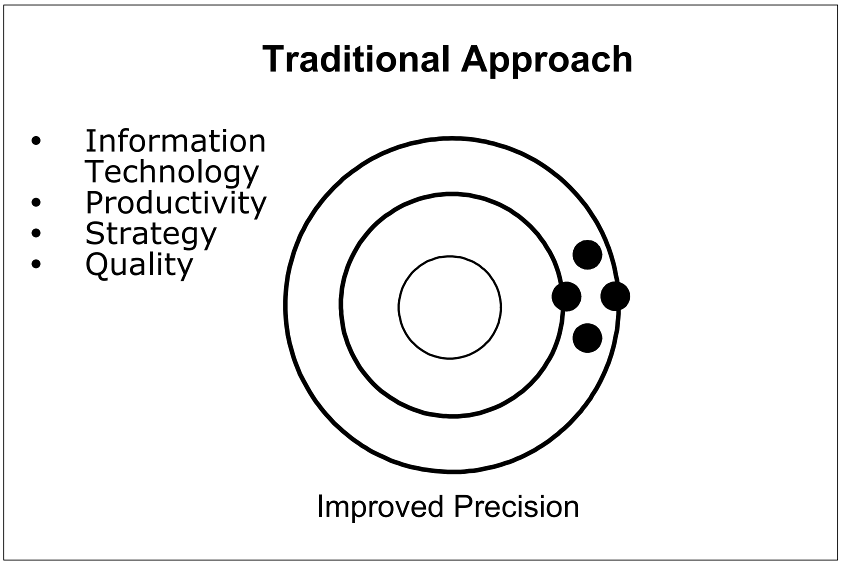


Figure 56. Traditional approach - old focus
(Absolute Information 2001)

The undesirable effect of this approach is that it does not focus on the core business issues of the enterprise - it only focuses on the processes in their current state. The processes must first be aligned with the core business functions of the company.

With a "re-engineering" approach, the issues of strategy, quality, productivity and information technology are addressed on a corporate strategy level to first align them with the enterprise strategic direction. The re-engineering approach does not merely improve old systems, it re-focuses the systems to align them with the enterprise direction and customer satisfaction processes - resulting in the following situation as depicted in **Figure 57**.

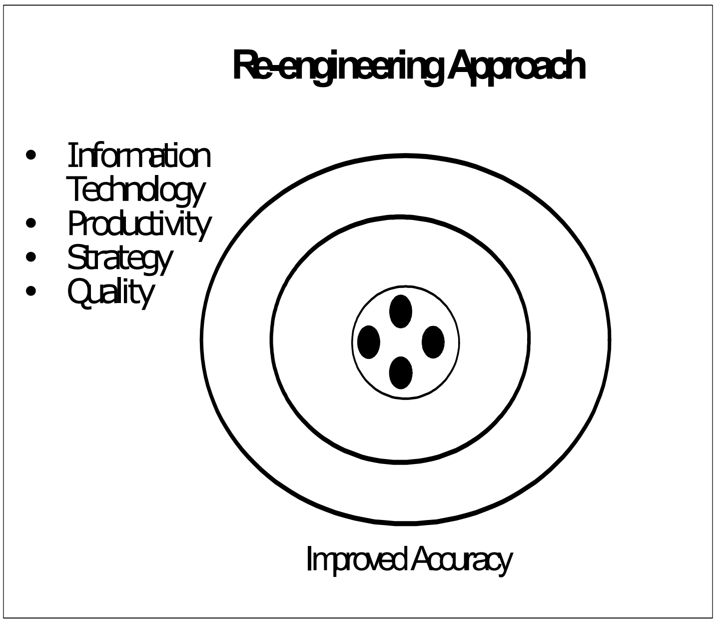


Figure 57. Re-engineering approach - new focus
(Absolute Information 2001)

Accuracy is achieved, instead of precision that still leads the enterprise in the wrong direction. This will provide the advantage companies require in the market place and it should also be the aim of any BI initiative. Although BI tools and technology can support the process to a large extent, it will always be human beings that make the final choice or decision, based on their judgement and creativity, given the available information.

2.8.3 Business intelligence tools

As mentioned in the beginning, the evaluation of BI tools falls outside of the scope of this thesis. However, it is necessary to name and briefly discuss some of the tools to give the reader an overview of the technological support that is available within the BI environment. (Much more information and many references are given on the CD-ROM.)

Because of the nature of this discussion, numerous hardware and software products are mentioned by their trade names. In most, if not all, cases the respective companies claim these designations as trademarks. The ownership of trademarks is respected and these names are used for no other reason than to refer to typical products in a certain category of BI tools.

It should also be mentioned that vendors of products would always portray the most positive picture of their products and will extend the functionality to the limit. When evaluating different tools (as the case with all software evaluations), the checklist of functions should not only ask for a "Yes" or "No", but should also make provision for a judgement on how easily or effectively a function is performed. Other factors that will definitely influence the decision on which BI tools to acquire:

- Affordability (including initial cost, additional cost of extra interfaces or modules, training and annual maintenance costs).
- Licensing model (per named user or per concurrent users; per server or per CPU).
- Ease of integration into the current IT environment.
- Compatibility of the tools.
- Breadth of application (back office, front office, web functions, and so forth)
- Current resource skills in the organization.
- Availability of support and consulting services from the supplier or other entities.
- Scalability of the solution.
- Implications in terms of required hardware and operating systems.

2.8.3.1 Views from Gartner Research

Gartner Inc. Research has developed a number of so-called magic quadrants over the years and some of them are applicable to BI tools. The concept of the magic quadrants is to position products and vendors in terms of their vision and potential to execute their vision. Although not without shortcomings (for example when a product falls into more than one category or in a category of its own!), these quadrants give a fair view of the movement in the market place and are annually reviewed. For purposes of this thesis, some of these magic quadrants will be shown (see the CD-ROM for full discussions). Apart from evaluating the product, Gartner also gives an evaluation of the supplier of the product. If there is a possibility that the supplier might not survive as a business entity, the product may be omitted from the matrix.

From time to time Gartner also publishes the so-called "Hype cycle" that shows different technologies as they move through a life cycle of the following phases:

- Technology trigger
- Peak of inflated expectations
- Trough of disillusionment
- Slope of enlightenment
- Plateau of productivity

See **Figure 58** for an example of the hype cycle for business intelligence, as seen by Gartner in 2003. The tools that are proposed to be part of the Bigger Picture BI Context Model that is developed in the next chapter are typically on their way to, or already in the "Plateau of productivity" phase.

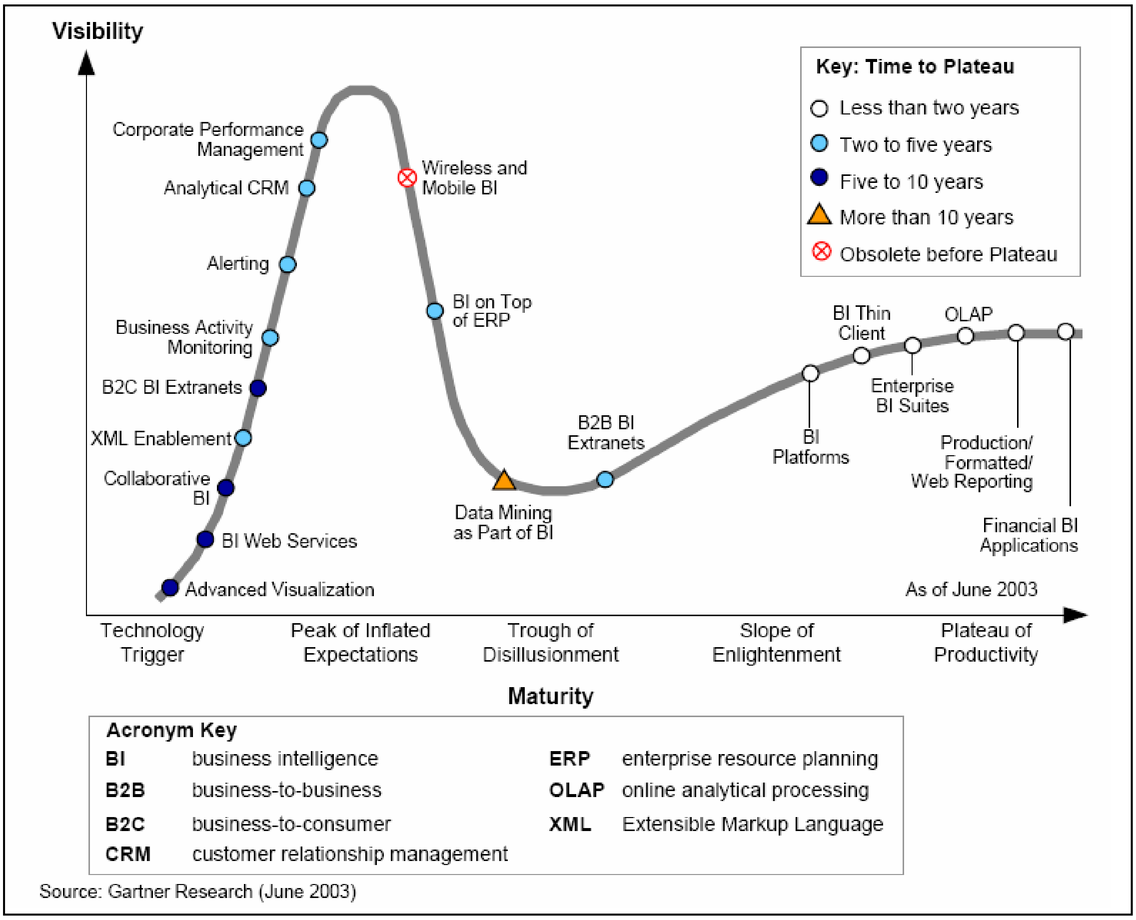


Figure 58. Hype cycle for BI (Buytendijk et al. 2003)

Gartner makes a distinction between EBIS (enterprise BI suite) and BI platforms. According to Dresner et al. (2004) *"an EBIS targets large communities of users with Web-based, interactive database query, user-focused reporting and online analytical processing (OLAP)-style viewing and navigation"*. In other words, it concentrates on the front-office functions of data access. See **Figure 59** and **Figure 60** for the last two publications of the quadrants to see the changes over time.

Dresner et al. (2004) comment that BI platforms, which are suitable as a basis for BI applications, are not nearly as mature as the EBIS market segment. Three categories of BI platform vendors are identified:

- Vendors that use their platform for the development and support of their own BI applications (such as Hyperion and SAS Institute).
- Enterprise resource planning (ERP) and enterprise application vendors (such as Oracle, PeopleSoft and SAP) using BI to complement their operational applications.
- Pure-play vendors that sell tools and remain application-neutral (such as Microsoft, MicroStrategy and ProClarity).

It is interesting to see that the Pure-play vendors seem to cluster in the Visionaries Quadrant on the BI Platform Magic Quadrant, while ERP and other application vendors tend towards the Challengers quadrant. (See **Figure 61** and **Figure 62**.)

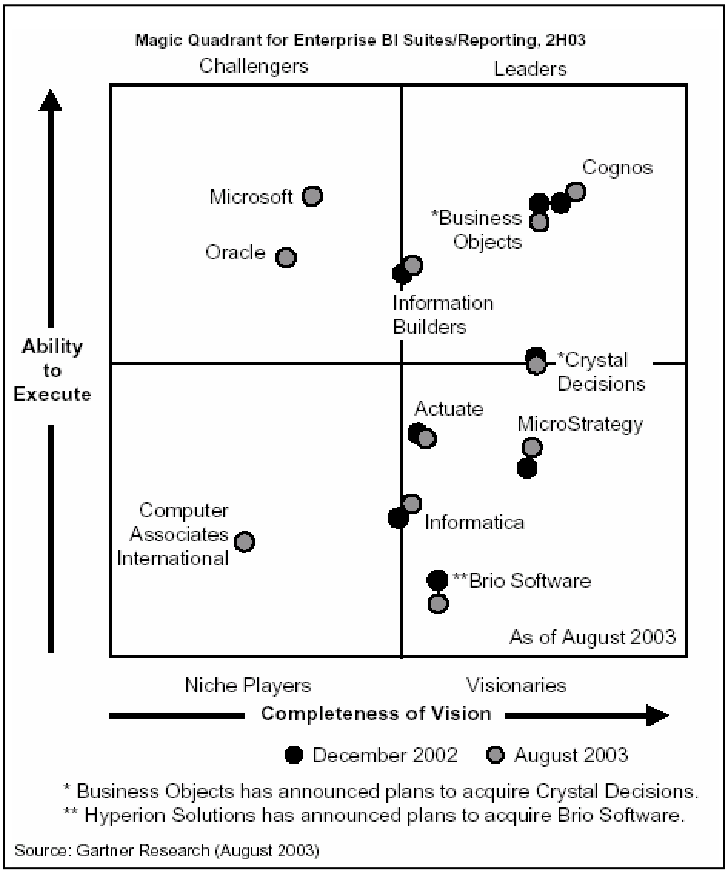


Figure 59. EBIS Magic Quadrant August 2003 (Dresner et al. 2003)

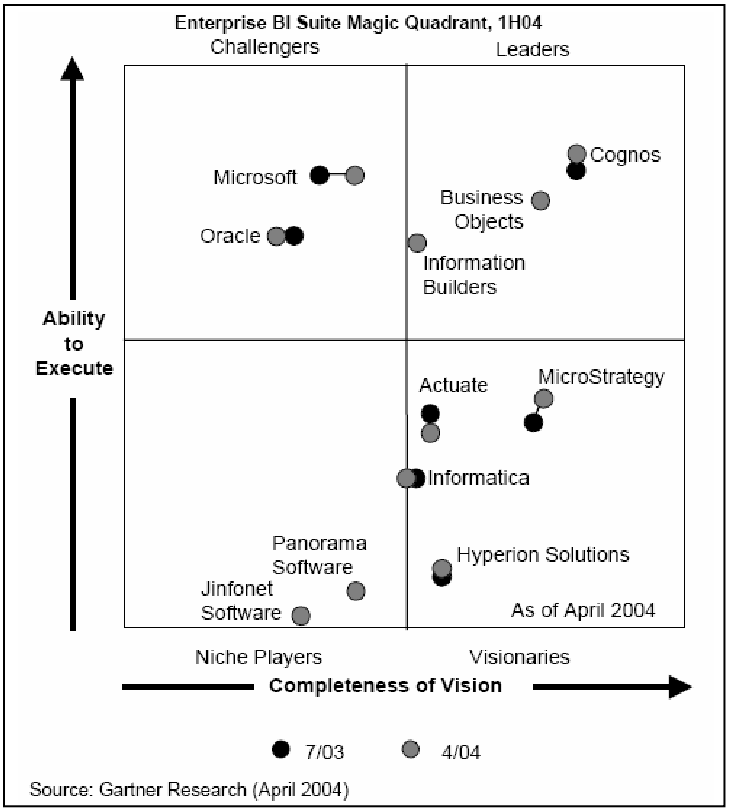


Figure 60. EBIS Magic Quadrant April 2004 (Dresner et al. 2004)

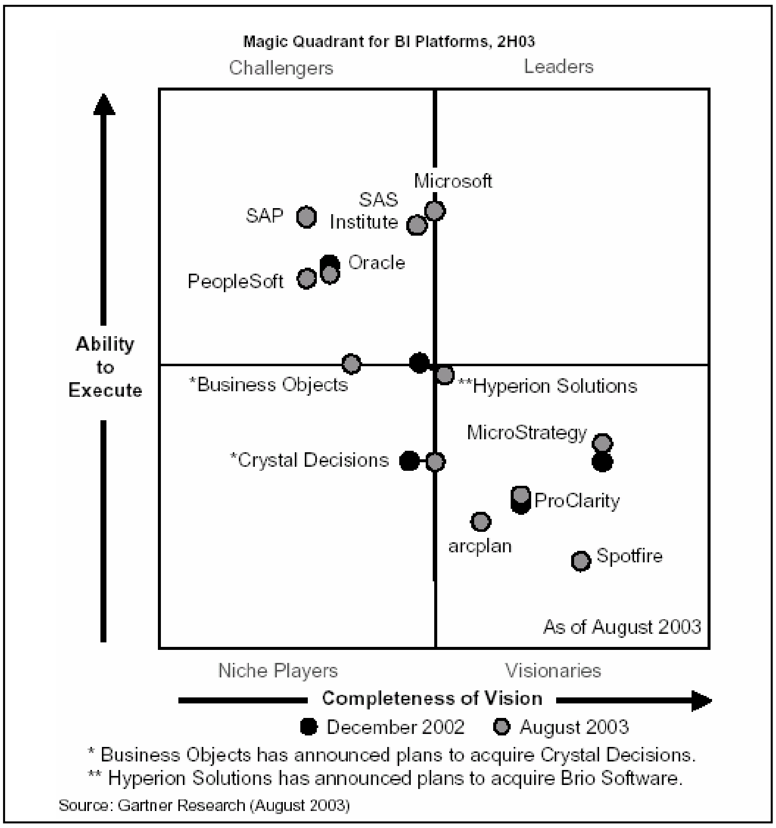


Figure 61. BI Platform Magic Quadrant August 2003 (Dresner et al. 2003)

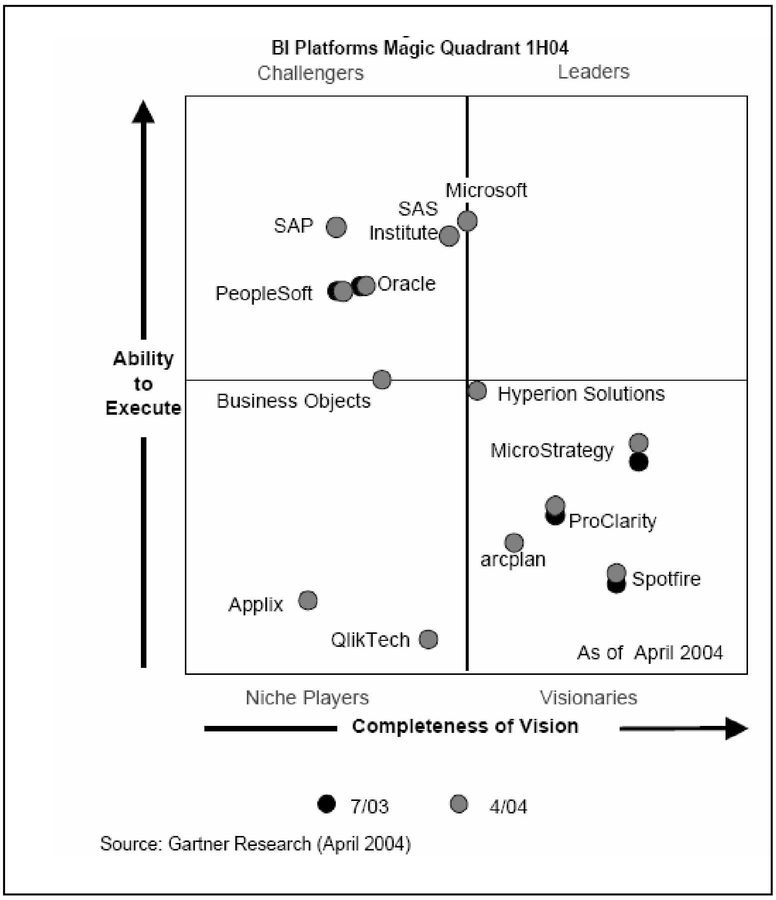


Figure 62. BI Platform Magic Quadrant April 2004 (Dresner et al. 2004)

Although their the magic quadrants are not given here, it can be mentioned that Gartner also analyses the databases that are typically used for data warehousing, as well as ETL tools. (See the CD-ROM for more information.)

Apart from the Gartner views, two other sources that are often referred to by BI consultants in practice are the OLAP Report and research by the Ventana Research Organization. These three are by no means the only sources, but they give enough information for the purposes of this thesis.

2.8.3.2 Views from the OLAP Report

The OLAP Report *(www.olapreport.com)* is updated regularly. It concentrates on the OLAP market and tries to isolate OLAP from other transactional tools and support services. The fact that products converge and vendors consolidate (or are also active in other areas of information technology) makes the isolation of OLAP and the attempt to measure it on its own more difficult. For example, Microsoft bundles Analysis Services with SQL Server and PivotTables with Excel, but it is very difficult to determine if clients are actually using those functions that are clearly OLAP related just because they are part of the package. Similarly, SAP BW is also bundled as part of several solutions, rather than being sold separately.

The OLAP Report estimates that the worldwide OLAP market (which forms only a part of the total BI market) grew as stated in **Table 12**. It shows that the growth rate has declined to single digits in the last few years, after a boom period in the late 1990s. The declining trend can, according to The OLAP Report, be attributed to the following factors (among others):

- The market is already big and it is difficult to maintain the growth rate, due to a degree of saturation.
- Average prices were reduced sharply after the entrance of Microsoft to the market.
- Many of the OLAP servers that were on sale when Microsoft entered the market in 1998 have now died (e.g. Acuity, Acumate, Gentia and WhiteLight). The overall market has grown more slowly after their disappearance.

Table 12. Growth in the OLAP market worldwide (www.olapreport.com 2004)

1996	1997	1998	1999	2000	2001	2002	2003	2004
$1bn	$1.4bn	$2bn	$2.5bn	$3bn	$3.3bn	$3.5bn	$3.7bn	Estimated $4.5bn

After a few takeovers between vendors lately, the top five OLAP vendors based on market share are estimated to be

- Microsoft (26,1%);
- Hyperion Solutions - including Brio (21.9%);
- Cognos - including Adaytum (14.2%);
- Business Objects - including Crystal Reports (7.7%);
- MicroStrategy (6.2%).

These vendors make up more than 75% of the market share and this demonstrates the extent of the consolidation that is taking place in the market.

2.8.3.3 Views from Ventana Research

Ventana Research has developed a product assessment guide for performance management as an aid to assess and recommend BI technologies, such as query, reporting, analysis, planning, information delivery and data mining. Part of the work is documented as a buying guide (see CD-ROM for Buyingguide2003.pdf) with product information on sixty products from seventeen vendors (although some vendors preferred not to participate in the exercise). It should, however, be read within the context of their "*DecisionCycle*" methodology. According to Ventana Research (www.ventanaresearch.com) the performance cycle consists of three major process steps, broken down into a more detailed framework that is available on the CD-ROM:

- ***PERFORMANCE CYCLE PROCESS 1: UNDERSTAND***

  To model the business processes, to get access to source data, discover through queries, analysis and interaction with the data.

- ***PERFORMANCE CYCLE PROCESS 2: OPTIMIZE***

  To make performance as effective as possible through forecasting, collaboration, integration and action taking.

- ***PERFORMANCE CYCLE PROCESS 3: ALIGN***

  To adjust action through goal setting, scoring, notifying and automating performance management.

The products in the buying guide are evaluated according to this framework and functionality is rated accordingly.

Although inputs from analysts are useful and should be taken into consideration, each organization will have to go through a process to identify the BI technology product(s) that will suit his individual needs. Eventually, the products are merely there to facilitate the bigger process of performance management in a more or less sophisticated way. They will not automatically bring positive change to the organization.

2.8.4 The role of chief information officer

Given the range of related subjects that have been addressed in this literature study and the strong link between business and information that has been established, it should be clear that the traditional perception of the role of the information system manager, or information technology manager, needs to be reviewed. It is also clear that information must be addressed on all levels of business, from enterprise level down to the communication level (see **Figure 63**). The responsibility of such a task goes far beyond that of the traditional IT manager or MIS manager and therefore Absolute Information (2001), introduces the role of CIO, chief information officer. Frenzel (1999) has also emphasized this new emerging role when he allocated a full chapter in his book on IT management to the subject.

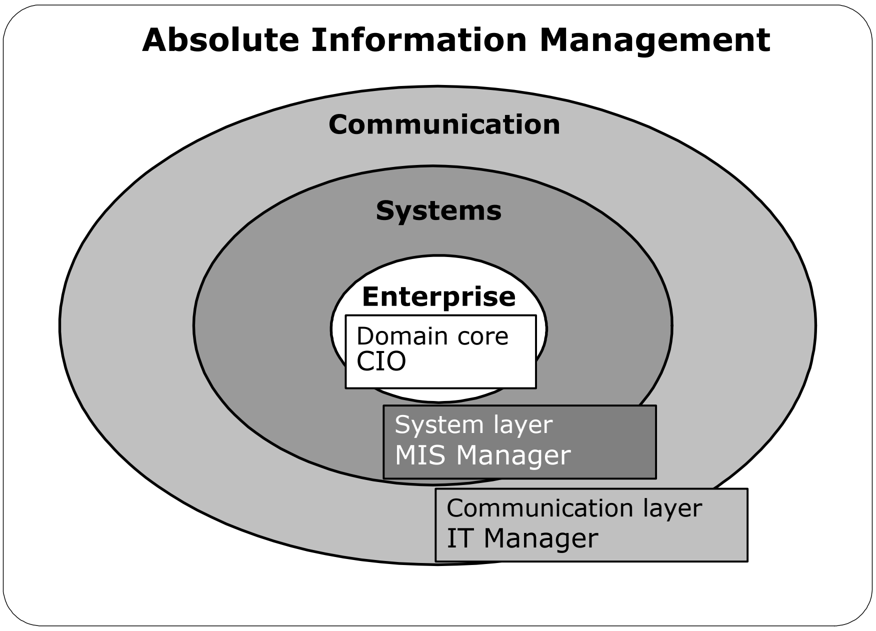


Figure 63. Evolution of information management
(As adapted from Absolute Information 2001)

The traditional IT manager was responsible for the outer communication layer only, the MIS manager was responsible from the system layer outwards, but the CIO also takes the core business issues into consideration and is therefore responsible from the domain core outwards.

Traditionally (and fortunately the situation is changing fast!) the role of an IT manager was as depicted in **Figure 64**. The structure was mainly focused on the technology. The IT manager usually reported to the CFO (chief financial officer), because most early applications were financially based. This structure was expanded to include application systems, which gave birth to the MIS (management information systems) manager. However, very often the responsibility lines still worked through the CFO. See **Figure 65**.

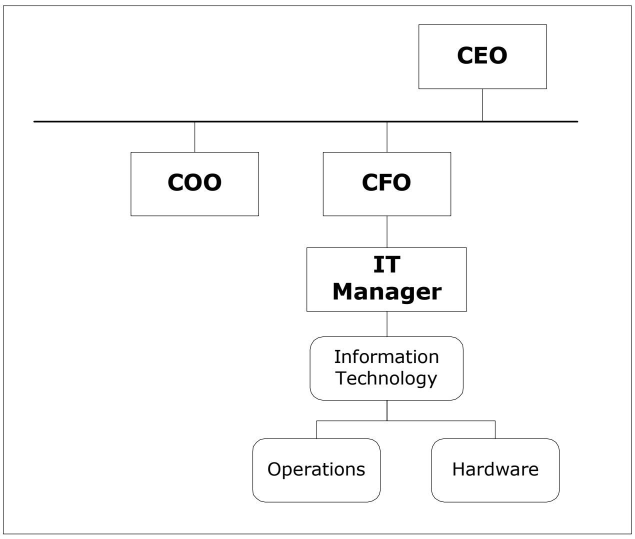


Figure 64. Traditional IT manager roles
(Absolute Information 2001)

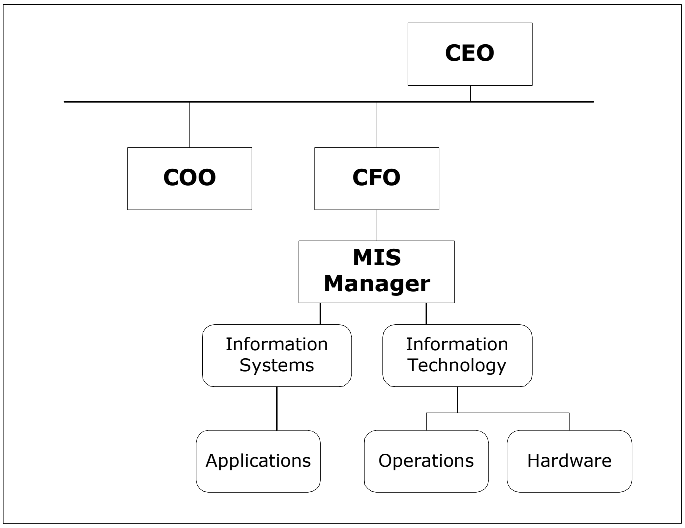


Figure 65. The traditional MIS manager
(Absolute Information 2001)

The CIO structure as proposed by Absolute Information (2001) and also supported by Frenzel (1999) in a similar structure, is illustrated in **Figure 66**. Note that the CIO now reports to the CEO (chief executive officer), because it is realised that the information function should provide services to the whole enterprise, supporting not only the financial function, but also other business functions such as operations, marketing, research and development.

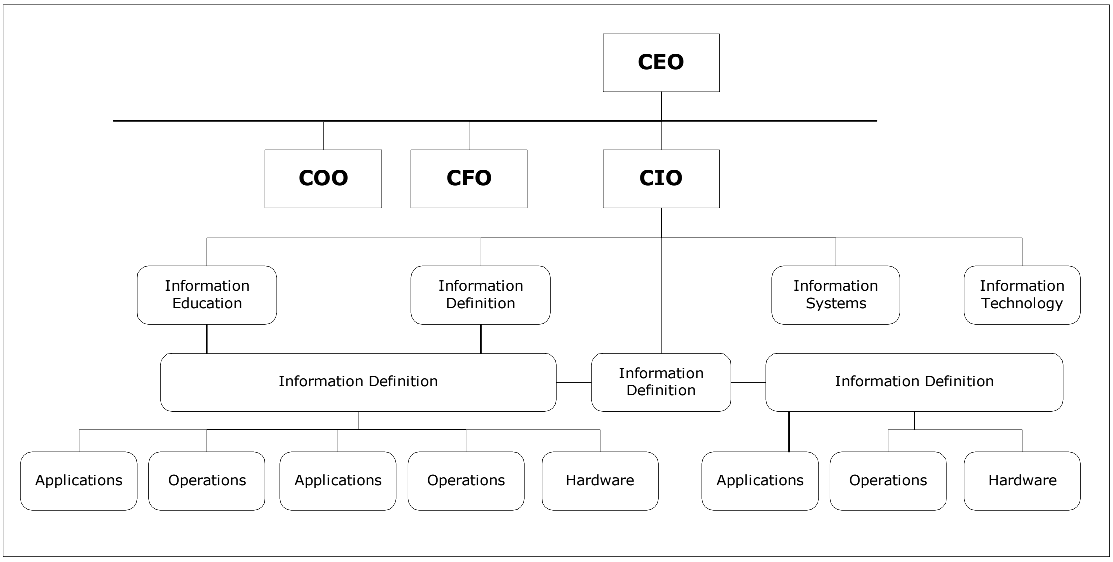


Figure 66. The CIO structure (Absolute Information 2001)

Information definition tasks include all contact with the rest of the enterprise to identify the information impact of any change to the current business strategy and business processes and to design and implement information solutions that will support the change in business in an integrated manner. This also includes changes to the BI environment. The CIO should co-ordinate these tasks and also manages the traditional IT functions. What an ambitious and multi-disciplinary role!

Given this background it is not that obvious anymore that the post should only be filled by a person with an IT background. It should be someone with a balanced view and experience of business strategy and business processes and of the supporting role that information technology plays in an enterprise.

2.8.5 Summary

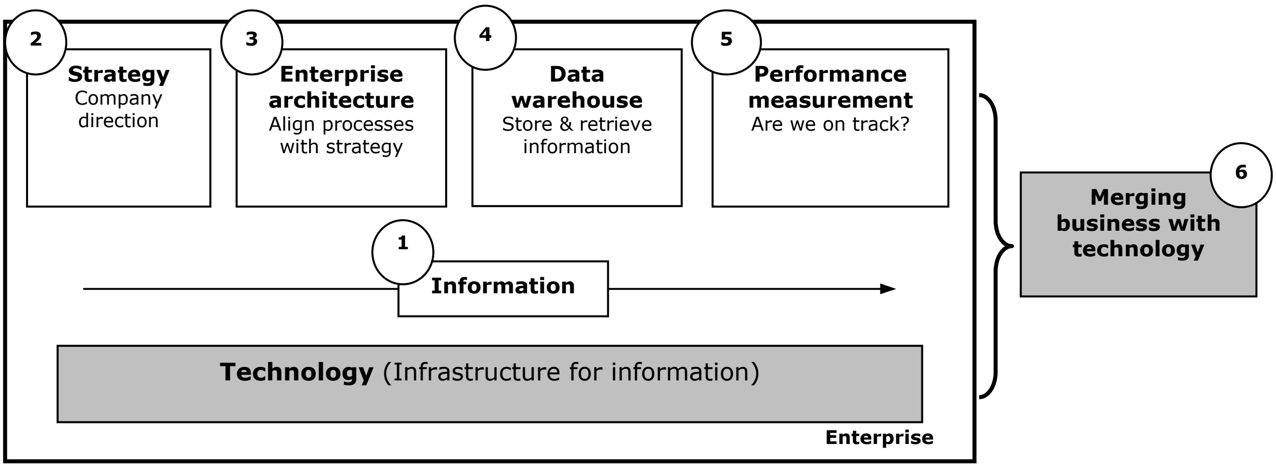
From this section - how to merge BI with technology - it can be concluded that technology and BI play a major facilitating and enabling role, but can never replace the role of human beings in the decision-making process. A human being will always be required to interpret the information that the BI tools present in such a useful manner and to take action on it.

It is also interesting to note that the quality of data from the source/transactional systems has great impact on the confidence with which the information presented by the BI tools can be used. It is often one of the spin-offs of a data warehousing and BI initiative to realise that the quality of transactional data is not good enough for use at all levels of the organization. Action is then normally taken to improve the accuracy of data capturing. These actions may include changes to application software to prevent errors; training of operators; and sometimes it may also include changes to business processes and procedures.

The leadership role of the CIO to ensure that the whole process from data capturing to information presentation to support better decision-making is acknowledged and that role is becoming more and more important in organizations. It is expected of the CIO not only to support existing business processes with the necessary information infrastructure, but also to initiate and suggest changes to business processes where information technology can improve operations and ultimately add value to shareholders.

2.9 Conclusion of literature study

The literature study was done to explore aspects in the business and technology environments which are deemed necessary to develop the Bigger Picture BI Context Model. The following main themes were covered:



Firstly, information as a subject was put into perspective by using the classification of Larry English (1999) to distinguish between data, information, knowledge and wisdom. The probe into the subject of information further included the refreshing, but somewhat unorthodox, views of Swanborough from Absolute Information (2001) regarding the attributes of information, the time dimensions of information (Synit, Revit, Operit and Cognitive), the sophistication of use of information and the levels in the organization where information plays a role.

Secondly, business strategy was explored from a number of angles with longer discussions on the following approaches:

- The future scenario views of Grulke (2001), including the aspects of lifecycles, creative destruction, the Innovation Matrix and the Learning from the Future approach to strategy formulation.
- The no-nonsense approach of Manning (2001), including the context of strategy, basic business concepts, the effect of human spirit in executing strategy, steps to implement change, questions to determine if the business logic adds up, the 7 Ps to consider and the Strategy Wheel.
- Scenario planning by Ilbury and Sunter (2001), demonstrating the Foxy Matrix.

Thirdly, enterprise architecture was investigated as a discipline to capture the design blue prints of an organization – including the information aspects. After a general overview of the subject, more attention was given to the following models:

- PERA
- GERAM
- The Zachman Framework

Reference was also made to CIMOSA, CuTS, GRAI-GIM and ARIS. Although the idea was not to evaluate or compare the different models, it was found that the Zachman Framework would be useful in the Bigger Picture BI Context Model that will be developed in the next chapter.

The fourth section of the literature study was allocated to data warehousing. The views of Inmon et al. (2001) and Kimball et al. (1998) were mainly investigated and compared. It was concluded that the concept of the Corporate Information Factory (as propagated by Inmon 2001) was appealing, but that the design methodology of Kimball will be incorporated into the BI context model that will be developed in the next chapter.

A short discussion on knowledge management was included to establish an additional, underlying philosophy for business intelligence.

As a fifth theme, the subject of performance measurement was explored. The work of Rummler and Brache (1995) was discussed in more detail, identifying the three levels of measurement (organization, process and job/performer), the swim-lane approach, performance needs in terms of goals, design and management, and the matrix that identifies Nine Performance Variables that should be addressed to develop sound performance measures. The work of Kaplan and Norton (1996) on the Balanced Scorecard was also investigated and their four-perspective approach provides a solid base for aligning operations with strategy. Corr (2001) explained the difference between facts, measures and KPIs. Other sources for valid KPIs were found in the 24 Ways of Connelly (1999) and the performance and management indicators (PIs and MIs) of Absolute Information (2001).

The last theme covered the merging between business intelligence and technology. Definitions of BI were analysed and because the underlying focus is to improve business decision-making, a generic decision process was explored to identify the steps where BI can play a role. A large part of this section was allocated to the identification of BI products and their role in the Bigger Picture BI Context Model. It concentrated on BI platforms and front end reporting tools with references to databases, ETL tools, data quality tools and meta data management tools on the CD-ROM. As a final aspect the role of the CIO to co-ordinate all these aspects in modern organizations was briefly discussed.

Although a large number of subjects were covered in the literature study, they all contribute to the foundation of the Bigger Picture BI Context Model that is developed in the next chapter. It should also be stated that this chapter did not merely document views that were found in literature, but critical discussions of those views form the basis of the conceptual model that is elaborated on in the following chapter.

3 BI in context – a conceptual model

"An organization's ability to learn and translate that learning into action rapidly, is the ultimate competitive advantage."

Jack Welch
Chairman, General Electric

3.1 Introduction

Someone once commented that the only constant in our lives is change. Human beings become older, sometimes wiser. Governments change, the value of money changes, motor cars change, technology develops, modes of communication change, lifestyles change, toys change, society changes, job content changes, rules and legislation change, tax on cigarettes and liquor changes …

Most of the time change is a good thing. Even changes that are perceived to be bad at the time can have positive end results – think about the creative destruction of job opportunities as illustrated in **Table 3** earlier on. Although people are normally change resistant, very few people would argue today that they prefer telegraphs to cell phones, or horse carriages to modern motorcars.

In situations where people are not directly involved, engineers have been quite successful in designing control systems to handle change. For example, sophisticated control systems would open more water gates in a dam when the water reaches certain levels and would close those water gates when the level drops below another level. Industrial engineers would calculate re-order points for stock replenishment and nowadays orders can be generated automatically to the preferred supplier, should the organization wish to do so. These control systems work well when the triggering event and the action that must follow can be logically defined in "If, Then" statements. For example, "If the stock level of part A is equal to or less than 100 and an order has not been placed, then order 1000 items from supplier XYZ". This implies that the control system has access to certain information and that the information is updated regularly.

Now what a pleasure (or bore!) business would have been if all business decisions could have been automated! Truth is, many business decisions do not have exact cause and effect patterns that can be followed. The same decision in different businesses (or even at different times in the same business) could have completely different results. The aim of this chapter is to propose a qualitative control system for businesses where business intelligence is put into context as the cornerstone of such a control system.

3.2 Overview of the Bigger Picture BI Context Model

For many people BI is a fancy name for boardroom reports, graphs and drill down tables, perhaps because it gets so much attention in demonstration sessions from BI vendors. Although it also includes the delivery of information in a professional and easy to understand format, BI should be seen in a much broader perspective. **Figure 67** gives an overview of this broader perspective, which will be described in more detail in this chapter. This diagram forms the foundation of the contribution by the author.

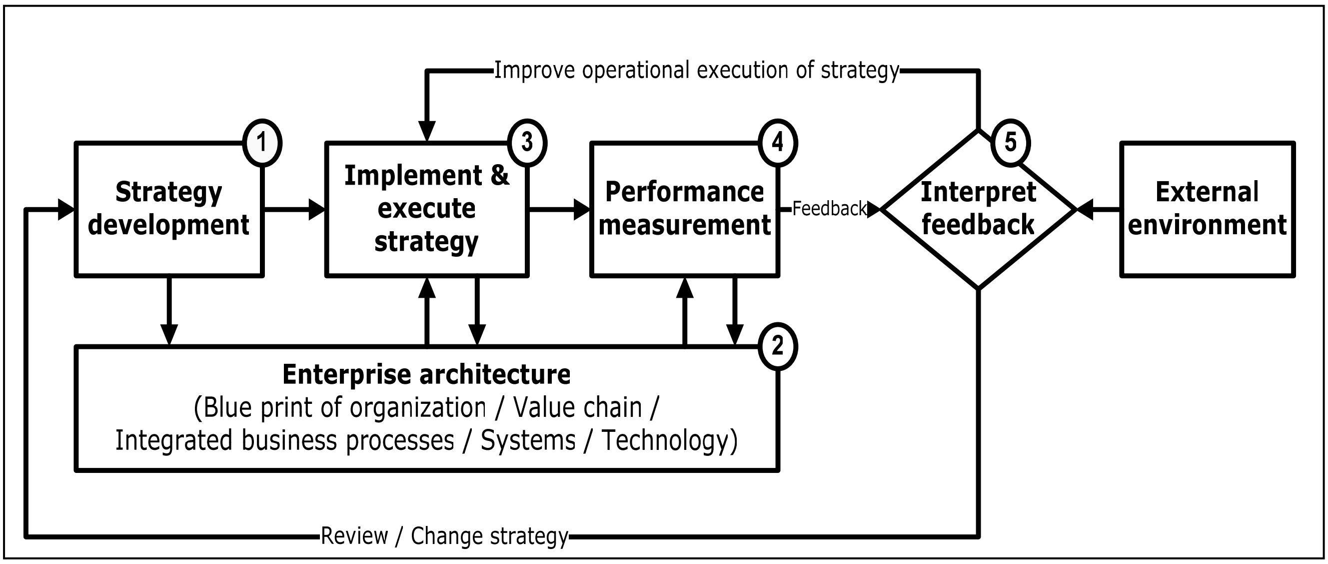


Figure 67. An overview of the Bigger Picture BI Context Model.

The diagram provides a conceptual framework for a qualitative control system in business, comprising of the following process steps:

- Business strategy development
- Enterprise architecture and modelling
- Implementation and execution of the selected strategy
- Capturing data for performance measurement in a data warehouse environment
- Interpretation of the feedback from the performance measurement system, taking into account inputs from the external environment
- Improvement of the operational execution of the strategy, or review and change of the strategy, based on the interpretation of the previous step
- Continuous updates of the enterprise architecture as and when the strategy, execution of the strategy, the performance measurement and the underlying business processes and systems change

It is in essence not a complex model, but it brings together a variety of subjects that are not normally discussed in the same context and are often focused on by different groups of people. The aim is to bridge the gap that often exists between strategy development and strategy execution – also known as the alignment problem.

The following paragraphs will elaborate on the detail of each step. The idea is not to be prescriptive in which tools or techniques to use, but to indicate typical mechanisms that will support each step.

3.2.1 Strategy development

Apart from the traditional approach that starts with a vision and mission statement, exploration of the macro and microenvironment, SWOT (strengths, weaknesses, opportunities and threats) analysis, identification of goals and the action plans that flow from that, the literature has also revealed a number of other approaches that can be used during this step.

Grulke (2001) has identified the following, which can help in the development of strategy:

- The deliberate effort that businesses should put into their strategic thinking to avoid the typical second half characteristics in the business life cycle (see **Figure 9**) – in other words to stay customer focused and improve value through radical innovations.
- The concept of the Innovation Matrix (see **Figure 10**) – The ideal is a good spread between the quadrants with 10-20% of its revenue being invested in carefully selected radical projects.
- Learning from the Future approach (see **Figure 11**). After creating the ideal future of choice, based on first divergent thinking about the future environment and the future market, followed by convergent thinking to define the future business, the strategic team is faced with the task of "looking back from the future" and identifying the sequence of actions that were taken to get there.

Manning (2001) has provided the idea that strategic management should be a constant conversation between the strategy makers and the strategy executors – that it is all about making choices, winning votes from all the stakeholders and building the strategic IQ of all the people in the organization.

He has also identified ten concepts that are important in the strategic management process (see paragraph 2.3.4.2) before describing the following process tools to assist in defining a workable strategy:

- Checking if the business logic adds up (see **Figure 17**) – asking questions about the business opportunity, purpose, recipe, priorities and actions, resources and capabilities within the context of stakeholder ambitions and external factors.
- Frameworks to learn your business (see **Figure 18**) by first analysing the competitive environment and then formulating a value proposition.
- Five building blocks of the strategic plan (see **Figure 19**) – answering a set of 20 detail questions to define the five main questions relating to purpose, business recipe, organizational character, goals/priorities/actions, and strategic conversation.
- The concept that the market is competing in terms of business models with regard to the 7 Ps (see **Figure 20**) – purpose, product, positioning, partners, people, processes and philosophies.
- The Strategy Wheel (see **Figure 21**) to identify and prioritise the strategic issues that need attention at a specific point in time. Innovation is suggested to handle these issues and a suggested 30 day interval between reviews of the Strategy Wheel ensures that those items get urgent attention.

To identify various scenarios from which strategic decisions can be made, Ilbury and Sunter (2001) suggested the use of scenario planning. Their Foxy Matrix approach (see **Figure 22**) provides a conceptual framework for a thought process that takes one through the matrix consisting of four quadrants, representing the stages of identifying the rules of the game, identifying key uncertainties and the scenarios that they imply, identifying options for each scenario and eventually making decisions regarding the options.

In conjunction with colleagues at Fourier Approach (Pty) Ltd the author has also developed another conceptual tool that is useful in the development of strategy – for purposes of this study called the Fourier Model. It consists of a number of concentric rings around a core of functional areas that are relevant to the business. The first ring around this core identifies products and services that can be related to that functional area. These related products and services normally fall into the following categories:

- Generic knowledge of the discipline
- Specific products related to the discipline

- Product knowledge to be able to implement, integrate, maintain or enhance the product
- Market information regarding the functional area

Since there can be multiple identified functional areas, these areas and their related products and services can be visualised as wheels on top of each other around a vertical axis.

The second ring from the core represents the different business entities that are providing those products and services. These entities could include various departments in your organization, but can also list external organizations with which you have partnership agreements, as well as competitors who also provide those products and services.

The third ring from the core represents integrated solutions that form the interface between the product and services offering from the inside and the market requirements on the outside. This ring could include typical pre-packed solutions, but is also used to configure unique solutions that could include components from various functional areas being supplied by different business entities. One can visualise the marketing person who has already gathered the requirements from the client in the market standing in this third ring and moving up and down through the functional area wheels with their products and services and selecting the most appropriate entity (or entities) to deliver the integrated solution.

The fourth ring from the core identifies the market segments in which the organization wishes to operate. It could also identify clients and potential clients by name.

See **Figure 68** for a graphical representation of the model.

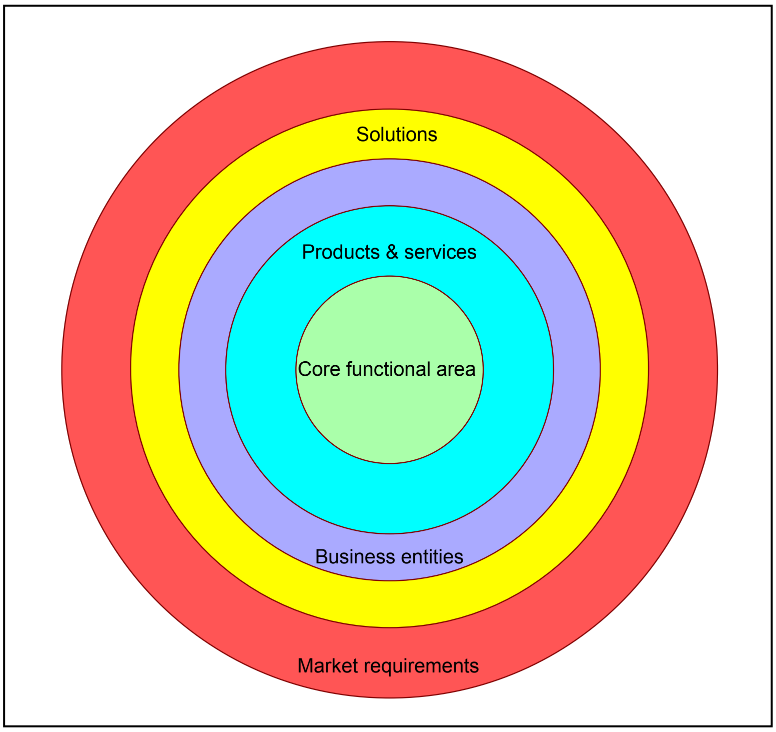


Figure 68. The Fourier Model.

Even though the figure shows the concentric rings in two dimensions, the reader should visualize a three dimensional structure with layers, or rings, for each functional area. The solution ring represents integrated solutions where components from various functional areas, products and services, as well as various business entities are packaged together to satisfy the needs of a specific client or market segment.

By going through the identification of the functional areas, products and services and related business entities from the inside and identifying target markets and their requirements from the outside, one is able to make various strategic decisions in terms of the priorities of functional areas, partnership agreements, etc.. Enterprise architecture tools facilitate the definition of the components of each concentric circle and the associations between these components very well. A logical entity relational diagram (ERD), without any associative entities to resolve the many-to-many relationships, is shown in **Figure 69**.

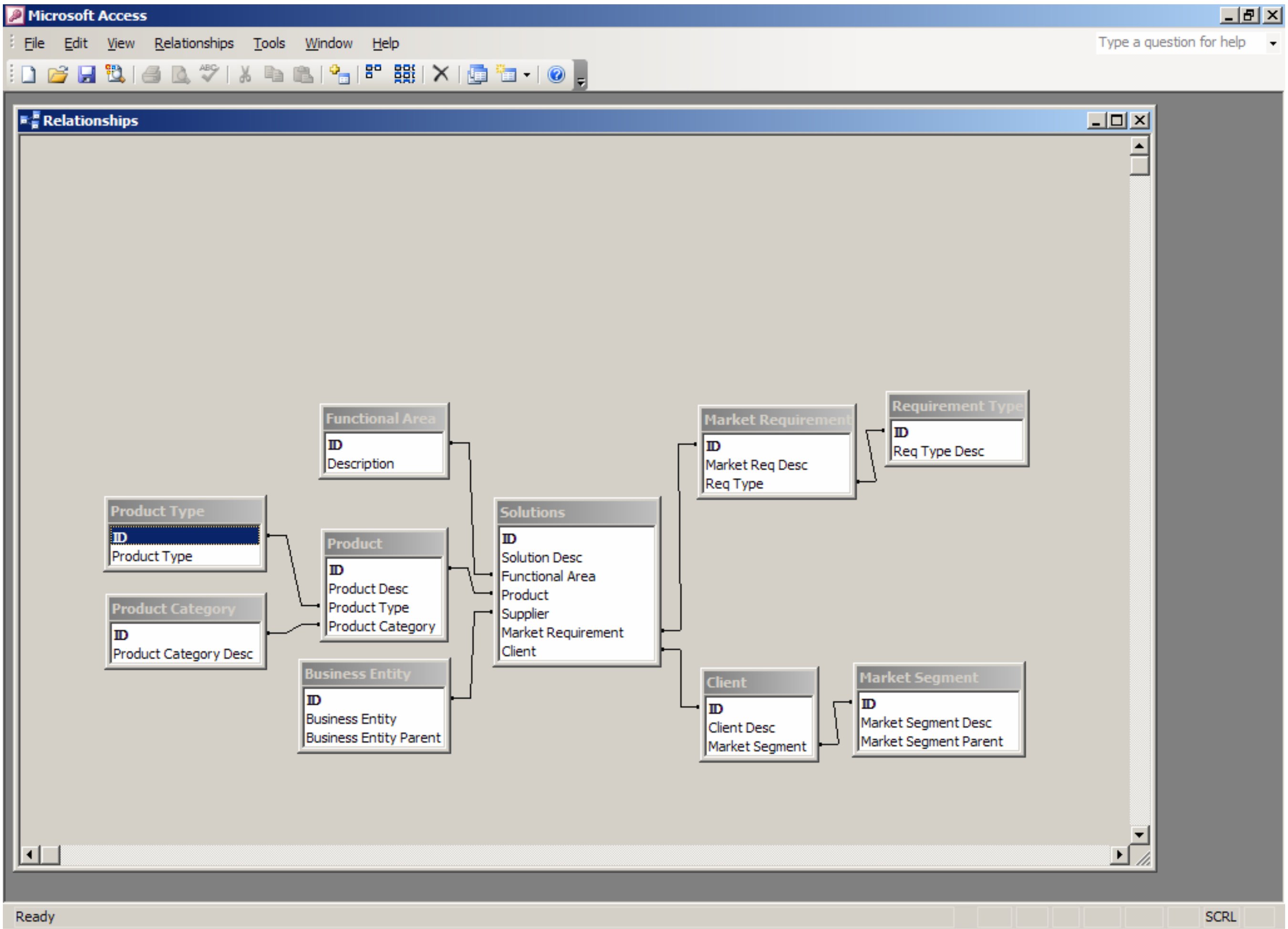


Figure 69. Logical ERD of the Fourier Model

The use of these conceptual frameworks from Grulke, Manning, Ilbury and Sunter and the author will be demonstrated in the next chapter.

3.2.2 Enterprise architecture

3.2.2.1 Selection of methodology

This component in the qualitative control system provides the same function as the blue print drawings, or data pack, of a big building. It provides the documented configuration baseline of the business in terms of organizational structure, the value chain and business processes, products and services, clients, systems and technology.

Although various enterprise architecture models were discussed in the literature study, the Zachman Framework provides enough substance for the overall configuration management and central repository functions that it should fulfil in the Bigger Picture BI Context Model. (See **Figure 26**.) The framework does not only make provision for the investigative questions What, How, Where, Who, When and Why, but also looks at the enterprise from the perspective of different role players, namely the planner, owner, designer, builder and sub-contractor.

The power of this thorough approach is revealed in the lists, or hierarchies, of information that are compiled – and even more so in the multiple associations that can and should be defined between the various dimensions. For example, by linking all business processes to business goals or strategies, one may discover redundant processes or at least be able to define the priorities among the processes, by identifying those business processes that support the high priority business goals.

3.2.2.2 Selection of a case tool

Various application software packages exist that support the enterprise architecture discipline, for example *Casewise* and *Aris*. In the next chapter *Casewise* will be used as an example to demonstrate the powerful functions of an enterprise architecture tool, since it is also firmly based on the conceptual Zachman Framework. See **Figure 70** for the navigation screen in *Casewise* that clearly indicates the Zachman Framework as the foundation for the application software.

The commercially available enterprise architecture software tools are not inexpensive, but they are comprehensive and flexible and provide user-friendly means to capture the different entities (in hierarchical format, if necessary) and build associations between all entities. The complete repository, or selections thereof, can normally be exported in various formats, including typical word processing format, or HTML to make it available through normal web browsing application software. If it is maintained on a central server on the network of an organization, all users will always have read access to the latest version of the repository and many users can access the complete data pack of the organization without having a licence for the enterprise modelling software.

There might be a temptation to build your own enterprise architecture tool in a program such as MS Access to capture the various entity attributes, as well as the associations, in a relational database. In very small organizations and where cost is really a limitation, it might be an option, but the author is of the opinion that investment in such a tool is justified. One should take into consideration that it will become the foundation for evaluation of all future changes to the organization in terms of strategy, structure, products and services, marketing information regarding clients and the competition, business processes, information systems, infrastructure and other technologies. See **Figure 71** for the various ways in which relevant entity data can be captured and associated with each other in *Casewise*. It makes provision for process flow diagrams, data flow diagrams, entity relationship diagrams, hierarchies (e.g. organizational structures), a matrix view to see associations and a generic diagramming tool.

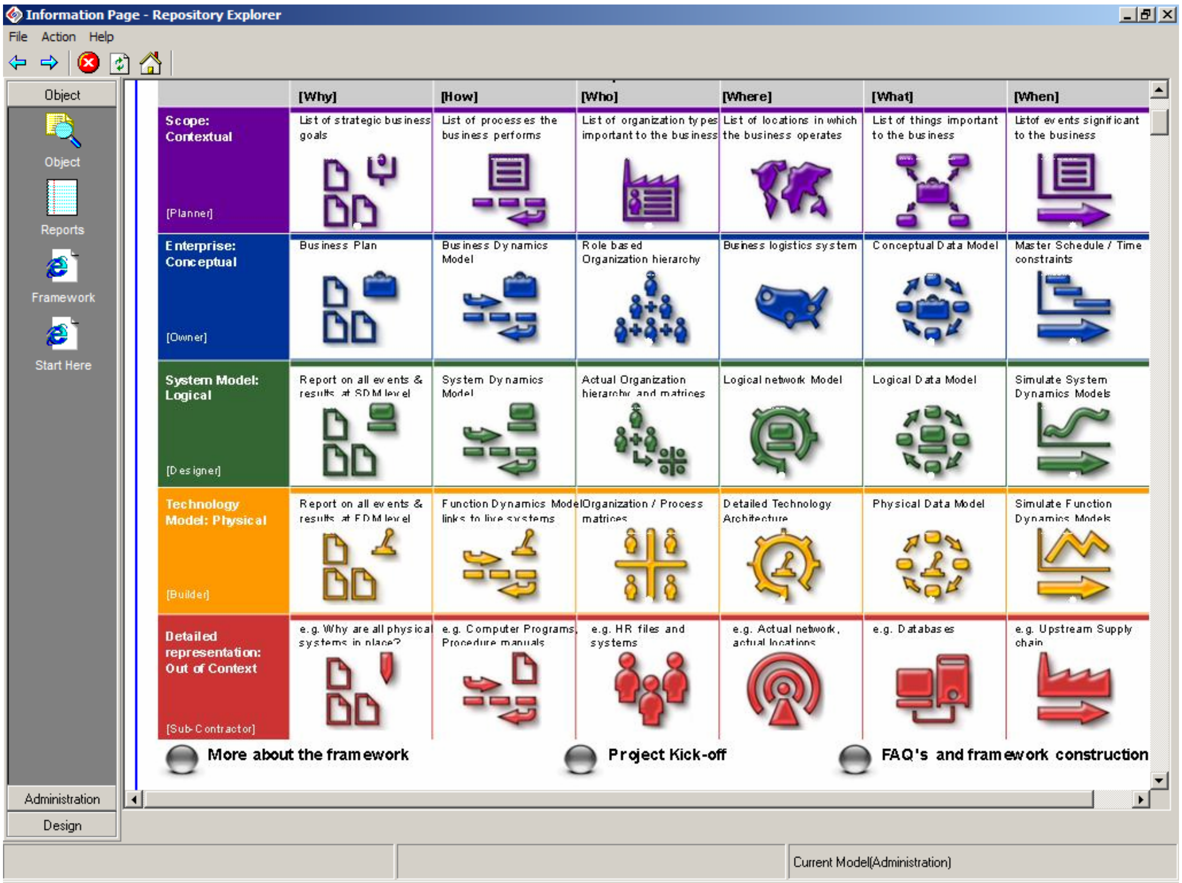


Figure 70. Zachman Framework embedded in *Casewise*

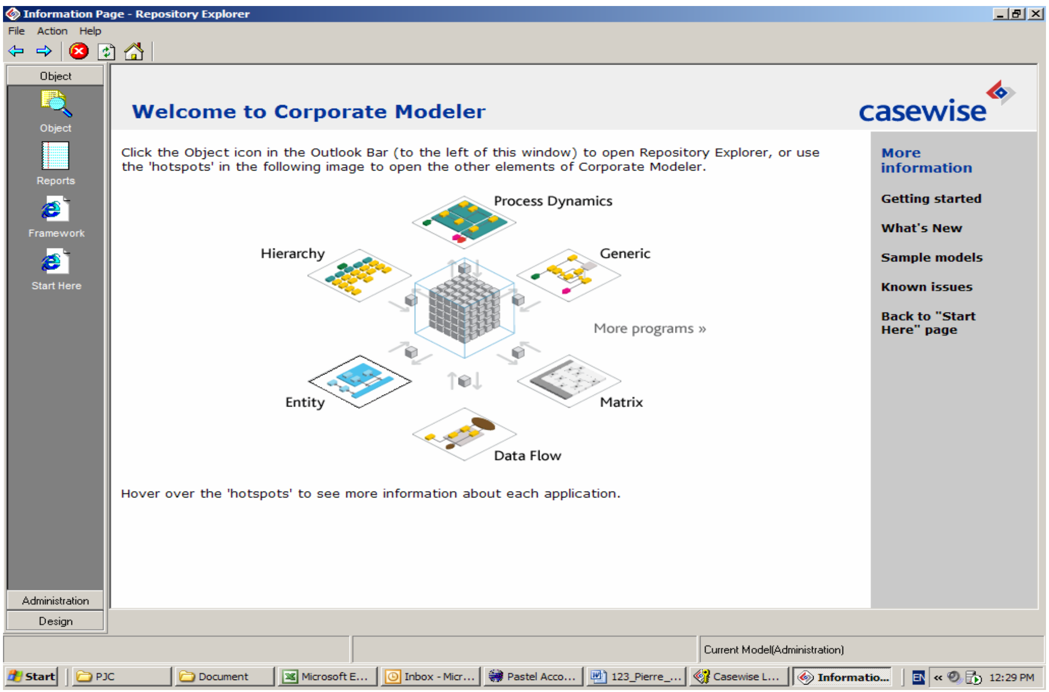


Figure 71. Various formats to capture and associate entities in *Casewise*.

It should be clear that the enterprise modelling component in the proposed Bigger Picture BI Context Model forms the glue that holds the model together. After the initial documentation of the organization in terms of strategy, organizational structure, business processes, products and services, marketing related entities such as clients and competition and information systems to support the business processes (including performance management processes), the strategy can be implemented through operational processes and performance can be measured and presented through BI related tools. The information that is revealed by these tools is then interpreted within the context of the organization as defined in the enterprise architecture, taking into account information from the external environment.

Any action that is proposed after interpreting the information from BI tools should be tested in the enterprise architecture by looking at the associations before the change is implemented. It can be compared to a multi-storeyed building where someone wants to remove a wall to combine two compartments. It will never be allowed unless the plans of the building are drawn to establish what other functions that wall might have apart from dividing the two compartments. It will also reveal the attributes (e.g. thickness) of the wall and other information that might imply other actions should the wall be removed (e.g. electrical wiring or plumbing that runs in the wall). All this information will help the relevant people to make an informed decision. Similarly, the enterprise architecture should be the central repository where proposed changes are evaluated to determine their complete impact. In the course of time the information in the enterprise architecture should be extended and updated - reducing the risk of bad decisions after the repository has been consulted.

3.2.2.3 Process simulation modelling

Apart from identifying entities and associating them with each other (e.g. a grade three technician is used during the second line preventive maintenance process in the workshop facility, where a skill level, human resource category, business process and facility are associated with each other), another type of modelling is often used by industrial engineers to quantify the number of resources that is required by the organization. This type of modelling is called stochastic process simulation modelling. Although case tools like *Casewise* and *Aris* have embedded simulation modules, other specialised simulation software like *Arena* may also be used. Dedicated simulation software normally has more sophisticated process modelling building blocks to model more complex situations, for example where automated guided vehicles (AGVs) are used to transport parts in a warehouse or manufacturing environment, or where continuous processes in a chemical plant are combined with discrete packaging processes.

The aim of stochastic process modelling is to quantify the number and type of resources that are needed at various locations and also to estimate the total process times given a certain set of input parameters. It is also used to choose between various decision rules that can be used during a process, for example priority rules at queues and resource selection rules. Often the results of these simulation models are used to hard code rules within the information systems that will support the operational business process. These simulation models can also be used to justify certain targets that are set for performance measurement. The models are entities in their own right and can be associated with other entities in the enterprise architecture repository. When changes are proposed to business processes, or technological enhancements promise changes to process times, or certain steps in a process become redundant, these models can be used to verify the promised impact on total process times, resource utilization and various other criteria. Where the normal association matrices will identify the entities that will be influenced by a proposed change, the simulation model(s) will quantify the effect.

Good simulation modelling practice requires that models be developed in an iterative manner with various levels of detail. Relatively simple models may be developed during the strategy development phase and these models may be enhanced to include more and more detail, which will eventually support implementation and execution of the strategy through business processes. Simulation modelling should therefore form an important component of the enterprise architecture building block.

3.2.3 Strategy implementation and execution

3.2.3.1 The move from planning to doing

Implementation and execution of the strategy may differ for different organizations (e.g. new organizations versus existing organizations), but generically it calls for **doing** the normal operational activities according to the **plans** that were made. Often it is not a turnkey event where planning stops and operation takes over. In the case of a new organization there will be a distinct implementation phase when infrastructure is commissioned, people are appointed, information systems are implemented and the organization is prepared to go into operations on a specific date. For existing organizations there is often no clear line between the various stages of the change cycle (see **Figure 16**), namely dissatisfaction with the status quo, planning the new future, implementing (acting to learn) and reviewing and revising.

According to the continuous strategic conversation approach of Manning (2001), the Strategy Wheel (see **Figure 21**) can help to identify the top priority issues that should be addressed in the next period of 30 days. This normally leads to an action plan with goals, priorities and responsible persons. Some issues will obviously stay on the Strategy Wheel for a number of months because they cannot be implemented or solved in 30 days, but the urgency that is created by shorter review cycles and progress reporting is important.

3.2.3.2 Business processes management (BPM)

Strategy is eventually implemented through business processes. There is a relatively new drive to advocate business improvements through a discipline called business process management (BPM). (See various articles on the CD ROM under BPM.) As Smith and Fingar (2004) point out:

- BPM is not new - the term was used when BPMI.org (an organization furthering the advancement of BPM) was founded in 1999 to distinguish it from the older reengineering methods that had become a dirty word at the time. The need for business process management can be traced back to the emergence of management theories in the 1920s.

- Business processes existed since the beginning of business and commerce. Regardless of whether they are called business processes, practices, work activities, procedures, workflow or any other term, they have always existed and **are** the work and **how** the work **gets done** - they exist independently of any technology.

- BPM efforts are called many names, e.g. industrial engineering, ISO certification, business process improvement (BPI), business process reengineering (BPR), Rummler-Brache, integrated definition function modelling (IDEF0) and Lean Thinking, but they all are work **with** processes (management) and work **in** processes (participation).

- Computerized tools for BPM - Business process management systems (BPMS) - will need to represent business processes in such a way that they can be directly manipulated by business analysts. These tools are not mature yet and even analysts like Gartner define BPM tools in various ways: They are the evolution of EAI (enterprise application integration), the evolution of workflow, the evolution of ERP (enterprise resource planning), or the bundling of these to create new products.

- SAP, a successful ERP software vendor that has used RDBMS (relational database management system) as the foundation for their product for the last ten years, is developing a BPMS (business process management system) called *Netweaver* and declared it their foundation for the next ten years.

It seems as if the basic concept of BPMS is process-oriented programming, where IT will provide back-end engines that will create executable processes. It will probably use simple visual metaphors similar to what business users are already familiar with through process modelling tools such as *Popkin* and *Casewise*. IT will probably control the BPMS platform as they have maintained control over the database management platforms, but business will have control over which processes are run over the BPMS platform. Smith and Fingar (2004) forecast: *"By the end of 2004 it will seem quaint indeed to do BPM using whiteboards, PowerPoint or Visio - BPM 2004 will be the year of flowcharts on steroids. Thanks to the breakthrough of BPMS, work with processes, and work within processes, will never be the same again."*

While the BPMS arena matures, many organizations will still use traditional tools such as flowcharts and swim-lane diagrams to document their business processes. Although the business processes will be identified (and perhaps even modelled with process simulation) at a high level during strategy development and will probably be explored in detail as the business processes are documented in the enterprise architecture, they are normally refined further during implementation to a level where each step in the process can be described in terms of a procedure. Therefore the Bigger Picture BI Context Model makes provision for an interactive relationship between these two components.

3.2.3.3 Workflow impact on business processes

Although the human influence in business processes will never be eliminated, the aim is to focus the human intervention on those aspects in a process where it is really necessary and to automate those steps that can be done better by machines or computers. Workflow packages such as Staffware and K2.net provide the means to automate business processes and to eliminate certain human activities. See **Figure 72** to **Figure 76** for a typical generic process with certain paperwork and "hand-offs" that can be simplified with the introduction of workflow and a few changes to the underlying information systems.

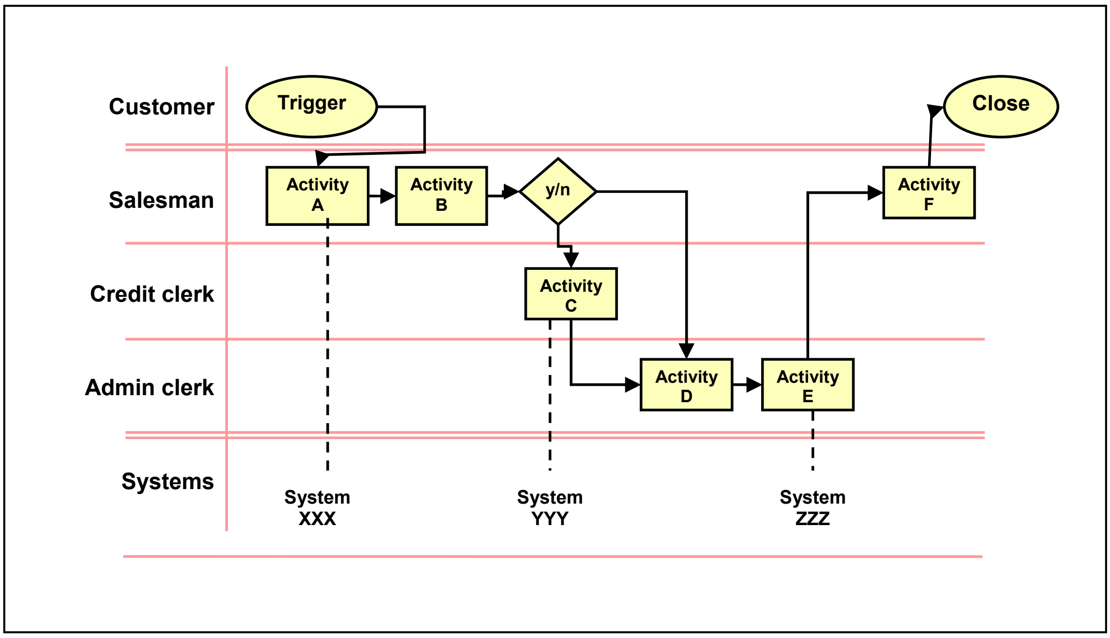


Figure 72. A typical generic process

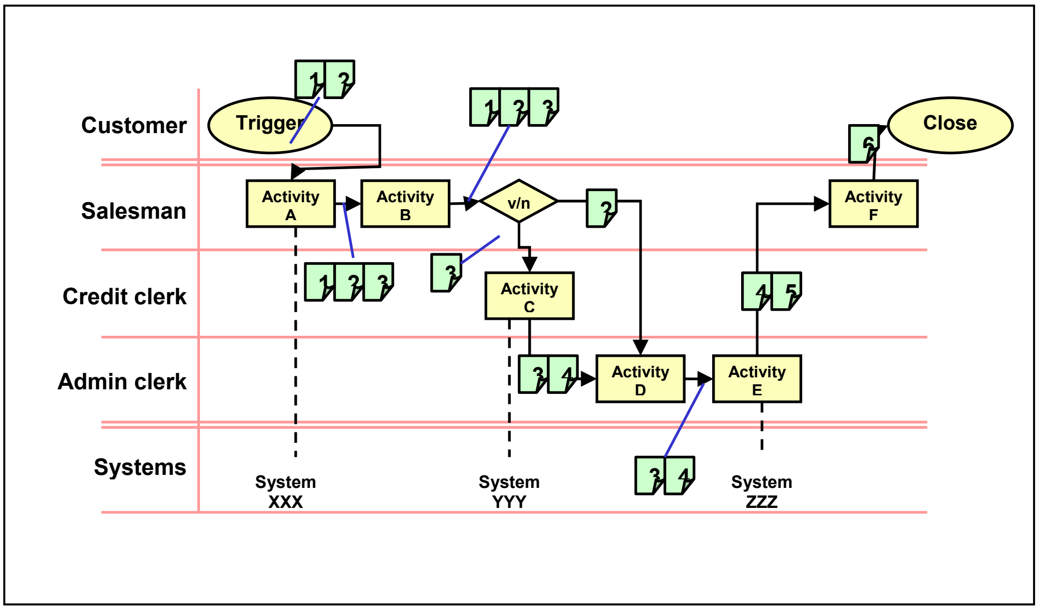


Figure 73. Typical paperwork during activities

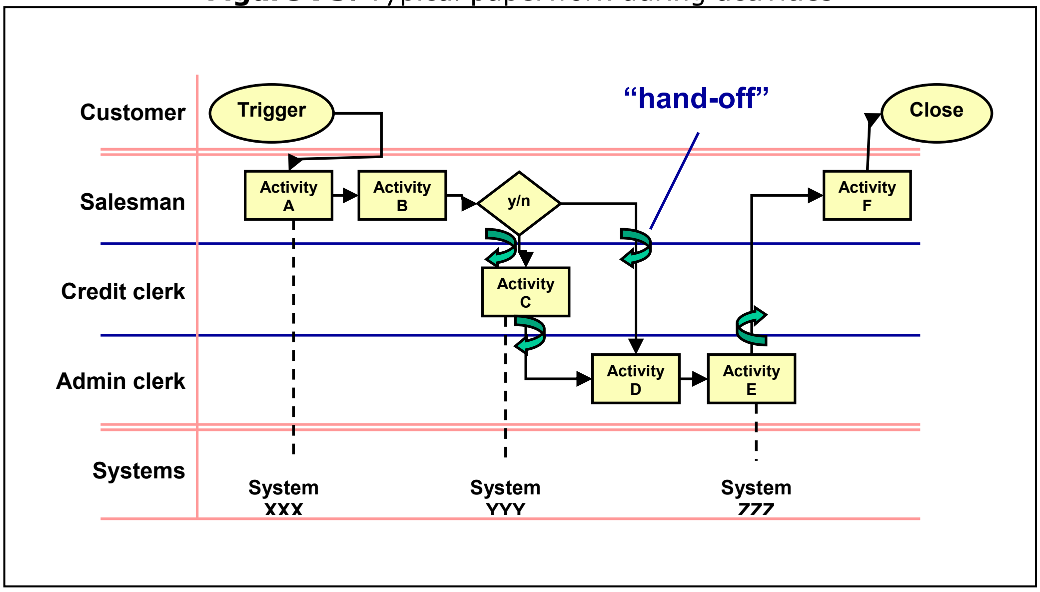


Figure 74. Typical "hand-offs" between human resources

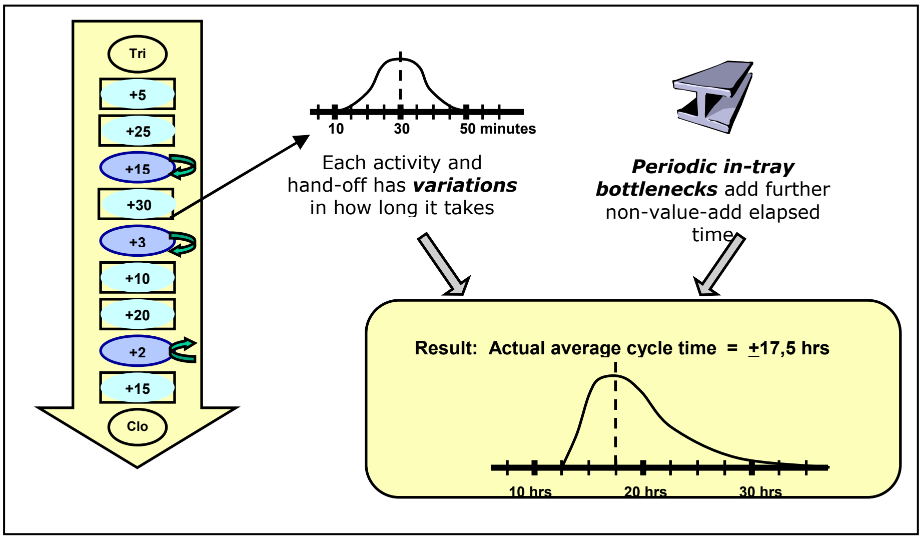


Figure 75. Estimated time for the total process

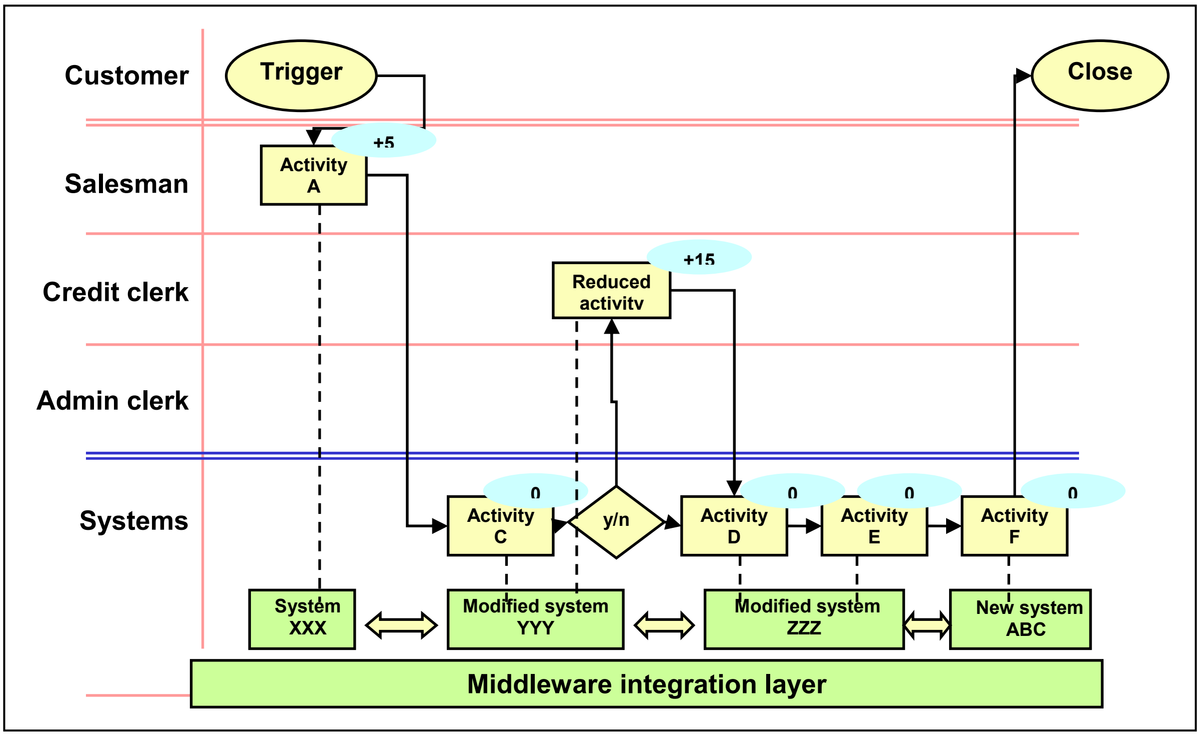


Figure 76. Improved system

The improved system has a dramatic reduction in lead-time for the client (improving customer satisfaction) and the savings in human time can be used in other processes where human intervention is required. The reduction in time is made possible through digitization of most of the paper work and workflow that ensures that the task is escalated to another worker, if the person cannot attend to it within a certain time frame, as well as rule engines that are embedded in the application systems and the fact that the different systems are "talking" to each other through middleware integration software.

Workflow can also be used very effectively to enforce a changed process. Many of the re-engineering projects in the late 1980s failed, because even though the new process was better and should have generated savings, it was possible for the people to fall back on the old ways of executing the process. Workflow also provides the basis for many performance measurements, since it provides time stamps as the work item moves through the process. By analysing the time between any two steps in the process, it is possible to identify bottlenecks and adjust resource allocation. (This data can also be used as valid input data for further simulation modelling of the process.)

In summary, the tools that can be used effectively in this step of the Bigger Picture BI Context Model are the following:

- The Strategy Wheel of Manning
- Lists with goals, priorities, actions and responsibilities
- Simulation modelling to quantify the resources, estimate total process times and to select decision rules
- Swim-lane diagrams to communicate the role of every resource in any process
- Workflow to enforce and streamline processes
- Integrated supporting information systems

Soon BPMS will also provide more control for business analysts to design and change their business processes during and after implementation.

3.2.4 Performance measurement from a data warehouse

This component of the Bigger Picture BI Context Model relies on the following concepts:

- By measuring certain performance criteria, people will behave in a way that will support these performance measures in a positive way.
- In an organization performance should be measured on three levels, namely the organization level, the process level and the individual, or job performer, level. This correlates with the Rummler and Brache (1995) framework.
- Performance measures must be carefully selected to limit them to a manageable amount and furthermore, they should support the cause-and-effect hypothesis of the strategy that management wants to implement. This correlates with the Balanced Scorecard approach of Kaplan and Norton (1996).
- The measurements must be calculated on a regular basis and in a consistent manner to ensure that valid trend information is gathered. If a measurement consists of more than one element in the formula, it should be possible to drill down to the individual components to identify the root cause of a problem. This concept correlates with the aim of establishing a data warehouse to support better decision-making and the use of BI tools.
- Businesses have generic functions and it is possible to refer to a generic list of typical measures (key performance indicators) like the one provided by Connelly (1999) in the 24 Ways. Naturally, given a specific organization with a certain strategy, some of them may be more applicable than others.
- Performance measurement is a sub-set of performance management that includes the planning of performance measures, the infrastructure to provide a basis for measurement, the measurement process itself, the interpretation of the measurements and the action taken. In this regard this component of the Bigger Picture BI Context Model concentrates on the first three steps, given the fact that interpretation and action are handled in other components.

3.2.4.1 Rummler and Brache framework

The Nine Performance Variables with relevant questions (see **Table 9**) provide a holistic view on how the performance needs (in terms of goals, design and management) can be measured at the different levels (organization, process and job/performer level).

The swim-lane approach to business process definition (see **Figure 50**) provides a visual display of the individual business process steps and the responsible organizational unit. It clearly shows the "hand-off" points between responsible parties and forces the designer of the business process to define where responsibility of each party starts and stops.

The identification of measurements should start at the process level, keeping in mind what the organizational goals and strategies are. In this regard the core processes in the value chain will probably have higher priority than supporting processes. Each step in the process is done within an organizational unit and by a person (or a system for which a person takes responsibility). If measurements are taken at appropriate places in the process, some of the measurements at the organizational level and job/performer level will be derived from these process related measurements.

3.2.4.2 Balanced Scorecard approach

The Balanced Scorecard approach from Kaplan and Norton (1996) covers four perspectives of the business (finance, customer, internal business processes and learning and growth) and it is suggested that the cause-and-effect relationships between different measurements should clearly support a strategic theme of the organization (see **Figure 54** for an example).

The reason why this approach forms a cornerstone of the Bigger Picture BI Context Model is the strong link between strategy and measurement. The measurements are often displayed on the BI dashboards of management in the same way as they are linked in the cause-and-effect diagrams. It is therefore easy to evaluate over time whether the assumptions that are made in the cause-and-effect arguments are true. If not, the measurements should be adjusted, or the strategy should be reviewed.

3.2.4.3 Data warehousing approach

The Kimball approach (1998) to build a data warehouse in incremental steps, adhering to a basic discipline regarding conformed dimensions, has been selected to form the foundation from where performance measures are calculated. Conceptual tools that are used include the following:

- Overview of the basic elements of the data warehouse (see **Figure 40**)
- The typical star schema, consisting of a fact table and a number of surrounding dimension tables (see **Figure 41**)
- The Warehouse Bus Architecture to identify conformed dimensions (see **Figure 42**)
- The Business Dimensional Lifecycle diagram that forms a framework for the establishment and maintenance of a dimensional data warehouse, including project management, identification of business requirements, development and acquisition of the technical environment, dimensional database and presentation tools and the implementation, maintenance and growth phases (see **Figure 43**).

The classification of fact tables (see **Table 8**) in transactional, periodic snapshot and accumulating snapshot types provides a valuable guide during the design of the different data marts that will eventually form the complete data warehouse. The concept of three basic ways in which changes to dimension tables are handled (slowly changing dimension types 1 to 3, indicating overwriting, adding a row, or adding a column), forces the data warehouse designer to consider every attribute in a dimension table and to define an update strategy that will eventually become part of the ETL (extraction, transformation and loading) plans.

A separate ODS (operational data store) is normally not necessary, if the data marts are designed at the right level of detail. Often an ODS is introduced when data quality standards of the data warehouse are set too high for the state of the transactional data. If this is the case, it could happen that a large portion of transactions is not loaded into the data warehouse, because they do not have valid dimensional keys and for certain performance measures the data in the warehouse can be completely wrong (e.g. count of transactions). This situation can be handled in various ways. One option is to admit all records and make sure that all dimensions have a record indicating "Not available". These records are then linked to each record in the fact table that does not have a valid dimensional key.

Another option is to reject the record from the data warehouse and to send it back to the source system to be completed. At the next loading process the record will then be loaded, if the errors were rectified. This is the preferred manner, if the turnaround time of rejected records is short and the update processes of the data warehouse are run frequently (e.g. once a day).

Sometimes an ODS is introduced to provide reports when certain data marts are still in development. This is acceptable, but as soon as the data mart(s) that can provide the same report is developed, that part of the ODS should be deactivated. The idea of a central data warehouse is to provide the single version of the truth in a user-friendly manner. If two sources of data are used to provide the same report (one being the data mart that goes through a process of data cleaning, transformation and quality checks, and the other being a copy of the transactional system tables in the ODS), it is quite possible to arrive at different results. Some users persist that a good (but not 100% accurate) answer from the ODS is better than no answer from the data warehouse - and it is difficult to argue against that.

It is concluded then that in certain cases the ODS is a necessary evil that should be tolerated under the control of the data warehouse manager to handle situations as discussed above and to do prototyping of reports that will eventually be provided through well designed data marts.

3.2.4.4 Business intelligence tools

A large number of BI tools exist ranging from simple reporting tools to sophisticated tools that do not only cover the data access functionality, but also provide functions to extract, transform and load data from various sources into a data warehouse environment (data staging functions). As stated in the beginning, it is not the aim of this thesis to evaluate and compare the various BI products. It is, however, necessary to illustrate some of the functionality that is necessary to present data in such a format that it can be described as business intelligence - information that can lead to better decision-making.

The size of the organization (as well as the size of the budget!) determines the choice between BI products. It does not make sense for a small organization with one or two source systems to spend a few hundred thousand rand or more to accomplish the same results that can be achieved by a professional version of MS Office, costing less than R5000. Investment in a sophisticated BI toolset is however justified if the environment is much more complex - if the organization has many source systems running on different platforms, if a lot of transformations are necessary before the data can be loaded in a consistent manner into a data warehouse database, or if the data volume is very large.

Since the arguments for the establishment of a separate data warehouse environment were put forward in the previous chapter and the author has decided to incorporate the data warehousing approach of Kimball in the Bigger Picture BI Context Model, the following typical tools will be needed:

- An ETL tool to extract data from various data bases, transform data where necessary and load data in a star scheme dimensional database format;
- A database that will serve as the dimensional data warehouse;
- Data access tool(s) to interrogate the data in the data warehouse in such ways that it will lead to better decisions. This could include normal reporting tools, charting tools, dashboard/robot logic tools, analytical tools (like OLAP cubes and pivot table functionality) and data mining tools (such as neural networks, fuzzy logic and classical statistics). Some of the tools may provide static reports that can be published on a portal or intranet, while others cater also for less structured ad hoc queries that users may want to run. Some are available as client / server applications, while others are also available in thin (or zero) client versions through normal web browsers.

Given the above categories of tools that are necessary to build and use the data warehouse environment, the author is also of the opinion that the tools should be as integrated as possible. If the environment already has an ERP system, for example SAP, then it is suggested that the Business Information Warehouse (BW) of SAP is used (even though The OLAP Report *(www.olapreport.com 2004)* states that *"there are very few successful deployments and large volumes of shelfware".*

If the environment uses MS SQL Server as a database and most of its source data is in MS SQL databases, then it is advised to use the Microsoft environment (see **Figure 77**) until it proves to be a problem. Included in the MS SQL Server pack are products such as *DTS* (data transformation services) as an ETL tool and *Analysis Services* with data access functionality. The pivot table functionality in *MS Excel* is extremely powerful when smaller amounts of data are analysed.

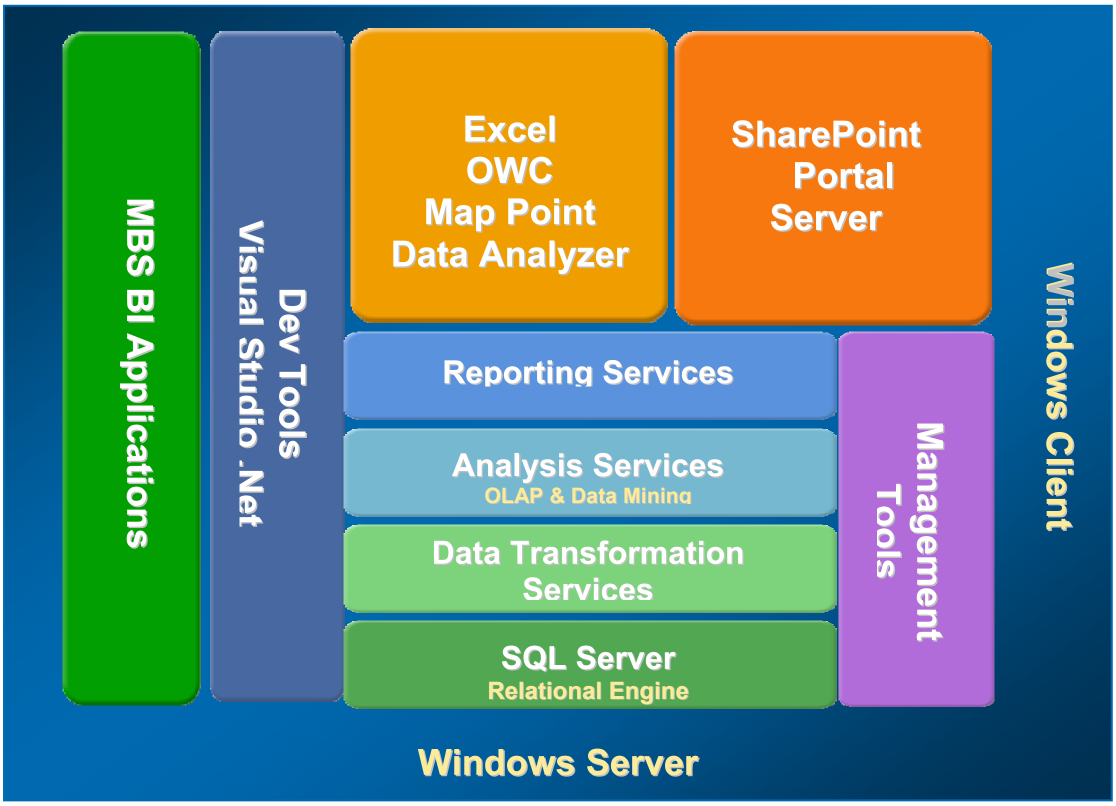


Figure 77. The Microsoft BI tool offering (Microsoft partner information 2004)

For even smaller organizations that use *MS Access* as a database, *MS Office Professional* with *MS Excel* as a data access tool may provide an entry-level environment.

Most organizations in the medium to large category would probably use more powerful products for ETL (such as *Datastage*, *Informatica* and *Sagent*). The more popular data access tools include *Business Objects*, *Cognos PowerPlay*, *Microstrategy*, *ProClarity* and *Hyperion*). It should be noted that many of the popular data access tools do not have any ETL functionality and are therefore running directly on the transactional systems, or rely on other tools to create the data warehouse environment from where the data can be accessed. These products normally create a meta layer (e.g. Business Objects calls it a universe) where a selection of the tables in a specific database are included and end-users have access via the meta layer. The field names of the database tables can also be changed to terminology more familiar to business users.

The author has become familiar with *Sagent Solution* as a BI tool over the last few years and therefore it will be used to demonstrate some of the necessary functionality in the next chapter. The interesting thing about Sagent is that it has always been a tool that supported the back-office (ETL), as well as front-office functions through a common user interface and panel of transforms. (Transforms are higher-level functions that create SQL statements in the background via a user-friendly interface.) These transforms include building blocks to extract data from various sources, a function to generate surrogate keys, a key lookup function to populate the fact table, functions to filter and remove duplicate records, functions for batch loading of data to various databases and many more. It is supported by a meta data database where all plans, meta views and base views (the link to database tables - similar to universes in Business Objects) are stored. It also provides a powerful automation module that can be used to trigger plans automatically at certain times and inform the responsible person of any problems via SMS, e-mail, or other means.

It can be concluded that BI tools of appropriate sophistication, depending on available funds and functional needs, should support the performance measurement component in the Bigger Picture BI Context Model. The principles on which the data warehouse is built should be adhered to, however, regardless of the BI tools that are used. The content of the data warehouse will be determined by the performance measures, based on the strategic themes. Although the emphasis on the data access side will be on the performance measures that support the current strategic themes, the warehouse will keep on gathering information (through automated update plans) on previous measurements to grow the history of existing data marts.

3.2.5 Interpretation of business intelligence

This component of the Bigger Picture BI Context Model is one step in a business process that will never be automated or taken over by a "rule engine". It requires a human being to make a judgement call on whether the performance measures that he/she is confronted with, within the context of other external environmental factors, ask for the improvement of the operational execution of the current strategy, or that the complete strategy should be reviewed and changed. After the judgement call has been made, it requires action. Even if all measures are according to expectations (which are very unlikely!), they should be communicated to all concerned to motivate them and targets should perhaps be reviewed.

Any deviations from expected performance levels should be investigated. Since performance measures will include measures on all three levels (organization, process and individual level), drill down functionality will be used to identify the core reason for deviations. For example, if the net profit performance of the organization is negative, it can either be that not enough money is coming in (possibly a marketing process problem), or too much money is spent (various expense accounts can be investigated to identify the overspending).

Within the context of the cause-and-effect diagrams of the Balanced Scorecard approach, it is also possible to realise that some of the links are not changing as expected. Sometimes it may be a timing issue (e.g. training of people will not have an immediate effect on customer satisfaction) and therefore the current strategy may still be valid and the results should be forthcoming in a few months. However, sometimes the reasoning behind the cause-and-effect diagrams is in error, or needs additional action to work as intended. In these cases the judgement of the manager is important to take the right action in terms of adjusted business processes and improved performance measurements.

External factors may prescribe drastical changes to the strategy. It may be that the current strategy has been developed during a period when the exchange rate favoured exports (and it could still be a good strategy for those circumstances), but if the exchange rate has now changed to favour local sales, the strategy should be reviewed and certain marketing and production processes might have to change. This will lead to the development of new strategies that will impact on the enterprise architecture. These strategies will be evaluated (given the associations between entities), before they will be implemented and executed through revised business processes. New performance measurements may be required and the whole process will be repeated.

This component in the BI context model emphasizes the point that BI is not just a technological solution to present information in a user-friendly manner - it is the trigger that leads to decisions and actions that will influence strategy changes or business process execution.

3.2.6 Updating of the enterprise architecture

Similar to updating building plans for a building whenever changes are made to ensure that future proposals for change are measured against the correct baseline (and to operate and maintain the building effectively), it is also important to update the documented enterprise architecture of a business whenever changes are made. This process is necessary for both feedback loops in the Bigger Picture BI Context Model, namely change of strategy and change of operational execution of the strategy.

Although the complete change of strategy may involve a more complete revision of the enterprise architecture, there are basically two categories of changes that must be addressed. Firstly, there may be changes to the existing entities as defined in the various hierarchies of strategies, goals, locations, organizational structure, processes and supporting systems and technologies. Secondly, there may be changes to the associations that were drawn between these entities. In both cases the changes may include additions, deletions or editing. In many cases the repository also refers to other documents, diagrams and even process simulation models. It should be clear that effective configuration management of the documented baseline of an organization in terms of enterprise architecture is therefore of the utmost importance.

Typical changes in the repository may include the following:

- Addition of new goals derived from a new strategy
- Deletion of certain goals, or allocation of different priorities to existing goals
- Addition or editing of business processes to reflect a new way of working, or the introduction of new technology in the process
- Addition or editing of the associations between a business process and the role players in the organizational structure
- Breaking of certain associations (e.g. cause-and-effect relationships in a Balanced Scorecard that proved to be wrong)
- Building of new associations between a new information system and the processes that are supported by the system, while simultaneously removing links to previous systems or manual procedures
- Building of new performance measures and the relevant associations to goals and processes to enable the organization to monitor the implementation of the changes

The value of enterprise architecture tools that are designed to handle these changes in a sophisticated manner and to make the latest baseline available in a timely and accurate way cannot be overlooked. It plays an important role in the quality of decisions that are made and provides a centralised version of the truth where all people in the organization can see what the current blue print of the organization looks like, including structures, business processes, infrastructure and systems, as well as the associations between all of these entities. This step in the Bigger Picture BI Context Model to update the enterprise architecture whenever changes are made is an important prerequisite for the reliable use of the model.

3.3 Supporting templates

A number of simplified templates to support some of the thought processes in the Bigger Picture BI Context Model have been developed, since some of the commercially available tools to support those aspects are expensive. These templates are available on the CD-ROM that accompanies the thesis. The aim of the templates is definitely not to replace, or compete with commercially available products – rather to illustrate the concepts in another manner through readily available software such as *MS Excel* and *MS Access*.

The following templates are included:

- Innovation Matrix (General idea from Grulke embedded in a spreadsheet)
- Business logic framework (General idea from Manning)
- 7 Ps model (General idea from Manning)
- Strategy Wheel of issues (General idea from Manning)
- Format for action list (General idea from Manning)
- Foxy Matrix (Ilbury and Sunter) combined with "Six hats" technique from De Bono
- Fourier Model of concentric circles
- Data mart matrix (Adapted from Kimball)
- Data mart design database (MS Access framework to document certain meta data)
- Fourier context model database (Basic *MS Access* framework to document associations)

Most of these templates are demonstrated in chapter 4.

3.4 Conclusion of BI in context

The aim of this chapter was to describe and explain the Bigger Picture BI Context Model that is repeated in Figure 78.

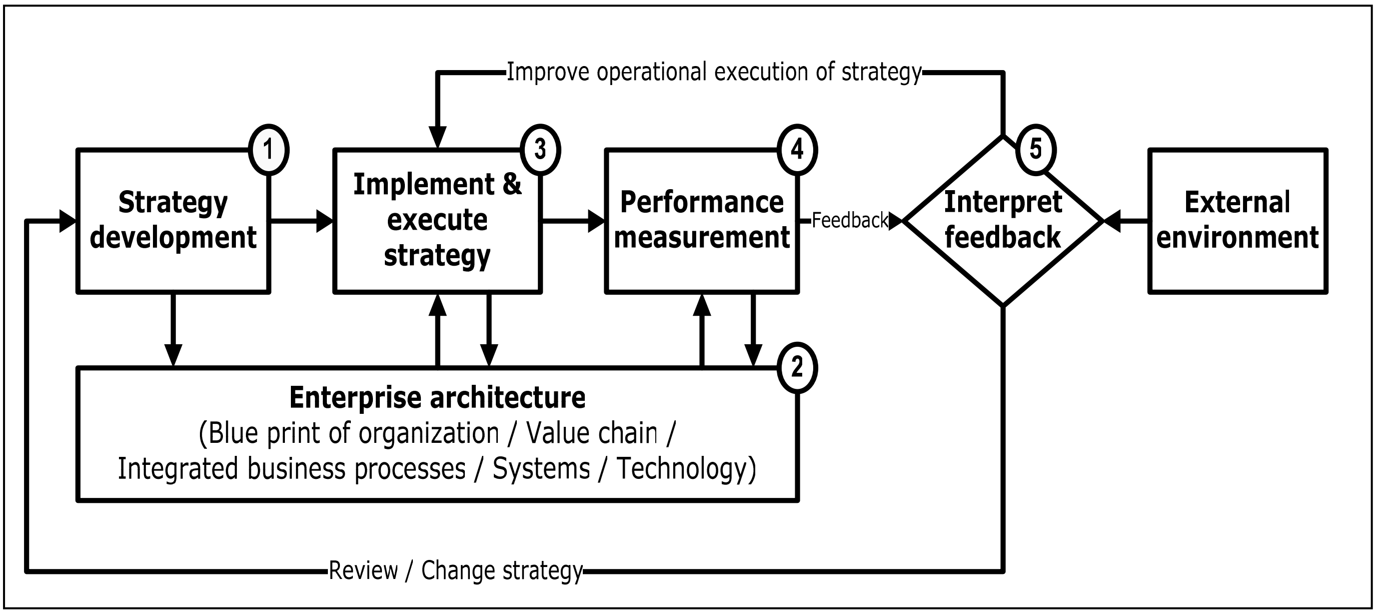


Figure 78. An overview of the Bigger Picture BI Context Model.

The popular view of BI and BI tools is that they provide business related information in various formats through reports, graphs and drill-down capabilities from which better decisions can be made. The author does not disagree with this view, but has provided a framework in which strategy development, enterprise architecture, implementation and execution of strategy through business processes and performance measurement are put into context to provide a qualitative control system. BI is positioned as part of the performance measurement component of the model.

Each of the components in the model was discussed by referring to various techniques or concepts that were identified during the literature study, without being prescriptive, or excluding other concepts that may also fall into an identified component of the model. For strategy development the following concepts were identified:

- Various ideas from Grulke (e.g. Innovation Matrix and Learning from the Future)
- Various techniques from Manning (e.g. Business Logic framework and 7 Ps)
- Foxy Matrix from Ilbury and Sunter
- Fourier Model developed by the author and colleagues

For the enterprise architecture component the following aspects were included in the model:

- The Zachman Framework for an enterprise architecture methodology
- *Casewise* as typical enterprise architecture software (supported by the Zachman Framework)
- Process simulation modelling to quantify required resources in business processes and to evaluate various operating rules

The following concepts were identified to support the implementation and execution of the strategy phase (moving from planning to doing):

- Business process management (BPM)
- Swim-lane diagrams to communicate business processes
- Workflow to enforce and streamline business processes and activate systems at appropriate times
- Integrated information systems to support business processes
- The Strategy Wheel and action list with goals, priorities and responsibilities from Manning

The following concepts and tools support the performance measurement component:

- The Nine Performance Variables from Rummler and Brache
- The Balanced Scorecard (BSC) approach from Kaplan and Norton
- The data warehouse approach from Kimball
- Various BI tools of appropriate sophistication to support the extraction, transformation and loading processes, as well as information delivery and data analysis

The role of human judgement was emphasized in the interpretation component of the model. At this stage information from the performance measurement component and the external environment is taken into consideration and after interpretation, action is taken to either

- improve the execution of the existing strategy, or
- review and change the strategy all together.

In both cases changes will definitely lead to updating of certain components in the enterprise architecture (e.g. changes in goals, business processes, supporting systems and various associations between these entities in the enterprise architecture). The impact of these changes should also be reflected in the performance measurement component. Since the enterprise architecture is used to determine the impact of any proposed changes (by looking at the various associations) and perhaps to simulate proposed process changes, the importance of keeping the architecture up to date was emphasized.

The practical use of the model is illustrated in the next chapter by applying it to a typical consulting organization.

4 Case study – conceptual model demonstrated

4.1 Introduction

The developed model is generic and can be applied to any organization. It is required that all steps or components of the model should be addressed to a larger or lesser extent. It also supports the Balanced Scorecard approach of formulates, communicates, executes and navigates. If all steps in the model are not performed in a balanced manner, the following situations (among many others) are possible:

- By skipping or neglecting the formal strategy development component, very little of the strategy will be known to the people who must document it in the enterprise modelling repository, execute it through the business units and improve the performance of the organization.

- By neglecting the documentation of the enterprise in a central repository, or failing to maintain that when changes are made, the baseline (blue prints) of the organization is lost and the impact of future proposed changes cannot be modelled effectively.

- Without effective execution of the strategy through specific initiatives, a well-thought-out strategy will remain merely a brilliant idea in some people's minds and any performance change will be a coincidence.

- If performance measurements are not aligned with the intended strategy, the behaviour of people will not necessarily support the strategy and successful implementation will be in jeopardy.

- If performance measurements are not consistently measured from a stable platform that supports all identified measurements (typically a data warehouse), people will lose faith in the measurement process and it will become much more dfficult to establish whether a strategy is successful.

The author has been extensively involved in the development and evolutionary implementation of this model at a consulting firm that provides clients with business solutions, which are mostly based on information and communication technology. The following paragraphs will illustrate the application of the model in that environment, after a brief background of the company has been given.

4.2 Background of the consulting firm

Fourier Approach is a privately owned company that was formally established in the late 1990s during the height of the IT boom era. Its vision was to bridge the apparent gap between business needs and the endless supply of IT products and services (which confused and intimidated many business managers), by positioning itself on the side of business. This approach led the company to help clients to formulate their IT strategy that was derived from the business strategy and to provide a framework of necessary IT infrastructure and information systems to support their business processes. The IT strategy would then guide the business in the acquisition and implementation of relevant IT products and services.

After insight had been gained into the business and IT strategy, opportunities emerged for business process development, simulation of processes, development of new information systems (where no suitable products at affordable prices could be found for the client), integration of systems, maintenance of systems and IT infrastructure. It was also clear that most clients needed business intelligence and that it would form an important part of the IT strategy of any business. The IT strategy was used as a vehicle (or road map) to explain to business managers that there should be a sequence in events when they acquire IT products and services - if real value was required! For example, the best workflow package would fail if the underlying business processes were not properly defined and designed for integration. Similarly, a fallacy can be created by vendors of business intelligence tools who show remarkable reporting tools, but fail to emphasize the importance of clean transactional data in electronic format.

A mixture of skills was needed to provide these services and products. Business analysts (mostly with an industrial engineering background), system analysts with an information system design background and programmers in the more popular programming languages of the day, as well as computer hardware and network specialists were drawn in. Not only the mix between different skills was important, but also the mix between senior and more junior resources.

As with many smaller, start-up companies, contracts were initially landed through the personal networking of the senior managers. A longer term outsourcing contract was negotiated with a large facility management organization to establish, support and in certain cases operate their information systems and IT infrastructure. A lot of development and integration work followed upon this contract and the company grew larger to accommodate all the work.

While a large component of the company concentrated on satisfying the needs of existing clients through various projects, the emphasis of senior management shifted to sustaining the company in the long run, by improving the way in which marketing was done and establishing the value chain of the organization. Formalization of policies and procedures, structuring according to focus areas and projects in a matrix organizational structure and establishing a common methodology took a lot of effort and management time. The basic support functions of general management (including infrastructure and IT support), finance, human resources management and procurement were also established to provide the necessary level of support to the company.

During the process of seeking solutions for clients, a number of non-exclusive partnerships were also attained from various product suppliers, for example in the workflow and BI areas. The reason for non-exclusive partnerships was to retain the right to advise clients according to their needs and not be bound by exclusive partnership agreements. It was found that businesses differ a lot in terms of their approach, sophistication level and above all their budgets. Therefore different solutions have to be offered for different circumstances.

The technical offering of the company was initially packaged into the following focus areas that were managed as lines within the production function of the organization:

- IT strategy development
- Business process design, simulation and workflow
- Information system development and integration
- IT infrastructure support
- Business intelligence

Figure 79 shows how these focus areas were positioned to bridge the gap between the normal business strategy of the client and the acquisition of IT related products and services.

The business solutions that are delivered to clients often need components and inputs from two, three, or more focus areas and therefore the concept of a matrix organizational structure, where the development of a solution for a client is handled as a project, was introduced. Investment opportunities where the company itself is the client and sponsor are also handled as projects within this structure. An operational manager plays a supervisory role as the manager of project managers and provides guidelines on how all projects must be managed.

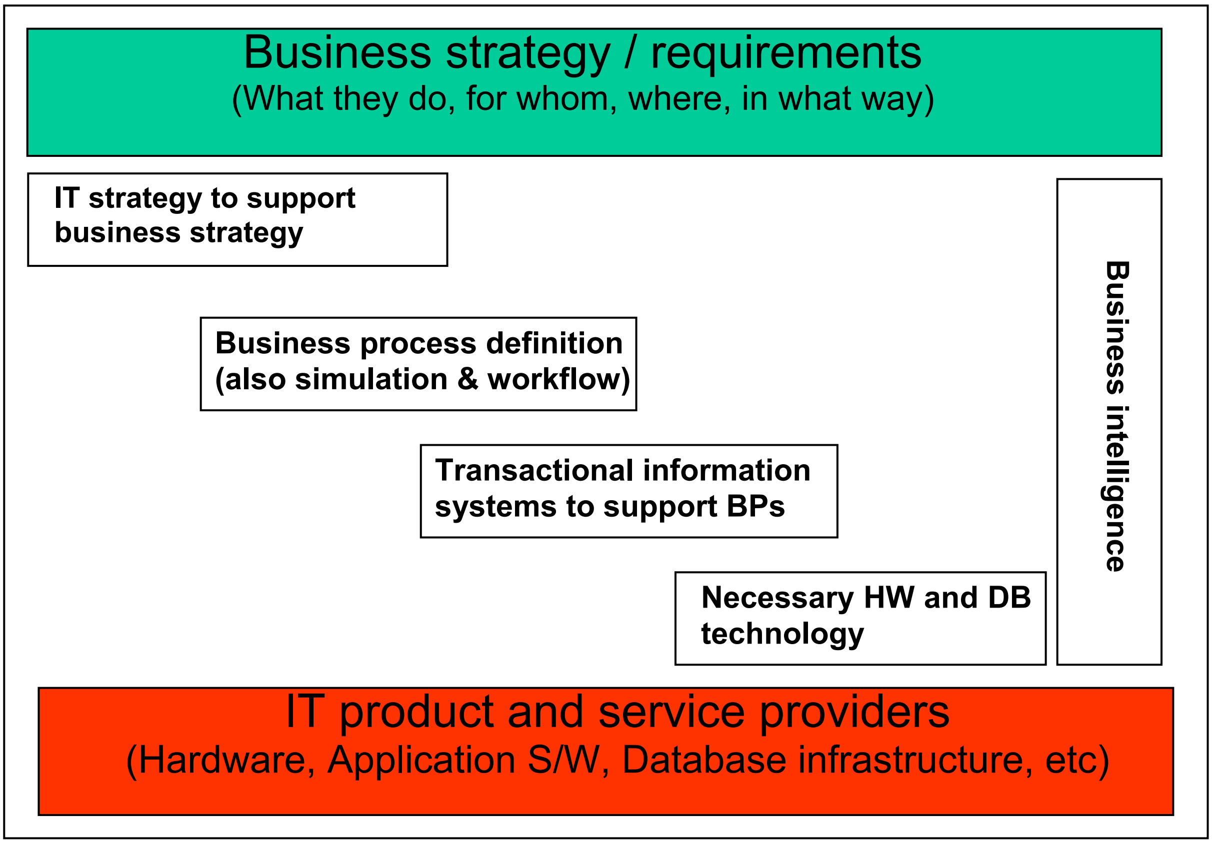


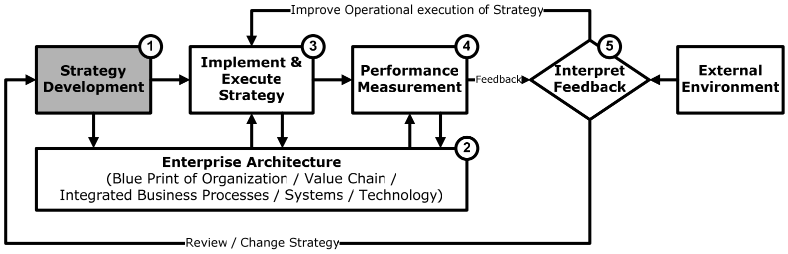
Figure 79. Focus areas to bridge the gap

During the first few years the abovementioned developments took place without a formal, continuous strategic management process. However, some very fruitful sessions were held from time to time to discuss the long-term direction of the company and to develop certain aspects of the way in which operational activity could be improved. A formal vision and mission statement were formulated and communicated to everyone in the organization. The organizational structure, the definition of the focus areas, extension of the marketing function, a value system and decisions on the type of investments that the company should be involved in were all results of these ad hoc strategic sessions. Very often these strategic sessions were facilitated by using some of the ideas from Porter, Manning, Kaplan and Norton, or through the Foxy Matrix approach of Ilbury and Sunter. There was often a lot of enthusiasm after these sessions, but urgent operational issues often hampered the implementation of the decisions.

As is typical of a smaller company, senior management is also involved in operational activities and it is often not so easy to distinguish clearly between the urgent and important activities, as suggested by Covey (1992) when discussing the third habit of highly effective people - "Put first things first". Attention to strategic issues is often perceived to be important, but not so urgent. According to Covey highly effective people concentrate on the important, but not so urgent activities, they spend very little time on unimportant activities (regardless of their urgency) and that provides them with the room to handle urgent and important activities (like crises) when they occur. *(The author finds himself in a constant process of striving towards achieving the seven habits in personal and business environment, but must admit he still has to do a lot of saw* *sharpening!)*

After this background on Fourier Approach, the next paragraphs describe how the process has changed since the adoption of the Bigger Picture BI Context Model and the implementation of an enterprise modelling approach. The emphasis is on the establishment of a data warehouse and the performance management component of the model to illustrate the approach to BI when it is driven from a strategic perspective. The aim is to show the links between the various components in the model and not so much to debate the selected strategies and choices. The design of the supporting data marts and key performance indicators are generic and can be used by similar organizations.

4.3 Strategy development



During the early 2000s it became clear that the requirements of the South African government for black economic empowerment (BEE) would have a major effect on all organizations that do business in South Africa. Apart from the legal requirements to develop and report against an employment equity (EE) plan, organizations are also strongly motivated to do business with BEE organizations through tender requirements that refer to their equity, management, employment and procurement status with regards to BEE. A number of models to address the question of BEE have been developed by businesses in South Africa - some more successful than others.

Fourier Approach decided to address the situation through a parallel strategy. Firstly, a BEE entity was founded with a black majority partner to provide programming services. The existing shareholding entities would channel their programming work to this new entity and with time it would generate more work that would enable it to grow and provide employment to previously disadvantaged people. Whenever BEE plays a significant role in any tender or proposal, this vehicle would also be used in the South African environment. The argument is further that the BEE partner would open up opportunities where Fourier Approach in its current profile would not be able to market.

Secondly, in parallel with this approach in the local market, it was felt that other African countries should be targeted to provide to them services and products similar to what the existing Fourier Approach could offer, but through local entities in those countries. Fourier Approach would directly or indirectly have shareholding in those entities. It was argued that if those markets could grow through the delivery of basic infrastructure (e.g. providing internet services), the need for transactional information systems, workflow and eventually business intelligence services would also grow in the long run. The provision of basic telecommunication services would therefore be a priority for the initial phases, although other products and services that Fourier Approach can deliver would also be available to the local entities. Two entities were founded with local partners in Botswana and Nigeria respectively.

The abovementioned strategies were derived from a traditional SWOT analysis, combined with a Foxy Matrix exercise. See **Figure 80** for an example of the Foxy Matrix exercise when the question of BEE (black economic empowerment) was discussed. It is obvious that a long debate led to the summary of the matrix as depicted in the figure.

The thought process of moving through the quadrants definitely helped to derive at certain decisions.

<table>
<tr><td></td><td colspan="2">(Strengths and weaknesses)
CONTROL</td><td></td></tr>
<tr><td colspan="2">3
Options:
1) Business as usual - do nothing and hope that skills and expertise will always be wanted by entities that win the tenders.
2) Run away - withdraw from RSA (no option).
3) Weather the storm - implement a parallel strategy for the RSA and certain African countries.</td><td colspan="2">4
Decisions:
1) Establish a new RSA entity with a carefully selected BEE partner with similar value system and grow the entity with channeled work initially. Use the entity as vehicle where BEE is important.
2) Invest in new entities with local partners in promising African countries to position for expected growth in basic IT services.</td></tr>
<tr><td>UNCERTAINTY</td><td></td><td></td><td>CERTAINTY</td></tr>
<tr><td colspan="2">a) Key uncertainties:
How long will BEE factor "reign" in the RSA?
Will a BEE partner in the RSA necessarily add value?
How long will it take and how much will it cost to start up businesses in African countries?
b) Scenarios:
BEE drive will become stronger, despite possible damage to the economy.
BEE will empower enough black businesses in the next 5-8 years to normalize the situation.
Selecting the wrong BEE partner will lead to destruction of value, while selecting the right one may unlock opportunities far outside the current range.
Thorough homework may lead to realistic African partners that may open opportunities cost effectively.
2</td><td colspan="2">Rules of the Game:
BEE plays a more important role in the RSA.
Various BEE initiatives from much stronger entities in the RSA have failed - it is a risky exercise.
BEE does not play a role in other (African) countries, although local entities are always preferred suppliers.
Certain IT services (e.g. desk top support) are becoming commodities in the RSA, while the rest of Africa is still growing.
First world economies are in recession, but funding is available for African investment.
1</td></tr>
<tr><td></td><td colspan="2">ABSENCE OF CONTROL
(Opportunities and threats)</td><td></td></tr>
</table>

Figure 80. An example of the Foxy Matrix applied to Fourier Approach.

The 7 Ps model of Manning was also applied to Fourier Approach to identify the business model that is most appropriate for the organization. The results are given in **Figure 81**. From the different strategy development tools a number of strategic themes were identified:

- Deliver B2B (business to business) solutions - including hosting of generic services.
- Enter Africa (outside of the RSA) to deliver basic infrastructure and to prepare the environment for other services later.
- Position for work in the RSA through a new entity with a carefully selected BEE partner.
- Strive for a better mix of clients - get more, bigger clients with a long-term relationship.
- Strive for a better mix in income streams (product sales, services through projects and annuity income through hosting services and product maintenance fees).
- Improve corporate governance by formally defining and documenting all relevant processes in an internal enterprise modelling exercise.

1	PURPOSE	To assist customers in bridging the gap between their business strategy and the IT-related products and services that may add value to their organizations and support their business processes.
2	POSITIONING	Fourier positions itself on the side of medium-sized businesses that want to bridge the gap and use IT-related solutions to improve their operations. As value for money supplier Fourier can also develop information systems, if no suitable product can be acquired off the shelf.
3	PRODUCT	IT-related products and services to satisfy business needs, including services on information strategy; definition, simulation and enforcing of business processes through work flow; development and implementation of information systems to support BPs; infrastructure to support information systems and business intelligence services and products.
4	PHILOSOPHIES	To have various building blocks of solutions readily available (either in-house or with partners) to package a solution for each customer. The mix between industrial engineers (who relate to business needs) and system analysts and programmers (who relate to systems) forms a good foundation for IT-related business solutions.
5	PROCESSES	Core processes consist of marketing (to get the work) and project execution (to successfully deliver products and services to satisfy customer requirements). Normal supporting processes from HR, finance, procurement, R & D and general management are also accommodated.
6	PEOPLE	A healthy mix between junior and more senior resources in the following categories forms part of the work force: business analysts, system analysts, programmers, infrastructure specialists (including telecommunication specialists) and marketing and administration staff.
7	PARTNERS	Non-exclusive partnerships with workflow product suppliers (Staffware and K2.net), BI (Sagent), telecommunications (Palmtree) and Microsoft (various solutions). Also consulting partners with various entities to overcome peak times and provision of specialist services.

Figure 81. The 7Ps model applied to Fourier Approach.

To determine the balance with which Fourier invests in various initiatives the innovative profile exercise suggested by Grulke was done, using the adapted template. The results can be seen in **Figure 82**. Without discussing the investment projects in detail, it is clear from the results that Fourier has a fairly balanced spread of investment in the various quadrants, with perhaps too much investment in the "Radical innovation" area where the probability of success in the short to medium term is not so high. The profile changes from time to time, but provides a useful barometer when new investment opportunities are considered.

	200	450
	Technology linkage	
	Enhance	Disrupt
Market linkage disrupt	2 Disruptive innovation (Market)	RADICAL 4 INNOVATION
Market linkage enhance	Evolutionary innovation	Disruptive innovation (Tech)
	1 150	230 3

Identification of top activities:

No	Innovation Activity	Investment (R '000)	Position
1	Upgrade of Time Sheet system	30	1
2	Smart card - e-Unity	250	4
3	Promt (Project management)	200	2
4	K2-workflow investment	200	4
5	Hosting of generic processes	230	3
6	Establishment of DW	120	1
7		0	
8		0	
9		0	
10		0	

Figure 82. Innovative Matrix applied to Fourier Approach.

The strategy falls broadly into the strategic theme of "revenue growth and mix" as defined by Kaplan and Norton (see **Table 11**). Specific activities to sustain and grow the client base were identified and they featured prominently in the Strategy Wheel for a number of months (see **Figure 83**).

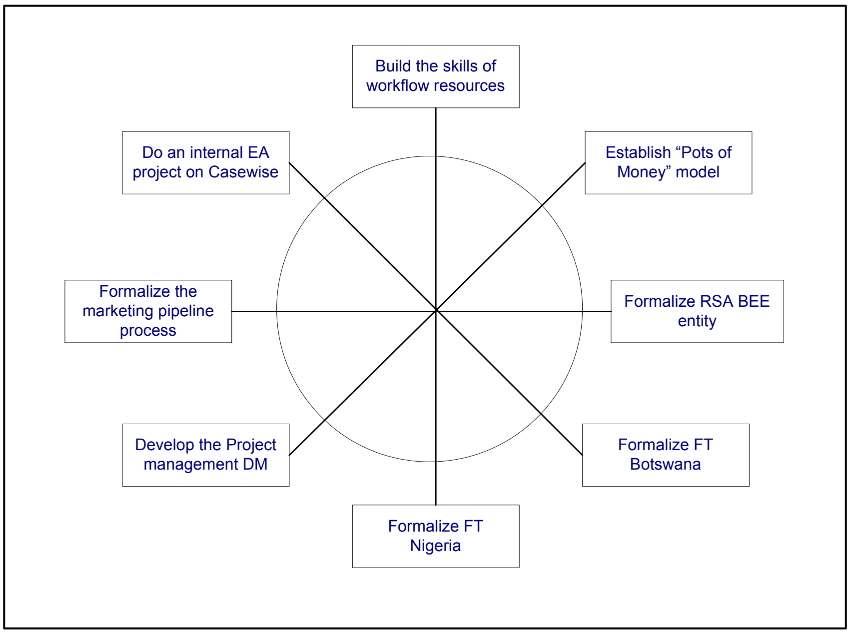
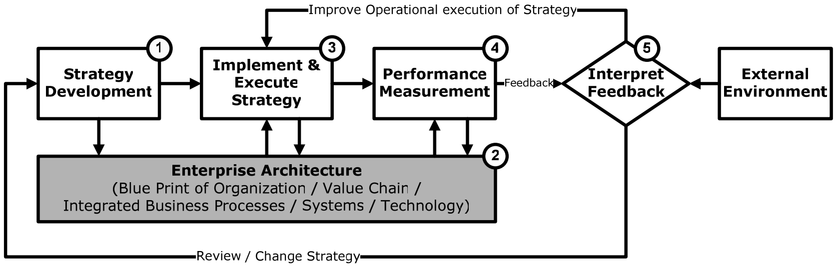


Figure 83. Example of a Strategy Wheel for Fourier Approach

The issues on the Strategy Wheel were monitored on a monthly basis and were supported by an activity list with more detailed actions, responsibilities and target dates, as suggested by Manning. For example, the author was responsible for the establishment of a Pots of Money Model and for the development of a data mart for project management. The Pots of Money Model was identified as a necessary conceptual tool to communicate to all stakeholders what the impact of certain decisions would be. For example, if more money is paid on project bonuses, less money will be available for investment projects that should ensure long-term survival. Although this sounds logical on a qualitative level, the quantified effect of a spreadsheet model with actual figures to which managers can relate helps a lot when trade-off decisions and priorities are discussed. The model will be discussed in more detail under the section on implementation and execution of the strategy.

The data mart for project management focuses on the profitability of all projects (recoverable, as well as investment projects) and will be discussed in more detail under the section on performance measurement.

4.4 Enterprise architecture



By far the the most time consuming step in the whole process is the initial population of the enterprise architecture repository. Although Fourier has been busy with this exercise for a number of months, it is not finished - partly because it is handled as an internal investment project with lower priority than recoverable projects, but also because the methodology forces the organization to make certain choices and to clarify how certain processes work, who is responsible for each step, which systems are involved, etc.. In many instances it is the first time that the processes are analyzed to that level of detail and it takes a while to get everybody to agree.

The main higher-level objects have been identified and in many cases the prime associations have been defined. Screen dumps from *Casewise* (the enterprise modelling tool that is used) of some of those elements are shown in this paragraph, without discussing them in detail. The goal is to let the reader get a feeling of the process and the way in which an enterprise modelling tool supports this important step in the Bigger Picture BI Context Model. It would not be practical for purposes of this thesis to show more than just a number of representative examples.

The first step was to document the strategic goals that were identified during the strategy development phase. See **Figure 84** for a hierarchy of the strategic goals. It is important to understand that each object can be exploded into lower level goals and can also be linked to various other objects through associations, for example to other business goals, other diagrams and a list of issues. Dialogue boxes facilitate the process to describe each object fully, to categorize it and to define an owner and version control parameters for each object. Since enterprise modelling tools are generic in nature and will accommodate almost any personal preference in terms of layout, categories, colours, etc., it is good practice to define a number of naming conventions and templates that everybody can use at the beginning of the project.

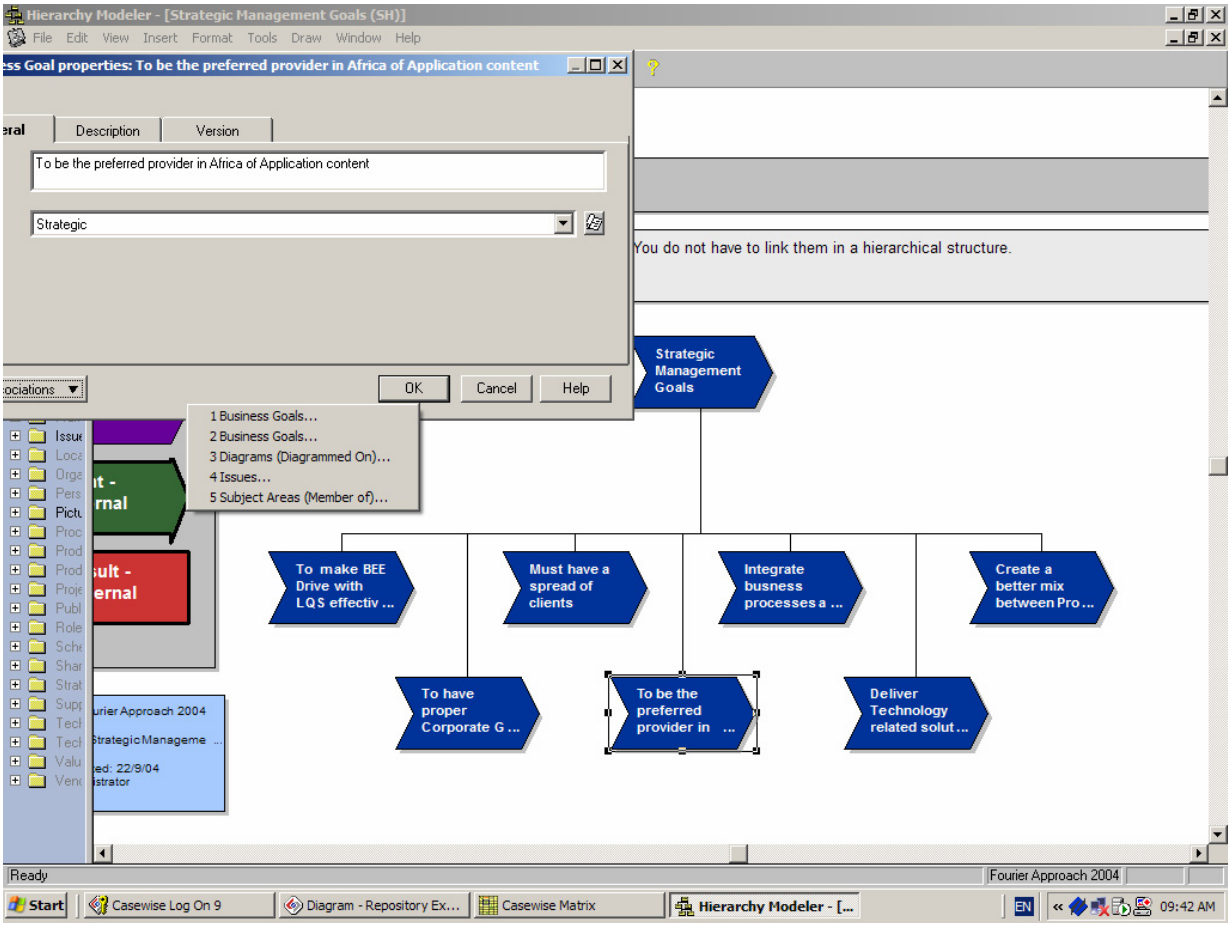


Figure 84. Definition of strategic goals

The next step for Fourier was to identify the organization and its external organizational context - see **Figure 85**. This organizational object in Casewise shows business entities that are relevant for the Fourier group. The entities in blue are entities in which Fourier Approach has shares. The other groupings of external entities represent the following:

- Suppliers of products that Fourier uses, or adds value to, in delivering services to its clients
- Strategic partners in business development and service delivery
- Suppliers of various support services
- Strategic partners that supply resource capacity

Figure 86 shows how the Fourier related enterprise group (the blue group in the previous figure) is broken down into individual entities on an exploded diagram. Each one of those entities can be exploded into lower level organizational structures up to the level of individual employees. Each exploded diagram forms an object on its own, and can be linked into various other hierarchies as depicted in **Figure 87**.

Each organizational object can also be associated with various other types of objects, for example the application software that is used by that unit. See **Figure 88** for an example.

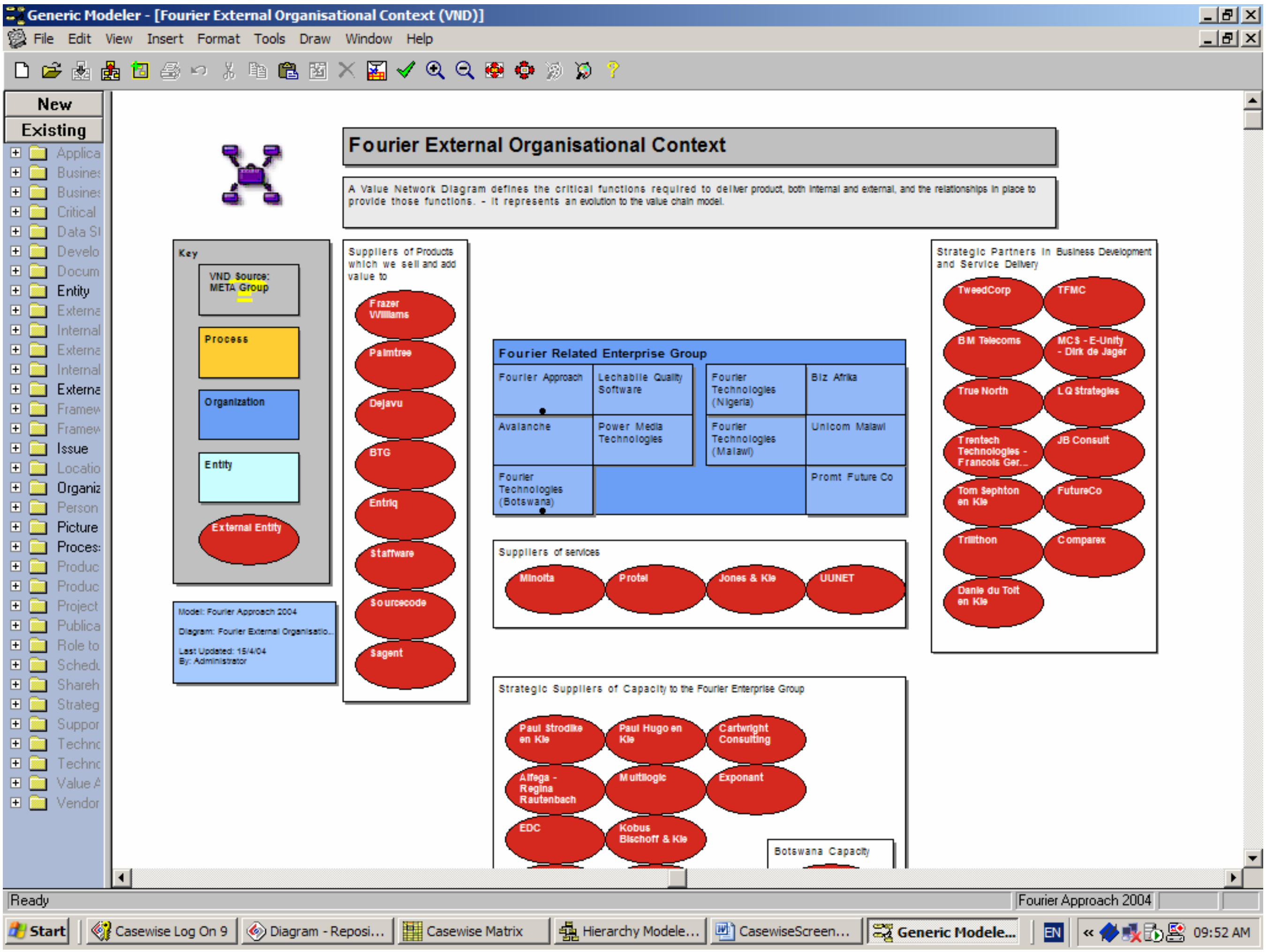


Figure 85. Fourier external organizational context

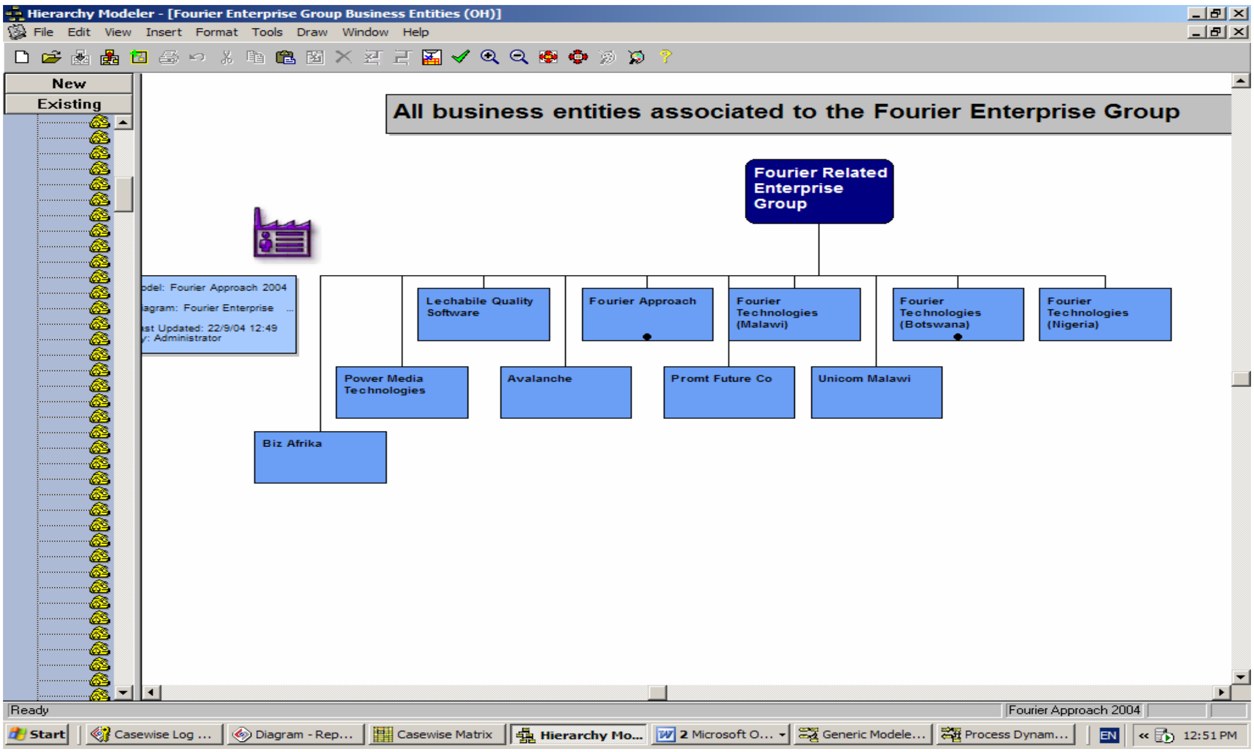


Figure 86. Breakdown of Fourier related enterprise group

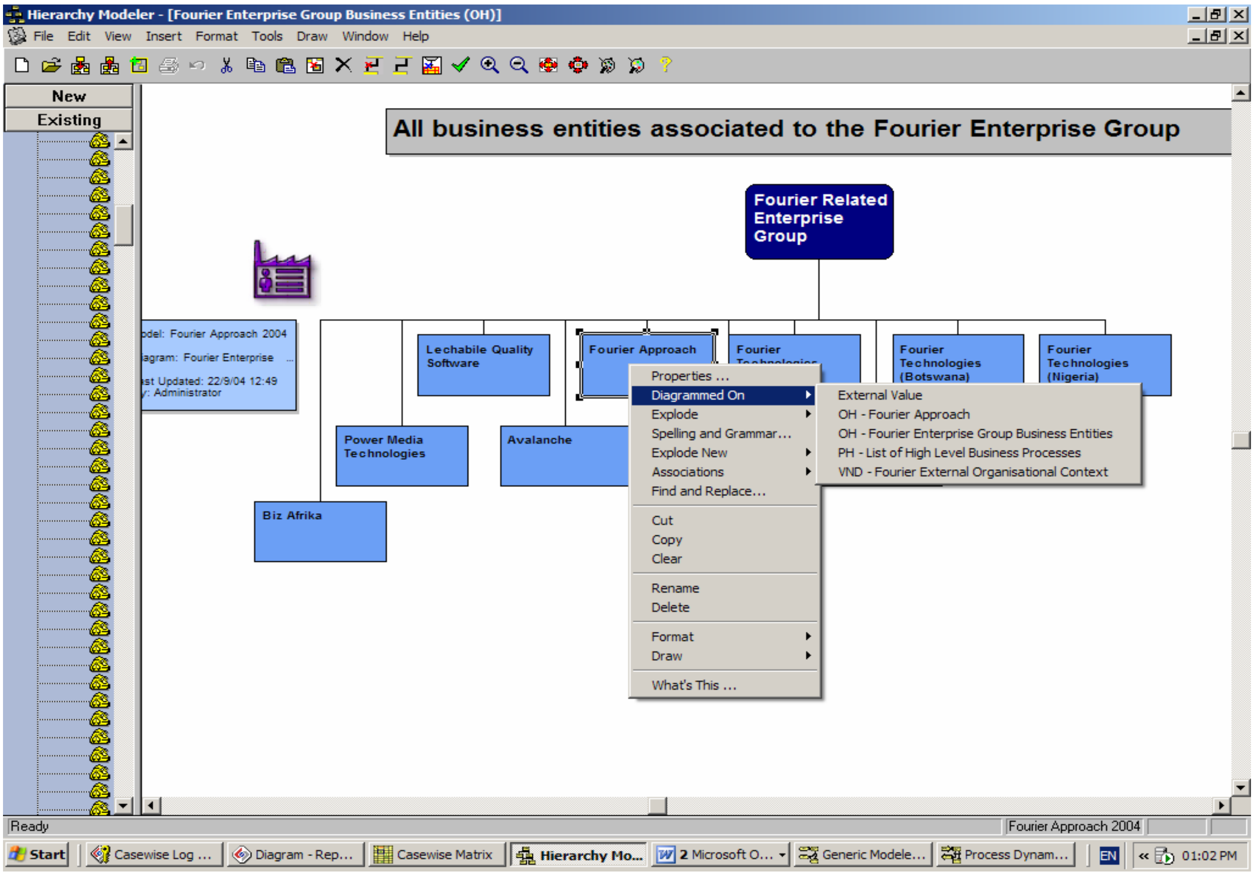


Figure 87. An object can be part of various hierarchies

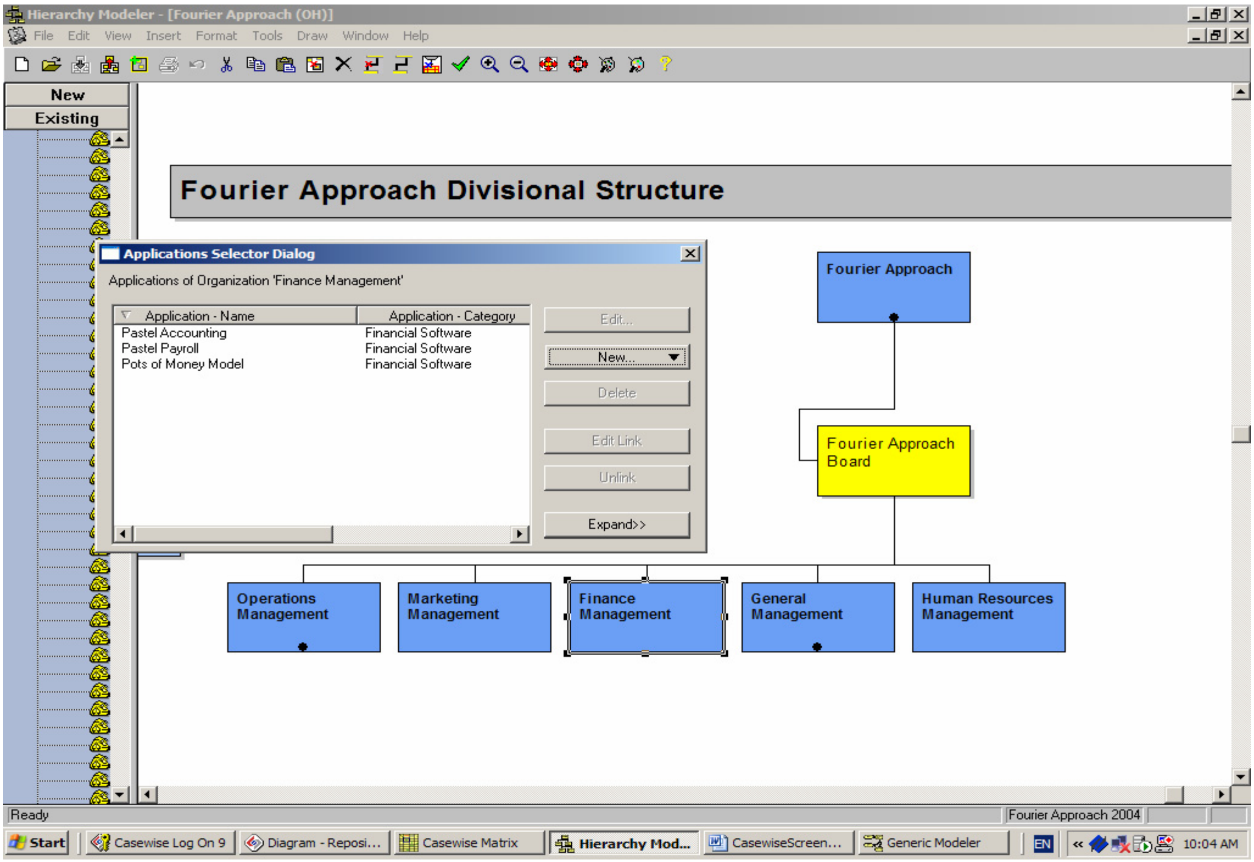


Figure 88. Application software associated with finance management

The definition of business processes for the organization was also done in a hierarchical manner. See **Figure 89** for the overall picture of the value chain, including the support functions like finance and purchasing.

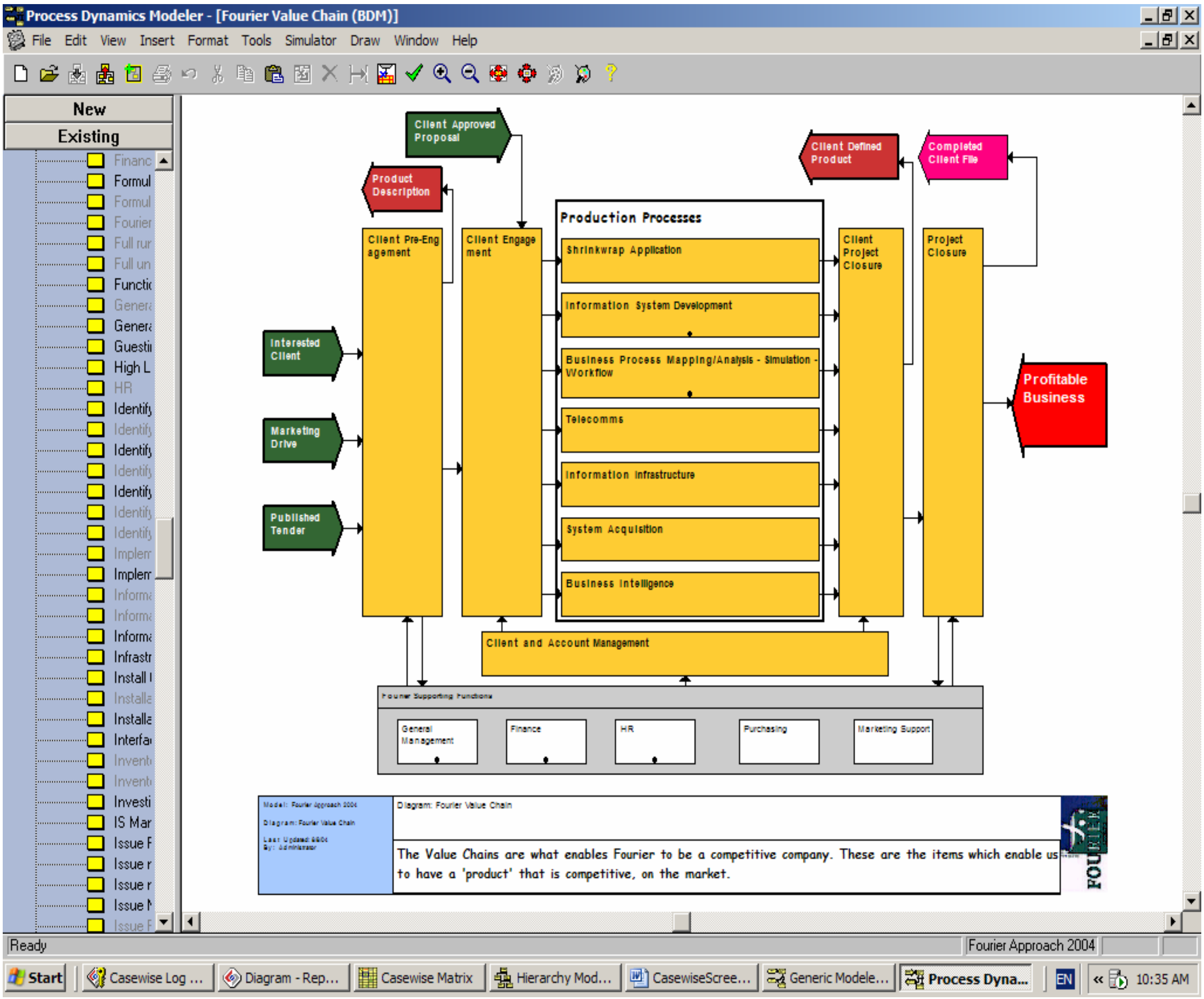


Figure 89. Value chain of Fourier Approach

Each one of the higher-level processes can be broken down into another hierarchy of processes - see **Figure 90** for the breakdown of financial processes. Eventually each process in the hierarchy can be described in terms of dynamic models with different levels of detail. Three types of dynamic models are pre-defined in *Casewise*, namely business dynamic model (BDM), system dynamic model (SDM) and a functional dynamic model (FDM). A dynamic model represents a process or business process that can be regarded as a single unit. It always starts with one or more events that are external to the process under consideration and ends with one or more results. Between the initiating events and concluding results, the other objects show the activities that take place. The FDM level is usually reserved for a detailed level necessary for the programming of a certain activity or process step.

See **Figure 91** and **Figure 92** for an example of the BDM and the SDM. It is good practice for complex processes to define the process steps in different exploded levels to prevent a single screen from becoming too busy.

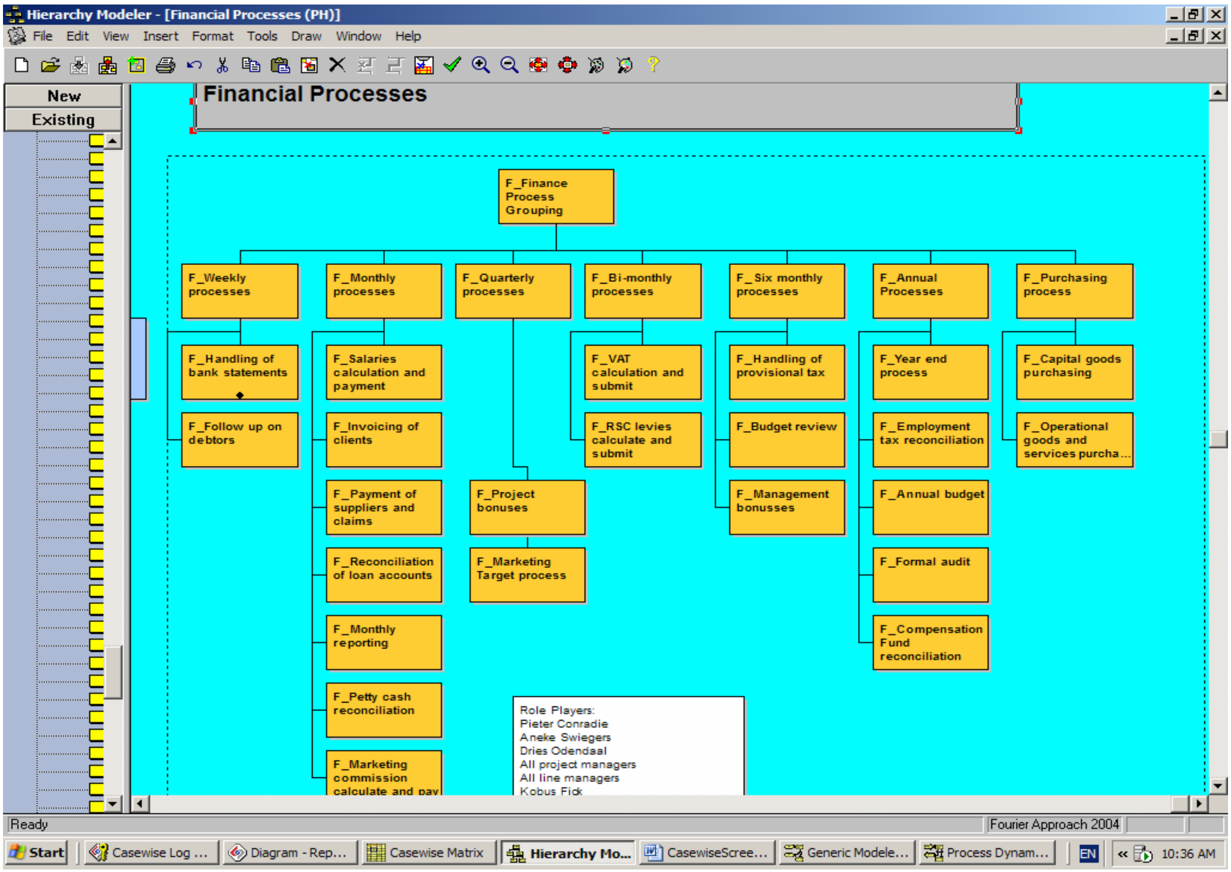


Figure 90. Hierarchy of financial processes

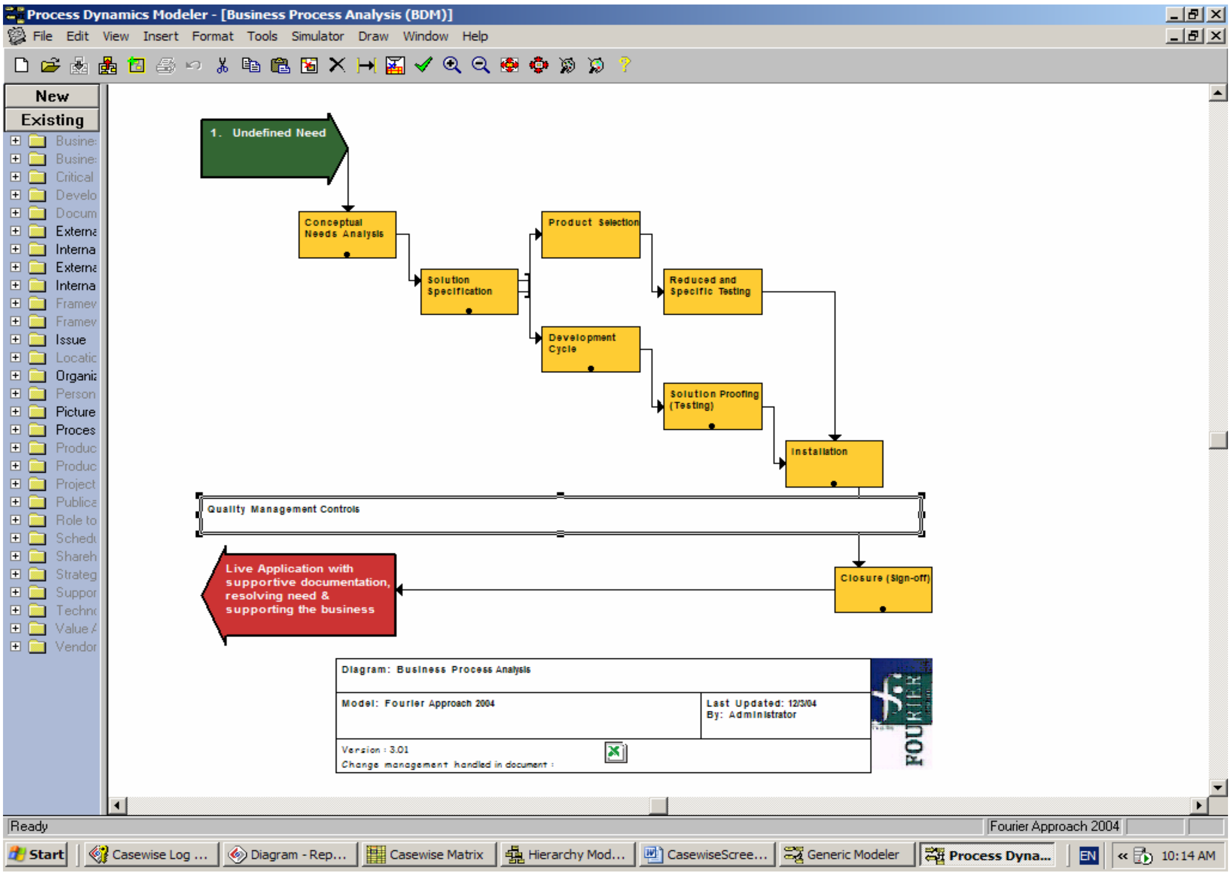


Figure 91. Example of a business dynamic model

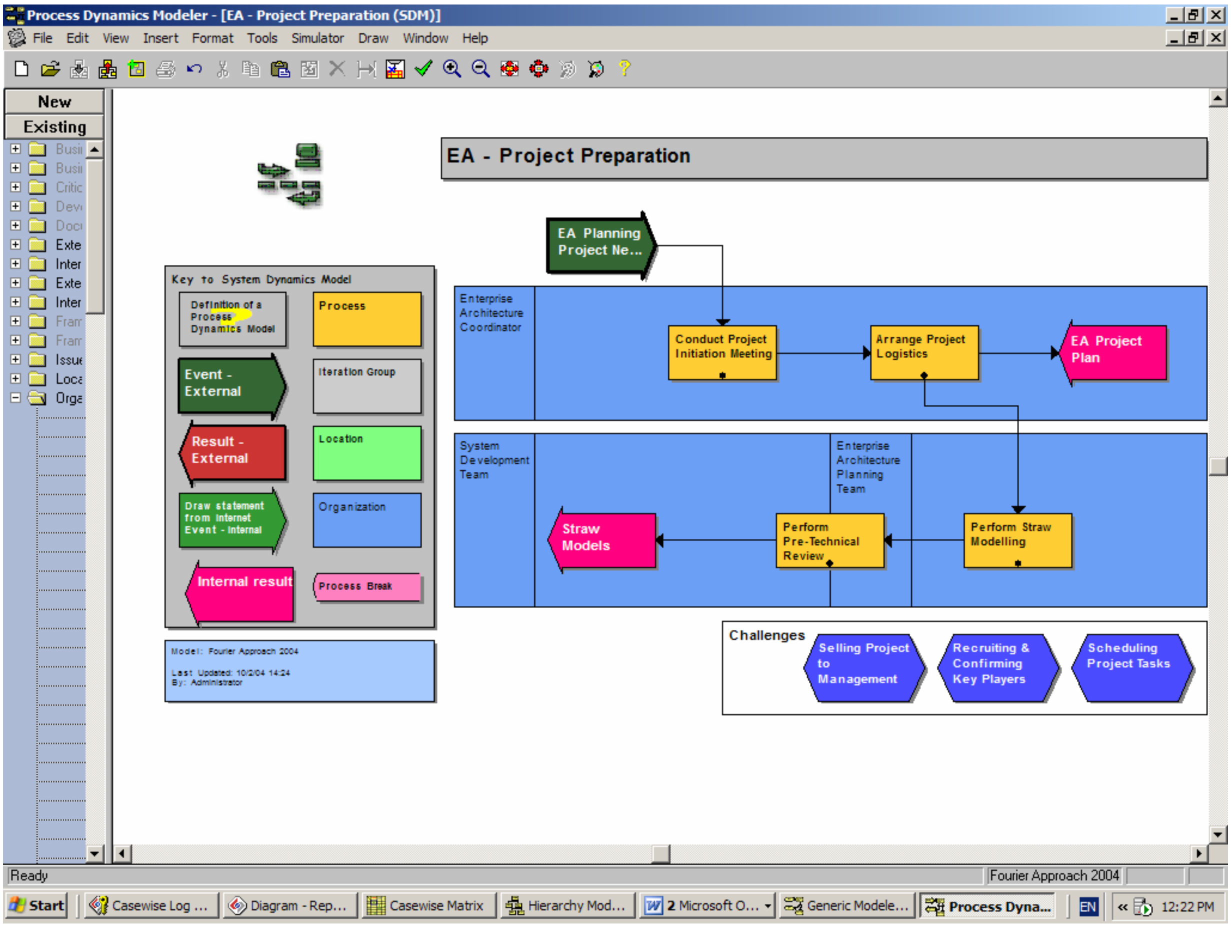


Figure 92. Example of a system dynamic model

Various other elements within the organization were also documented in the enterprise repository, such as products and services, locations and roles in the organization. By linking the elements with each other where relevant, useful association relationships are built, such as:

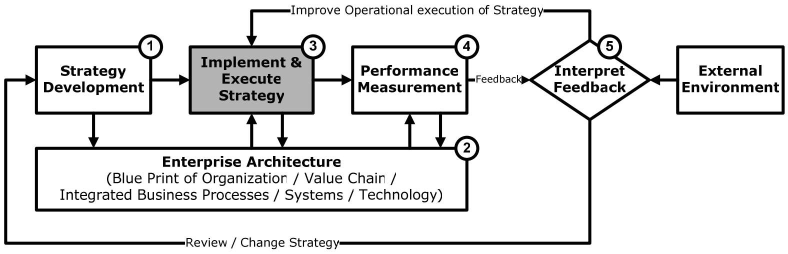
- Products associated with clients
- Business processes associated with organizational units
- Individuals associated with roles
- Individuals associated with clients
- Application software associated with business processes

These associations (with specified attributes of each type of object) can be exported to *MS Excel* through a user-friendly wizard process in *Casewise*. Obviously, these spreadsheets can be large and it is not practical to show a useful matrix in this document. An example is included on the CD ROM.

The whole repository (or specified parts thereof) can be published in various formats, including *MS Word* and HTML. In Fourier Approach it is published on the intranet in HTML format, where it is available to everybody in the company who has access to the network via normal browser software.

After the initial population of the repository it is not such a big task to maintain its data - it boils down to a disciplined approach by all responsible persons to add, amend and publish any changes.

4.5 Implement and execute strategy



Although part of the implementation process can be addressed by the Strategy Wheel and action list approaches suggested by Manning (which were demonstrated earlier), the Balanced Scorecard technique of Kaplan and Norton is much more focused. The strength of the approach is the logical cause-and-effect links that map out the strategy and the underlying hypothesis of the strategy in terms of the four perspectives (finance, customer, internal processes and learning and growth). If developed properly, these strategy maps can provide the alignment of activities that is needed for successful execution and measurement of the strategy.

Combined with the Balanced Scorecard approach, the Fourier Model (see **Figure 68**) was used to establish various technical wheels, which form the foundation or building blocks of any solution offered to customers.

Finally the Pots of Money Model was developed to communicate the application of funds to all stakeholders and to make sure that the budget supports the priorities in the strategy. (It is surprising how few people in an organization really know how money flows through the different "pots" in the organization!)

The application of these three methods to implement and execute the strategy in Fourier will be discussed briefly in this section.

4.5.1 Using the Balanced Scorecard

A three-step approach was followed to establish the first Balanced Scorecard for Fourier:

- Answer some pertinent questions on the four perspectives.
- Select objectives for each perspective.
- Select meaningful measurements for each perspective.

Firstly the question on financial goals was answered as follows:

- Increase revenue by 25% per year, without a significant increase in human resources.
- Change the mix in revenue streams between traditional (human intensive) projects, product sales and annuity income from 90:10:0 to 50:20:30 in five years.

Annuity income refers to fixed monthly or annual income based on maintenance fees for product sales and hosting or other services where very little human effort is required once the initial processes have been set up.

For the customer perspective the pertinent questions and answers were:

What market segments do we serve and what value proposition do we offer to each segment?

Here the parallel strategy clearly identified two market segments, namely:

- The RSA, where business-to-business (B2B) solutions are offered to medium-sized enterprises, including hosting of services or processes, integration of application software, enforcement of business processes through workflow, business intelligence services and "last mile" solutions through new telecommunication technology.
- The African market outside the RSA (Botswana, Nigeria and Malawi), where larger corporations are targeted for basic internet service provider (ISP) services, desk top support services and basic, shrink-wrap application software, such as Biogate II (a biometric access control system).

The value propositions for the two segments are the following:

- For the RSA market - affordable, integrated solutions where the design is primarily based on business requirements (and not necessarily the latest technology flavour of the month)
- For the African market - affordable, basic and stable IT services and entry level transactional information systems

Identifying the key internal business processes that will help Fourier to deliver the value propositions to the market segments led to the following two value chains (see **Figure 93** which is a simplified version of the one shown in **Figure 89**):

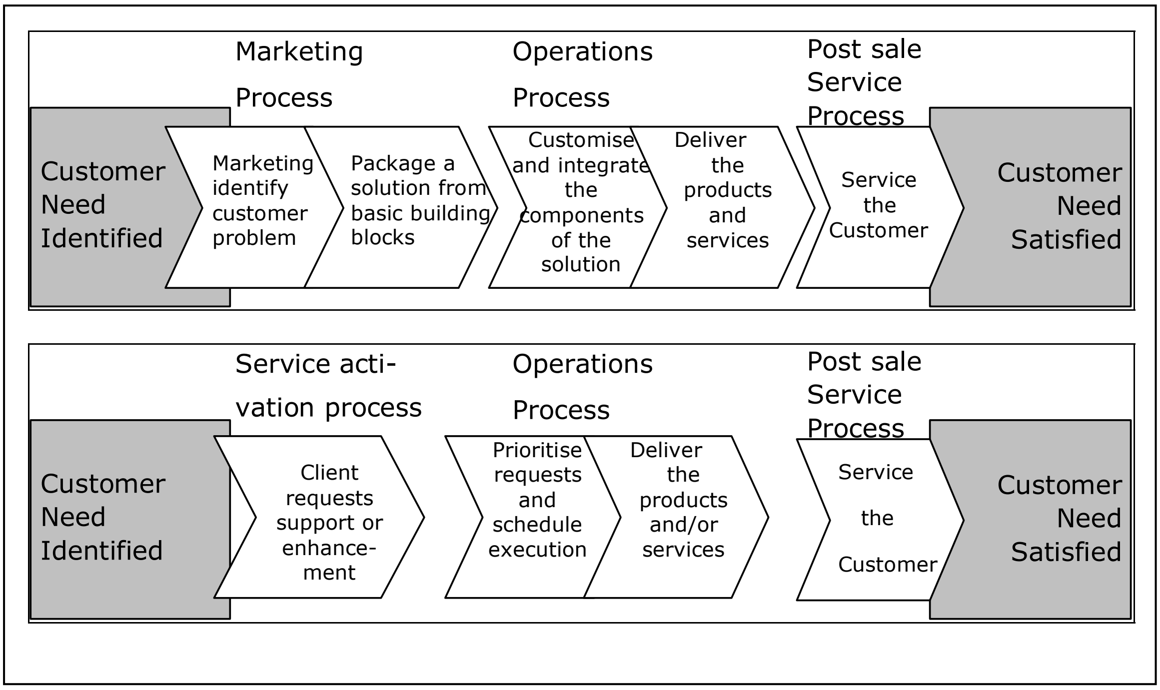


Figure 93. Simplified version of the value chains

Under learning and growth the question is "What skills and infrastructure are necessary for maintaining long-term growth?" In the case of Fourier the following items were identified:

- Scalable servers to provide hosting services
- Increase in project management skills in all resources
- Cross-training between business analysts (BAs) and systems analysts (SAs) to enable both groups to provide more effective services, especially in the workflow area

- Upskilling of certain infrastructure resources to provide telecommunication services as well

During step two of the process objectives were identified for the four perspectives and they were linked to each other as in **Figure 94**.

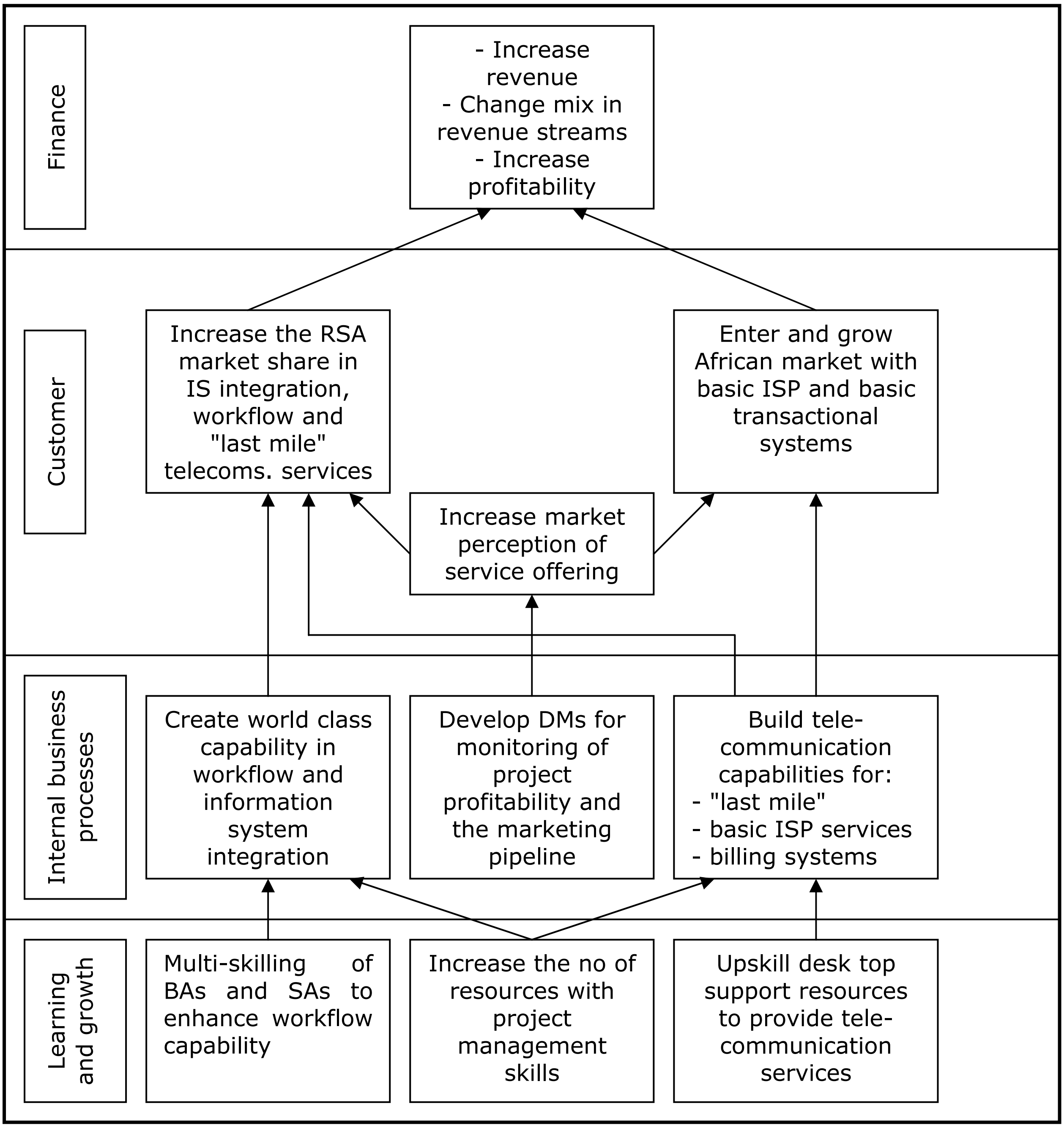


Figure 94. Strategy map for Fourier Approach

The last step in the Balanced Scorecard process requires the definition of meaningful measures. The following measures were identified for the different perspectives:

Learning and growth:

- Average skill level of workflow resources
- Average project management skill level
- Average skill level of telecommunication resources

Internal business processes:
- Maturity index of the technical wheels (see Fourier Model) with emphasis on the following functional areas - workflow, IS integration and telecommunication.
- Progress on the establishment of the data marts for
    - project profitability and
    - marketing pipeline.

Customer perspective:
- Customer satisfaction index - RSA
- Customer satisfaction index - Africa

Financial perspective:
- Monthly and year to date (YTD) revenue per category
- Project profitability

Even though not all measurements can be determined from the outset (e.g. customer satisfaction), the identification of these measures provides a roadmap of which systems need to be developed to provide the answers.

4.5.2 Using the Fourier Model

The conceptual Fourier Model consists of a number of concentric circles of which the inner two are referred to as the technical wheel (see **Figure 95**).

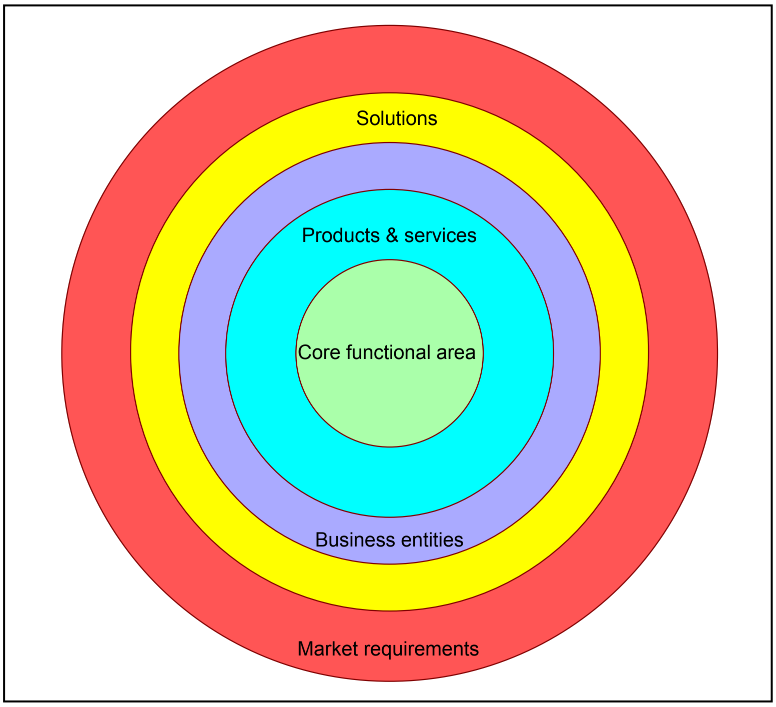


Figure 95. The Fourier Model

Each technical wheel contains elements of the following:

- Generic knowledge of the discipline
- Specific products related to the discipline
- Product knowledge to be able to implement, integrate, maintain or enhance the product

- Market information regarding the functional area (including competition, technical and marketing partners and movement in user requirements)

Over the years Fourier has invested in the development of various technical wheels - some are currently more mature than others. Since the technical wheels form the foundation or building blocks of every solution that is offered to clients, they need to be maintained. Based on the selected strategy they are prioritized in the following manner:

Primary focus:

- Workflow
- IS integration (and broader systems integration)
- Telecommunication

Secondary focus:

- Enterprise modelling (including business analysis and simulation modelling)
- IS development (mature)
- Business intelligence (mature)
- Biometrics (reasonably mature)

Tertiary focus:

- Information strategy
- Facility management solutions (mature)
- Project management support systems

An example of how the technical wheels are developed is given in an *MS Powerpoint* presentation on the CD ROM.

4.5.3 Using the Pots of Money Model

As pointed out earlier not all stakeholders understand how money flows through an organization. To implement a strategy successfully hard choices are sometimes made - also in terms of where money is spent. The aim of the Pots of Money Model is to illustrate to everybody how choices that are made in one area of the company influence choices in other areas. An overview of the model is given in **Figure 96**.

Pot 1 represents the money that is used for production activities. Income for this pot comes from money that is paid by customers for service fees, products, projects and cost recovery. The company itself can also put funds into this pot for investment projects by internal production resources, but that money comes from pot 4, which will be discussed soon. Although a pot can also be allocated to each project, it is seldom managed like that and normally the individual project pots all form part of pot 1, as defined in this model. The outflow from pot 1 rewards production resources and direct marketing cost (commission) and is called "Cost of sales" in financial circles. The result of pot 1 (inflows minus outflows) represents the gross profit.

Gross profit is normally the main inflow for pot 2, although other income such as interest received and dividends received may also add to the money in pot 2. Pot 2 rewards the support functions of the organization and the outflows are therefore indirect cost. These expenses may be fixed or discretionary and in some cases a combination. For example, the basic salaries of employees are fixed expenses, while management bonuses may be discretionary (depending on certain conditions). In some cases the formula of an expense is fixed, although the amount may differ depending on the formula - for example, regional levies. The result of pot 2 represents net profit before tax and dividends.

The result of pot 2 is the only inflow for pot 3, which must reward the shareholders and the state through taxes and dividends. The formulae for company tax and secondary tax on companies (STC) are fixed. A dividend policy may be applicable in which case the formula is also fixed, but normally it is a discretionary outflow. The result from pot 3 is available as capital funds in pot 4.

Pot 4 may also receive new capital from shareholders or money from loans (which will also cause an additional fixed outflow from pot 2 for interest on the loan). The outflows from pot 4 are normally capital items such as furniture, computers, machines and software, as well as investment projects (internally and externally). Furthermore, this pot will also weather the cash flow storms in terms of late (or no!) payments from debtors and will finance the odd staff loan. Any net result from pot 4 will form part of the reserve fund of the company.

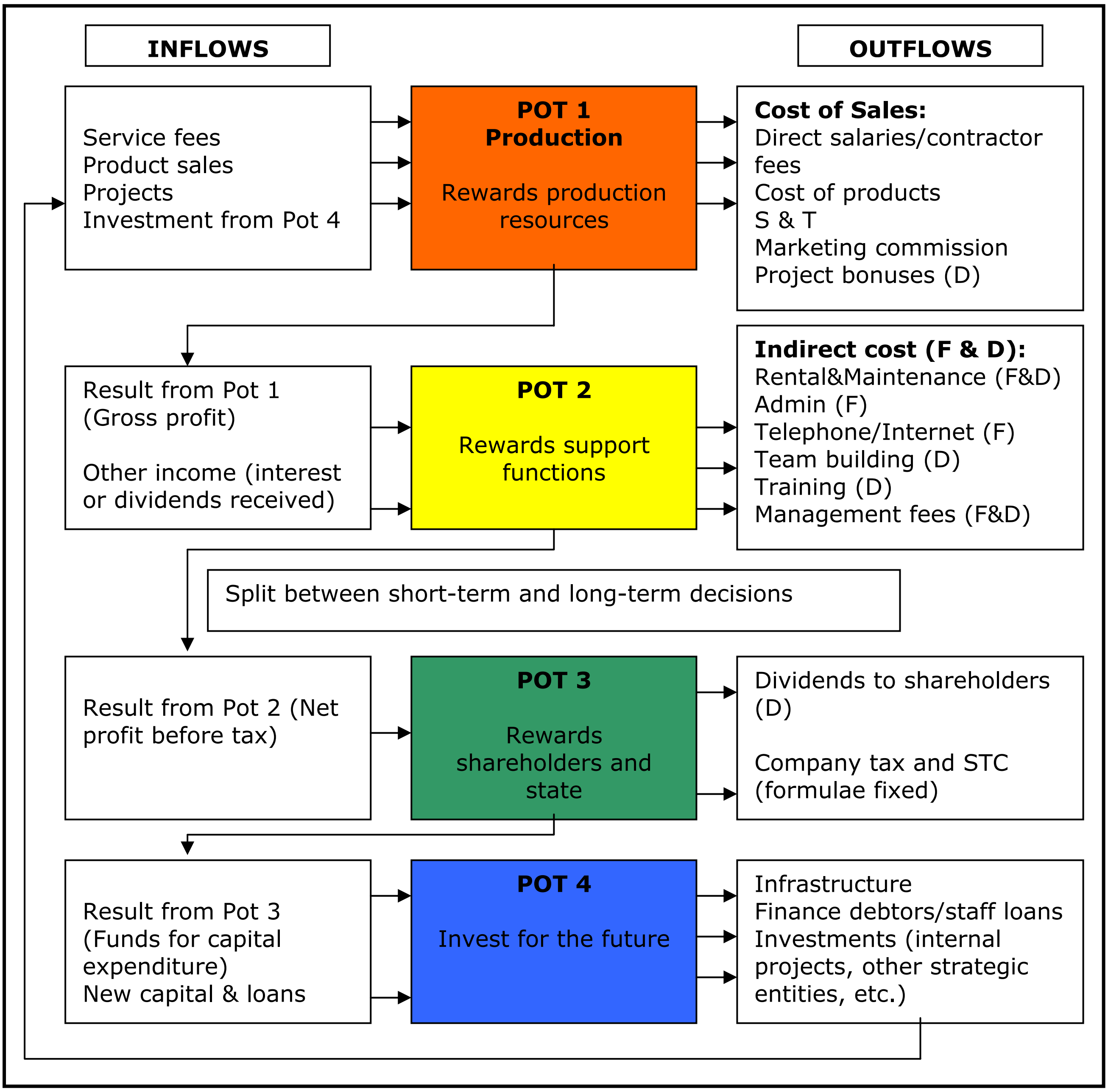


Figure 96. Overview of the Pots of Money Model

It may sound simplistic to explain the flow of money in these terms, but most people can understand and relate to it. A more detailed example in spreadsheet format is provided in **Figure 97**.

Pot 1 - Detailed view and impact on other Pots

Project Name	Client	Income (Turnover) from financial system	Human effort cost from time sheet system	Other expenses before project bonuses	Total Expenses	Gross Profit = Income-Total Expenses	GP %
Recoverable Projects:							
A	1	100000	56000	10000	66000	34000	34.00%
B	2	700000	660000	12000	672000	28000	4.00%
C	2	2000000	5500	700000	705500	1294500	64.73%
D	4	24000	24800	3000	27800	-3800	-15.83%
E	5	55000	40000	0	40000	15000	27.27%
F	1	3500000	2000000		2000000	1500000	42.86%
		6379000	**2786300**	**725000**	**3511300**	**2867700**	**44.96%**
Investment Projects: (Funded from Pot 4)							
G	FA	280000	200000	80000	280000	0	0.00%
H	FA	150000	100000	150000	250000	-100000	-66.67%
I	FA	30000	32000	0	32000	-2000	-6.67%
J	FA	50000	30000	15000	45000	5000	10.00%
		510000	**362000**	**245000**	**607000**	**-97000**	**-19.02%**
Total: (All Projects)		**6889000**	**3148300**	**970000**	**4118300**	**2770700**	**40.22%**

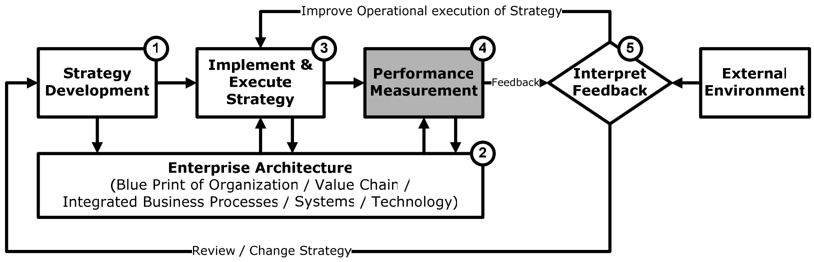
Project bonuses (a % of total gross profit guideline)	4.50%	124682
Result from Pot 1		**2646019**
Minimum required for Pot 2 (Fixed overhead obligations):		850000
Additional Marketing effort		100000
Additional Management bonuses		250000
Other discretionary indirect cost		20000
Deemed Net Profit: (Result from Pot 2)		**1426019**
Minimum required for Pot 3 (30% of Net Profit):		427806
Dividends & STC (a % of Net Profit after tax guideline)	50.00%	499106
Result from Pot 3:		**926912**
Minimum required for Pot 4 (Finance internal projects):		607000
Other Capital Items		100000
		707000
Remaining as reserve (Result from Pot 4)		**-207894**

(Any deficit in Pot 4 is funded by internal reserve funds, new capital from shareholders or external loans)

Figure 97. Detailed example of Pots of Money Model

This concludes the examples on how strategy is implemented in Fourier, using some of the templates and approaches recommended in the Bigger Picture BI Context Model.

4.6 Performance measurement



This step in the process at Fourier is supported by a data warehouse approach. The Kimball methodology is followed by which the warehouse is built data mart by data mart. In this section the design of the project profitability data mart will be discussed to demonstrate the concept. The principle is that all performance measurements that are reliant on quantitive calculations will eventually be reported from the data warehouse.

According to the four step procedure the data mart was defined in the following terms:

Business process

This data mart supports the business process of project management and provides insight into the detailed income and expense transactions associated with any project. A data mart in the same group will carry project planning data and from the two data marts various relevant project management measures will be calculated, for example actual versus planned hours, cost, income and profitability.

The context of the different data marts that support project management are shown in **Figure 98**. The data mart marked in blue will be discussed further.

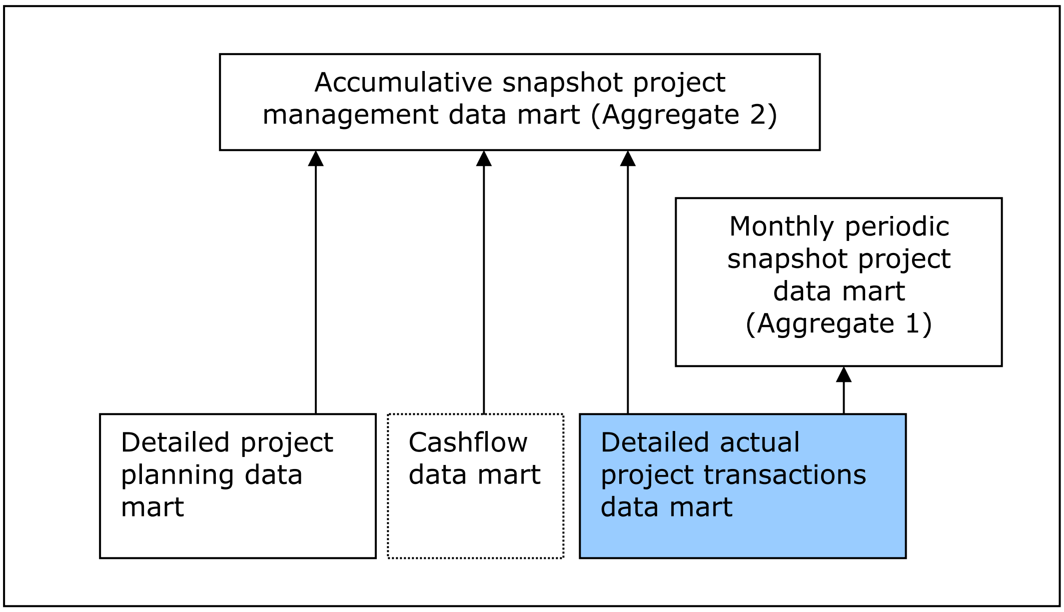


Figure 98. Context of the project management data marts

To ensure that all conformed dimensions (those shared by more than one data mart) are identified, a Bus Matrix was established and an extract is shown in **Figure 99**.

Data marts	DATE_DIM	WBS_DIM	EMPL_DIM	CLIENT_DIM	SUPPLIER_DIM	TRANS_TYPE_DIM										
Actual project transactions	**X**	**X**	**X**	**X**	**X**	**X**										
Project planning	**X**	**X**	**X**	**X**		**X**										
Monthly actual project transactions	**X**	**X**		**X**												
Accumulative project management	**X**	**X**		**X**												
Cash flow	X	X		X	X	X										

Figure 99. Extract from Bus Matrix for Fourier data warehouse

Grain of the fact table

The grain of the fact table was defined as a financial transaction on any project. This includes invoices to the client, credit notes to the client, claims paid out on the project, purchases on the project and all time booked on the project which will be reflected as an expense calculated by the amount of hours multiplied by the internal tariff of the resource. It is therefore a transactional fact table, which will be appended every time transactions are added.

Dimensions

The following dimensions were identified and defined as in **Table 13**:

Table 13. Definition of dimensions

Dimension name	Dimension description
Date dimension	Details for each day of year for an amount of entries enable special groupings on date attributes like; "per month", "for all Mondays", "comparing the first financial quarter of every financial year"
WBS/Project dimension	Contains all hierarchical work breakdown structure attributes, as well as the de-normalized project attributes
Employee dimension	Details of all current and past employees (and contractors) in the total Fourier group.
Client dimension	Details of all current and past clients, as well as potential clients.
Supplier dimension	Details of all Fourier's current and past suppliers
Transaction type dimension	Description of all relevant transaction types, e.g. invoice, credit note, cash expense, human effort expense, credit purchase.

Facts

The following facts with their definitions were identified (see **Table 14**).

Table 14. Fact definitions for actual project transaction data mart

Fact name	Fact description	Default aggregation rule
Qty	Amount of hours booked by employee for human effort transactions. In most other transactions it will be 1.	Sum (Qty)
Tariff	Internal tariff 2 for all human effort transactions. In all other cases where the Qty was specified as 1, it will be the total amount excluding VAT.	Sum (Qty * Tariff)
Amount	Qty * Tariff which will give the total amount excluding VAT.	Sum (Amount)
Transaction description	Degenerate dimension (limited to 56 characters)	None
Transaction reference	Degenerate dimension	None

Negative values in most financial systems indicate credit amounts (income) and positive values indicate debit amounts (expenses). However, in the DW the standard is adjusted to show inflows as positive amounts and outflows as negative amounts. The sum of all transactions for a specific project is therefore positive if the income is more than the expenses.

The high-level star scheme design of the data mart is shown in **Figure 100**.

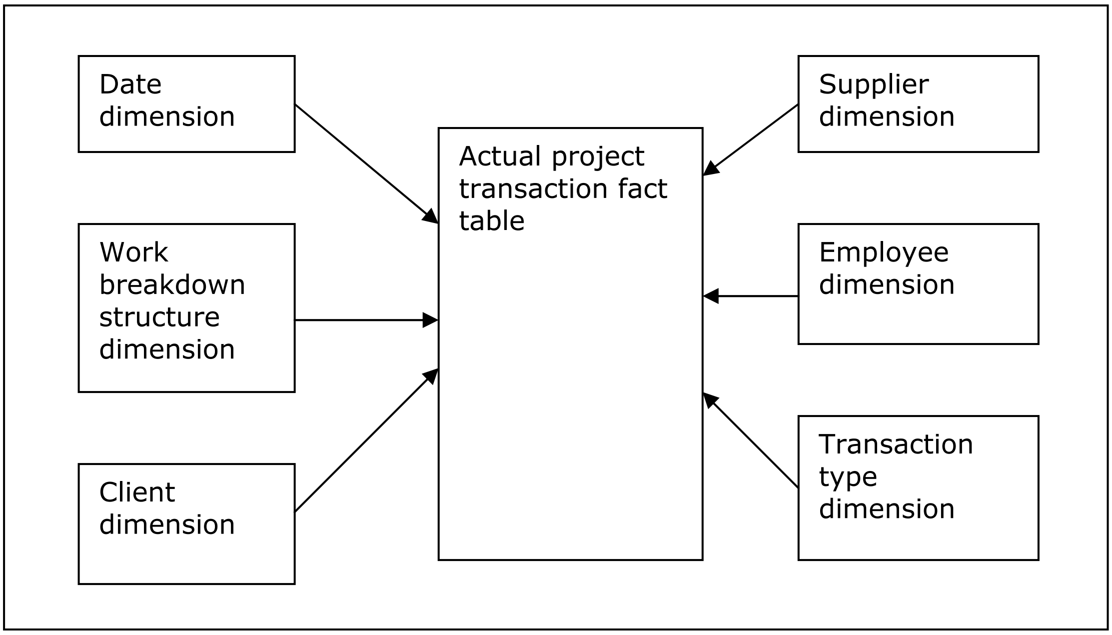


Figure 100. Star scheme of the actual project transaction mart

Each dimension is defined in much more detail. This means that each attribute in the table is defined in terms of an attribute name, description, type of update and sample values. The type of update refers to the update types identified by Kimball where, for example, Type 1 indicates that the value will be overwritten when it changes and Type 2 implies that a new record will be added to the dimension table when the value changes. An example of the detail specification of the client dimension is shown in **Table 15**.

Some of the dimensions (e.g. supplier and employee) have a special "Not applicable" record that are used to link to transactions in the fact table where it is not possible to identify a relevant record in the dimension. For example: a time booked transaction will not be linked to a valid supplier and therefore the "Not applicable" record will be used.

Table 15. Detailed specification of the client dimension

Attribute name	Attribute description	Update type	Sample values
Key	Unique surrogate key	2	105, 106
Extract date	Date that record was extracted from TPS	1	2003/5/1
Load date	Date that record was loaded into dimension	1	2003/5/2
Current indicator	Go-No go indicator to indicate if the record is the current active record in the dimension.	2	Y, N
Client code	Client code in Pastel or master file	2	C001, C002
Client name	Client name in Pastel or master file	2	TFMC, Nedcor
Client contact person	Client contact person	2	John Dow
Suburb	Suburb	2	Eastville
Town/City	Town/City	2	Johannesburg
Postal code	Postal code	2	0101
Client category	Client category ito marketing life cycle	2	Suspect, prospect, ordering, paying
Current client status	Current client status ito activity (marketing or project activity)	2	Active, Inactive

Various ETL (extraction, transformation and loading) plans were developed in *Sagent* to update the various dimension and fact tables. In this case two source systems are used:

- The *Time sheet system* is used as source for the employee dimension and work breakdown/project dimension, as well as the transactional records of hours booked per person.
- *Pastel Accounting* is used as source for the supplier dimension, client dimension and all other financial transactions that are linked to a project.

The date dimension and the transaction type dimension are created and maintained in the data warehouse database.

Figure 101 gives an example of a typical data flow or ETL plan in *Sagent*. It was found that having a two-phase approach to the data warehouse update process is actually smart. The first ETL plan will only extract the data from the source system and dump it in a flat file (actually just extracting and loading). The second ETL plan will extract data from the flat file, compare it with data in the existing dimension table and (depending on the update type for a dimension) will overwrite some records, append new records where applicable and transform certain values. The different ETL plans are linked together in an automation process within *Sagent* to ensure that the ETL plans are executed in the right sequence. First all dimensions are updated, then the detailed transactional fact tables are updated and after that relevant aggregation fact tables are updated from the newly updated transactional fact tables.

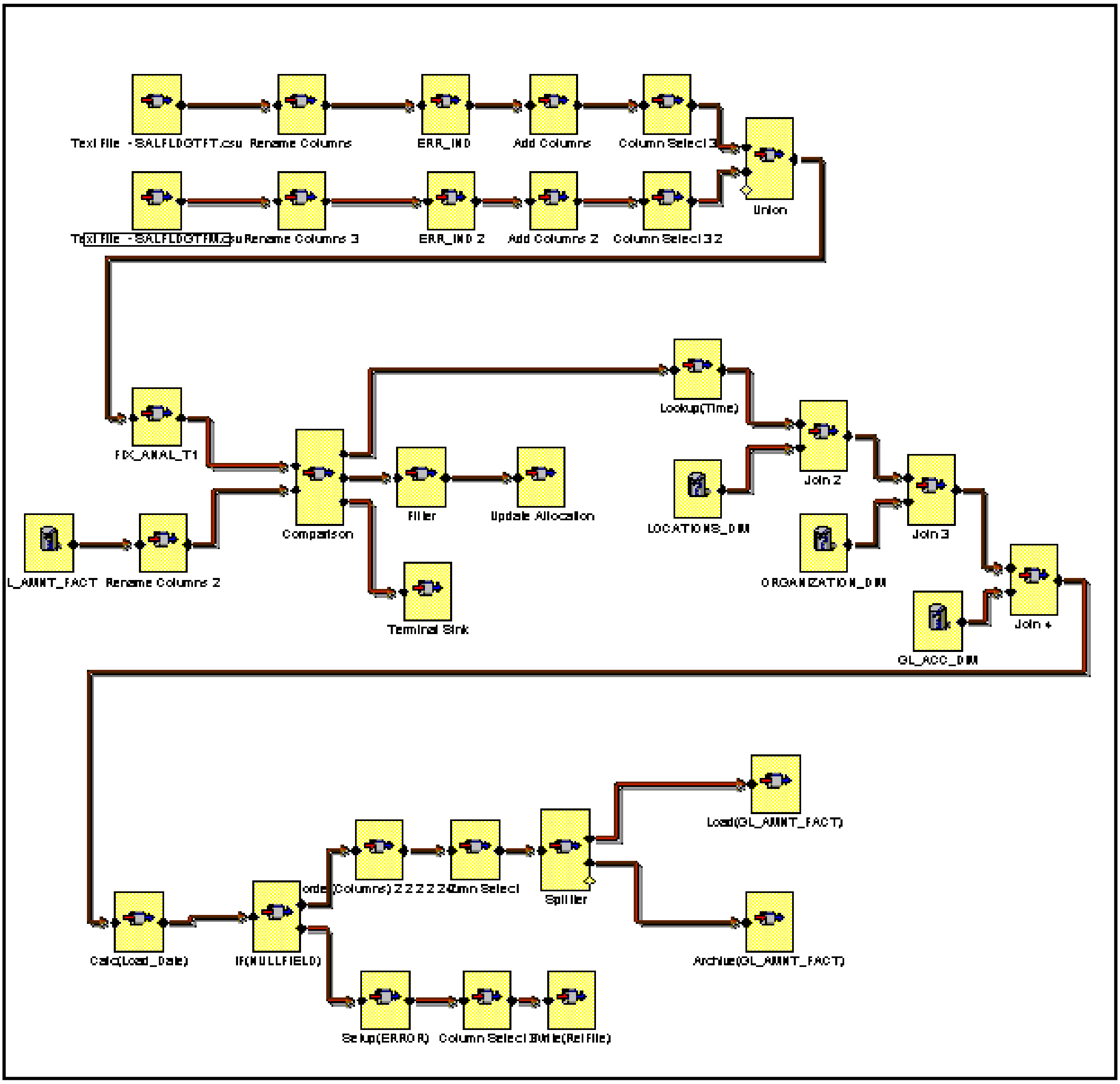
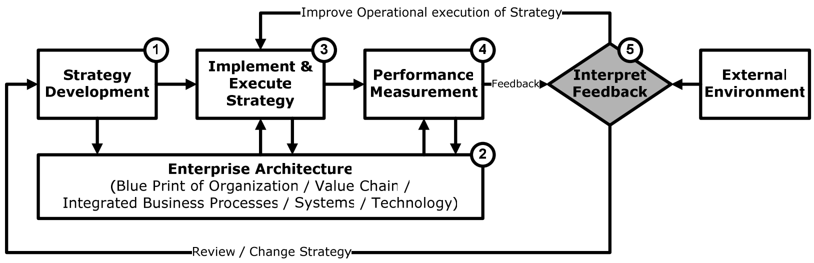


Figure 101. An example of a typical *Sagent* ETL plan

With the data in a star scheme format, it is easy to compile various queries from the meta view in *Sagent.* However, some of the standard reports are exported to *MS Excel* where people without access to *Sagent* can interrogate the data further using the powerful pivot table capabilities. An example of the data in *MS Excel* format is included on the CD ROM.

As always the most time consuming part of the data warehousing process is to ensure data quality. Various business process changes were made to ensure that the data is captured more accurately. For example, the claim form format was changed to ensure that the correct cost code was identified to link the transaction to the correct project.

4.7 Interpret feedback



As mentioned in the general discussion of the model, this step in the process requires human judgement and cannot be automated. Even though not all measurements are yet in place at Fourier Approach to support all the selected measures of the Balanced Scorecard, a number of conclusions were drawn from those that are in place. Some of them led to improvements in business processes, others to refinement of the measuring method. Changes in the external environment such as the relaxation of the monopoly that Telkom had with regard to internet services led to the strategy to provide billing system services - not only in other African countries, but also in the RSA. A few examples of how the interpretation of measurements in context with the current strategy and changes in the external environment led to changes in the organization are listed in this section.

- After discovering that not all project expense claims were allocated to the correct project in Pastel, distorting the project profitability figures, the business process for handling of claims was changed, as well as the claim form format. No change in strategy, but improvement of business process.

- The marketing pipeline showed a growing potential requirement for workflow resources. This trend influenced the strategy to launch a multi-skilling training exercise for business and systems analysts and to prioritise the workflow technical wheel in the primary focus group.

- The changes regarding Telkom (input from the external environment) justified the emphasis on the development of the telecommunication technical wheel and the upskilling of current desktop support resources. It also influenced a decision to become a value adding reseller of an American billing system with the necessary investment that goes along with that decision.

- The drop in market tariffs for desktop support services in the RSA (also an external environment input) was also reflected in the profitability of this type of project. This influenced the decision to move out of this market in the RSA.

- A need for improvement in project management skills was highlighted when it was discovered that basic causes were responsible for low project profitability - things like uncontrolled scope creep, spending of additional hours by resources to refine solutions because they were not allocated to other projects in time, informal handling of change requests and inadequate testing procedures. This directly led to the learning and growth objective to increase the project management skills of all relevant resources.

- From the project profitability measures it was also discovered that certain projects were less profitable than planned, even though the amount of hours spent were within budget. The cause of the problem was allocation of more senior (and expensive) resources to certain tasks, without changing the allocated amount of hours. It also pointed to lack of business sensitivity on the side of the responsible project manager - further justifying the strategic objective to increase project management skills. It also highlighted the importance of having a good mix of junior and senior resources and this insight influenced the business process of recruiting employees.

- The Pots of Money Model clearly pointed out that internal investment projects (even though the company is the sponsor/client in these cases) should be managed like all other projects, because an overspent project could reduce the total project bonus amount.

The list could be extended, but it is believed that the reader can get a feeling of the importance of this step in the Bigger Picture BI Context Model from the examples above. The value of this step lies in the **action** that is taken when confronted with information that the business intelligence tools so handsomely present, as well as monitoring whether the action that was taken had the expected or desired effect.

4.8 Discussion of other case studies

This section briefly discusses some other experiences that the author had where the suggested Bigger Picture BI Context Model had not been used yet. The one example is based on a data warehouse exercise at a facilities management organization and the other explores the use of the model in a typical academic environment.

4.8.1 Data warehousing in a facility management environment

Although this client had a well thought-out business intelligence strategy based on the incremental approach of Kimball, business users became impatient and a project was launched to deliver a robot system for performance management. Much emphasis was put on the delivery side of the process and a very sophisticated robot application was specified and developed. Since the data warehouse was not fully developed at that stage, it was agreed that the robot application would be driven from so-called delivery tables. Eventually these delivery tables would be populated via ETL plans that would use the data warehouse as a source, but until that stage any method would be used to put data into the delivery tables.

The robot application was fairly complex, with different levels of detail, weighted index figures for each set of KPIs, actual figures for the current monthly period, year to date figures, rate of improvement and so forth. Limited development resources were available due to budget restrictions and eventually more time went into the development of the delivery mechanism than into the development of the underlying foundation - the data warehouse. See **Figure 102**, **Figure 103** and **Figure 104** for typical screens related to the robot application, showing the different levels of detail.

Each parameter has upper and lower limits that determine whether the KPI is green (above the upper limit), red (below the lower limit) or yellow (between the limits). Each robot could have any number of KPIs and the formula (the underlying SQL statement) for the same KPI could differ depending on which robot it appears. For example, the number of on-time delivered work orders for the organization as a whole would include all work orders in all regions, while the same KPI on regional level would only include work orders relevant to that region.

It soon became clear that a separate application would be needed to manage the definition of robots and individual KPIs, as well as the targets (upper and lower limits) for each parameter. A meta data application was developed to document all this information and to maintain the definitions of the KPIs, because a business definition in English had to be translated into an SQL statement that accurately reflected what the business person wanted. See **Figure 105** for the main screen of the meta data application and **Figure 106** for an enlargement of what is meant by the translation from English to SQL statement. The meta data application also has a simple workflow facility whereby the developers can document any issues and e-mail any questions regarding the KPI.

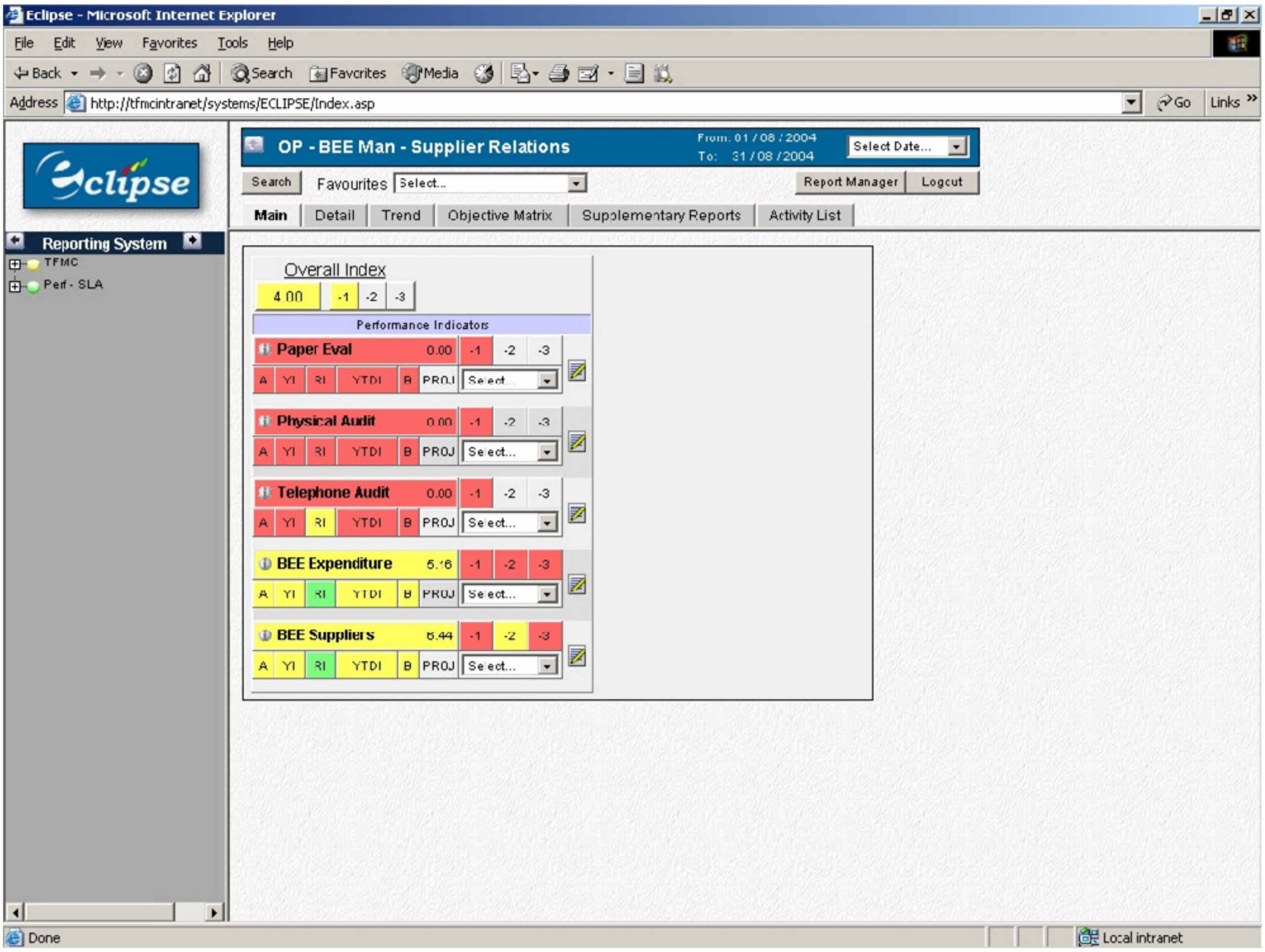


Figure 102. Typical overall robot screen

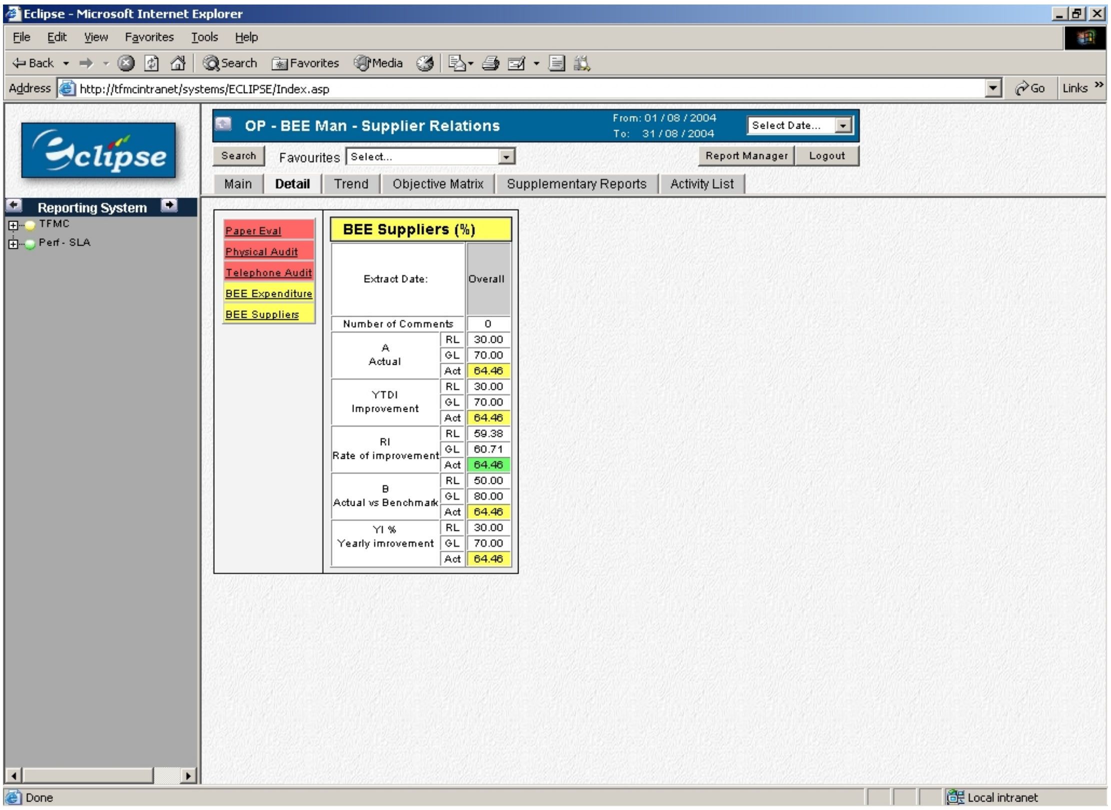


Figure 103. Detail figures for a specific KPI

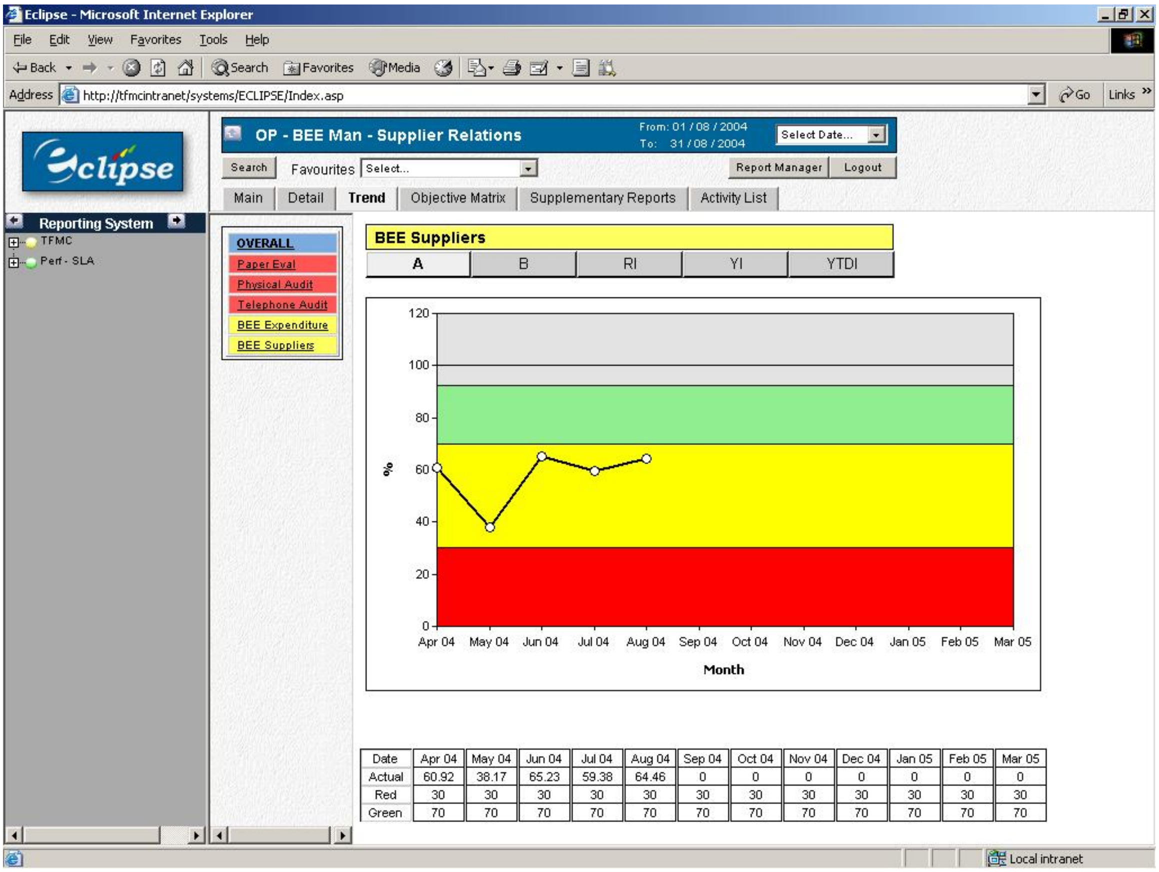


Figure 104. Typical trend report for a specific KPI

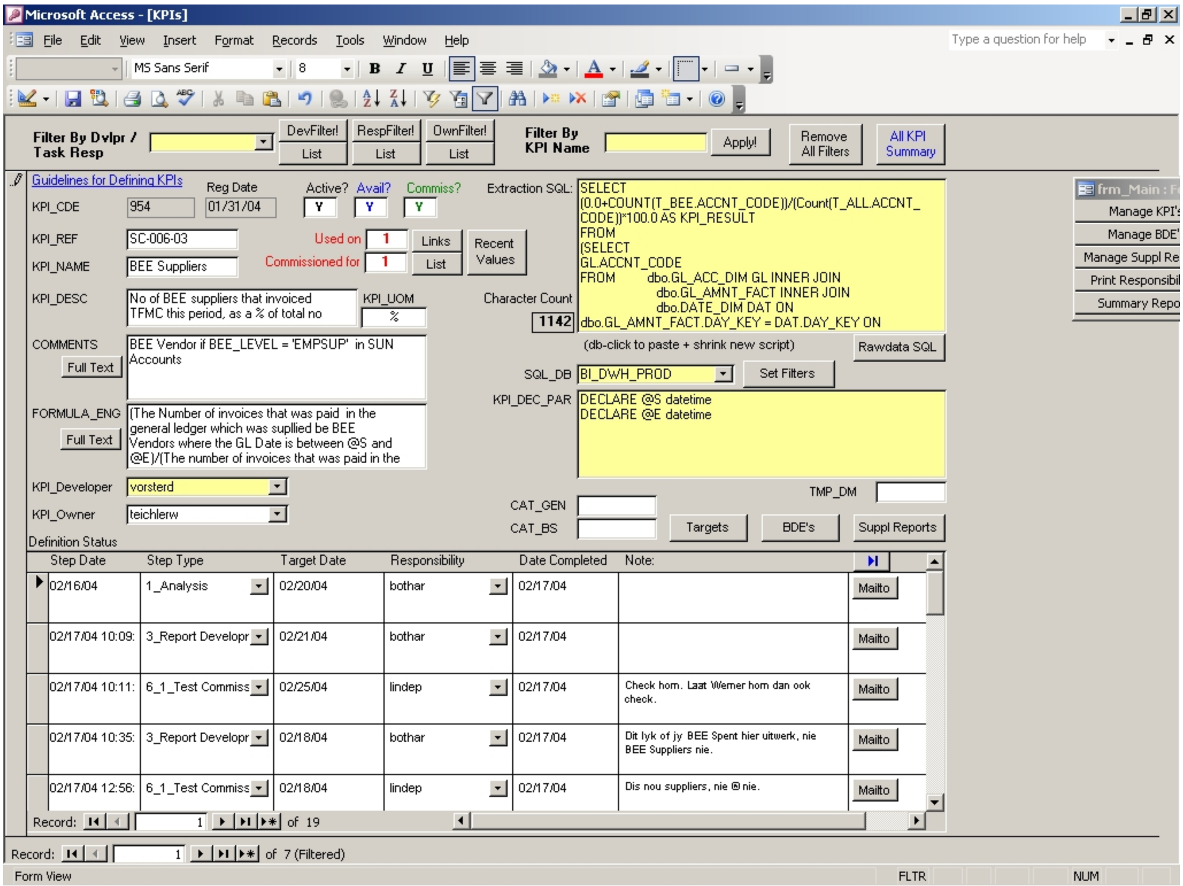


Figure 105. KPI definition and management application

Number of BEE suppliers invoiced during this month
/
Total number of suppliers invoiced during this month

```
SELECT (0.0+COUNT(T_BEE.ACCNT_CODE))/(Count(T_ALL.ACCNT_CODE))*100.0
AS KPI_RESULT
FROM
(SELECT
GL.ACCNT_CODE
FROM     dbo.GL_ACC_DIM GL INNER JOIN
            dbo.GL_AMNT_FACT INNER JOIN
            dbo.DATE_DIM DAT ON dbo.GL_AMNT_FACT.DAY_KEY =
DAT.DAY_KEY ON GL.GL_ACC_KEY = dbo.GL_AMNT_FACT.GL_ACC_KEY
WHERE      (DAT.DATE_TIME >= @S) AND (DAT.DATE_TIME <=@E) AND
(GL.ACCNT_CODE LIKE '810Z%') AND
            (dbo.GL_AMNT_FACT.JRNL_TYP = 'INV') AND
(dbo.GL_AMNT_FACT.ALLOCATION = 'P')
 AND GL.BEE_LEVEL = 'EMPSUP'
AND (dbo.GL_AMNT_FACT.SUN_DB = 'TFT'))T_BEE
,
(SELECT
GL.ACCNT_CODE
FROM     dbo.GL_ACC_DIM GL INNER JOIN
```

Figure 106. English definition versus SQL statement

Another difficulty that arose was the fact that business users also had access to an ODS (operational data store), which was a simple (daily) copy of the transactional databases. Some reports were drawn from that data source and when the answers did not match with the answers from the robot system, the suspicion normally pointed to the data warehouse team. Meanwhile the definition and rules that were defined by business and implemented in the data warehouse, were not necessarily applied when reports were drawn from the ODS. Naturally the timing of the reports and the refresh rate of the robot also played a role in the discrepancies.

At some stage more than 500 KPIs were reported. One colleague commented: "There is something wrong with this statement. How can there be 500 **key** performance indicators?" That was probably the main reason why progress was slow - the pure volume and the lack of prioritization. Had the Balanced Scorecard methodology been followed only a manageable amount of measurements would have been identified (let us estimate 20 or 30 real critical measurements).

Lastly, user expectations were based on the generic potential of the robot application specification. It was promoted to the business that any robot could be defined with various KPIs from various subject areas - see **Table 16**. This implied that all the data marts for all the subject areas had to be in place before the robot could be delivered - or that data for those KPIs that were not supported by data marts yet, should be sourced from a temporary area. The client opted for this temporary source, which further diluted the effort that went into the development of the real data warehouse. The quality of this data could not be guaranteed and if errors were pointed out on one of the KPIs of a robot, the integrity of the whole robot was questioned. The solution for data quality problems usually lies in changes to the ways in which the transactional data is captured in the first place - something that is also not achieved overnight for a nationally distributed organization!

Table 16. Expectations of KPIs from various subject areas

Report 1	**Subject 1**	**Subject 2**	**Subject 3**	**Subject 4**	**Subject 5**	**Subject 6**
KPI 1				X		
KPI 2						X
KPI 3		X				
KPI 4		X				
KPI 5			X			
KPI 6	X					
KPI 7	X				X	
KPI 8			X			
KPI 9	X					
KPI 10		X				

Many lessons were learned during the process, even though some of the most powerful tools (e.g. the meta data application and the robot application) were developed during the time. In retrospect, however, most of the frustrations experienced during the project can be traced back to the fact that the basic and proven methodology of evolutionary development of the data warehouse was not followed. Furthermore, too much emphasis was placed on the delivery mechanism before the foundation for such a delivery tool (the data warehouse) was mature enough - thus creating unrealistic user expectations.

4.8.2 Applying BI in a typical academic environment

Until now most of the discussion and examples were based on business or commercial scenarios. The author is of the opinion that the principles can also be applied to many other situations such as schools, churches, sport organizations and political parties. The use of the model in an academic environment is debated briefly in the following paragraphs.

Most tertiary academic institutions such as universities have strategic goals - to do research, to transfer knowledge to students and to do community service. These goals differenciate them from normal businesses, but they have many issues in common with businesses. They also struggle with BEE questions; they have challenges to ensure that their income is enough to cover all their expenses; that their product offering (content of their academic courses) stays aligned with the expectations of their clients (students and businesses in the economy); they have to do benchmarking against international standards; they must ensure that their pricing models are acceptable and sustainable; they need to ensure personal growth for their employees and have to maintain facilities.

Naturally it would be better to apply the model to a university as a whole, but for the purposes of this discussion it will be applied to an academic department such as industrial engineering. The strategy development part will be derived to a large extent from the strategy of the university. The strategy implementation and execution part may however be adapted for the situation of the department. For example, the university may have a research objective of one publication on average per academic staff member per year in order to compare favourably with international standards. From a department with 12 staff members the university would expect 12 publications in a year. The department may structure its activities in such a way that three or four staff members with pertinent research activities during a certain period will produce the required quota of publications. In turn the other staff members will have to take over some of the lecturing responsibilities to provide the research group with enough time to prepare their publications. (This is just an example of how the implementation of strategy at a departmental level may be different for individual departments, while the higher-level objective can still be achieved.)

The Fourier Model can be used to identify, prioritize and develop various technical wheels that are important for the department at a certain time. A functional subject area such as supply chain management or a vertically integrated market segment such as the one for the automotive industry may be examples.

The Balanced Scorecard approach may also be used to identify objectives related to the four different perspectives and to build the cause-and-effect relationships to establish a strategy map. Since the university is not a profit-making organization, it might be that the ultimate objective in the cause-and-effect map would end up in the customer perspective (while most commercial strategy maps end with the financial perspective). The map will clarify and communicate the strategy to various stakeholders.

To measure progress in terms of the execution of the strategy a data warehouse approach may be followed. Typical subject areas for data marts may include undergraduate and post graduate student performance, research activities of lecturers (wider than just a count of publications!), industry involvement of lecturers, skills and qualifications of lecturers and the tracking of former students.

Some of these marts may be used to analyze data with the objective to influence future strategy. A colleague at the department is currently analyzing student performance during their total involvement with the university to try and identify preventive measures (e.g. additional prerequisite subjects or alternative routes) that can be used to prevent students from failing certain courses. The typical star scheme for such an analysis environment would be a student performance fact table with semester, examination and final marks for a course as the facts. The fact table is surrounded by the following dimensions:

- Student (with attributes such as matric marks for certain key subjects)
- Course
- Date (with attributes to indicate first and second semesters)
- Department that is responsible for the course
- Lecturer who presents the course

Some of the transactional sources for the data marts suggested above already exist (for example a student administration system), but others may require that a transactional system be developed to capture the data.

This brief discussion on the application of the BI model in an academic environment may have triggered more questions than answers, but the author is convinced that it can add value if the process is completed in the structured manner that the model suggests and if the relevant elements (such as goals, business processes, systems, courses and organization) are properly documented and linked in an enterprise modelling repository.

4.9 Conclusion

The purpose of this chapter was to demonstrate how the Bigger Picture BI Context Model that was developed in the previous chapter is applied in practice. Most of the methodologies and templates that were described as components of the model were applied to a typical consulting firm. The consulting firm acted as an experimental environment where many of the concepts were tested and refined.

Another practical data warehousing environment was discussed where the sequential flow of activities as suggested by the Bigger Picture BI Context Model was not followed. Various consequences of this approach were pointed out. The message from that exercise was not that BI could not be applied any other way than the "Bigger Picture BI" way - only that a lot of frustration could have been prevented and progress could have been faster if the suggested model had been followed.

Finally the author debated on a high level the value that could be added if the model would be applied in an academic environment - just to show that the model is generic and not only applicable to commercial business environments.

5 Thesis summary

5.1 Contribution to the body of knowledge

The goal of the thesis was to develop a "bigger picture" model, or framework, that would put a number of the existing theoretical models into context and would provide a generic process for implementing BI in organizations. The conceptual model that was developed is shown again in **Figure 107**.

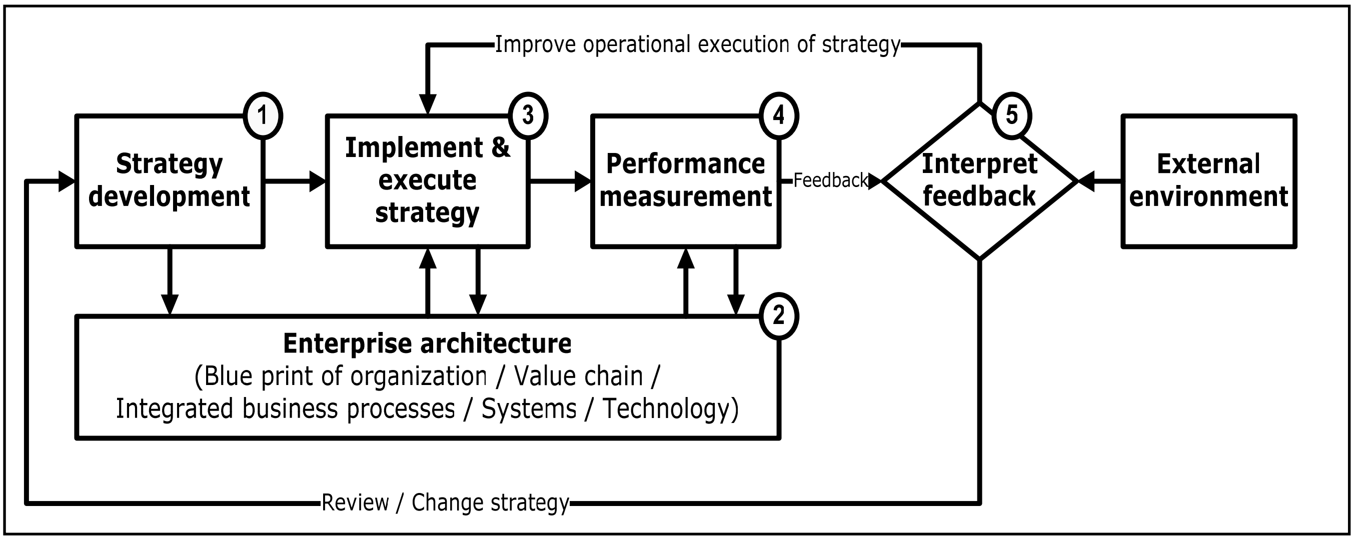


Figure 107. The Bigger Picture BI Context Model.

Most of the individual components of the model are supported by existing theories and the contribution of the author was to position them in the bigger picture to indicate how they can add value with regard to the establishment of business intelligence in organizations. Instead of packaging existing ideas slightly differently under a new name, the author intentionally searched for existing theories to fulfil certain requirements in the Bigger Picture BI Context Model. An extensive literature study led to the inclusion of the following work done by other people:

- Grulke, Manning, Ilbury and Sunter contributed to the strategy development component.
- The Foxy Matrix idea of Ilbury and Sunter was repackaged into a template where it is also suggested how the Six Hats concept of De Bono could be used to enhance the processes in the four quadrants of the Foxy Matrix.
- The Zachman Framework on enterprise architecture was found to fulfil all the requirements for a blue print of the organization that forms the glue between the different components in the model.
- Certain useful templates of Manning and Grulke were adapted to make them quantifiable tools in *MS Excel* (e.g. the Innovation Matrix of Grulke).
- The nine performance measurement variables idea from Rummler and Brache and the Balanced Scorecard concept of Kaplan and Norton were used as the basis for identifying performance measurement parameters. The latter concept forms a specific link between strategy definition and measurement.
- The data warehouse approach of Kimball was adopted as the basis for the establishment of a central data warehouse from where one consistent version of the performance measurements can be reported.

Apart from the set of MS Excel templates that were adapted from various other sources and packaged into useful formats that can be used during facilitation sessions, the author has also developed and described the conceptual Fourier Model and the Pots of Money Model. The Fourier Model is a powerful conceptual model consisting of concentric rings that helps a business to package solutions for market related requirements through selections of previously defined building blocks (technical components) that can be delivered through various business entities, depending on the requirements of the opportunity. The Pots of Money Model is a quantitative model embedded in a spreadsheet format to illustrate and communicate the effect of spending decisions in one area of the business on other areas.

During the preparation of the case study at Fourier a number of data marts were developed. The basic functional design of a typical project profitability data mart is included in the thesis. Ample examples were provided of screen dumps using various software applications such as *Casewise*, *Sagent* and other internally developed software. The emphasis was, however, not on specific products, but rather on the type of applications that can support the conceptual model.

Finally, a CD ROM accompanies the thesis. It contains a rich source of related literature - most of the articles are electronically available in full text and from many articles various other sources can be accessed via internet hyper links. It was not practical to refer to all the literature that was gathered during the study period in the thesis itself, but the author is of the opinion that many of those articles formed and influenced his thought process during the study even though they were not directly referenced. It therefore provides a categorized basis for further research. The sources are captured in a basic database that makes it possible to do various searches and to open those articles, spreadsheets, Powerpoint presentations and other types of sources that are electronically available.

5.2 Retrospection on the process

The study was undertaken over the best part of five years on a part time basis. This approach helped the author to get really familiar with the different components that are included in the model - not only from a theoretical point of view, but also through practical experimenting with the concepts at his own company, as well as at different clients.

The negative side of this approach was that many side issues distracted the author during the research process and although they enriched the experience, they did not all really add specific value in the end. (It is easy to say it now in hindsight, but at the time they all looked like logical avenues to pursue.)

Being an industrial engineer whose typical job it is to define and improve business processes, it was quite challenging to be involved in the definition and development of a less conventional process. A process which integrates inputs from people who are not traditionally thinking along the same process lines as industrial engineers - a process that links strategy with performance management (which is normally led by management science) and which is strongly supported by information technology tools (which are normally provided by people from ICT).

Taking all factors into consideration, the author believes that the goals of the study have been achieved: The Bigger Picture BI Context Model provides a solid foundation for the alignment of strategy with operational implementation of strategy through the important role of performance management that is supported by a well-designed data warehouse and relevant BI tools.

5.3 Material for further investigation

Every study of this kind ends with a number of new questions and questions that have not been addressed to a satisfactory level, even if the overall goal of the study has been reached. The author would like to identify the following issues that may be dealt with in future research projects:

- Data quality is the one factor that can sink a whole BI initiative. As any industrial engineer knows, quality is not inspected into any product - it should be designed into the manufacturing process. Similarly, data quality should be addressed at various levels such as the systems in which it is captured, the business process from where it is captured, the way in which it is extracted from the transactional systems, the way in which it is integrated with other data items, any transformations that are made to the data and the way in which it is used in calculations. The whole subject of data quality justifies a much deeper study, taken into consideration that more and more important decisions will be made from BI environments that will have to rely on quality data.

- The author believes that an opportunity exists to provide standard data marts for a number of industries from where common measurements can be drawn. The suggestion is not that all companies in the same industry should have the same vanilla data warehouse design and use only that - that would defeat the claim that BI should give an organization a competitive edge. It is rather suggested that a large portion of the data warehouse design would be the same for basic measurements that are the same for all role players in that industry. If a company can get a head start regarding the basic stuff, more quality time and effort can be spent on the company specific data marts that will support its specific strategies.

- As suggested in the last part of Chapter 4, the thorough application of the model in an academic environment might be a challenge with interesting results.

- There are probably many other management techniques (e.g. Six Sigma) that can be used fruitfully at various steps in the conceptual model for certain environments that had not been identified by the author. Further research might position new and existing techniques in the right category.

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