2 Literature study

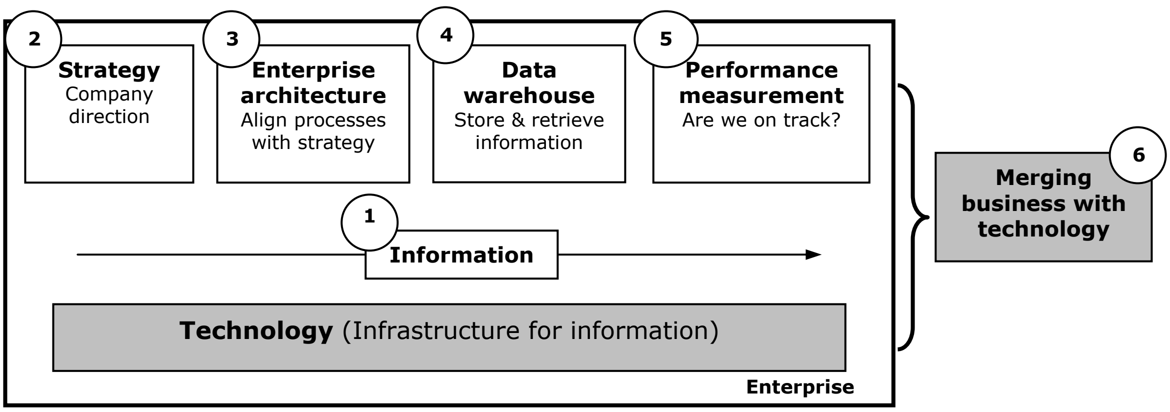
2.1 Introduction

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**.

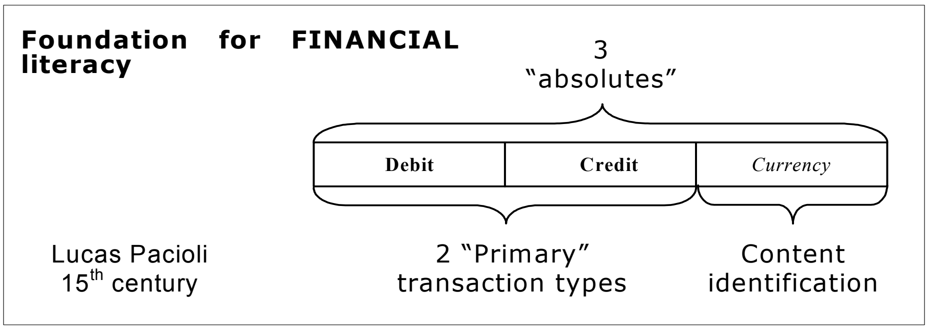


Figure 4. The three financial management "absolutes"
(Absolute Information 2001)

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

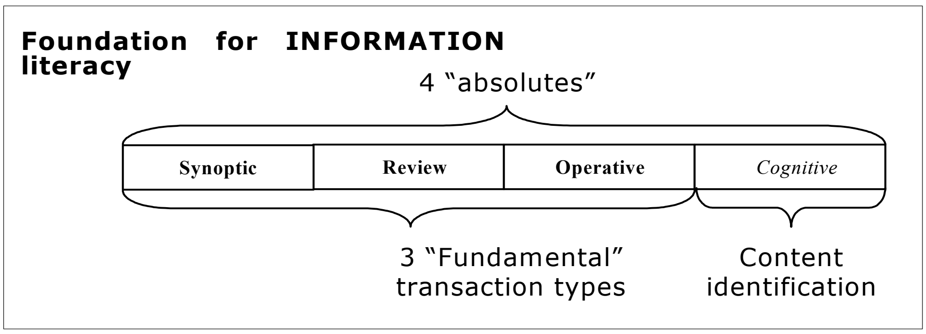


Figure 5. The four informational management "absolutes"
(Absolute Information 2001)

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.

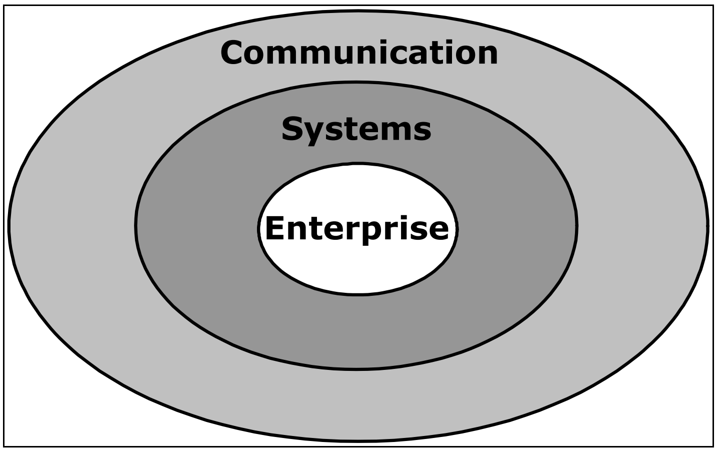


Figure 6. Levels of corporate information focus
(As adapted from Absolute Information 2001)

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**:

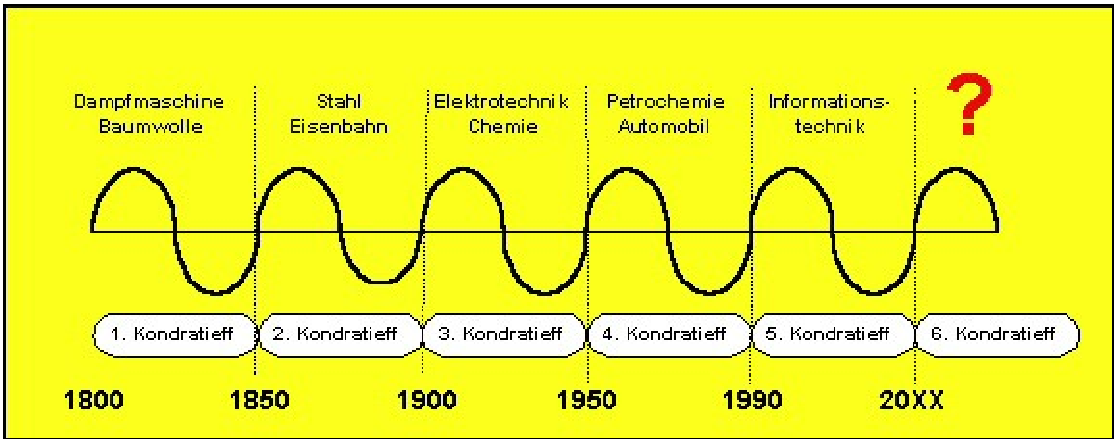


Figure 7. Economic cycles (Kondratieff, as referred to by Grulke 2001)

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.

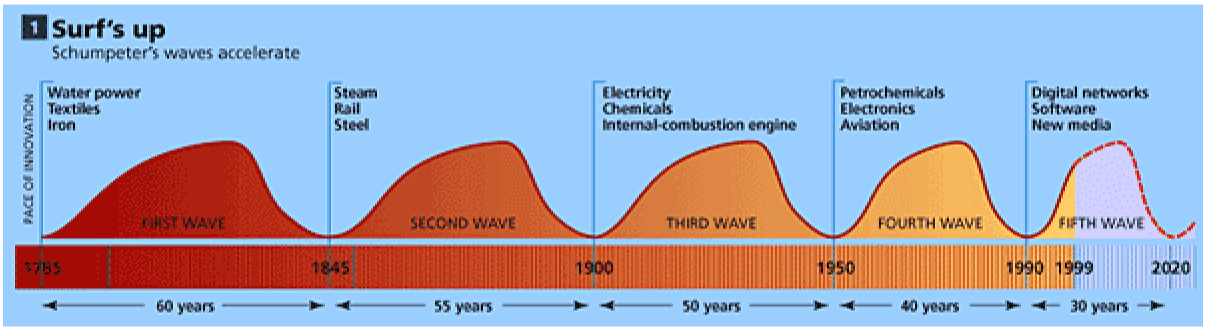


Figure 8. Schumpeter's waves (as referred to by Grulke 2001)

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**.

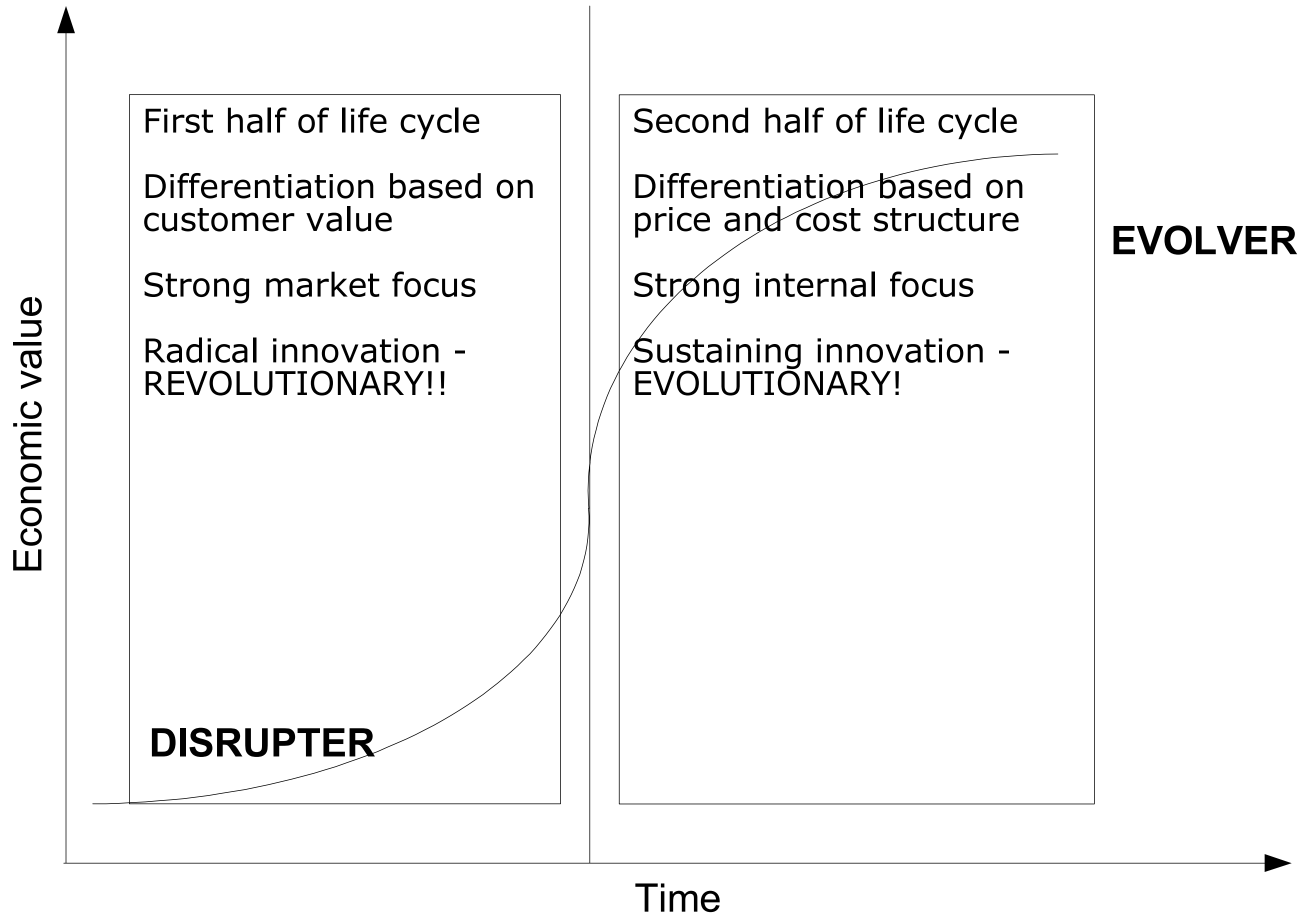


Figure 9. Business cycle (Grulke 2001)

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.

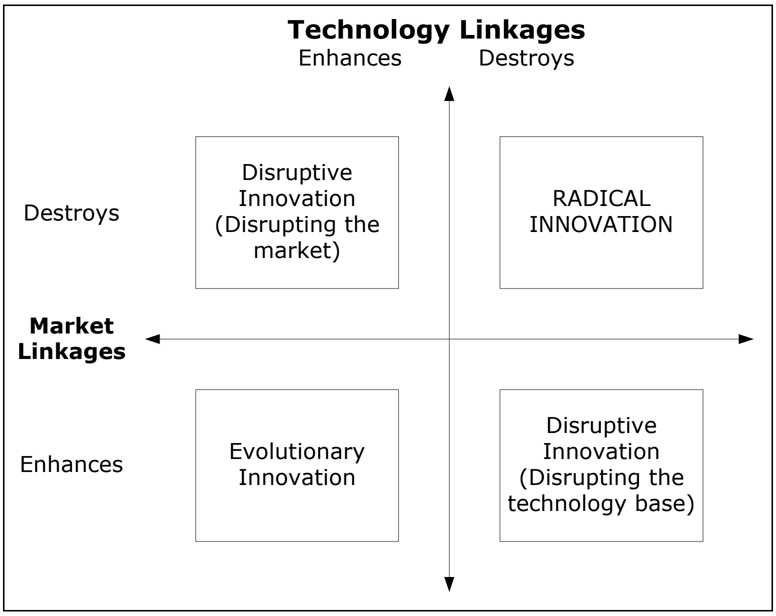


Figure 10. Innovation Matrix (Grulke 2001)

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!

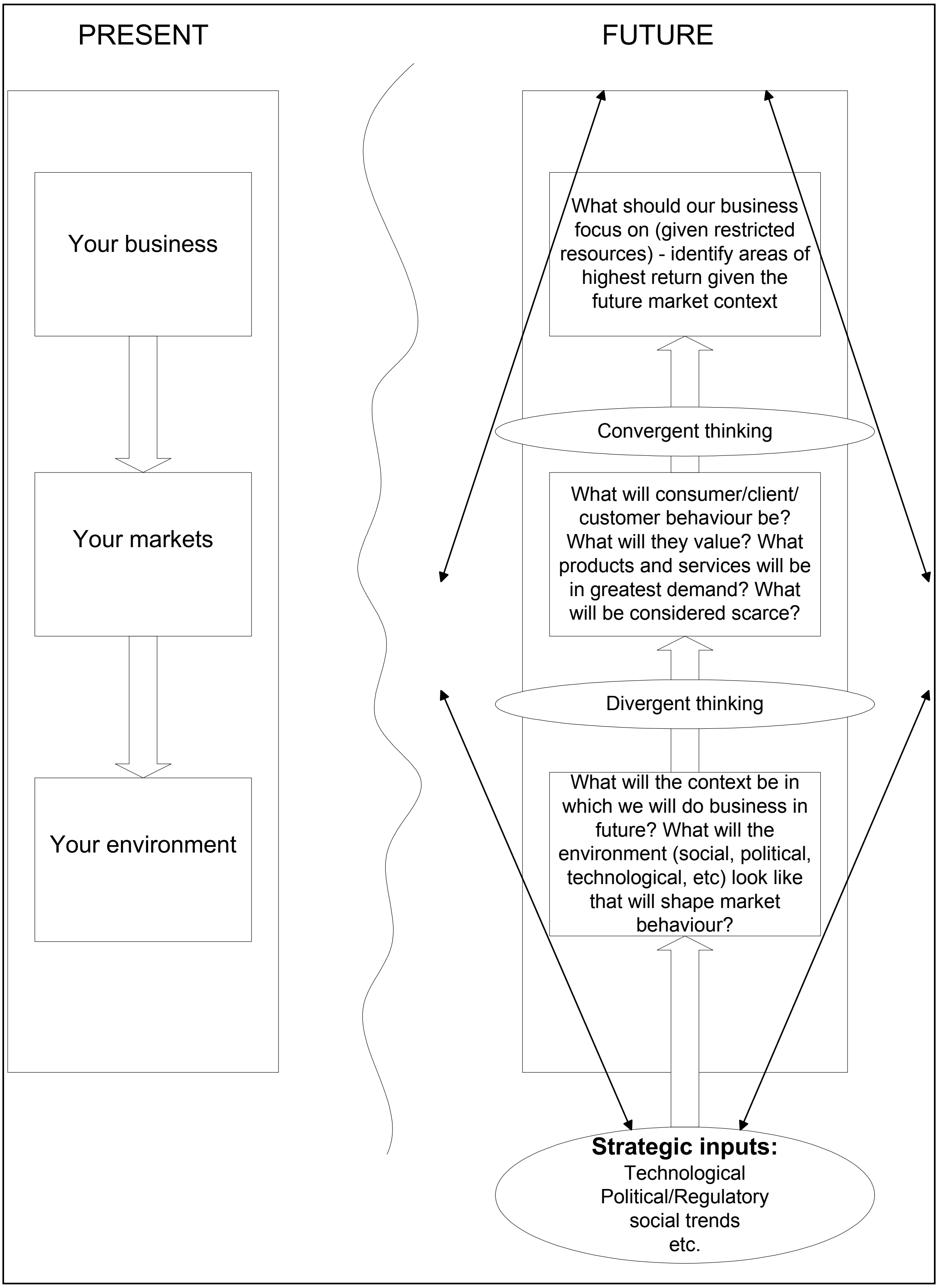


Figure 11. Learning from the future (As adapted from Grulke 2001)

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**.

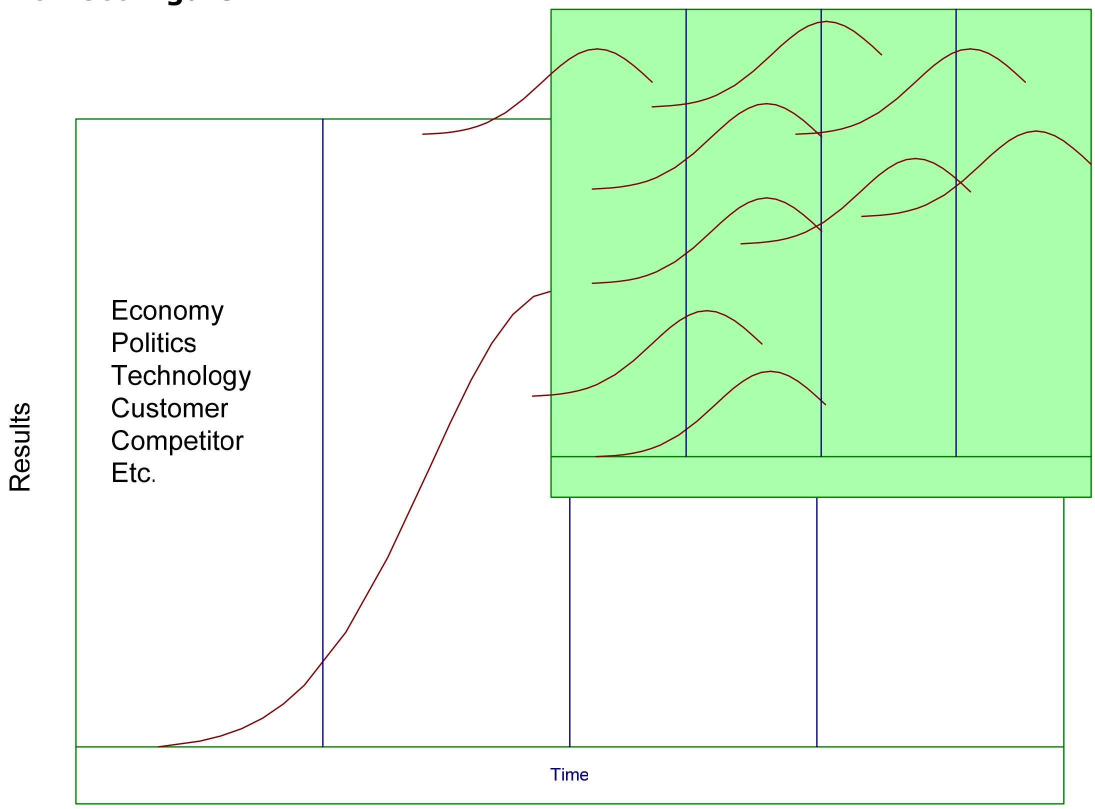


Figure 12. Hustling with a purpose (Manning 2001)

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**.

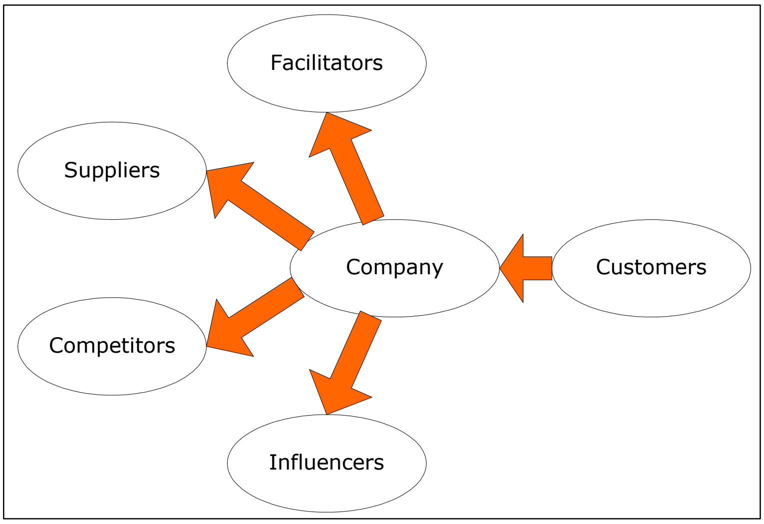


Figure 13. Unaligned stakeholders (Manning 2001)

Moving from this ……

To this!

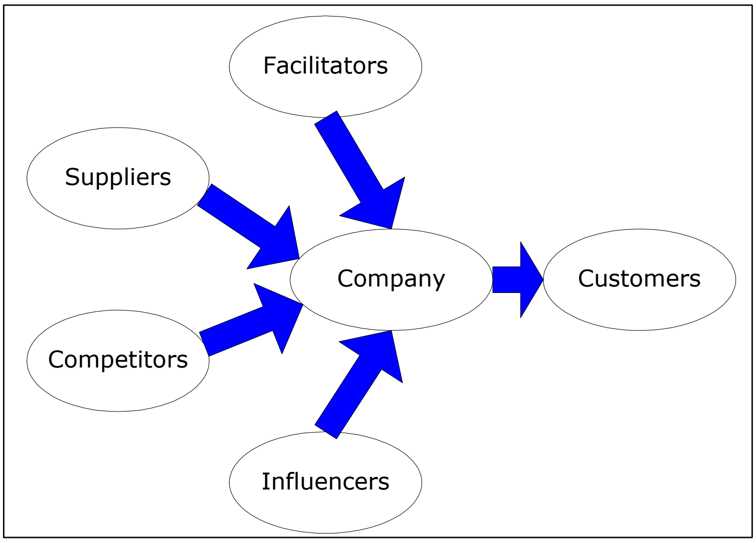


Figure 14. Aligned stakeholders (Manning 2001)

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**.

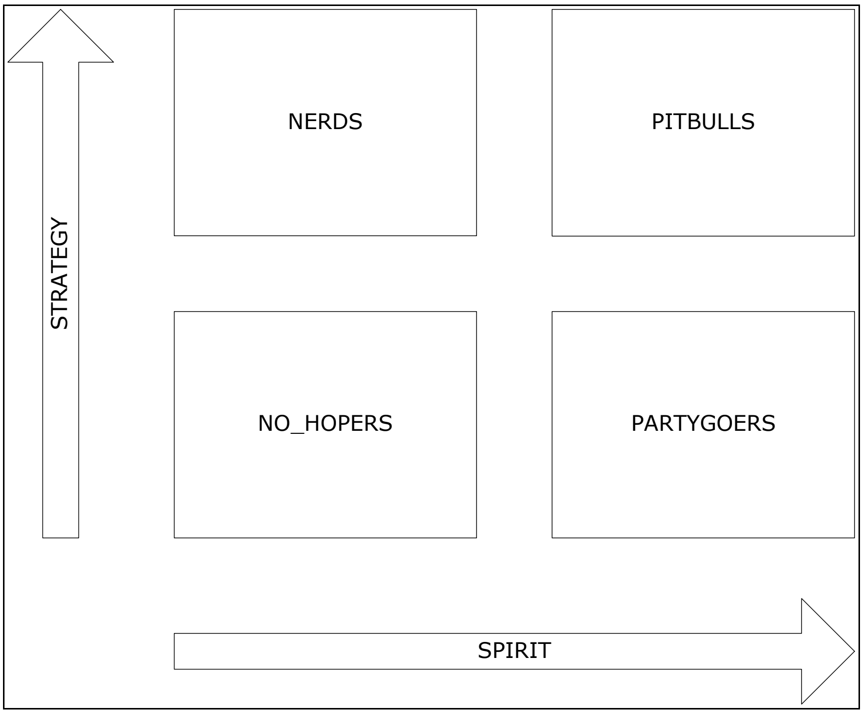


Figure 15. Effect of human spirit on strategy (Manning 2001)

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.*

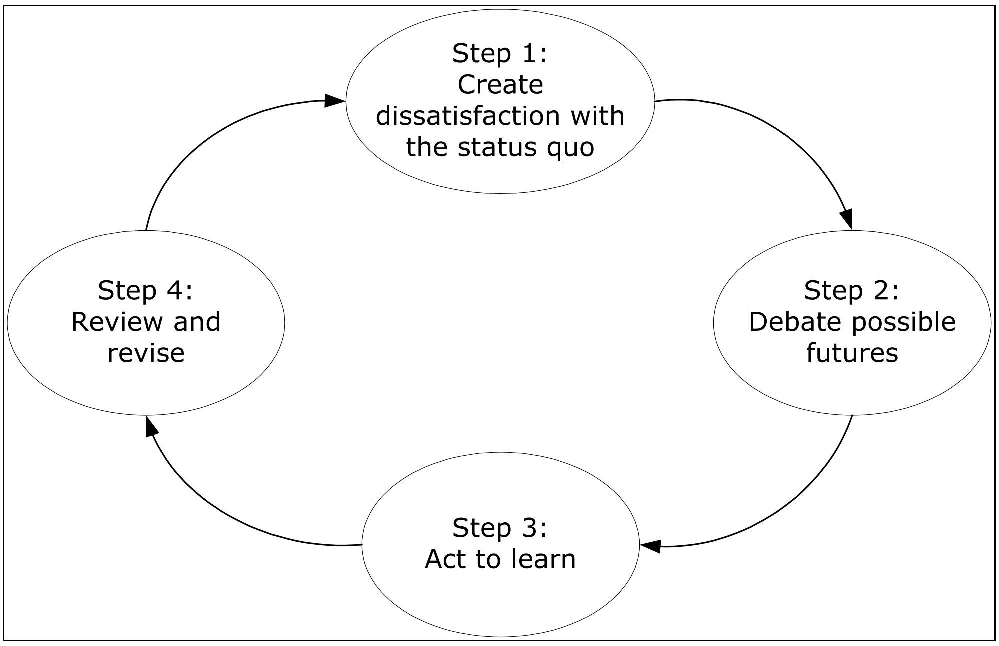


Figure 16. Four steps to implement change (Manning 2001)

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**.

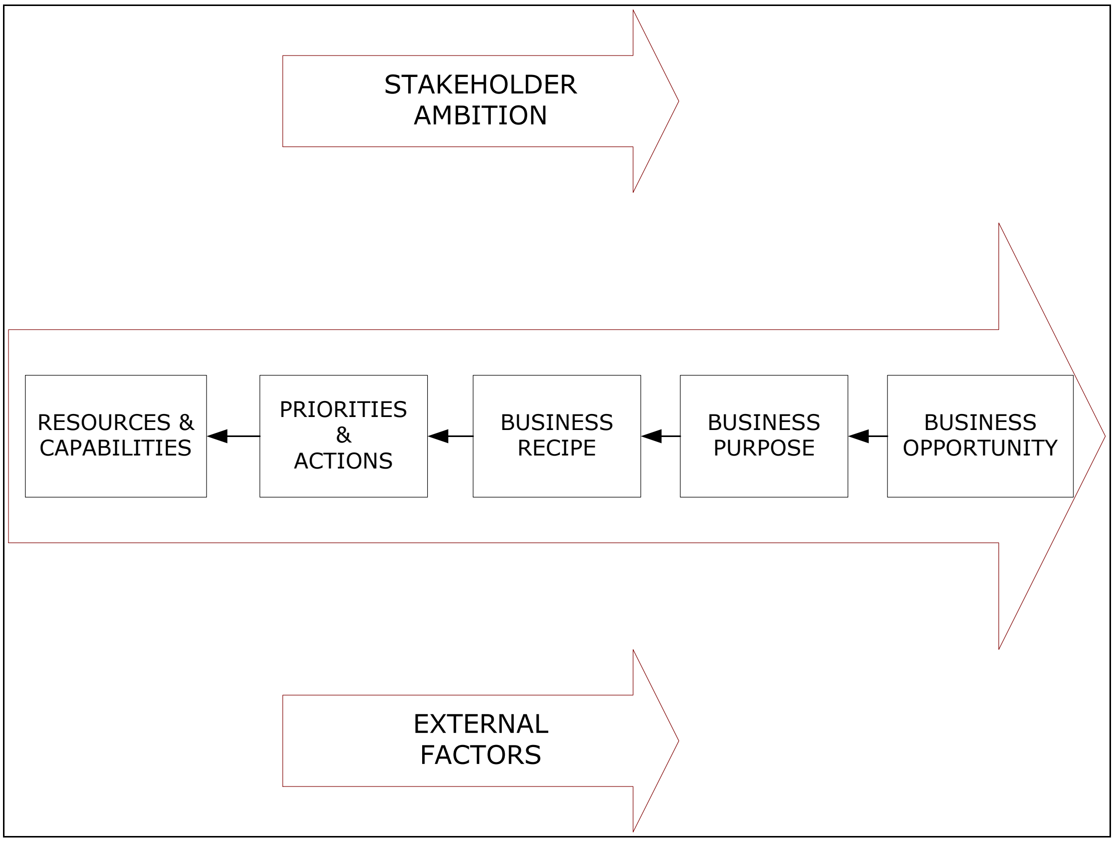


Figure 17. Does the business logic add up? (Manning 2001)

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)

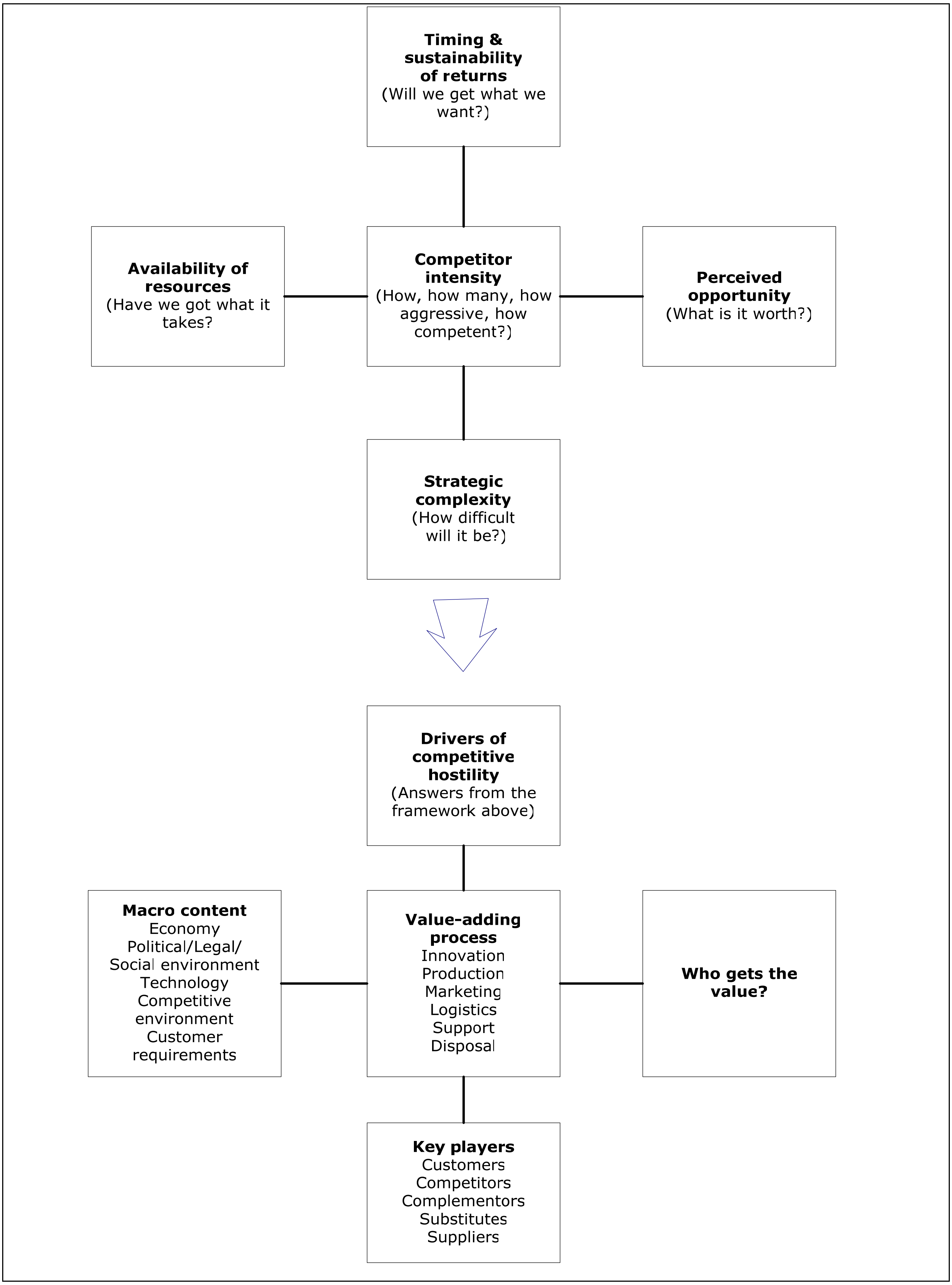


Figure 18. Two frameworks to explore your business environment
(Adapted from Manning 2001)

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**.

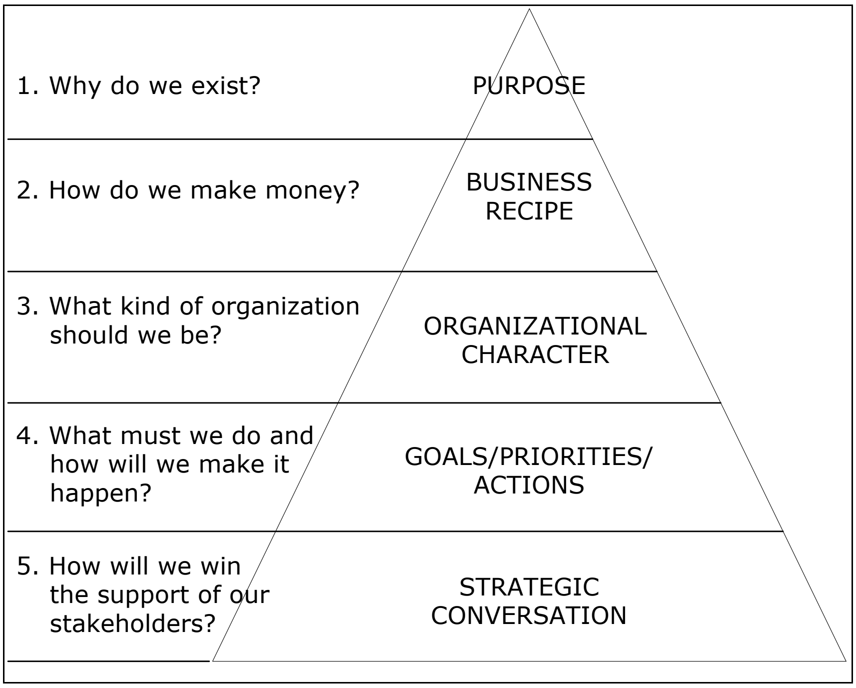


Figure 19. Five building blocks of a strategic plan (Manning 2001)

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.

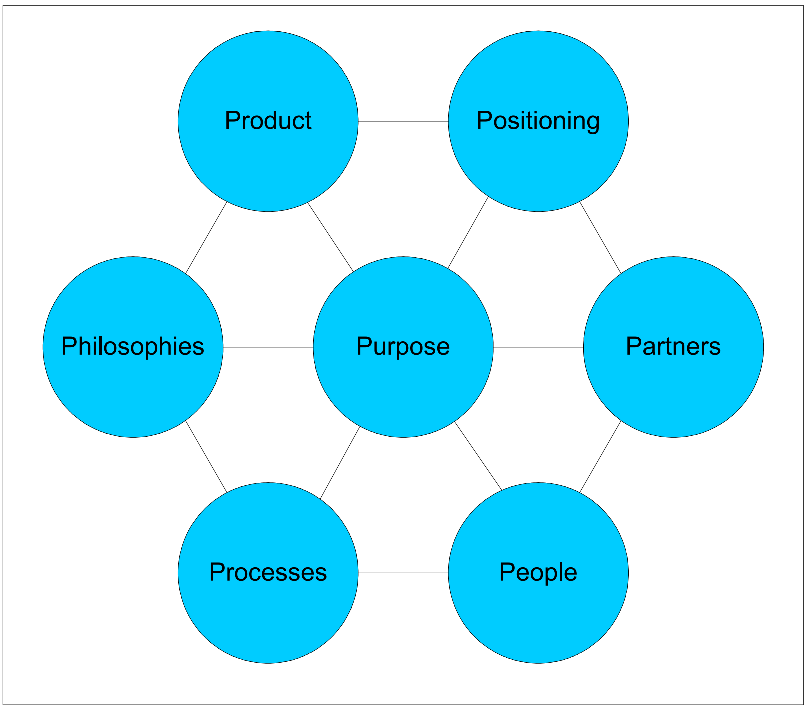


Figure 20. The 7 Ps Model (Manning 2001)

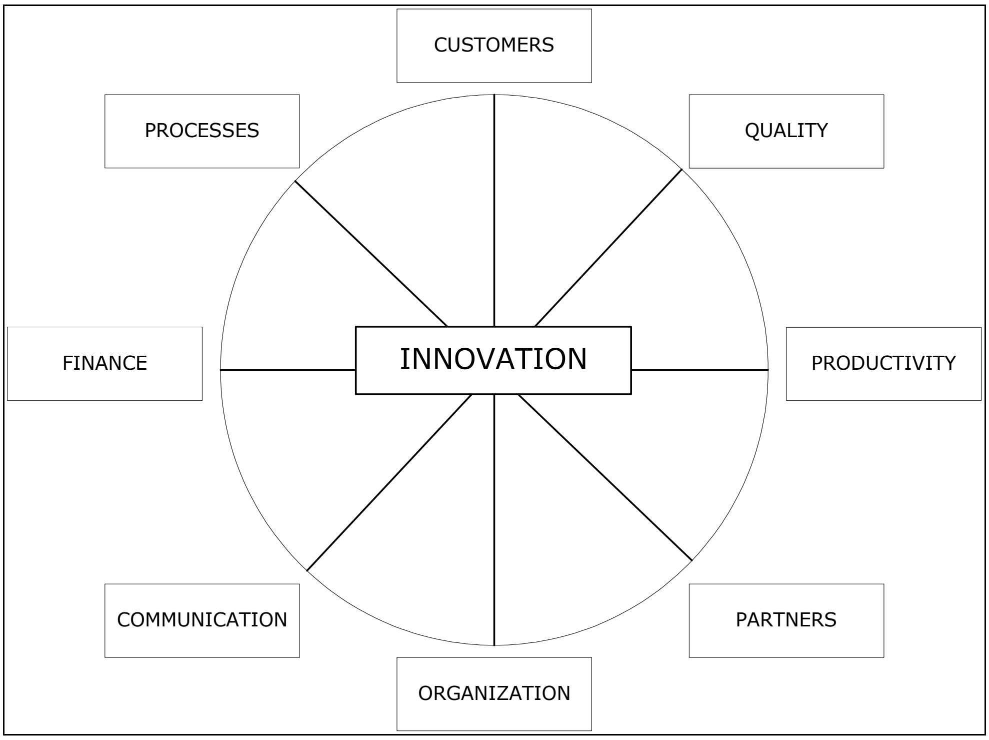


Figure 21. The Strategy Wheel to identify top priority issues
(Adapted from Manning 2001)

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**.

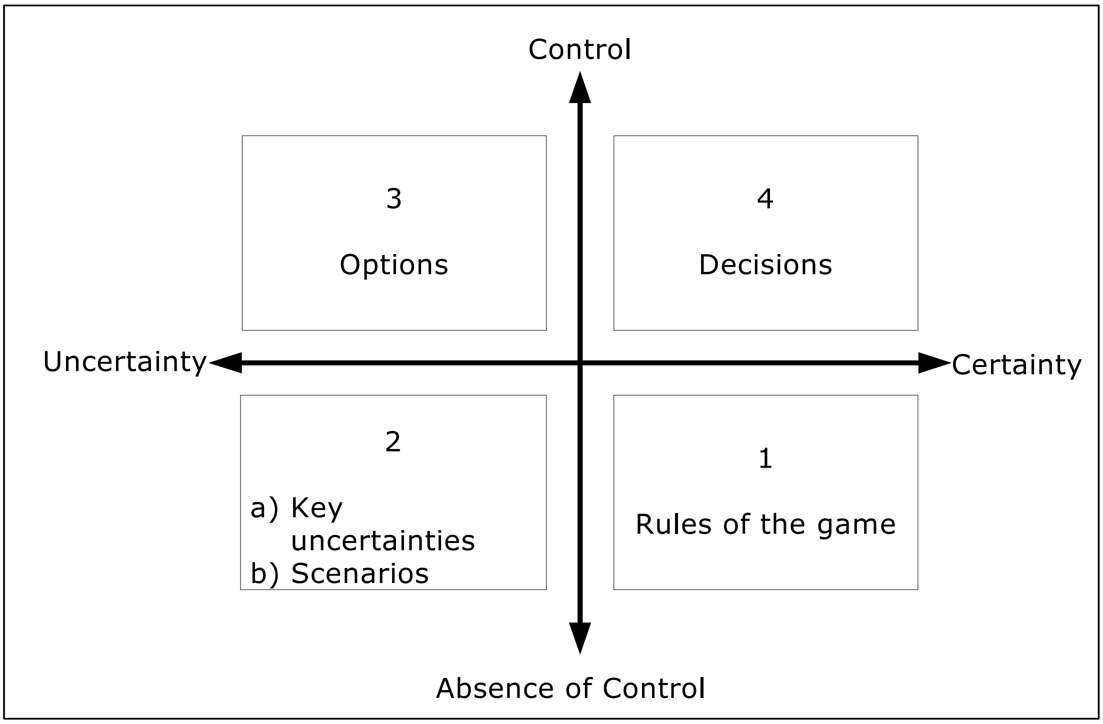


Figure 22. Foxy Matrix (Ilbury and Sunter 2001)

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.

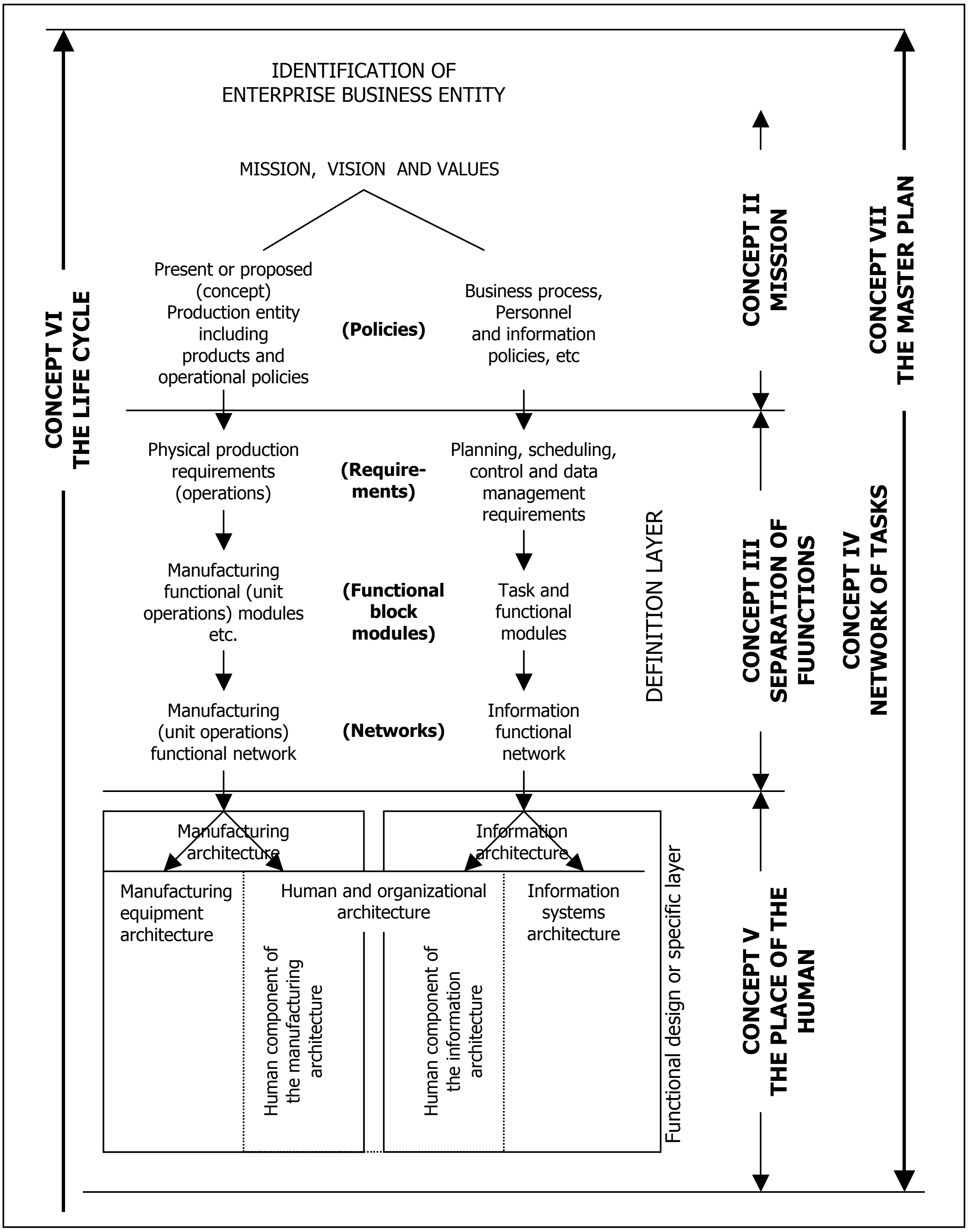


Figure 23. Purdue Enterprise Reference Architecture
(Adapted from Williams and Li 1998)

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.

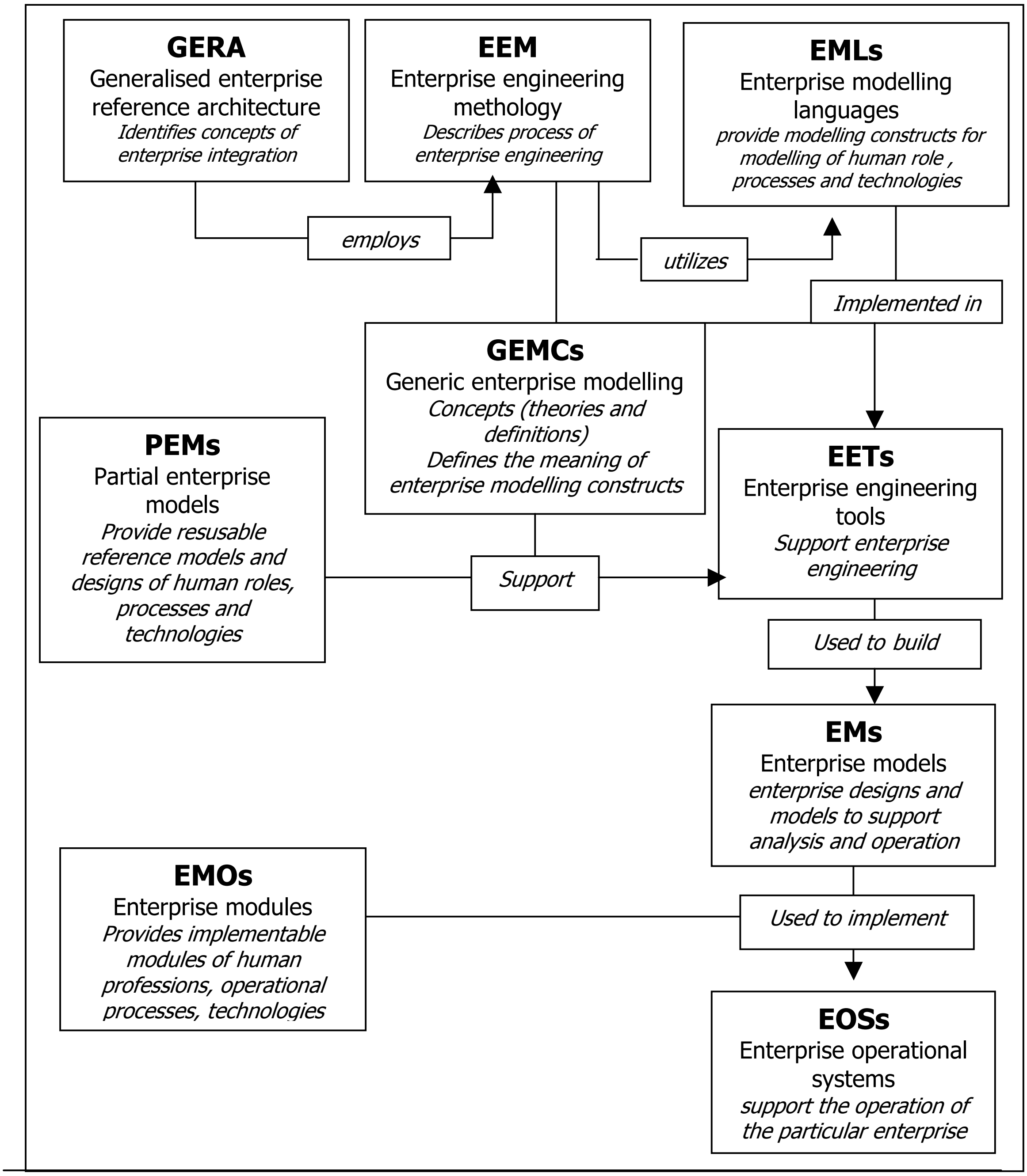


Figure 24. GERAM framework components (Adapted from Williams and Li 1998)

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 (denormaliz ed) 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.

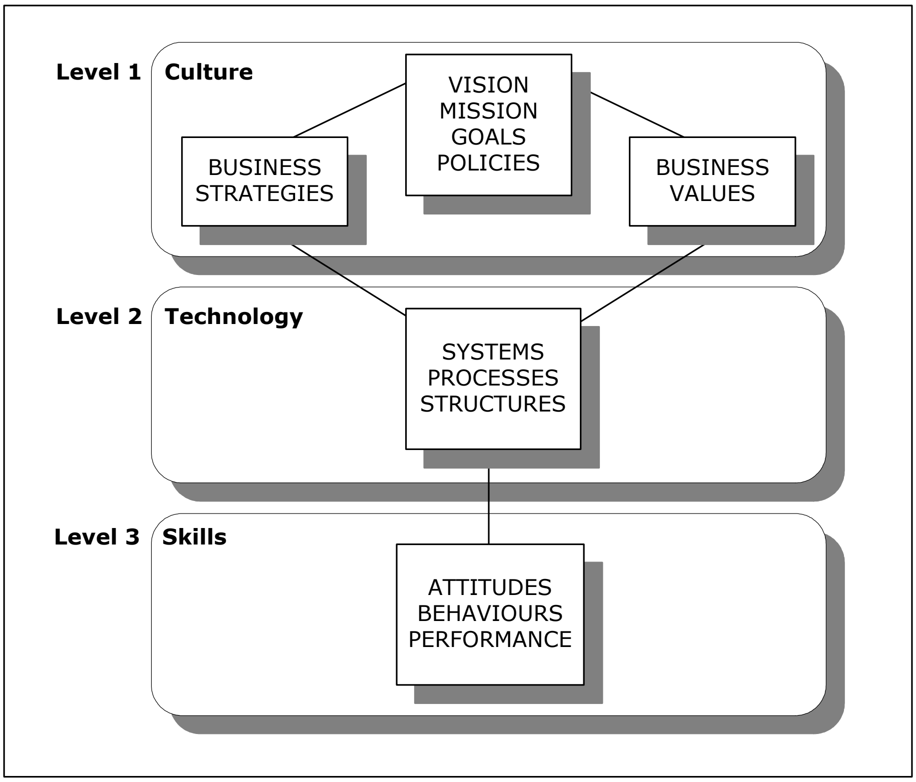


Figure 27. The CuTS model (Absolute Information 2001)

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**.

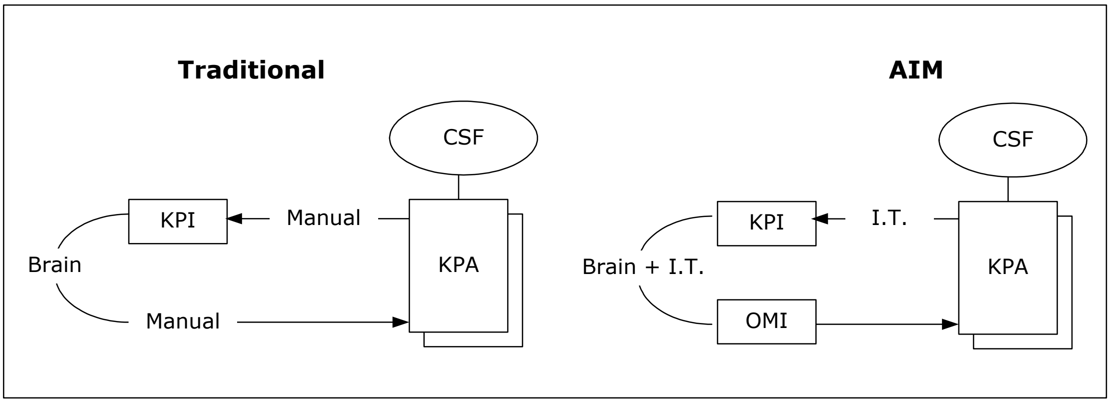


Figure 28. Defining information needs (Absolute Information 2001)

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.

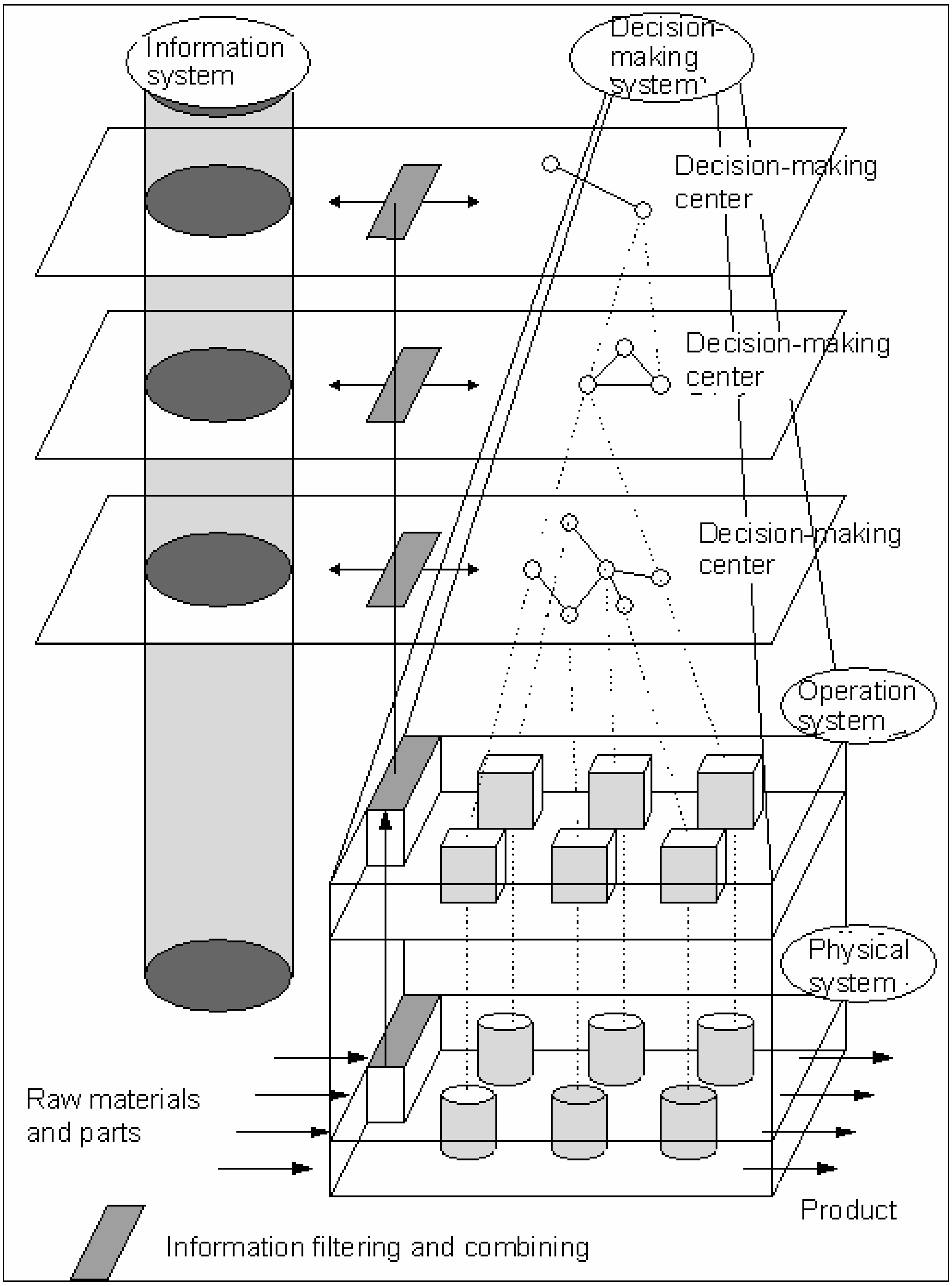


Figure 29. GRAI Global Model *(http://www.atb-bremen.de/projects/prosme/Doku/oqim/GRAI.htm)*

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.

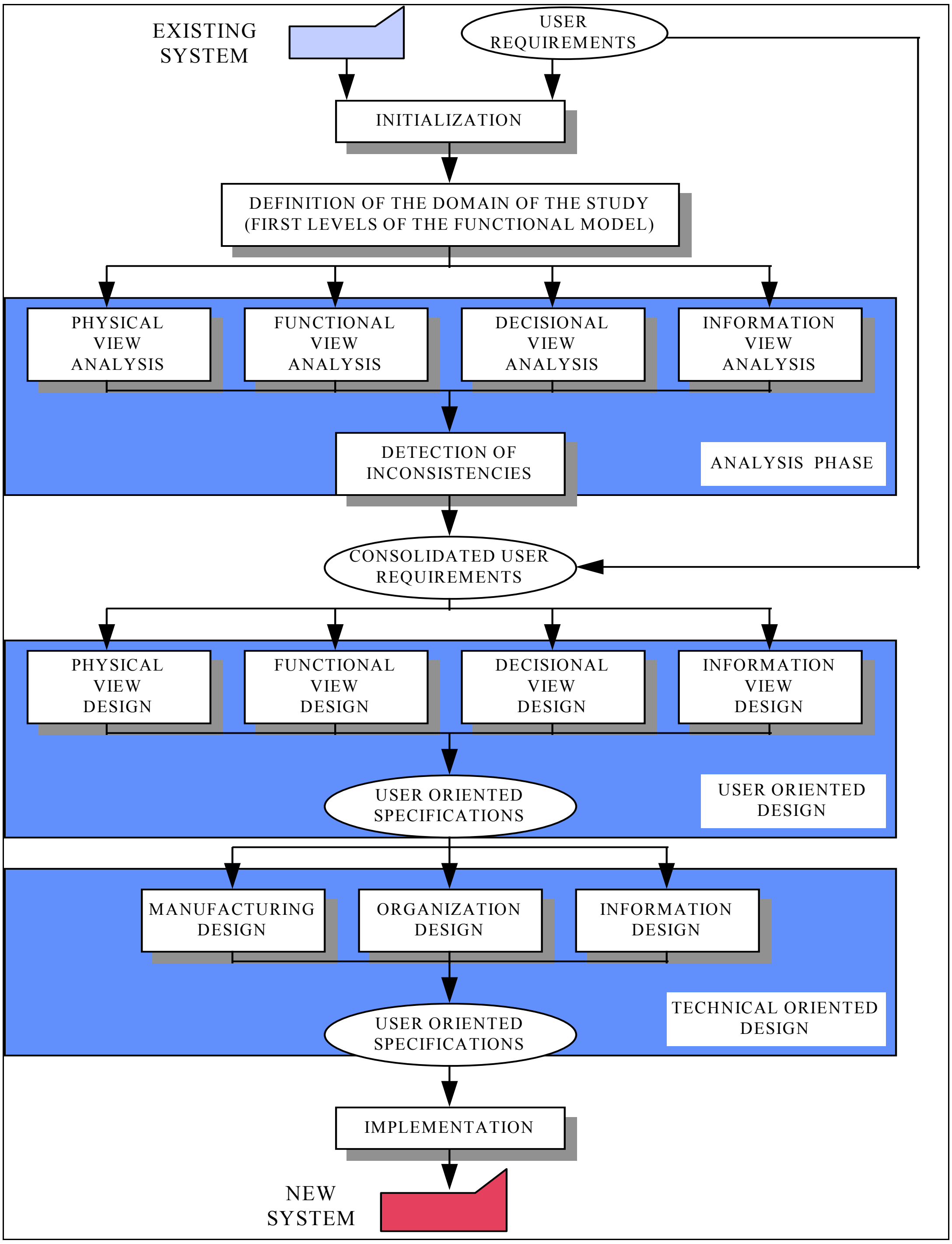


Figure 30. GRAI-GIM Enterprise Life Cycle (Adapted from Koorts 2000)

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.

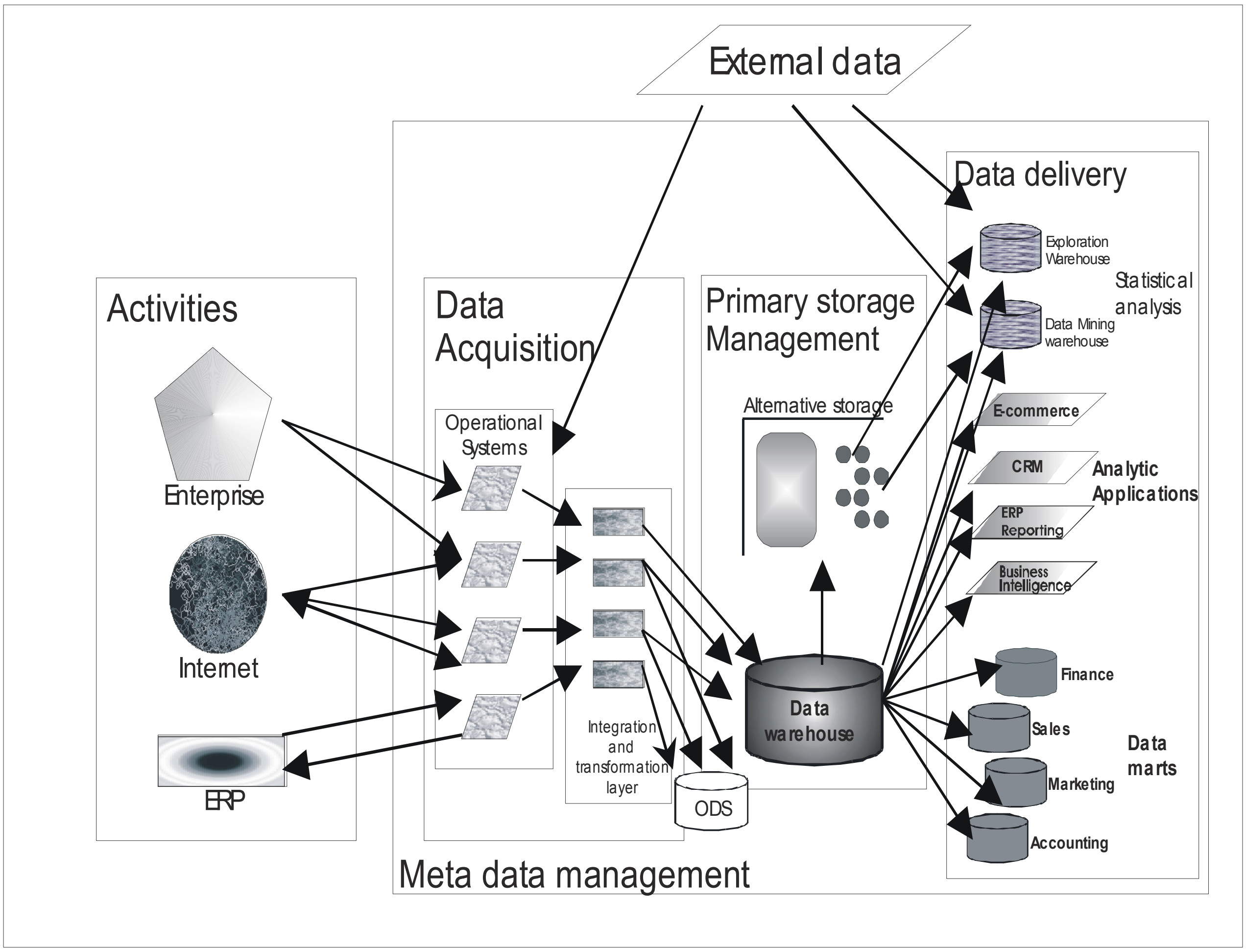


Figure 31. The Corporate Information Factory (Inmon et al. 2001)

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.

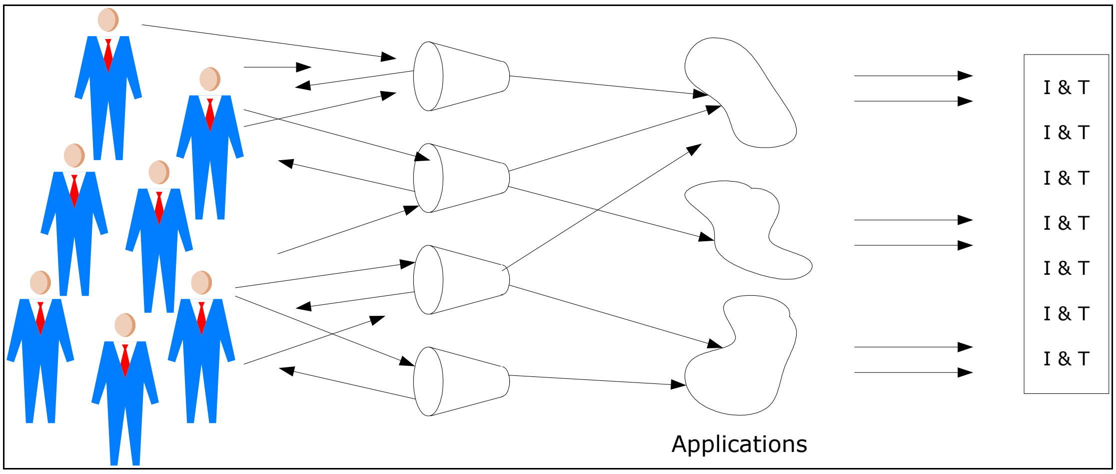


Figure 32. Applications feed data into the I and T layer (Inmon et al. 2001)

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

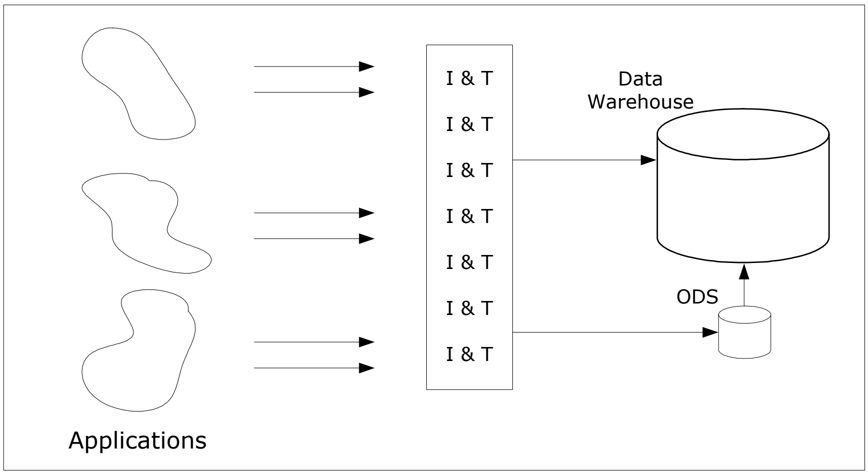


Figure 33. The feeds into and out of the I and T layer (Inmon et al. 2001)

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**.

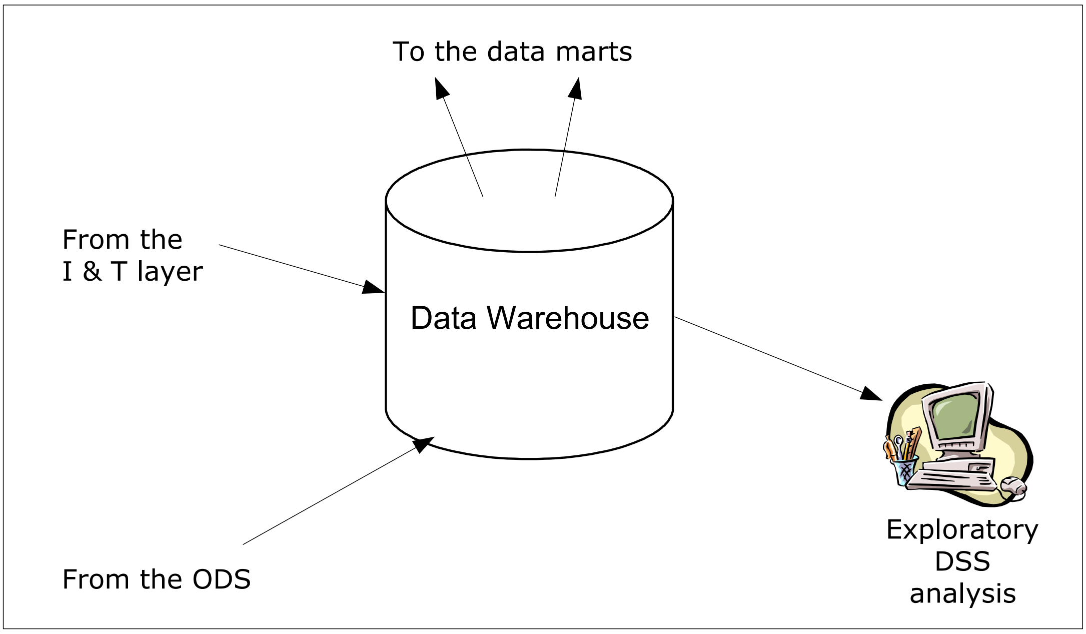


Figure 34. A data warehouse in the context of the CIF (Inmon et al. 2001)

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.

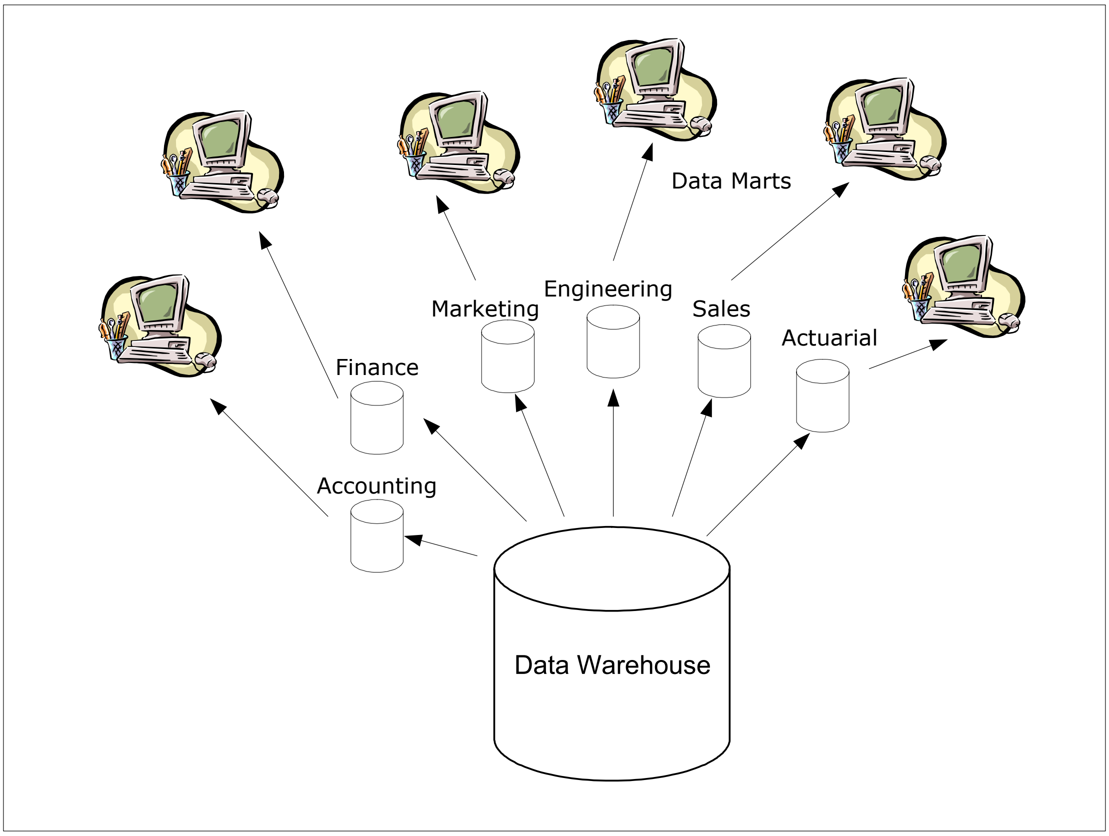


Figure 35. The data warehouse feeds to the data marts (Inmon et al. 2001)

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**.

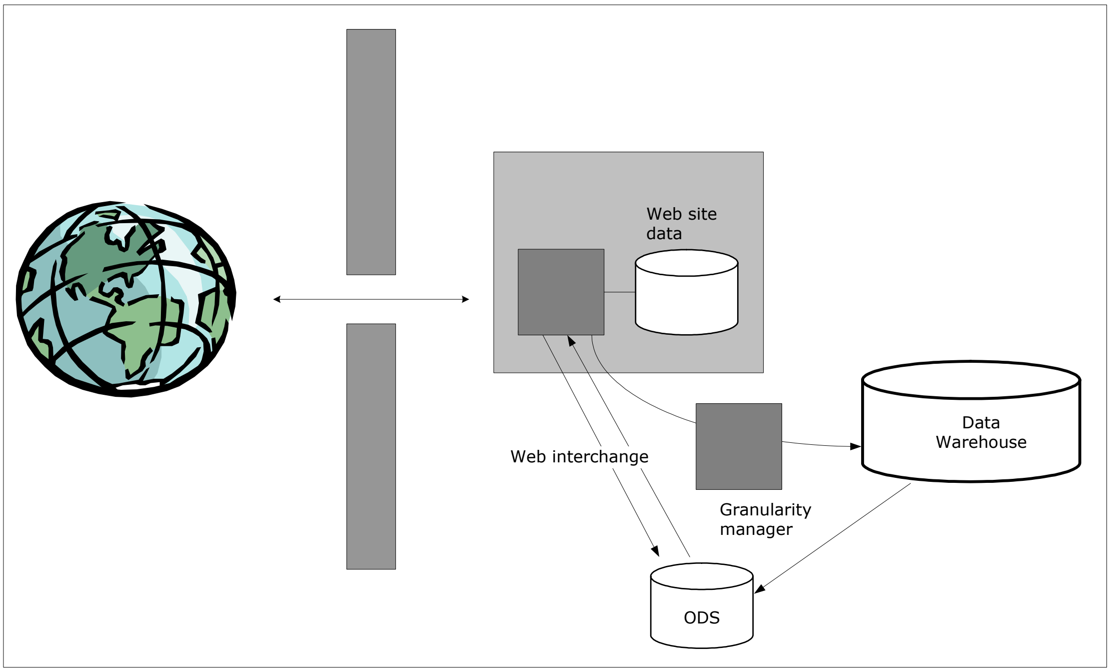


Figure 36. The essential components of the web and the CIF (Inmon et al. 2001)

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**.

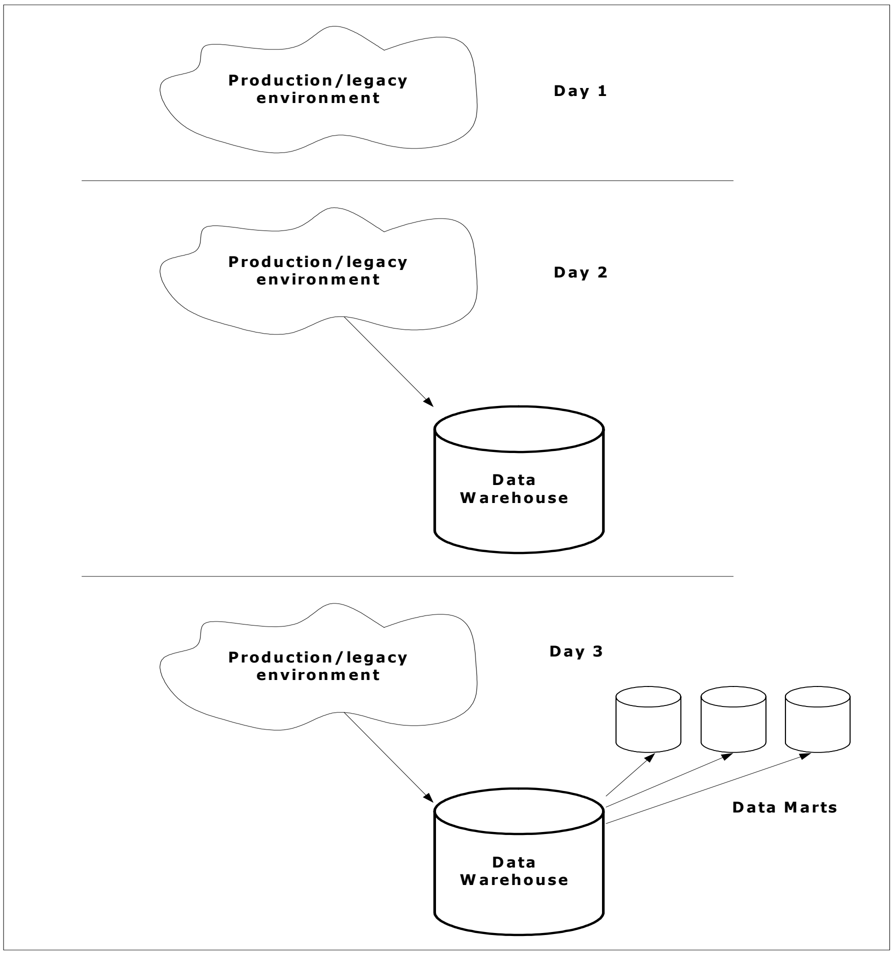


Figure 37. First three steps to building the CIF (Inmon et al. 2001)

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.

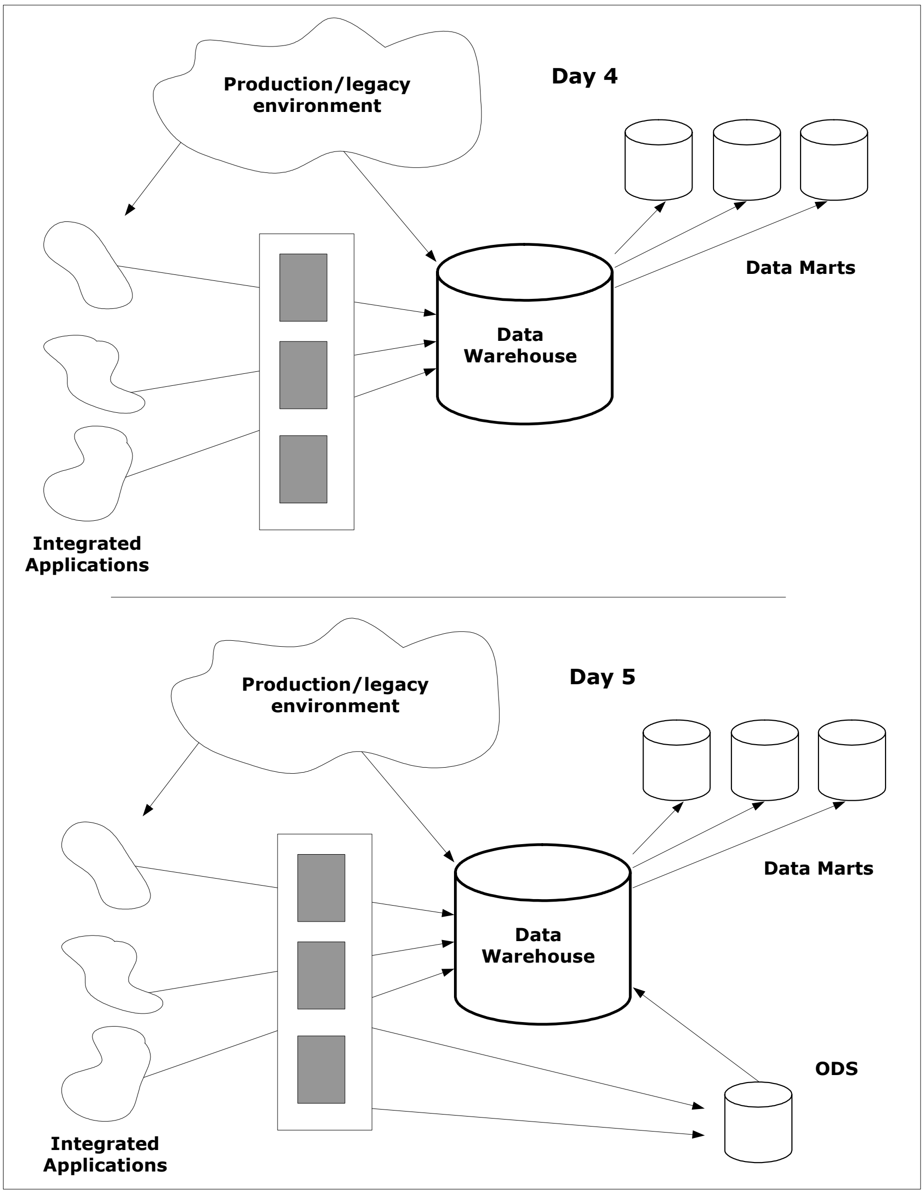


Figure 38. The next steps to building the CIF (Inmon et al. 2001)

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.

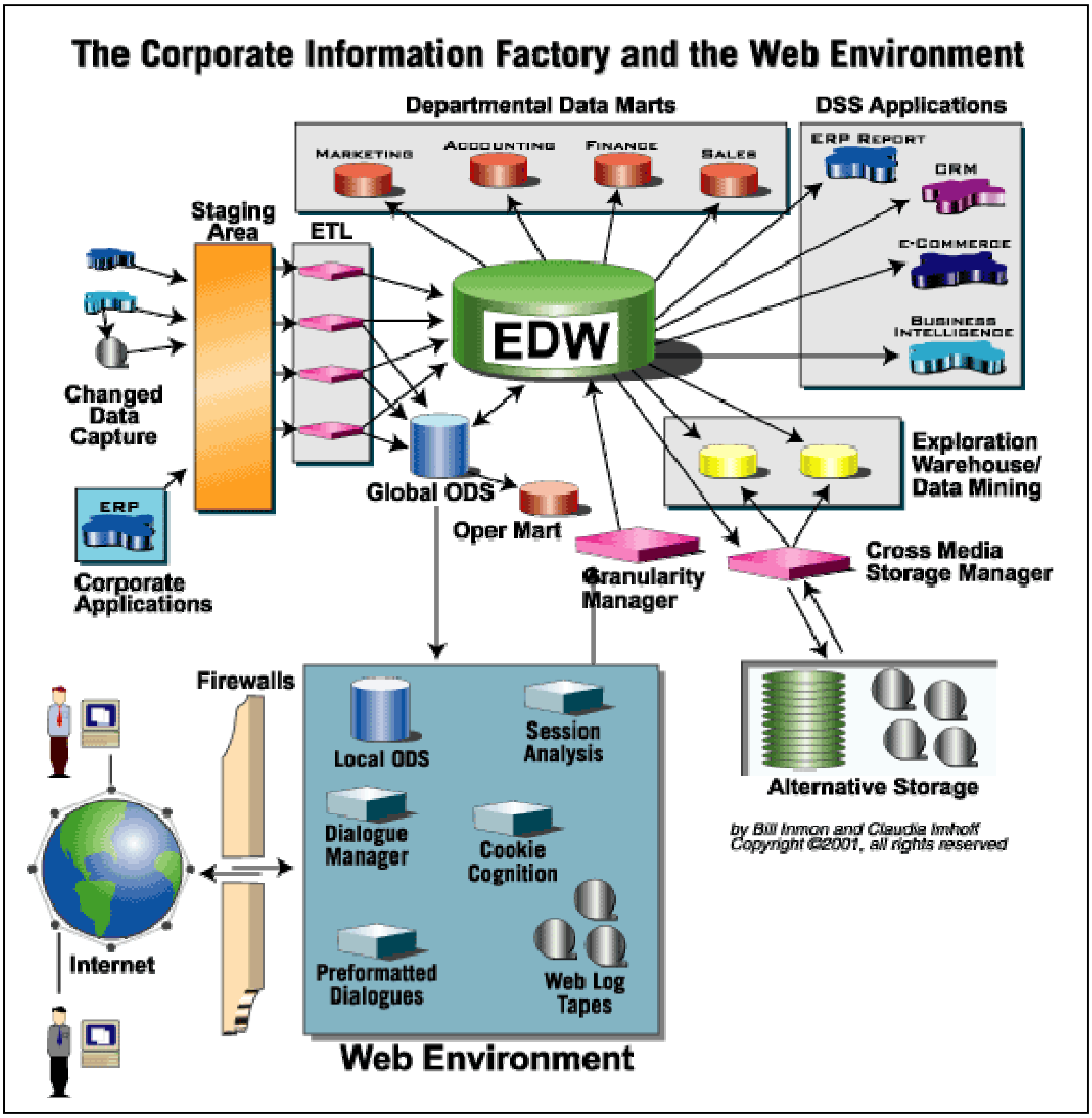


Figure 39. Enhanced CIF picture (Inmon and Imhoff 2001)

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.

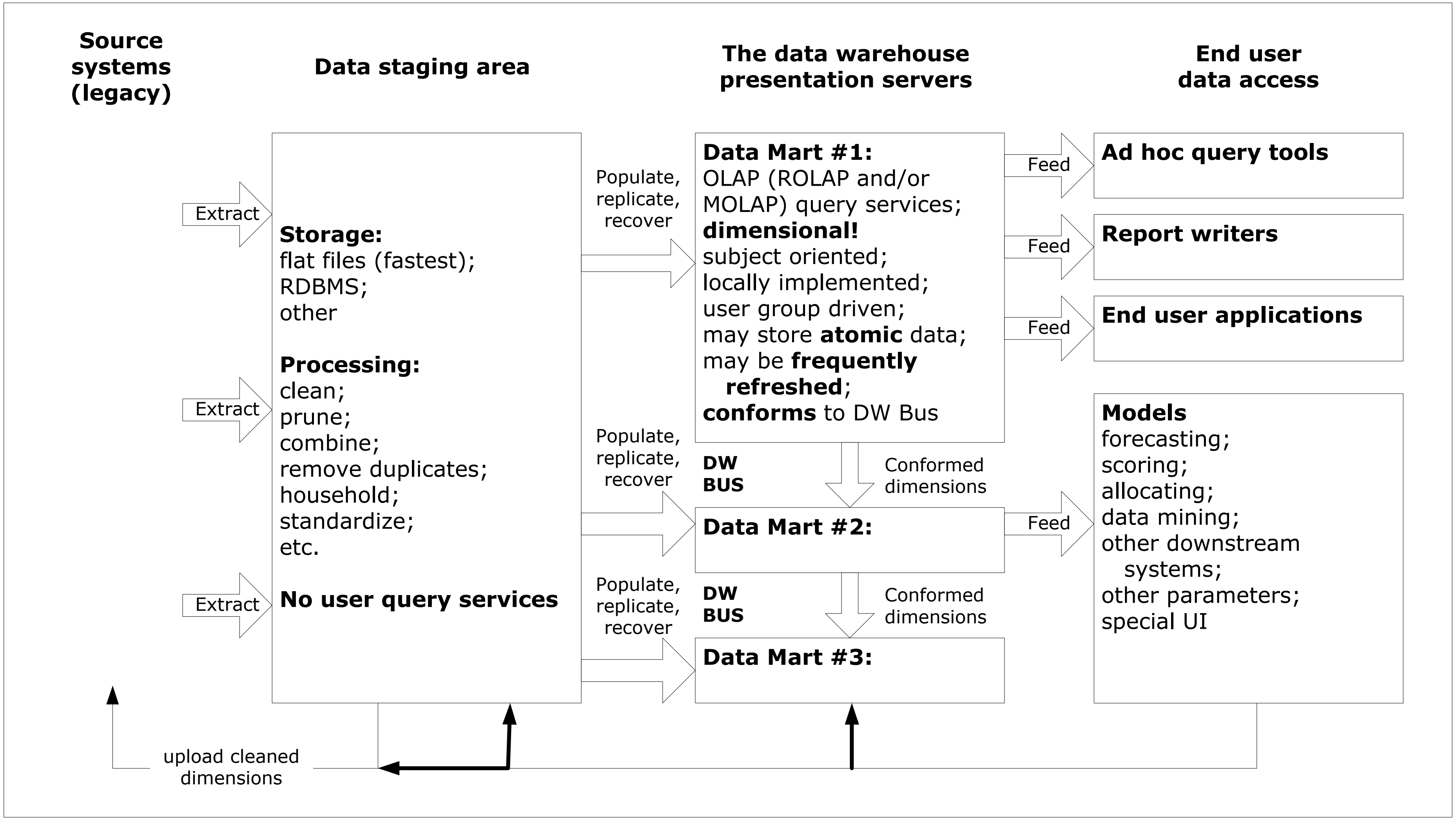


Figure 40. The basic elements of the data warehouse (Kimball et al. 1998)

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**.

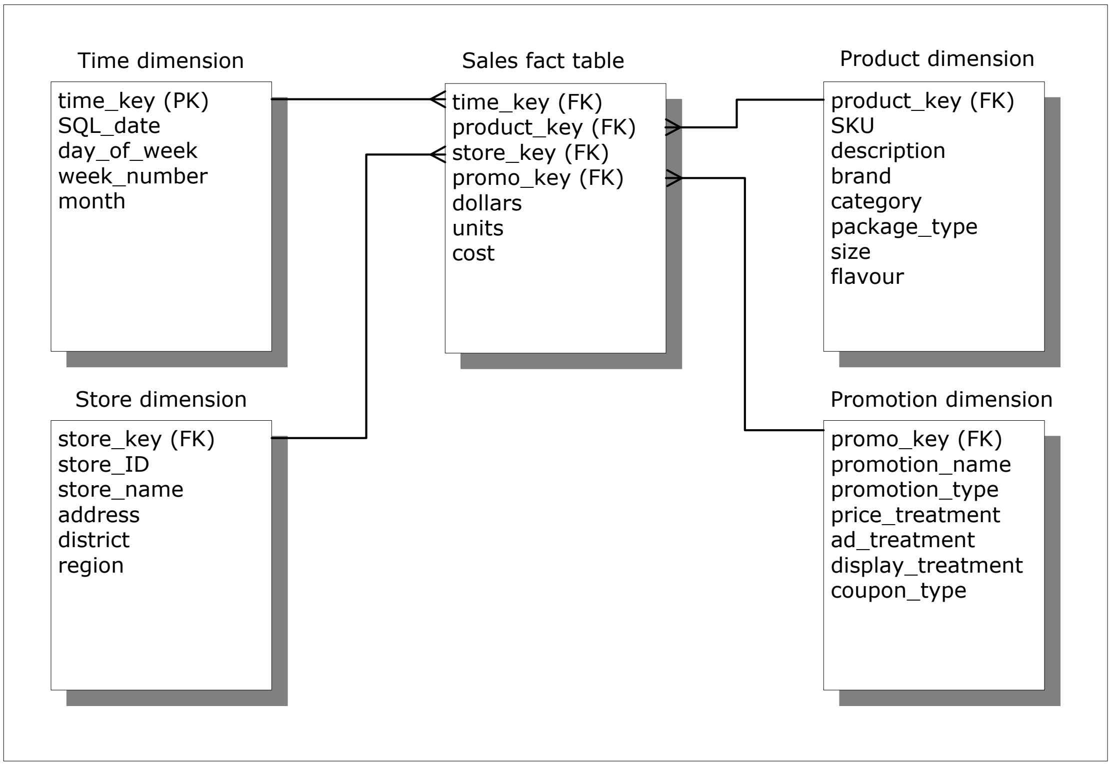


Figure 41. Star schema (Kimball et al. 1998)

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

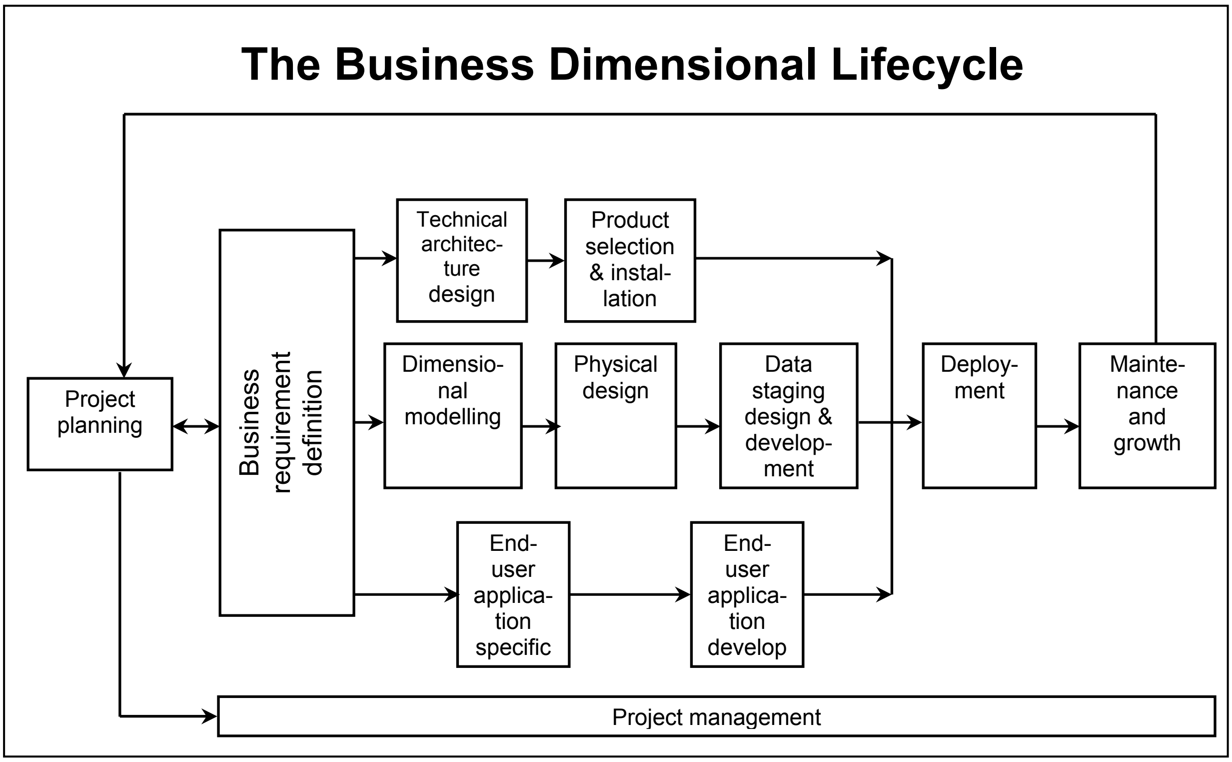


Figure 43. Business Dimensional Lifecycle diagram (Kimball et al. 1998)

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.

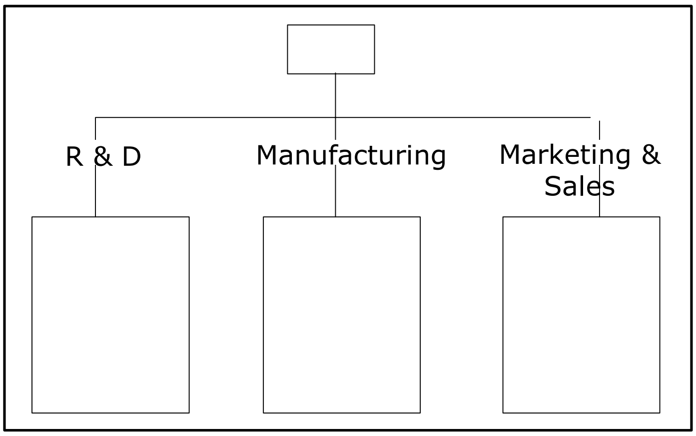


Figure 44. Traditional (vertical) view of an organization
(Rummler and Brache 1995)

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.

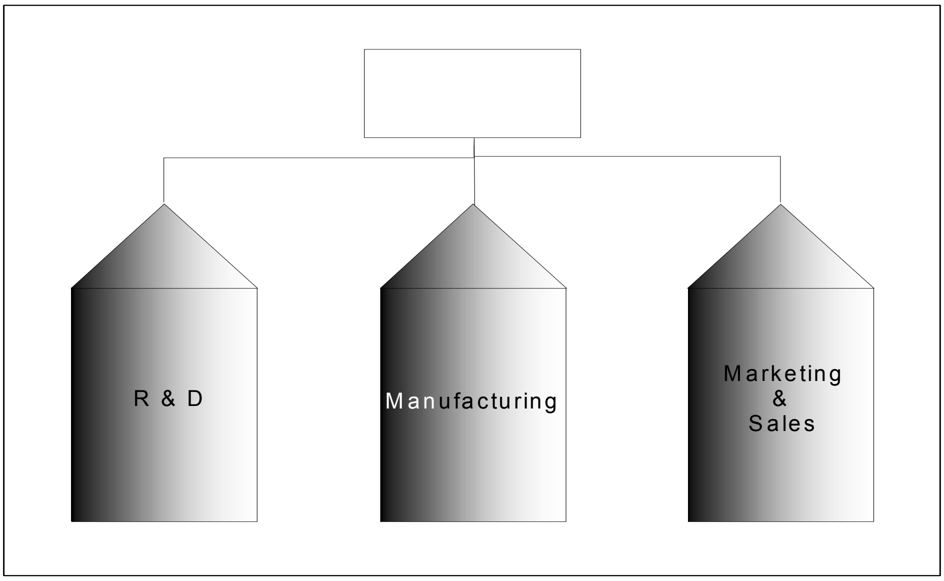


Figure 45. The "silo" phenomenon (Rummler and Brache 1995)

> *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**.

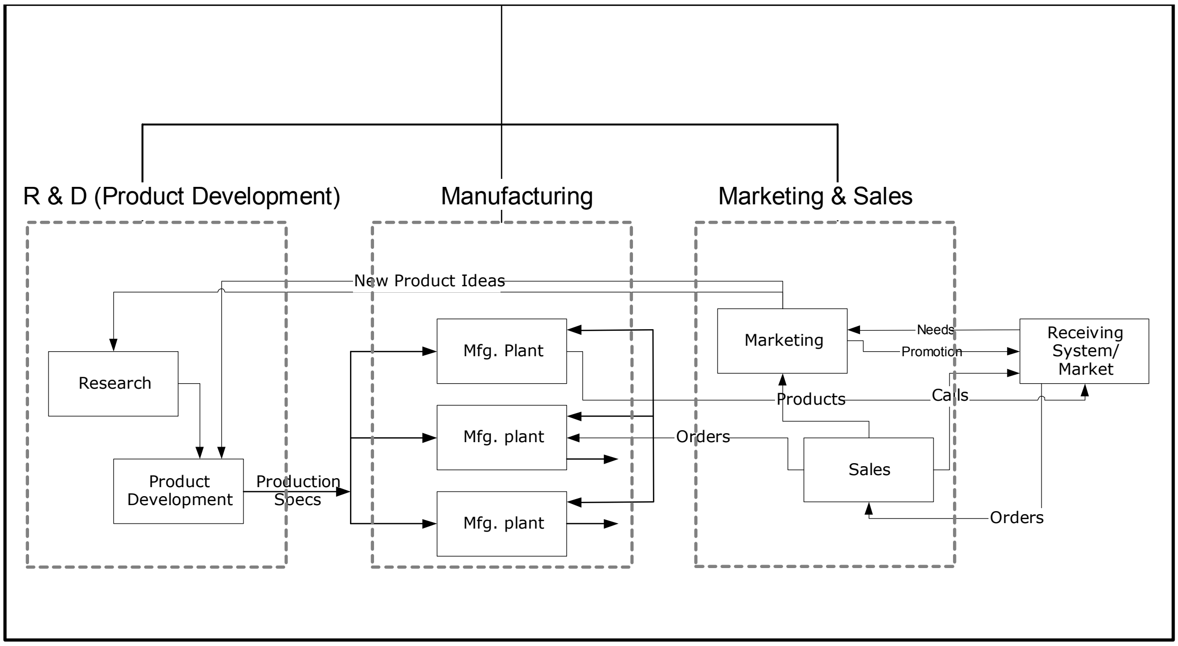


Figure 46. Systems (horizontal) view of an organization
(Rummler and Brache 1995)

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.

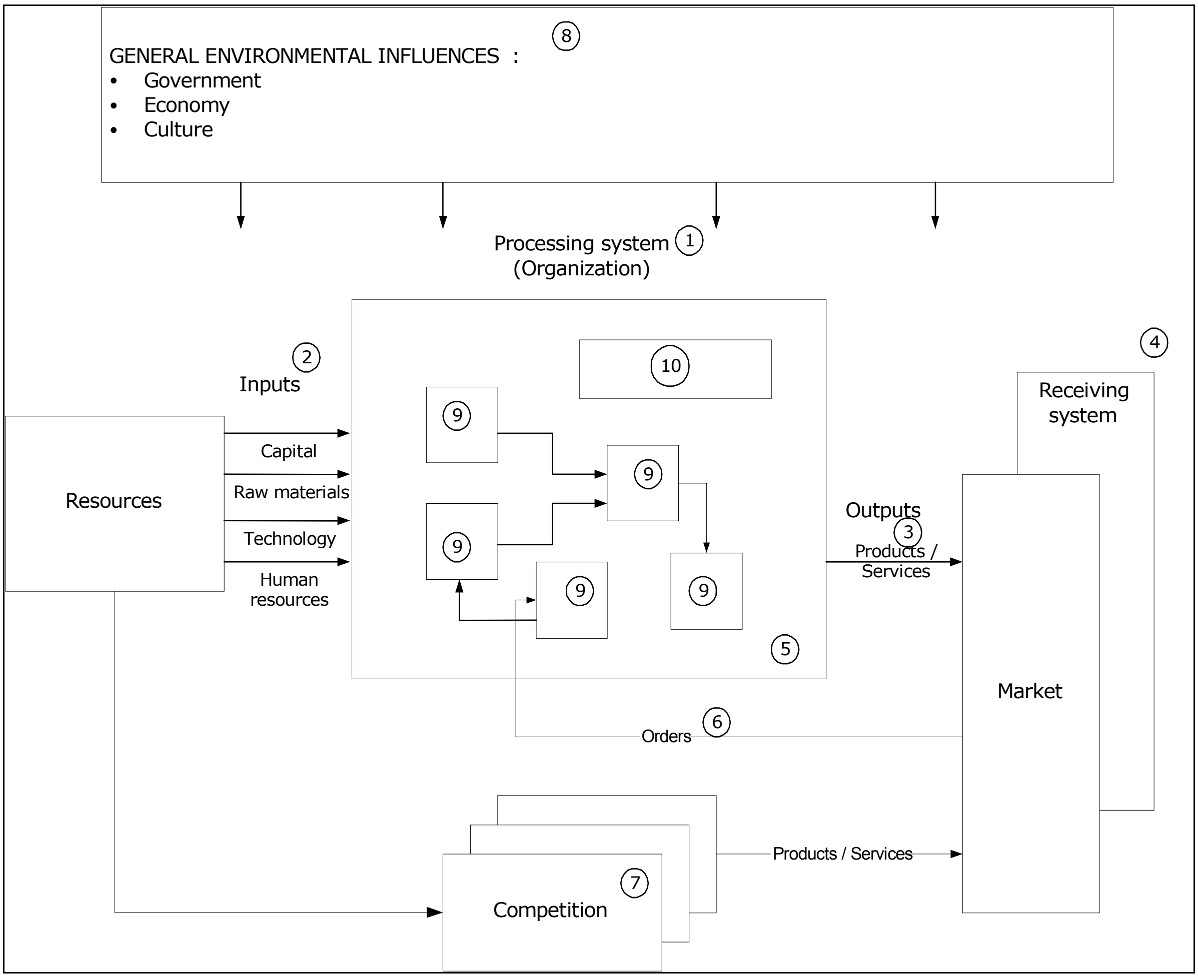


Figure 47. An organization as an adaptive system
(Rummler and Brache 1995)

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".*

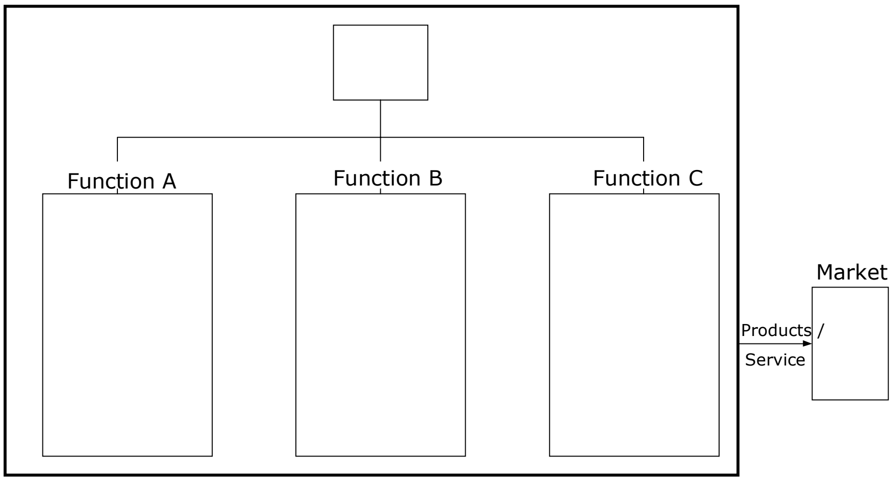


Figure 48. The organization level of performance
(Rummler and Brache 1995)

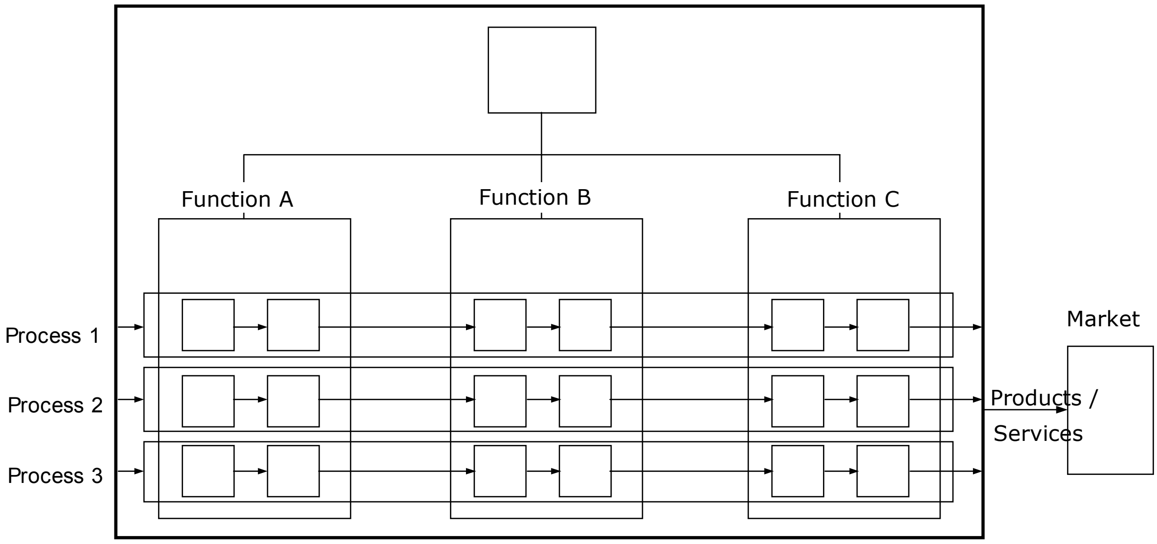


Figure 49. The process level of performance
(Rummler and Brache 1995)

"*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.

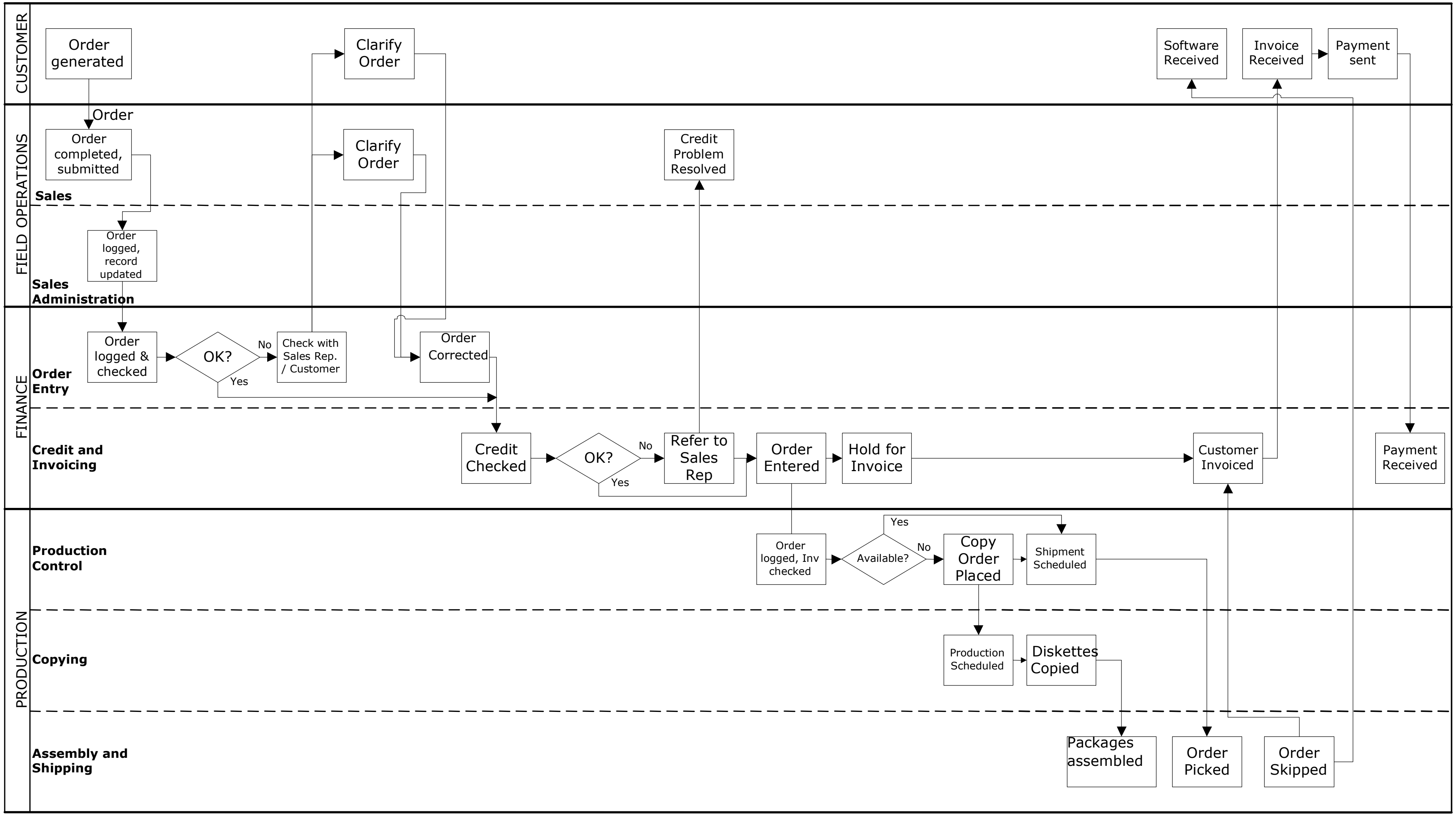


Figure 50. Computec order filling: "As-is" process map (Rummler and Brache 1995)

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**.

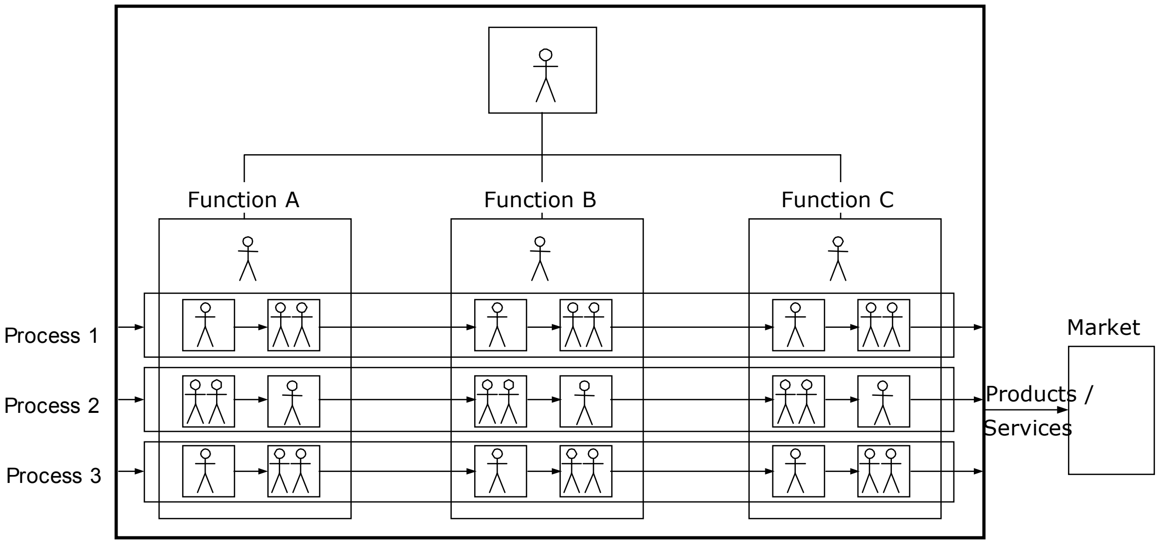


Figure 51. The job/performer level of performance
(Rummler and Brache 1995)

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)

Business unit strategy		Strategic themes: Revenue growth and mix	Strategic themes: Cost reduction/ Productivity improvement	Strategic themes: Asset utilization
	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**.

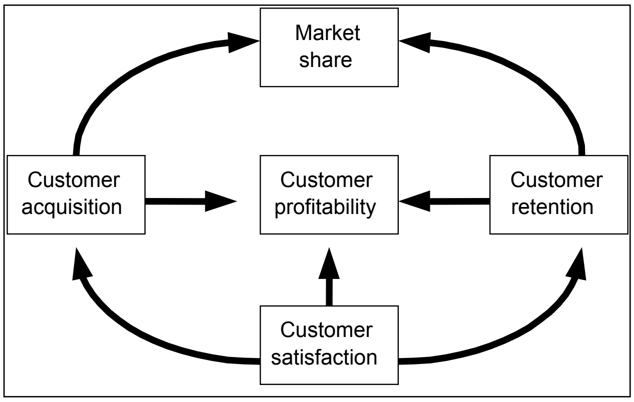


Figure 52. The customer perspective
(Kaplan and Norton 1996)

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.

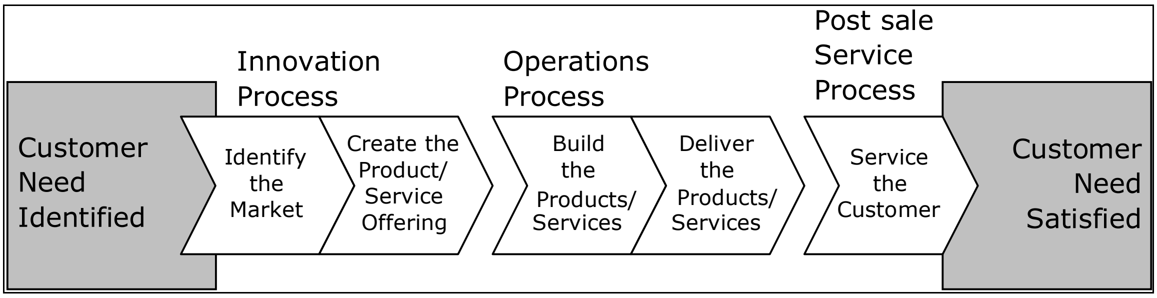


Figure 53. The generic value model (Kaplan and Norton 1996)

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**.

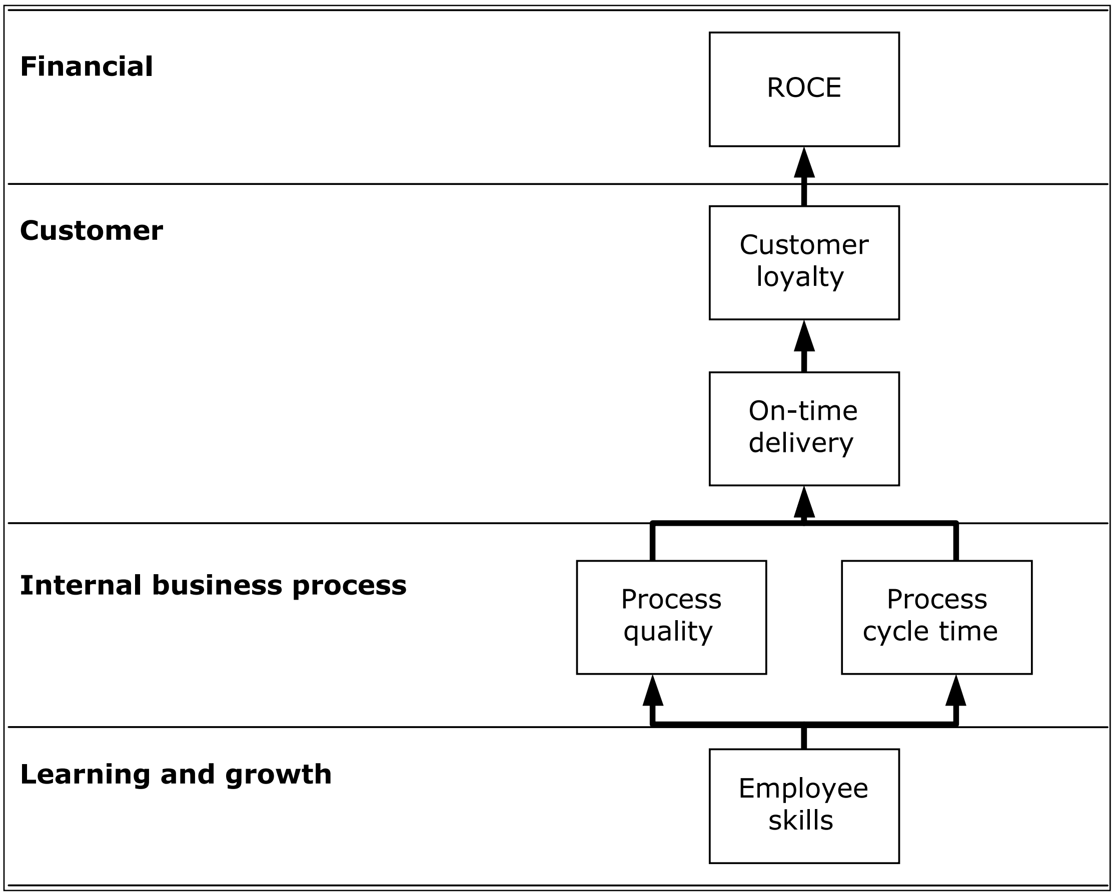


Figure 54. Cause-and-effect example (Kaplan and Norton 1996)

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**.

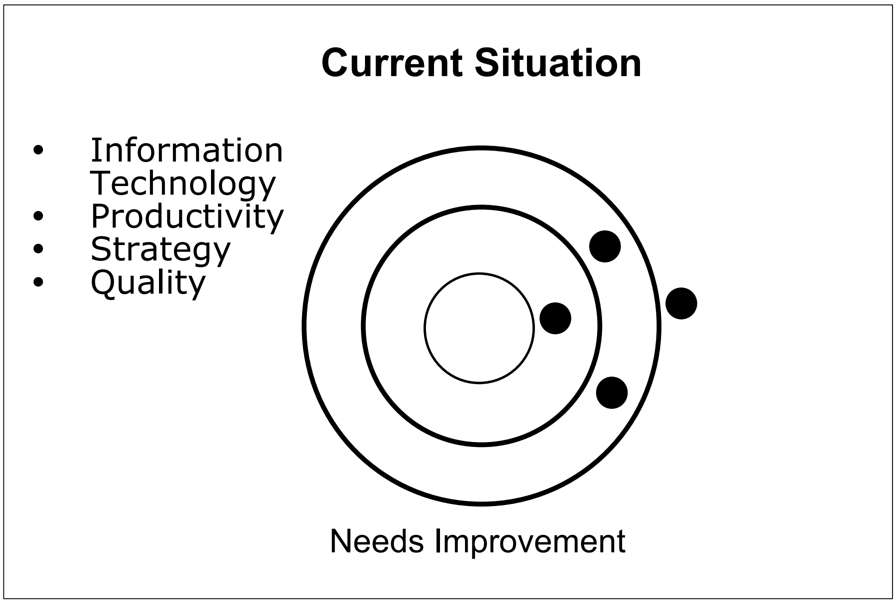


Figure 55. Typical current situation - old focus
(Absolute Information 2001)

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**.

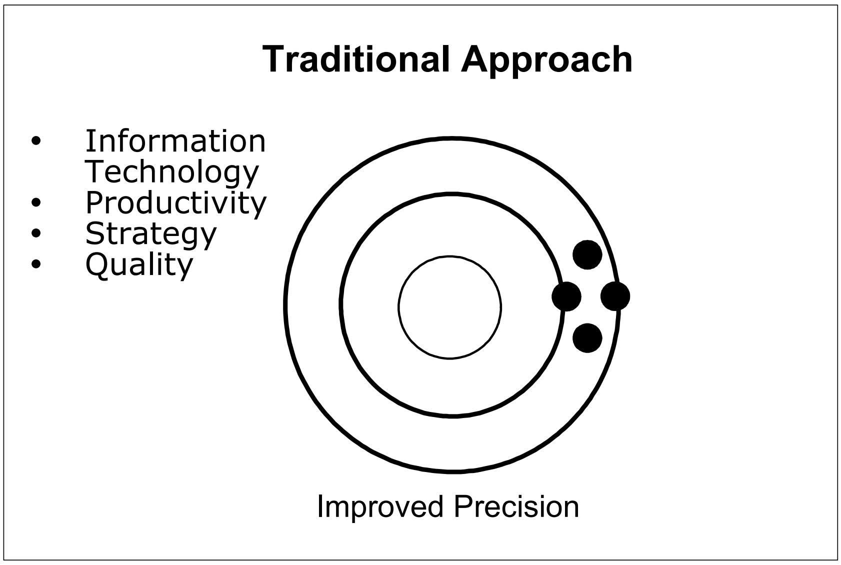


Figure 56. Traditional approach - old focus
(Absolute Information 2001)

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**.

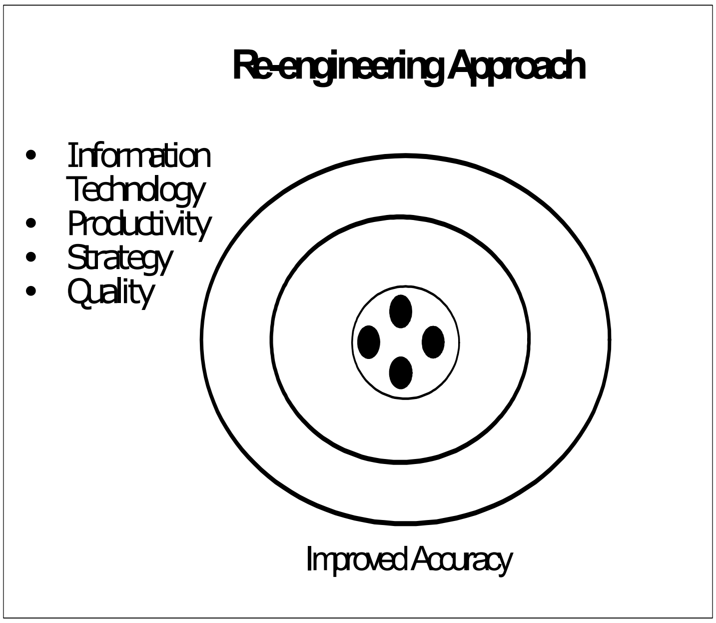


Figure 57. Re-engineering approach - new focus
(Absolute Information 2001)

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.

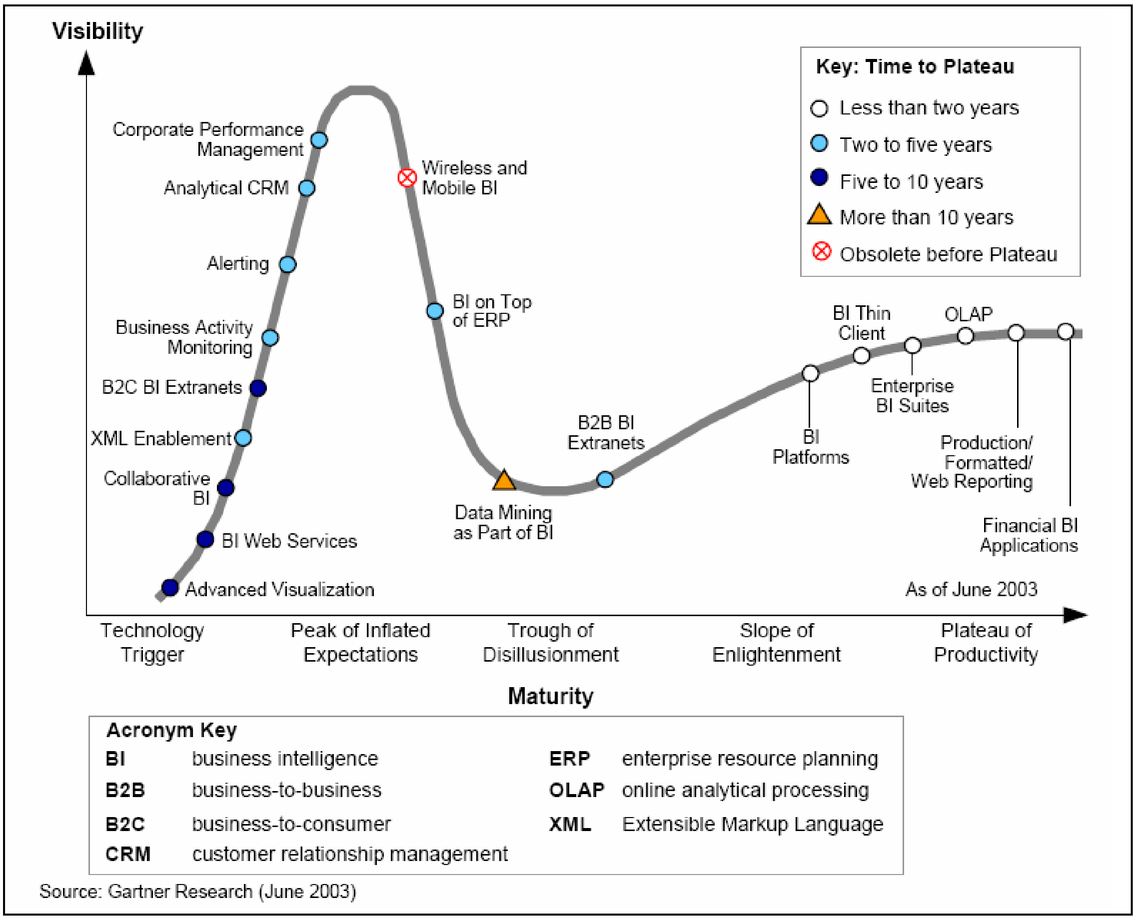


Figure 58. Hype cycle for BI (Buytendijk et al. 2003)

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**.)

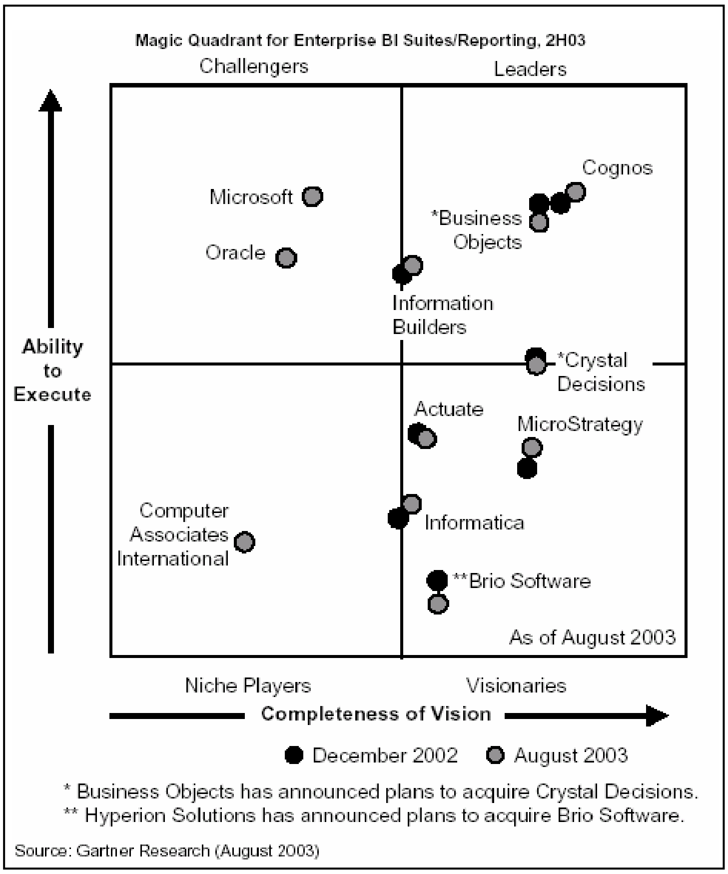


Figure 59. EBIS Magic Quadrant August 2003 (Dresner et al. 2003)

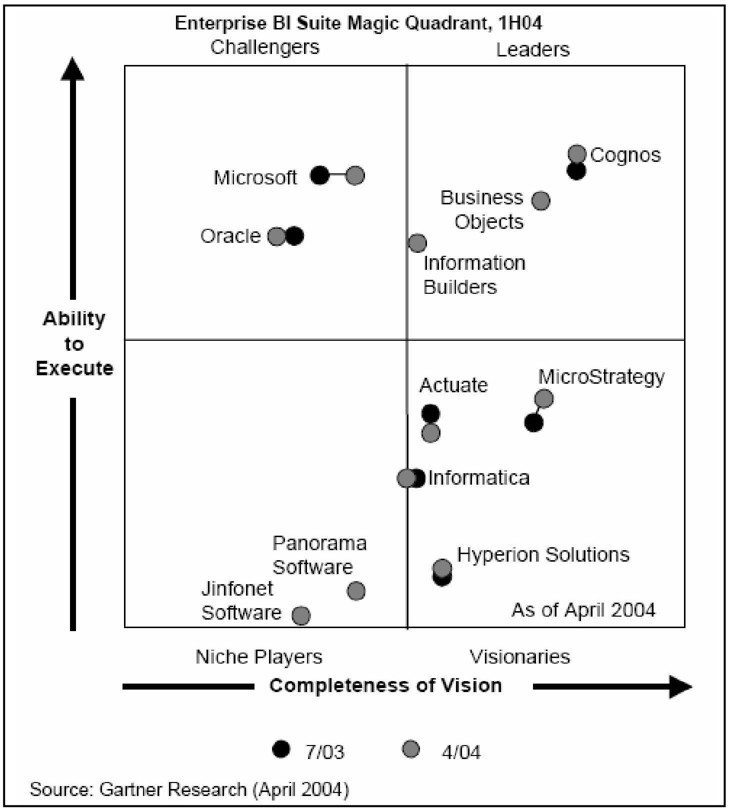


Figure 60. EBIS Magic Quadrant April 2004 (Dresner et al. 2004)

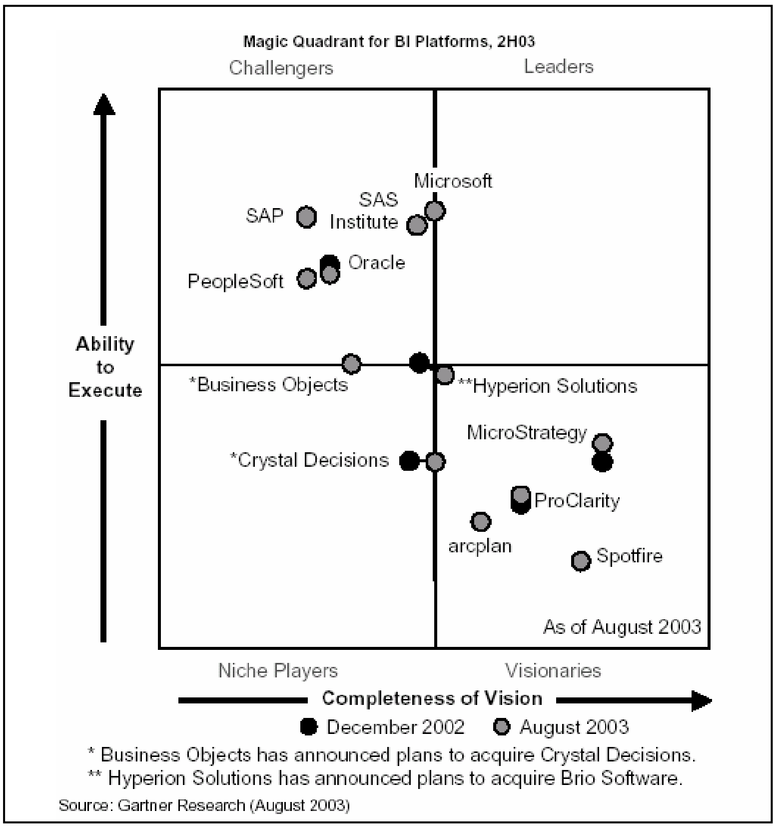


Figure 61. BI Platform Magic Quadrant August 2003 (Dresner et al. 2003)

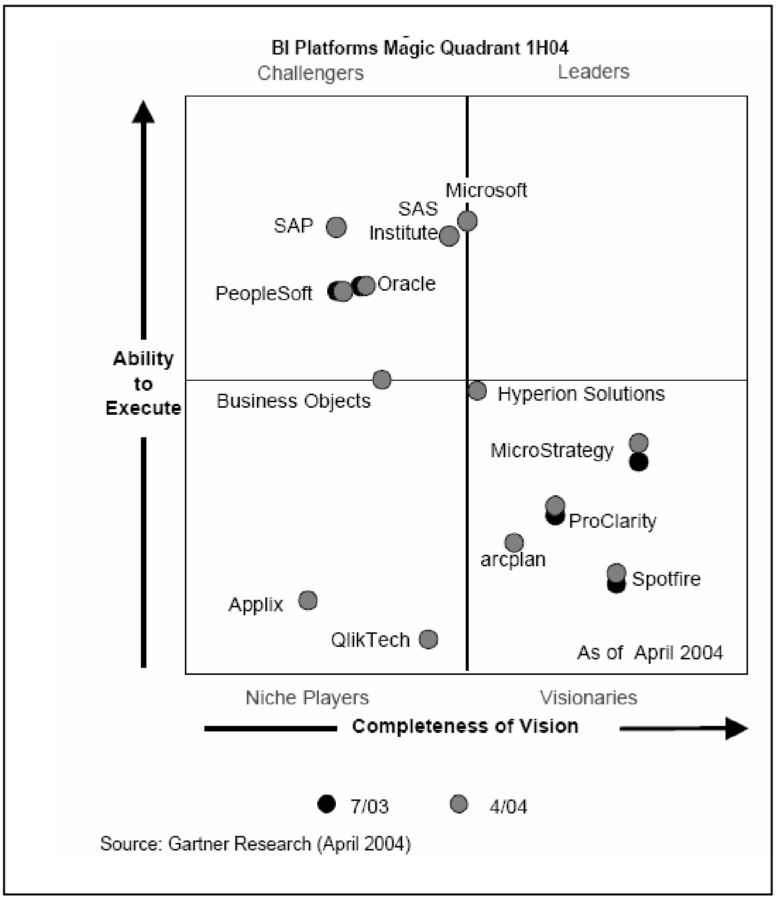


Figure 62. BI Platform Magic Quadrant April 2004 (Dresner et al. 2004)

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.

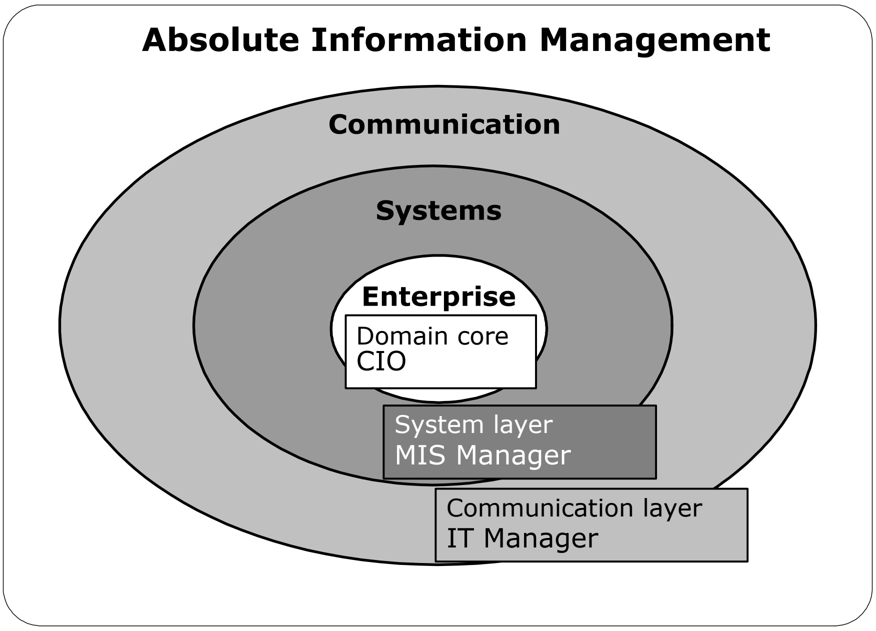


Figure 63. Evolution of information management
(As adapted from Absolute Information 2001)

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**.

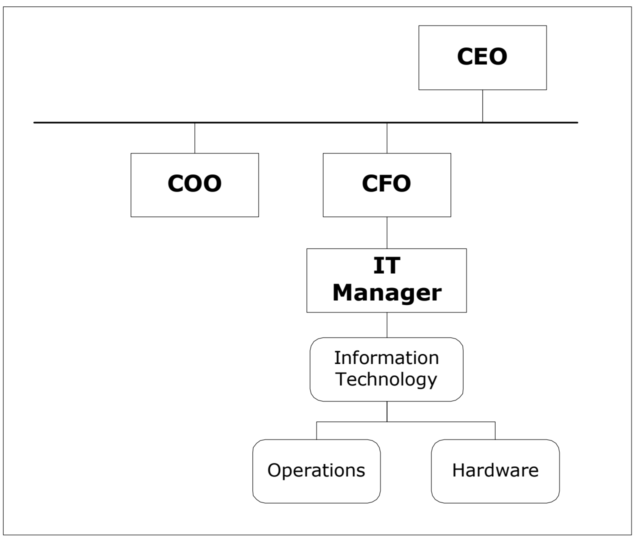


Figure 64. Traditional IT manager roles
(Absolute Information 2001)

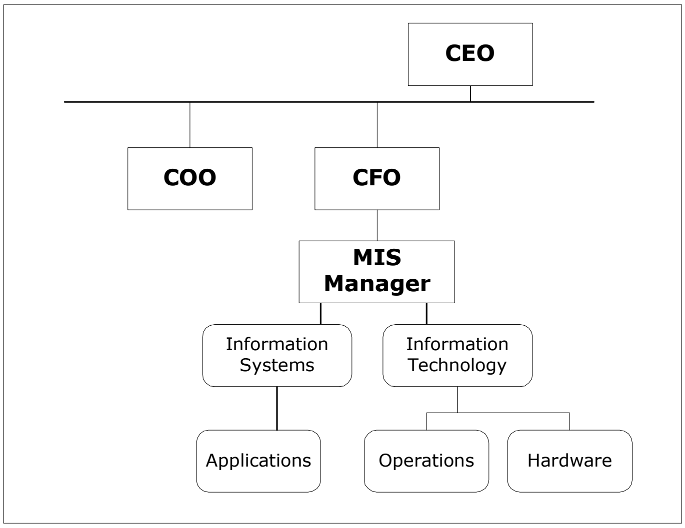


Figure 65. The traditional MIS manager
(Absolute Information 2001)

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.

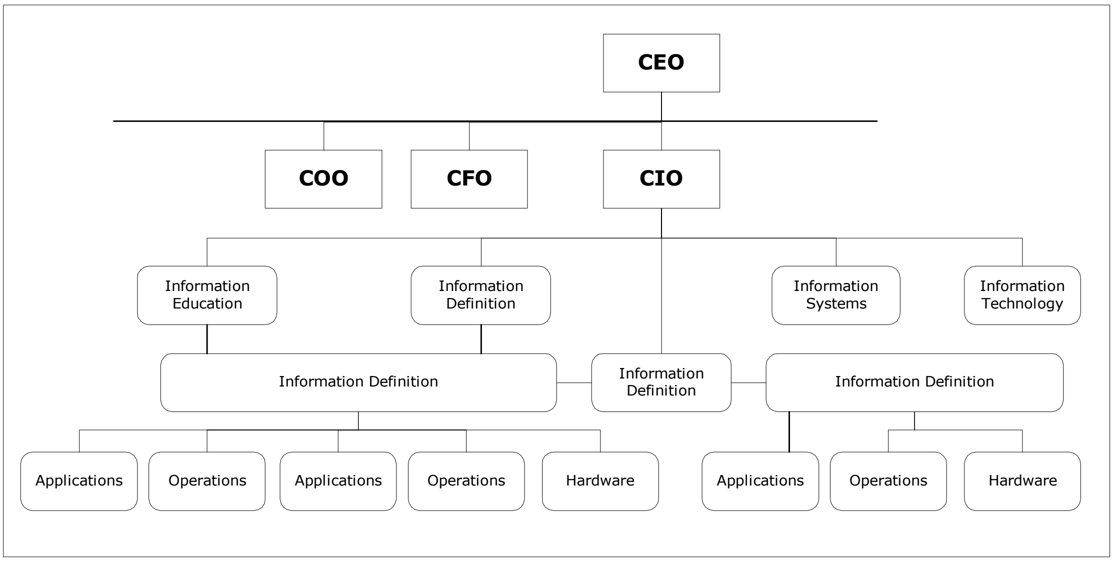


Figure 66. The CIO structure (Absolute Information 2001)

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

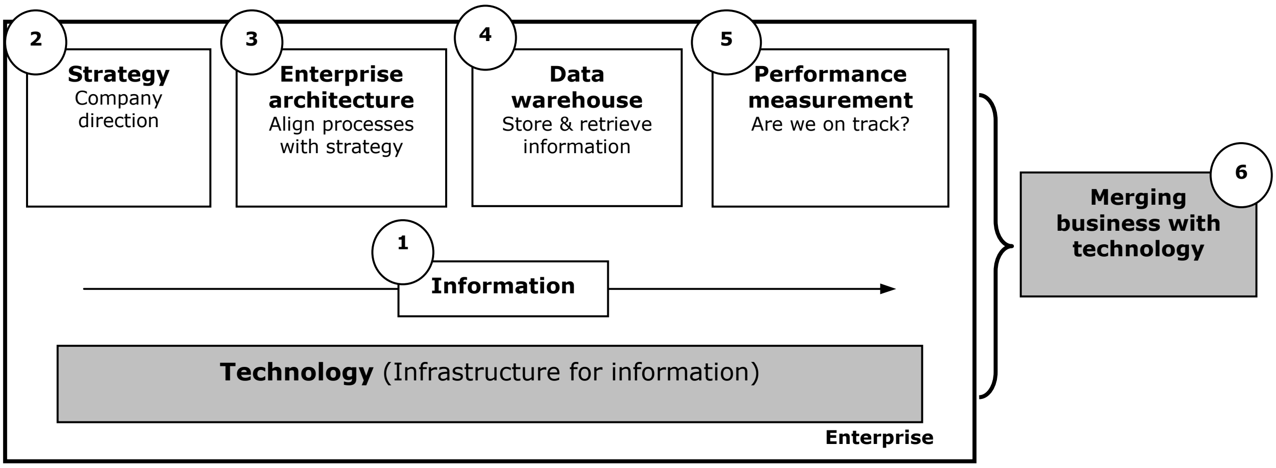
From this section - how to merge BI with technology - it can be concluded that technology and BI play a major facilitating and enabling role, but can never replace the role of human beings in the decision-making process. A human being will always be required to interpret the information that the BI tools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