8 Business Architectures

8.1 Business Architectures Introduction

The use of architectures can be found in most disciplines where it is required to produce quality, timely results, and to manage change in complex products. These 'products' can vary in anything from buildings, aeroplanes, computer and information systems through to businesses. In the creation of these 'products', architectures facilitate two important thoughts:

- All 'products' have a life cycle;
- Depending on who is viewing the 'product', every management level requires a different perspective.

This suggest that the architecture approach have a wider scope than just a step by step recipe or method for producing 'products. For the sake of this study we will focus on the use of architectures in the design and build of businesses or enterprises, thus Business or Enterprise Architectures (BA/EA).

BA/EA has two very distinctive roots in the areas of System Development Life Cycles (SDLC) and Computer Integrated Manufacturing (CIM) systems. Zachman's framework is a classic example of a SDLC architecture that is used in BA/EA. The PERA and Grai-Gim approaches are examples of architectures from the CIM environment.

8.2 Chapter Objective

Various of these architectures, such as 'Zachman', PERA, Grai-GIM and the encompassing GERAM structure will be described in this chapter with referral to the logic and components of each. First though, a motivation for BA/EA will be looked at, in which its history is reviewed. In the conclusion the uses and future of BA/EA are postulated in terms of its role in BPR. The concluding case study chapter will look at an architecture designed and used for a Network Engineering department within Sietel.

8.3 Motivation for Business Architectures

As mentioned, BA/EA evolved from System Development Life Cycles on one root, and the Computer Integrated Manufacturing systems on the other. Zachman himself motivates the use of BA/EA with the following quote:

"I came from the information strategy community in the early days and even by the late 1960's, we were quite competent to do information strategy. Although the strategy tools and the methods have improved substantially, the analytical process was quite well understood decades ago. Our problem was, we were having grave difficulties getting from strategy ... to implementation. We knew that architecture had everything to do with bridging the gap between the strategy (expectations) and the

implementations, and with establishing an Enterprise environment that was conducive to change. The problem was, we didn't know what architecture was".

Thus SDLC required architectures to provide the cornerstone for containing Enterprise frustration and leveraging technology innovations to fulfil the expectations of a viable and dynamic Information Age Enterprise. [37. Zachman]

CIM is based on developing and organising manufacturing processes and systems so that it can be integrated and co-ordinated via computer networks. The problems with CIM systems are its complexity, expensiveness and that these systems are very hard to change. Further more, when automating, human issues are usually a problem. The objectives of CIM systems are also not properly linked to the business objectives of the company. [35. Williams et al]

These problems have resulted in the need for production systems with agility and changeability. Along with such systems, there is also a need for effective exchange of information and co-ordination of activities within companies. As a consequence various techniques and management philosophies emerged to address some of the above problems:

- Total Quality Management (TQM) and Quality Circles, which emphasised the improvement of the production processes leading to better quality products.
- Concurrent Engineering (CE) improves the product's quality and time-to-market by optimising the development process.
- Business Process Re-engineering (BPR) improves customer service and the management of the value chain, but requires drastic changes in the organisation.
- Benchmarking improves the business by comparing it to other businesses.

The concept of the BA/EA approach is a systematic application of these management and engineering methods & tools, and especially the 'way of thinking' behind these techniques, to turn an enterprise into a world class entity and to constantly evolve toward that goal.

The characteristics of a proper engineered, integrated enterprise would be [11. Bernus]:

- Information needed for decision-making, and actions taken is available when and where needed.
- There is an ability to face global competition and flourish.
- The company can shift from 'produce and sell' to 'produce what has already been sold'.
- Production is totally customer focused.
- There is an ability to easily adapt to new technology and to change the business processes.
- The mission, strategy and goals of the company are linked to the mission, strategies and goals of its internal business entities.

8.4 Types of Business Architectures

8.4.1 Zachman's Framework for Enterprise Architecture

In 1987, John Zachman published a different approach to the elements of system development. Instead of representing the process as a series of steps, he organised it around the points of view taken by the various players. These players included (1) the CEO or whoever is setting the agenda and strategy for an organisation, (2) the business people who run the organisation, (3) the systems analyst who wants to represent the business in a disciplined form, (4) the designer, who applies specific technologies to solve the problems of the business, and finally, (5) the system itself. Zachman represents each of these perspectives as a row in his matrix.

He then defined columns in the matrix to represent the kinds of things people should be looking at. These include functions and data, as addressed by most methodologies. In addition, however, Zachman has set up columns to represent locations, or where business is conducted, the people and organisations involved, events that cause things to happen, and the motivations and constraints, which determine how the business behaves. [37. Zachman]

This approach has several immediate effects on our understanding of the SDLC:

- First of all, the analysis phase typically takes on two different perspectives: one is to describe the situation in purely business terms, while the second, without yet addressing technology, describes the situation in information processing terms.
- Second, he addresses more than data and functions. He establishes a matrix that encompasses, for each phase, data, function, location, people, time, and motivation.
- Third, he doesn't call them "phases" or "steps." Each row in his matrix represents the perspective of one of the set of players in the development process. It is more important, he asserts, to recognise that systems are developed by distinct groups with different points of view, than to see the movement of systems from one step to another.
- Finally, he does not address either documentation or transition explicitly. The matrix itself provides an organisation for system documentation. And transition is the process of moving from the "as is" matrix to the "to be" matrix.

John Zachman's "Framework" is diagrammed in Table 8-1. The rows represent the points of view of different players in the systems development process, while columns represent different aspects of the process. [37. Zachman] The players are:

1. ***Outside observer (scope):*** Definition of the enterprise's direction and business purpose. This is necessary to establish the context for any system development effort.
2. ***Owner (Models of the business):*** This defines — in business terms — the nature of the business, including its structure, functions, organisation, and so forth.

3. ***Architect (Models of the business system):*** This defines the business described in step 2, but in more rigorous terms. Where row two described business functions, for example, as perceived by the people performing them, row three might describe them specifically as transformations of data. Where row two described all the things of interest to the enterprise, row three describes those things about which the organisation wishes to collect and maintain information, and begins to describe that information.

4. ***Designer (Technology models):*** These describe how technology might be used to address the needs identified in the previous rows. Here, for example, relational databases might be chosen over network ones (or vice versa), kinds of languages could be selected and program structures defined, user interfaces might be described, and so forth.

5. ***Builder (Detailed representations):*** Here a particular language is chosen, and the program listings, database specifications, networks, and so forth are all produced.

6. ***User (Functioning system):*** Finally, a system is implemented and made part of an organisation.

	Data (What)	Function (How)	Network (Where)	People (Who)	Time (When)	Motivation (Why)
Objectives / Scope	List of things important to the enterprise	List of processes the enterprise performs	List of locations where the enterprise operates	List of organisational units	List of business events / cycles	List of business goals / strategies
Model of the Business	Entity relationship diagram (including m:m, n-ary, attributed relationships)	Business process model (physical data flow diagram)	Logistics network (nodes and links)	Organisation chart, with roles; skill sets; security issues.	Business master schedule	Business plan
Model of the Information System	Data model (converged entities, fully normalised)	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
Technology Model	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
Detailed Represen-tation	Data design (denormalize d), 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

Table 8-1: The Zachman Framework [37. Zachman]

The columns in the Zachman framework represent different areas of interest for each perspective. The columns describe the dimensions of the systems development effort. These are:

8.4.1.1 The Data (What) Column:

Each of the rows in this column address understanding of and dealing with an enterprise's data.

1. ***Row One*** - A list of the things that concern the company and affect its direction and purpose.
2. ***Row Two*** - A contiguous model of the things seen by the participants in the business. Many-to-many and n-ary relationships may be present, reflecting the way the business views them. Also, relationships may be shown which themselves have attributes.
3. ***Row Three*** - An information-based perspective, resolving many-to-many and n-ary relationships, along with relationships containing their own attributes. Indeed, attributes are more exhaustively defined, and unique identifiers are specified. Entities are generalised to more closely reflect the underlying structure of the business and its relationships.
4. ***Row Four*** - Entities are converted to table definitions, object classes, hierarchy segments, or whatever is appropriate for the kind of data base management system to be used. This is tantamount to creating the data definition language statements.
5. ***Row Five*** - Tables are actually implemented on physical disk drives, using the underlying organisation of the database management system. This is where table spaces are defined, disk packs are allocated, and so forth.
6. ***Row Six*** - The actual database itself is created and initial data are converted and loaded

8.4.1.2 The Function (How) Column:

The rows in the function column describe the process of translating the mission of the enterprise into successively more detailed definitions of its operations.

1. ***Row One*** - A list of the kinds of activities the enterprise conducts.
2. ***Row Two*** - These activities, described in a contiguous model.
3. ***Row Three*** - Activities portrayed in terms of data transforming processes, described exclusively in terms of the conversion of input data into output data.
4. ***Row Four*** - The technology model converts these data conversion processes into the definition of program modules and how they interact with each other. Pseudo-code is produced here.
5. ***Row five*** - The program modules are converted into source and object code.
6. ***Row six*** - Code is linked and converted to executable programs.

8.4.1.3 The Network (Where) Column:

This column is concerned with the geographical distribution of the enterprise's activities.

1. ***Row One*** - A listing of the places where the enterprise does business.
2. ***Row Two*** - Here we have a more detailed communications chart, describing how the various locations interact with each other.
3. ***Row Three*** - The architecture for data distribution, itemising what information is created where and where it is to be used.
4. ***Row Four*** - This distribution is translated into the kinds of computer facilities that are required in each location.
5. ***Row Five*** -The facilities requirements are translated into specification of particular computers, protocols, communications facilities, and the like.
6. ***Row six*** - Describes the implemented communications facilities.

8.4.1.4 The People (Who) Column:

The fourth column describes who is involved in the business and in the introduction of new technology.

1. ***Row One*** - A simple list of the organisational units and each unit's mission.
2. ***Row Two*** - This list is fleshed out into a full organisation chart, linked to the function column. Here also, requirements for security are described in general terms.
3. ***Row Three*** - The potential interaction between people and technology begins to be specified here, specifically in terms of whom needs what information to do his job. What roles do each play and what data are necessary for those roles? Along with this are specific definitions of security requirements, in terms of who (which role) is *permitted* access to what.
4. ***Row Four*** - The actual interface between each person and the technology is designed here. In this row, issues of interface graphics, navigation paths, security rules and presentation style are addressed.
5. ***Row Five*** - The design is converted into the outward appearance of each program, as well as the definitions of access permissions in terms of specific tables and/or columns each user can have access to.
6. ***Row Six*** - Trained people use the new system.

8.4.1.5 The Time (When) Column:

The fifth column describes the effects of time on the enterprise. It is difficult to describe or address this column in isolation from the others, especially column two.

1. ***Row One*** - A description of the business cycle and overall business events.
2. ***Row Two*** - This row of the time column defines when functions are to happen and under what circumstances.
3. ***Row three*** - The business events that cause specific data transformations and entity state changes to take place.
4. ***Row Four*** - Events become program triggers and messages, and the information processing responses are designed in detail.
5. ***Row Five*** - Designs become part of specific programs.
6. ***Row Six*** - Business events are correctly responded to by the system.

8.4.1.6 The Motivation (Why) Column:

As Zachman originally described this column, it concerned the translation of business goals and strategies into specific ends and means. This can be expanded to include the entire set of constraints that apply to an enterprise's efforts.

1. ***Row One*** - The enterprise identifies its goals and strategies in general, common language terms.
2. ***Row Two*** - The goals and strategies are translated into the specific rules and constraints that apply to an enterprise's operation.
3. ***Row Three*** - Business rules are expressed in terms of information that is and is not permitted to exist. This includes constraints on the creation of rows in a database as well as on the updating of specific values.
4. ***Row four*** - The business rules are converted to program design elements.
5. ***Row five*** - The business rules become specific programs.
6. ***Row Six*** - Business rules are enforced.

8.4.1.7 Application of Zachman's Framework.

What does it mean to view the development process in these terms? In some cases the Zachman framework provides more insight and greater detail than other methods, although in other cases, some important information is lost. Overall this framework acts as a comprehensive checklist to follow during BA/EA design and implementation. The most critical issue is the amount of detail, or depth into which this framework must be taken.

In his book: 'Enterprise Architecture Planning', Spewak restricts the scope of planning BA/EA only two the first 2 rows of the Zachman framework, namely the Outside observer's view and the Owner's view. [9. Spewak] His opinion is that from the third layer onwards the Zachman framework starts with the designing of systems specifications for enterprises, which starts to become too much detail for normal BA/EA understanding. The case study in the final chapter do go beyond the planning layer of the Network Engineering department as an enterprise, but only in some areas, such as Data, Functions and People, and only to support operational understanding of the enterprise.

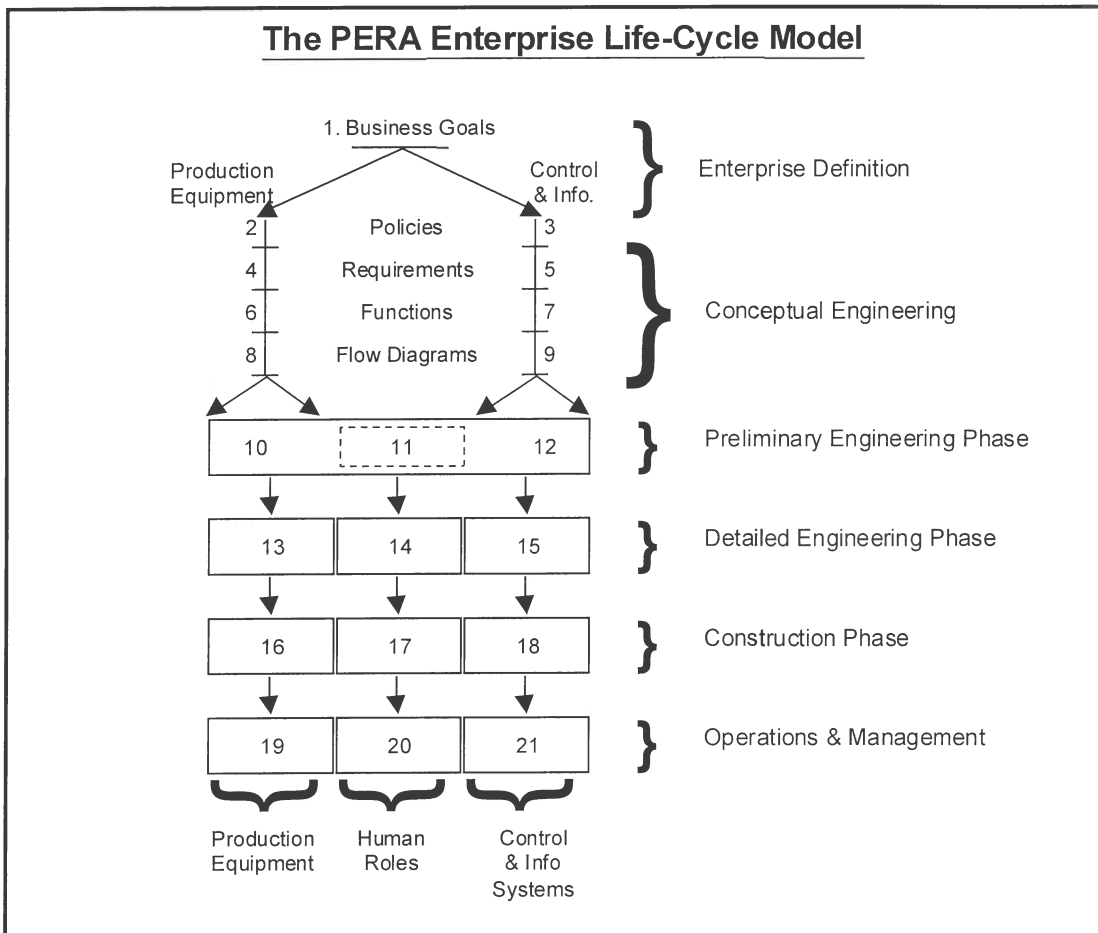
8.4.2 The PERA model for Enterprise Architectures

The Purdue Enterprise Reference Architecture (PERA) was developed by the Purdue University. The Purdue Reference Architecture's development started in 1986 and evolved from Applied Industrial Control studies done by the Purdue Laboratories before this time. This Reference Architecture demonstrates in great detail the life-cycle diagram of an enterprise, and explains the phases and layers of a BA/EA project or exercise. [36. Williams]

In the Purdue Enterprise Reference Architecture (PERA), the basic building blocks are synthesised into the main functions of Production, and Control & Information. Human roles are then integrated in between these two main functions. Thus this BA/EA not only depicts perspectives on the three elements of production, human roles and Control & Information, but also demonstrates how these elements integrate on the various levels / life cycle phases. PERA describes the whole life cycle of how an organisation would be designed, build and integrated. See figure 8-1 for an illustration of this life cycle with descriptions of each block making up the life-cycle model. This life cycle mainly consists of the following steps:

- Enterprise definition;
- Enterprise concept identification;
- Specification and design of the organisation (this is done in a preliminary and detail engineering phases);
- Construction phase;
- and finally organisation operation.

From these steps, it can be seen that there is a correlation between the design and build life cycle of an organisation, and the development and production of a new product. Organisationally seen it follows a top-down approach in identifying its elements.



1. Definition of Business Entities, Mission, Goals, ect	
2. Production Policies - e.g. Distributed Manufacturing	3. Info Policies - e.g. Corp. Network Standard
4. Production Requirements - e.g. OSHA, Underwriters	5. Info Requirements - e.g. Maintenance Mgt System
6. Production Functions - e.g. Generic Unit Operations	7. Info Functions - e.g. Work Order Tracing
8. Process Diagrams - e.g. PFD, Mat. Flow Balance	9. Info Diagrams - e.g. Dataflow, Systems Arch

10. Functional Design of Production Equipment - e.g. P&IDs Plant Layouts	11. Functional Design of Human Roles & Organisation - e.g. Org chart, Staff levels	12. Functional Design of Control & Info Systems - e.g. Entity Rel. Dgms, ISA Logic
13. Detail Design of Production Equipment - e.g. Piping & Conduit Drawings	14. Detail Design of Tasks, Training Plan - e.g. Operation & Maint Manuals	15. Detail Design of Hardware & Software - e.g. Configuration, Programming
16. Construct, Checkout & Commission Production Equip. e.g. Machinery Install & Test	17. Staffing, Training, Checkout Plant procedures e.g. Simulator Training	18. Assembly, Test & Commiss. Control & Info Systems -e.g. DCS Checkout, Program Test
19. Production e.g. Debottlenecking, Cost & Quality Improvement	20. Operate & Maintain - e.g. Ongoing Training, Performance Improvement	21. Operation of Info & Control Systems - e.g. Maintenance Debug & Upgrade

Figure 8-1 The PERA life-cycle model [36. Willimas]

8.4.2.1 Descriptions of each block making up the PERA model.

1. The **Business Goals** describe the vision, mission and values of the company as expressed from company annual reports.
2. Operational strategies relate into **Production Policies**, examples being scope of activities for development and operation of specific processes and plants.
3. **Information & Control Policies** relate to topics such as: control capabilities, performance of processes, adherence to classes of regulations and laws, quality, productivity and economic return.
4. **Requirements for production of products or services** to be generated by the company for specific processes and process plants – general safety requirements, fire rules, ect.
5. **Requirements for the implementation of Information Architectures** to carry out operational policies of the company.
6. Sets of **production tasks and function modules** required to carry out the production or service processes.
7. Sets of **control tasks and function modules** required to carry out the Information Architecture activities.
8. **Process Flow diagrams** showing the connectivity of tasks and function modules of the production processes involved.
9. **Connectivity / E-R diagrams** of tasks and function modules of the Information Architecture.
10. Functional design of **production equipment** – these would include plant layouts, production planning, and CIM systems.
11. Functional design of the **Human and Organisational** Architecture containing information such as required personnel tasks and skill levels.
12. Functional design of **Information Systems** Architecture – Detail E-R diagrams.
13. **Detail design** of components, processes, and equipment of the **Production Processes and Equipment.**
14. **Detail design** of task assignments, skills development training and organisation of the **Human Organisational Architecture.**
15. **Detail design** of the equipment and software of the **Information Systems Architecture.**

16. **Construction**, project management and commissioning of the equipment and processes in the **Production Architecture**.

17. **Implementation** of task assignments, skills development training and organisation of the **Human Organisational Architecture.**

18. **Construction**, project management and commissioning of the equipment and processes in the **Information Systems Architecture**.

19. **Production Operation** – Continued improvement of process and equipment operating conditions to increase quality and productivity.

20. Continued **organisational development**, skill and human relations development training.

21. **Operation of the Information and Control System**, including its continued improvement.

8.4.2.2 Application of PERA

The beauty of PERA is that in itself it is an architecture as well as working methodology for an organisation to follow in the creation/implementation of itself. It allows a phased approach for the implementation of its elements, while still facilitating the overall integration during the life cycle.

In the Network Engineering case study, later in this dissertation, this methodology is used for the creation of the department. During the Definition and Conceptual phases it would be required though, to thoroughly define Network Engineering's interaction with the rest of the organisation. For the sake of this case study the PERA approach will only be applied until the Detail Engineering phase for the design of the Network Engineering department.

8.4.3 The Grai-Gim model for Enterprise Architectures

The GRAI Integrated Methodology was developed by the Grai laboratory of the University of Bordeaux. This GRAI-GIM Architecture represent four co-operating systems, according to which an organisation is modelled:

- Decision system,
- Information system,
- Operating system,
- Physical system.

The integration and working of this architecture is shown in Figure 8-2. 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 organisation is to make decisions. The decision system is the company's brain, and to achieve an 'aware enterprise' a good decision system is needed. [11. Bernus]

The decision system congregates from decision centres. Decision centres originate in the top management structure, where strategic decision making takes place, and decompose down to operation decisions. The operational- and physical systems are utilised 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.

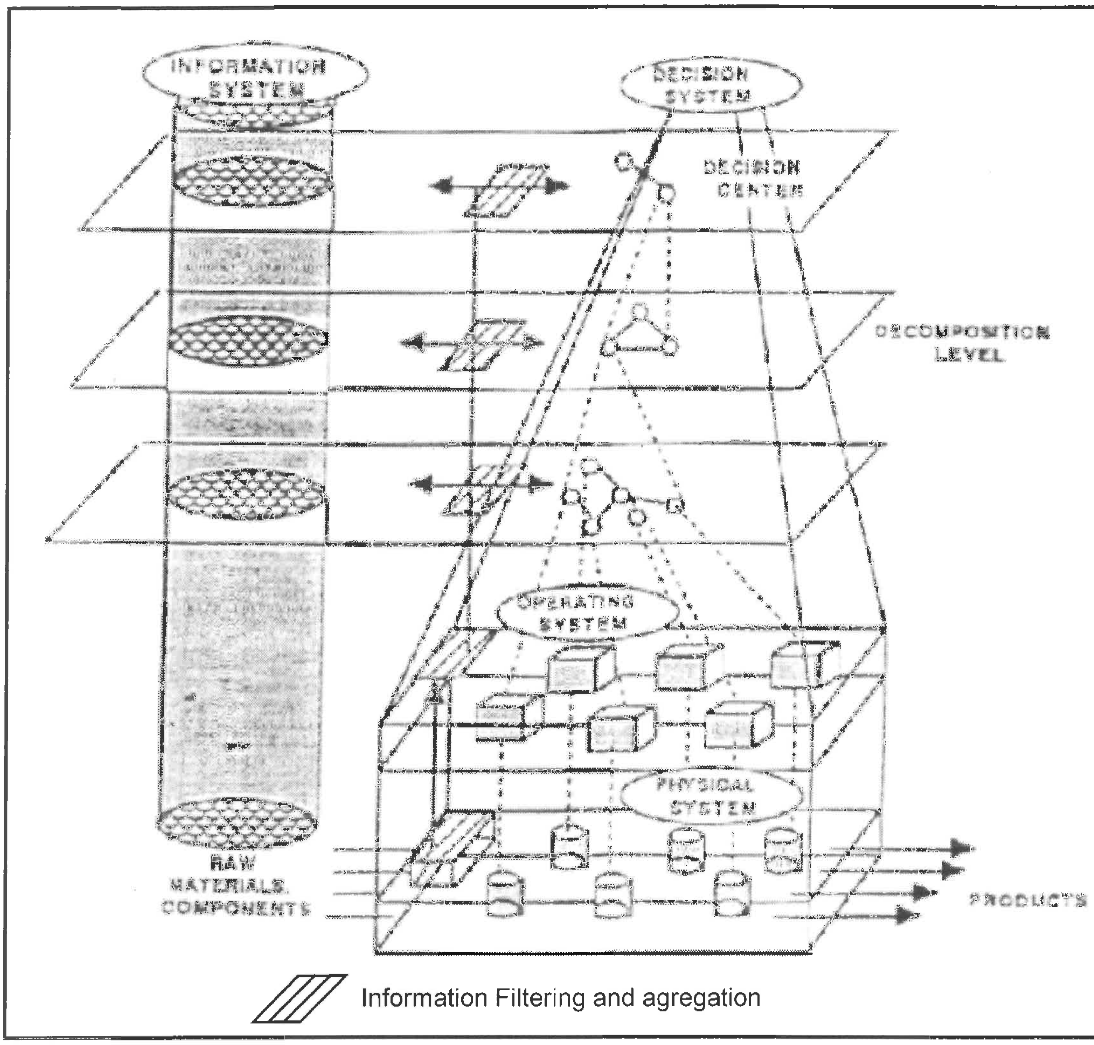


Figure 8-2 Grai Gim decision making model [11. Bernus]

Figure 8-3 shows the structured procedure of Enterprise Design according to GRAI-GIM. As can be seen the analysis and design is being done in terms of the four co-operating systems.

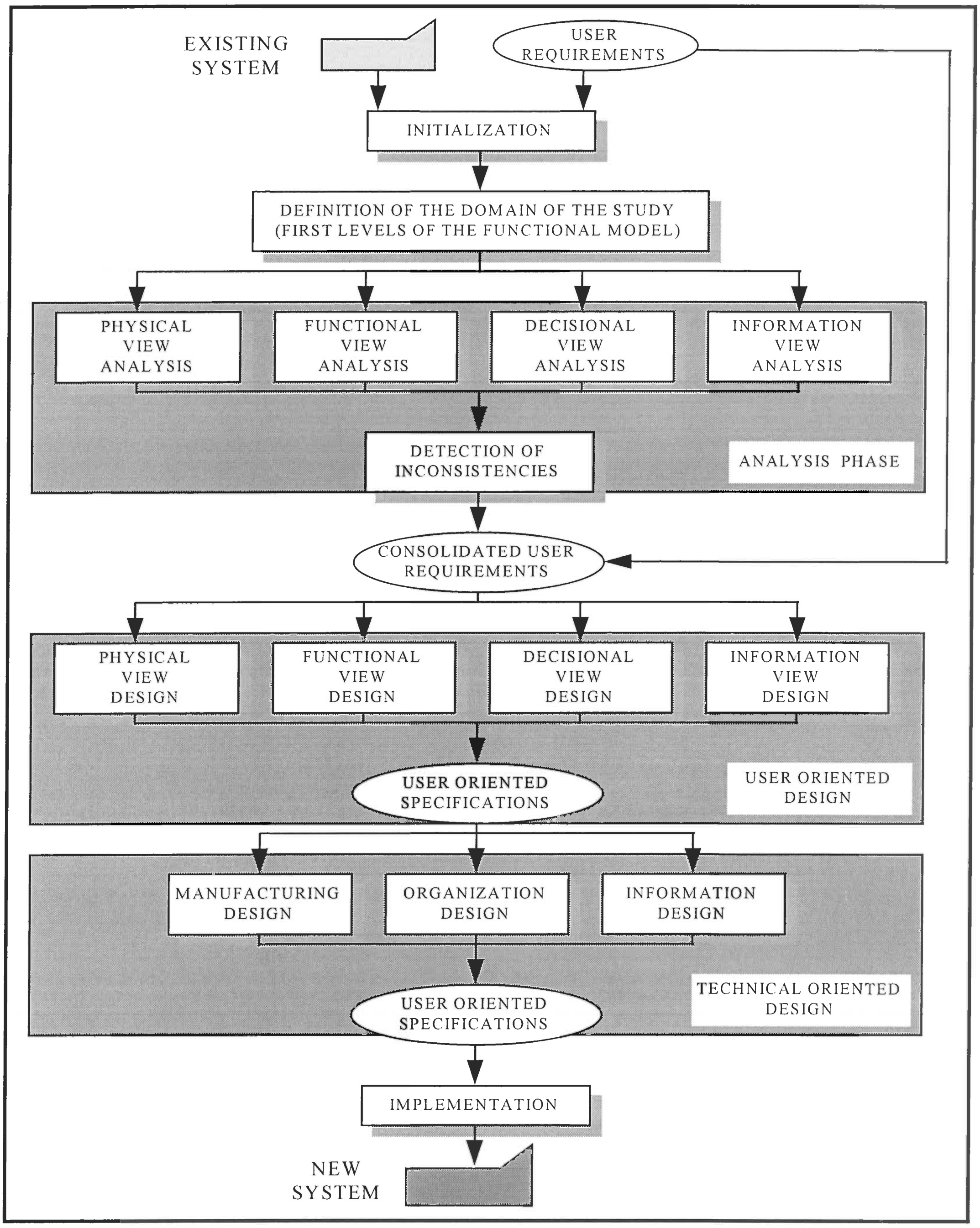


Figure 8-3 Grai-GIM Enterprise life cycle [11. Bernus]

8.4.3.1 3.3.2. GRAI-GIM Enterprise Functioning

To help identify the decision centres needed for the functioning of a production enterprise, a Grai-Grid can be used to classify the areas of management activity. Both the management and production activities can be then modelled to an IDEF0 rough diagram. An example is shown in Figure 8-4 and Figure 8-5.

Generic Grai-Gim grid

	External Information	Management of products (input)	Management of products (output)	Planning	Management of Resources	Internal Information
Period / Horizon driven activities	9. Receive and gather information from the outside world to support management activities, for ex. Data for market forecasting.	4.1.The assurance of incoming material and services when needed. Activities include: - Purchasing plans - Supplier contracting - MRP planning - (R&D ?)	4.2. The assurance that the product reaches the client, activities include: - Production planning - Forecasting - Marketing	7. Co-ordinate the products inputs and outputs with resource management: -High lvl: Achieving company goals -Mid lvl: Achieving sales goals - Low lvl: Customer satisfaction via scheduling.	6. Assure that there will be resources (people, capital, machines) available for production / providing services.	8. Store and supply information to any area of activity in the company. -This is usually in the form of a databases which provide management information. - (This is not application programs)
Real time activities	1. Recording of any input information: - Client orders - Supplier information	2. Purchasing operations.	3. Incoming material/services- and outgoing products control.		5. The co-ordination and control of people, capital and machines to assure production and services.	

Figure 8-4 Grai-Grid defining management functions [11. Bernus]

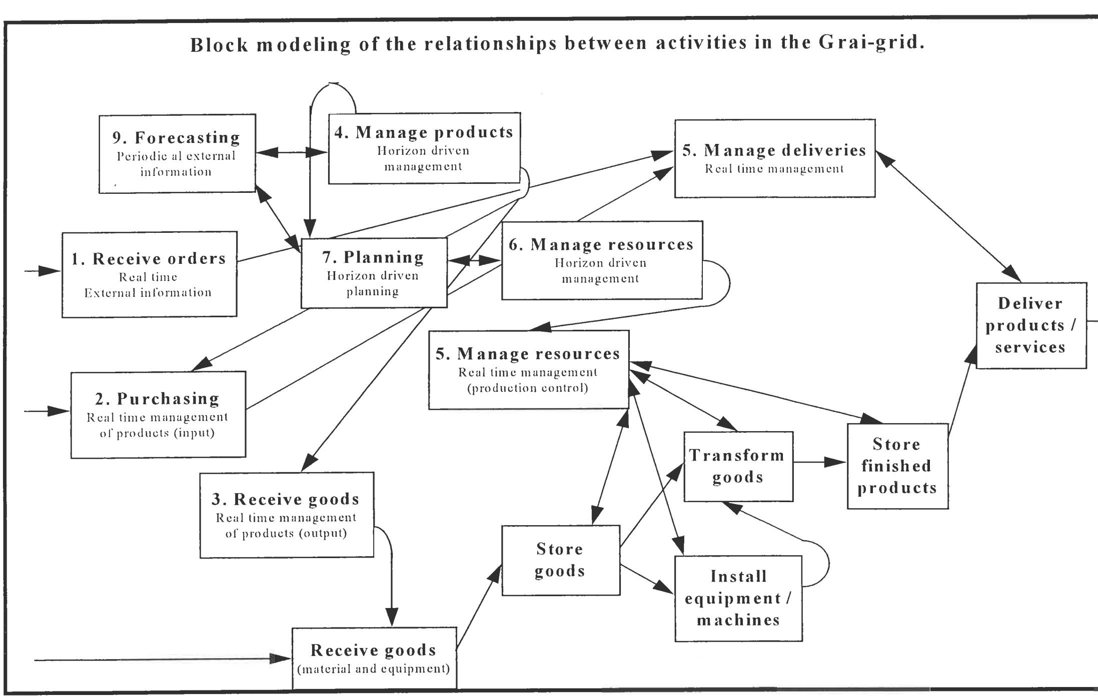


Figure 8-5 Relationships between activities in the Grai-Grid [11. Bernus,96]

8.4.3.2 Application of Grai-Gim

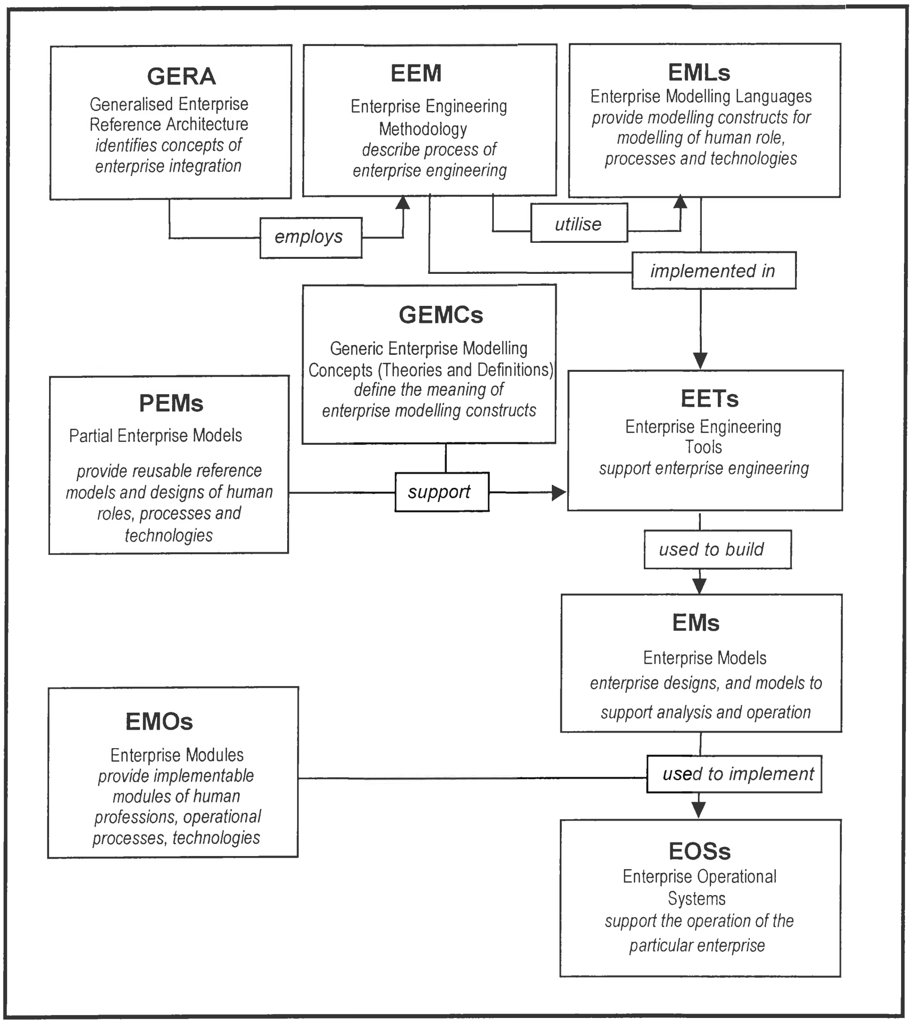
The Grai-Gim methodology is useful in defining a hierargy for decision making and control within an enterprise, especially in already existing organisations. Using the Grai-grid with its corresponding decision centres, would describe all the relevant decision roles in an enterprise. When a proper model of the necessary systems is build, it is easy to define the communication links between the components. This BA/EA can also be used in conjunction with the Balance Scorecard, in which a set of measurements are defined for the Balance Scorecard and the GRAI-GIM architecture is used to define the measurement and control tree down into the enterprise.

8.4.4 The GERAM envelope for Business Architectures

Due to the existence of various BA/EA's there was a need to compare and evaluate these and to combine the various methodologies and modelling techniques and to identify the missing tools. Based on the investigation of an international task force in 1995, a new Generic Enterprise Reference Architecture and Methodology (GERAM) was defined. This architecture defined a toolbox of concepts for designing and maintaining enterprises during their life cycle. The significance of GERAM is that it combines individual reference architectures and thus acts as a mediator, or common framework. [22. IFIP-IFAC]

8.4.4.1 The structure of GERAM

The GERAM framework can be described as an Entity-Relationship diagram shown in the following figure.



`Figure 8-6 GERAM framework components [22. IFIP-IFAC]`

Some of the basic components which GERAM consists of are the following [22. IFIP-IFAC]:

- **EEMs - Enterprise Engineering Methodology** - describe the processes of enterprise engineering and integration. An enterprise engineering methodology may be expressed in the form of a process model or structured procedure with detailed instructions for each enterprise engineering and integration activity.

- **EMLs - Enterprise Modelling Languages** - define the generic modelling constructs for enterprise modelling adapted to the needs of people creating and using enterprise models. In particular enterprise modelling languages will provide construct to describe and model human roles, operational processes and their functional contents as well as the supporting information, office and production technologies.

- **GEMCs - Generic Enterprise Modelling Concepts -** define and formalise the most generic concepts of enterprise modelling. Generic Enterprise modelling concepts may be defined in various ways. In increasing order of formality generic enterprise modelling concepts may be defined as:
  - Natural language explanation of the meaning of modelling concepts (glossaries);
  - Some form of meta model (e.g. entity relationship meta schema) describing the relationship among modelling concepts available in enterprise modelling languages;
  - Ontological Theories defining the meaning (semantics) of enterprise modelling languages, to improve the analytic capability of engineering tools, and through them the usefulness of enterprise models. Typically, these theories would be built inside the engineering tools.
- **PEMs - Partial Enterprise Models** (reusable-, paradigmatic-, typical models) - capture characteristics common to many enterprises within or across one or more industrial sectors. Thereby these models capitalise on previous knowledge by allowing model libraries to be developed and reused in a 'plug-and-play' manner rather than developing the models from scratch. Partial models make the modelling process more efficient. The scope of these models extends to all possible components of the enterprise, such as models of humans roles (skills and competencies of humans in enterprise operation and management), operational processes (functionality and behaviour) and technology components (service or manufacturing oriented), and infrastructure components (information technology, energy, services, etc.). Partial models may cover the whole or a part of a typical enterprise. They may concern various enterprise entities such as products, projects, or companies, and may represent these from various points of view such as data models, process models, or organisation models, to name a few. Partial enterprise models are also referred to in the literature as 'Reference Models'.
- **EETs - Enterprise Engineering Tools -** support the processes of enterprise engineering and integration by implementing an enterprise engineering methodology and supporting modelling languages. Engineering tools should provide for analysis, design and use of enterprise models.
- **EMs - (Particular) Enterprise Models** - represent the particular enterprise. Enterprise models can be expressed using enterprise-modelling languages. EMs include various designs, models prepared for analysis, executable models to support the operation of the enterprise, etc. They may consist of several models describing various aspects (or views) of the enterprise.
- **EMOs - Enterprise Modules -** are products that can be utilised in the implementation of the enterprise. Examples of enterprise modules are human resources with given skill profiles (specific professions), types of manufacturing resources, common business equipment or IT infrastructure (software and hardware) intended to support the operational use of enterprise models. Special

emphasis is placed on the IT infrastructure which will support enterprise operations as well as enterprise engineering. The services of the IT infrastructure will provide two main functions:

1. Model portability and interoperability by providing an integrating infrastructure across heterogeneous enterprise environments;
2. Model driven operational support (decision support, operation monitoring and control) by providing real-time access to the enterprise environment.

The latter functionality will be especially helpful in the engineering tasks of model update and modification. Access to real world data provides much more realistic scenarios for model validation and verification than simulation based on 'artificial' data.

- **EOSs** - (Particular) Enterprise Operational Systems - support the operation of a particular enterprise. Their implementation is guided by the particular enterprise model that provides the system specifications and identifies the enterprise modules used in the implementation of the particular enterprise system.

8.4.4.2 The life cycle approach for BA/EA.

The enterprise life cycle are all the management, engineering, construction and operation processes which are involved in the creation, use and possible decommissioning of an enterprise. In the Generic Enterprise Reference Architecture the following four life cycles are taken into consideration and each form apart of one another:

1. Strategic enterprise management, that gives the go-ahead for the enterprise.
2. The enterprise engineering project, whom is responsible for the building of the enterprise.
3. The enterprise itself.
4. The product that is produced by the enterprise.

These four life cycles fit into one another as illustrated in the figure 8-7.

The integration of the four life-cycles of an Enterprise.

Strategic Enterprise Management	Enterprise Concept	Enterprise Definition	Enterprise Design	Enterprise Building	Enterprise Use	Decommissioning
Enterprise Engineering Project	Project Concept	Enterprise Project Specification	Enterprise Project Design	Enterprise Project compilation	Project Operation	Decommissioning
Enterprise	Enterprise Concept	Enterprise Definition	Enterprise Design	Enterprise Building	Enterprise Operation	Decommissioning
Product	Product Idea	Product Specification	Product Design	Production	Product Use	Decommissioning

Figure 8-7 Integration of four life cycles

8.5 Business Architectures Conclusion

In the BA/EA's industry opinions are that Architectures will only come to their full right at the beginning of the new millennium. Those individuals that understand BA/EA and know how to use it, find it to be a huge advantage in the design and engineering of systems, enterprises and even businesses.

It is well accepted that the most important phase in a product's life cycle is the design phase. The more time and planning spent in this phase, the more time and cost is saved in later stages of the product life. Business life cycles work the same way. Planning and developing the business thoroughly at the start will save effort and energy in the implementation phases. BA/EA is the ideal tool for such planning and can do for organisational structuring what CAD/CAM did for product design. However, before the concept of BA/EA planning using meta-models understood and accepted, architectures will not be used to their full potential.

Another problem BA/EA encounters is that it provides more of a long-term impact than a short-term impact. The immediate fruits are not directly apparent and in the culture of quick fix methods and bottom line impacts, the value of BA/EA is still to be realised, especially as life cycles of enterprises reduce and the need for flexibility increases.

From all the examples mentioned, it can be seen that there are a couple of BA/EA meta-models already existing, and depending on the type of business to be engineered, an applicable model needs to be selected. These models are like flow diagrams with all the steps included, but some might not be necessary and can be skipped. This is helpful to ensure that all relevant aspects are considered and the business design is as complete as possible. In a way already existing meta-models can thus be seen as a form of best practices that ensures thoroughness during BPR design phases.

As mentioned earlier, the Grai-Gim architecture is good for already existing organisations where decision centres need to be defined, or control paths for Balanced Scorecard KPI's established. But it does not provide comprehensive guidance for building new enterprises. In contrast Zachman's BA/EA is very complete regarding all aspects that need to be considered for enterprise structuring. Because it is based on a SDLC approach, it is very technical and very seldom would it be possible, or useful to define the total architecture for an enterprise. The author gives preference to PERA because of its simple life cycle approach to enterprise structuring, while providing a complete checklist of functions to be considered. In the last chapter's case study the PERA life cycle is used and combined with components from Zachman's BA/EA.

In conclusion, the biggest benefit BA/EA provides for BPR exercises are ready-made structures for capturing blue prints of re-engineered processes. The meta-models are also used as examples to give a BPR team guidance in how the processes should look in order to produce BA/EA blue prints. At later stages, after the completion of the BPR exercise, these blue prints can be used for similar exercises in other business units as meta-models, or to facilitate understanding in ISO procedures.

9 Concluding Case Study Chapter

9.1 Concluding Chapter Introduction

This dissertation systematically examined seven critical elements of Business Process Re-engineering, each time from a different perspective. It started with financial and executive management's perspectives on the need for BPR and how to align its objectives with the strategy of the organisation. The core chapters examined re-engineering methods, tools, best practices and project management techniques for BPR projects, as utilised by BPR practitioners and teams. The implementation chapter provided insights in critical success factors for BPR. These implementation drivers are of importance to process owners who have to ensure the sustainability of re-engineered processes. The final chapter returned to an Industrial Engineering academic orientated focus, proposing generic meta-models to capture knowledge from these elements into reusable structures.

Because the approach was a broad scope analysis of involvement required for BPR, instead of detail, narrow focussed studies, this dissertation also facilitates practical examples. The case study in this chapter is such an example that will illustrate most of the elements discussed.

9.2 Chapter Objective

As stated in the introduction, although all elements are interlinked, each can also be utilised separately, or 'plug-and-played' into a workable solution for any type of BPR project. The objective of this concluding case study chapter is to demonstrate how various BPR elements were incorporated into a Business / Enterprise Architecture (BA/EA) for designing and implementing a Network Engineering (NE) department in Sietel.

9.3 Business Architecture case study of Network Engineering

9.3.1 Background

The South African telecommunication market undergone some major changes due to the deregulation of communication services. This had a huge impact on Sietel, which was one of the big suppliers for telecommunication equipment. Except for the need to re-engineer its organisation, Sietel also had to re-align its strategy towards the changed market. The Market no longer required just delivery of telecommunication equipment, but also expected a wide range of specialist services to be included. From a strategic point of view, Sietel refocused its vision in order to pursue a niche market of providing unique telecommunication solutions through its products and services. In line with this strategy, the ability to provide such specialist services had to be ensured, which created the need for a Network Engineering (NE) function.

Such a NE function had to be able of dimensioning telecommunication networks, from the amount of switching systems needed down to the number of nuts and bolts required. For example: a customer could require a cellular network for an average of 50 000 subscribers in a densely populated area over a region of 2500 square kilometres. A NE function then has to dimension the network in terms of: how many base stations will be needed, where each will be located, the type of switching systems required, which other networks it needs to access and finally detail BOMs required for each component. This service has to be provided in addition to the delivery of telecommunication equipment, its installation and commissioning.

Sietel decided to pursue this opportunity and had to formally create a Network Engineering department, due to the fact that this type of functionality only existed partly within the organisation.

9.3.2 Using Business Architecture as basis for approach

The BA/EA approach was utilised in the structuring of the NE department. The motivation to use BA/EA was to ensure the NE function was engineered correctly and thoroughly, avoiding critical elements being forgotten that can lead to a bad quality service. The requirement was to do a detail design of the NE department in co-ordination with the future function owners. The physical implementation and operation of this department, or 'enterprise', were left to the process owners.

This approach of enterprise engineering relates to defining the top three rows of the Zachman Framework for the NE enterprise, or implementing PERA up to detail design level. Thus the combination of these two BA/EAs were used as the basis for structuring the NE function. As result the following checklist of enterprise engineering activities were performed to create a BA/EA for NE:

1. NE **Enterprise Definition**, which requires defining:

    - The NE mission in relation to the Sietel vision,
    - The motivation for the NE department,
    - The list of Goals for the NE department.

    These components correlate with the *Enterprise Definition* phase of PERA and the first row of the Zachman framework identifying the *Motivation*. Strategy deployment techniques were used to define these components of the NE architecture.

2. **Conceptual Engineering** of the NE enterprise, required the definition of:

    - List of services provided by NE,
    - Activities, or functions performed by NE,
    - The list of organisational units in NE,
    - A Business Case for NE.

These components correlate with the *Conceptual Engineering* phase of PERA and the first rows of *Data, Function, and People* on the Zachman framework as well as *Motivation* – row two. Concepts from BPR 'Could-Be' modelling and identification of EVA opportunities were used for this part of the NE architecture.

3. **Preliminary Engineering** of the NE enterprise required defining the following processes and structures:

   - Relationship diagrams indicating NE integration in the organisation / business,
   - Supply Chain process flows indicating NE interaction in the business schedule,
   - Business processes for NE,
   - The Matrix organisational structure required for NE and job descriptions.

   These components correlate with *Preliminary Engineering* phase from PERA and defining *row two* for the Zachman framework. Applying BPR techniques and Best Practice concepts were most useful for these enterprise engineering activities.

4. **Detailed Engineering** of the NE enterprise, which consisted of the following components:

   - A data model & data flow indicating applications used by NE,
   - RACI charts indicating NE's Roles & Responsibilities,
   - Detail task and workflow descriptions for NE,
   - Key Performance Indicators for NE linked to their Dashboard.

Defining of these aspects would correlate with the *Detail Engineering* phase of PERA and row three for *Data, Function, People and Motivation* on the Zachman framework. Strategy deployment and BPR tools were used for this detail part of the NE architecture.

In figure 9-1 it can exactly be seen which of the Zachman Business Architecture components were relevant to describing the Network Engineering department.

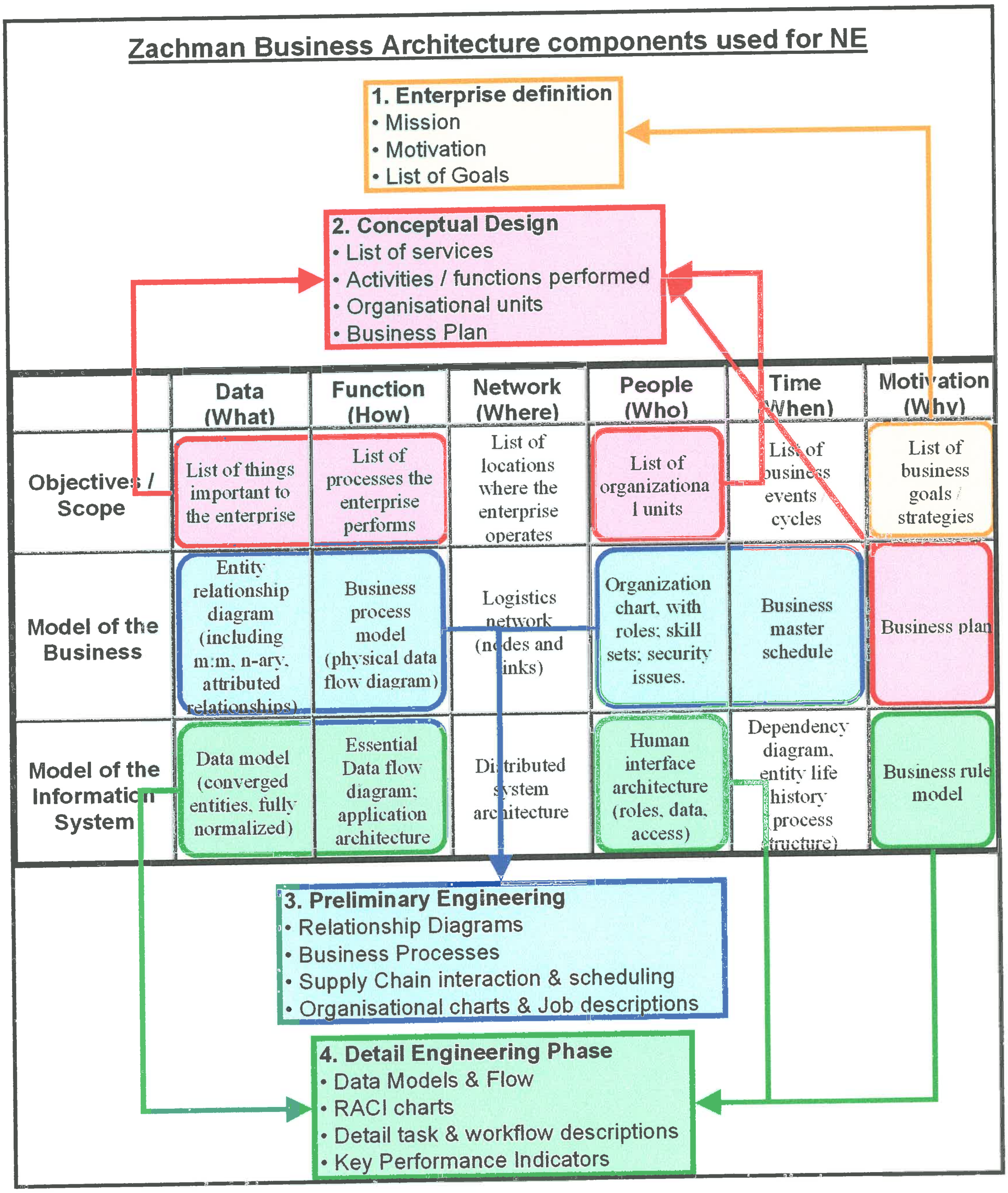


Figure 9-1 Applicable components from Zachman Framework for NE

9.3.3 The Network Engineering department Architecture

9.3.3.1 NE enterprise definition.

The BA/EA approach is to start-off by defining NE in concept from a high level perspective. This is done most effectively by linking NE's enterprise definition to the organisation's strategy. By means of strategy deployment the motivation and goals of NE can also be described.

9.3.3.1.1 NE mission in relation to the Sietel vision

The Sietel vision:

Our vision is to be the
most successful telecommunications solutions provider
in Southern Africa...

Directly related to this vision, NE's mission is:

Enable Sietel to remain a
world class telecommunications solutions provider
by supplying an expert Network Engineering service
to internal and external customers.

This mission were used for the NE strategy, from which a motivation and a list of strategy goals were deducted.

9.3.3.1.2 The motivation for the NE department

In order to pursue the opportunity of providing telecommunication solutions, the following discrepancies were found in Sietel, which proved as motivation for the NE function:

- Most components of Network Engineering are present in the organisation but are not fully developed and are scattered throughout the organisation.
- This leads to inefficient network design and control over the design of the customer networks.
- There is nobody that has technical accountability for the functionality as a whole.
- The tools used in the organisation are not compatible and every part of the network is stored in a different system.
- There is little control over tools for different network components.

By introducing the NE function, and centralising all network design activities to this function, these discrepancies would be addressed.

9.3.3.1.3 The list of Strategy Goals for the NE department

In reply to the motivation for NE, the following goals were established:

- To provide our customer with total solutions for his business.
- To provide the competence and know how in order to ensure the successful implementation and operation of telecommunications networks.
- To develop the competence in Sietel and promote the sales of this service through the Key Accounts.

9.3.3.2 Conceptual design of the NE enterprise.

Utilising BPR aspirational modelling were the most appropriate to design NE in concept. It required NE's services, functions and structure to be defined in a simple and ideal way. In addition a holistic business case had to be drawn-up to indicate the financial relevance of the enterprise. Identification of EVA opportunities was applicable for this purpose.

9.3.3.2.1 List of Services provided by NE.

To provide 'total telecommunication solutions', NE has to perform the following services:

- **Network analysis** of customer requirements for tendering purposes.
- **Conceptual design** of networks in conjunction with the Technical Sales department.
- **Rough cut dimensioning** of networks and produce BOM's for quotation purposes.
- **Consult** Key Accounts during contract negotiation on best possible solutions.
- **Detail analysis** of customer equipment requirements once an order is placed.
- **Detail design** of networks and produce of detail BOMs with material master lists.

All these services have to be produced for the following technologies:

- Mobile Networks based on GSM-type switching technology.
- Fixed (wire-line) Networks based on PSTN-type switching technology.
- Transmission and Broadband Networks utilising high-bandwidth technology to carry high volumes of data.
- Radio Networks based on technology to enable wireless communication.

The services provided by NE can be demonstrated in the following value chain:

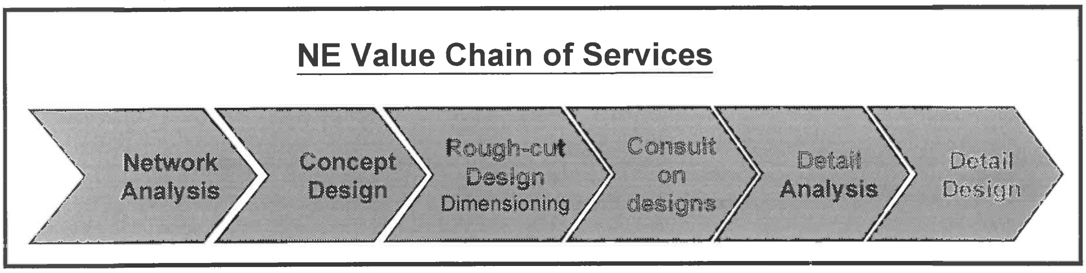


Figure 9-2 Services provided by NE

9.3.3.2.2 Activities / Functions performed by NE

The following were high level descriptions of actions and functions NE had to perform through out its value chain of services it provided:

- Sales Support through:
  - Supporting of the Sales department during the tender phase.
  - Product and feature descriptions.
  - Conceptual design and dimensioning for pricing purposes.
- Network design:
  - System specifications and feature descriptions.
  - Design of the network system and interfacing of different systems and technologies.
  - Plan network infrastructure requirements, taking buildings, roads, geography, etc. into consideration.
  - Specification of system changes.
- Detail design
  - Co-ordinate detail design by different systems experts.
  - Ensure Inter-working and compliance to specifications and requirements of the customer.
- System integration.
  - Specification of interfacing, protocols, etc. for integration of new systems.
  - Approval of designs, test procedures, verification of acceptance testing.
- Network Quality Management
  - Interpretation of network operational data and system improvement proposals to customers.
  - Ensuring that the quality of the system is within the requirements specified.
- Customer Processes
  - Development of the business processes for the customer to operate his system.
  - User documentation and operating instructions.
  - After Sales logistics - spares, back-ups, maintenance recommendations.

9.3.3.2.3 The list of organisational units in NE.

In order to provide network solution services over all types of technology, NE had to structure itself into the following sub-departments:

- A Mobile Networks department to engineer GSM-type switching networks.
- A Fixed Networks department to engineer wire line PSTN-type switching networks.
- A Transmission Networks department to engineer broadband links for networks.
- A Radio Networks department to engineer wireless communication networks.

- A group of project specific Network Engineers to perform co-ordination activities between various technologies.

9.3.3.2.4 NE Business Case

A business case for this new enterprise had to be drawn-up based on EVA opportunities that would be realised from creating the NE function. The types of opportunities that would result were:

- Sales Increase resulting from an increase in the percentage tenders won due to better service offerings through the NE function.

- Cost Reduction of sub-contractor costs on outsourced design work.

The lay-out of the total business case is presented in Figure 9-3.

Business Case for Network Engineering function

Information not accurate for confidentiality purposes

Opportunity Idea:

Creation of an Network Engineering division will benefit:
- Reduction of sub-contracting design costs
- Improved solutions to increase % tenders won

Objectives

- **Centralise all people performing Network Engineering functions currently into a devoted department**
- **Build up competence & handle all Network Engineering work (avoid sub-contracting work overseas)**
- **Improve % rate of successful tender through designing competitive solution for customer needs**
- **Reduce project error costs due to bad Network planning**

KPI's measuring

- **NE costs compared to previous sub-contracting design costs (baseline cost DM 1'5m = R4'8m)**
- **% rate of Tenders won (baseline rate between 15% - 20%)**

Basis for Calculation

Baseline costs & turnover:
- **Baseline subcontracting cost = R 4'8m* (baseline)**
- **Africa KA turnover (17,5% success) = R182m (baseline)**

NE startup year costs & turnover
- **NE Budgeted staff costs = R 4'2m**
- **NE Overheads, Equipment, Rent = R 0'96m**
- **Africa KA turnover (20% success) = R208m**

→ R26m Increased turnover → R5'3m profit increase

Area of Improvement

All planning & design areas involved in:
- Design Network Solutions for Quotation purposes
- Configuration design of Network projects for orders

Type of Benefit

☐ **Sales Increase**: ☐ Existing customers; ☐ New customers; ☐ New Markets

☐ **Cost Reduction**: ☐ Value Engineering; ☐ Design-to-cost; ☐ Reduce complexity; ☐ Optimize process; ☐ Purchase optimize; ☐ Reduce Overheads

☐ **Asset Management**: ☐ Optimize 'Order to Cash'; ☐ Optimize 'total Supply Chain'; ☐ Optimize 'Purchase to Pay'

Target Improvements

	Baseline	1999	2000	2001
% tender success	17.5%	20%	25%	30%
KA Africa turnover	R182m	R208m	R260m	R312
Increased turnover		R26m	R78m	R130m
Increase bruto profit		R5'3m	R13m	R21'6m
NE budgeted staff		R4'2m	R6'6m	R7'3m
NE additional cost	R4'8m*	R0'96m	R0'45m	R0'13m
NE benefit:		*R0'14m*	*R5'95m*	*R14'21m*

Validated with:

F Smit - Service Director; P Adrian - Services commercial
P da Silva - KA Director; N v Aulock - Financial director

Figure 9-3 Motivation Business Case for NE

The steps followed to create a business base was very much the same as the initial steps in the benefits case methodology. The most important difference in a business case is that it must also indicate implementation costs. The general steps followed for the NE business case were:

1. Identify the opportunities that will be realized, as well as costs involved.

2. Define targets for the costs and opportunities, and if possible project the break-even point. In the NE business case break-even was predicted within the first year. (1999: R0'14m benefit)

3. Formalize and scoreboard the business case. It also first needs to be validated by the process owners and then signed-off by the ESG.

Opportunity realization and results monitoring could only be done once NE was operational. In this event both costs and increased profits had to be measured.

9.3.3.3 Preliminary Engineering of the NE enterprise.

Various BPR process mapping and data flow methods, as well as best practices knowledge were used in this basic engineering phase of NE. Most of the architecture components were presented in the form of process flows. Best practices were of importance to ensure sound logic applied during the network design process, based on Workflow Management and Teamwork principles.

9.3.3.3.1 Relationship diagrams indicating NE integration in the organisation / business

The following functional - relation diagram indicated NE's main customers and suppliers within Sietel. These are the departments NE interacts with in its business processes.

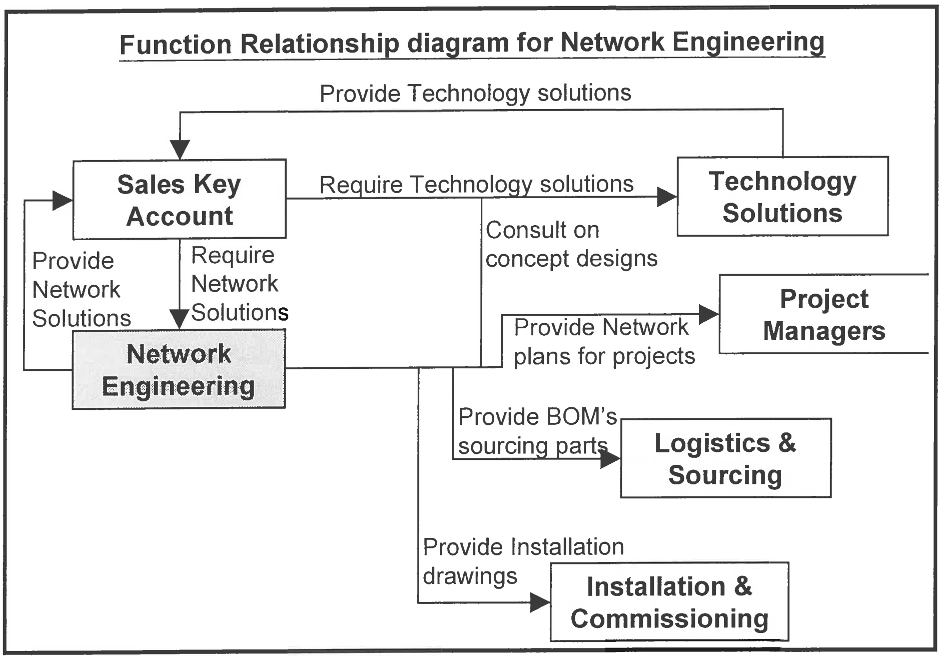


Figure 9-4 NE Function relationships with other functions

9.3.3.3.2 Supply Chain process flows indicating NE interaction in the business schedule

In relation to the function-relationship diagram, NE's interaction in the Supply Chain are indicated in the following process flows. These are parts of Sietel's overall Supply Chain process flow that acts as a generic business schedule with milestones at the top and responsible functions on the left axis. Figure 9-5 illustrates NE's interaction during the preparation of quotes for tenders and figure 9-6 illustrates NE's interaction after order release.

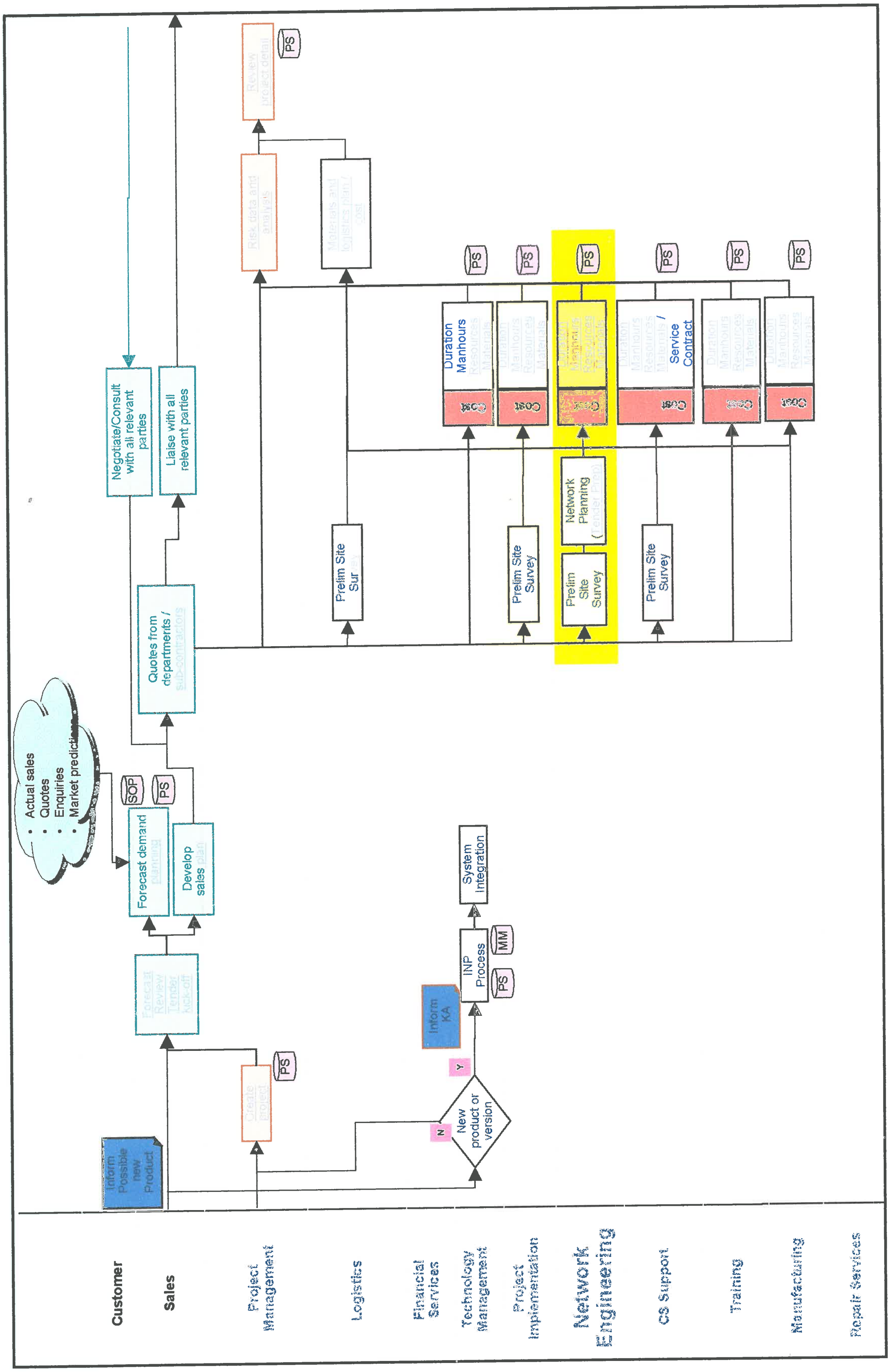


Figure 9-5 NE interaction in the Supply Chain process (1)

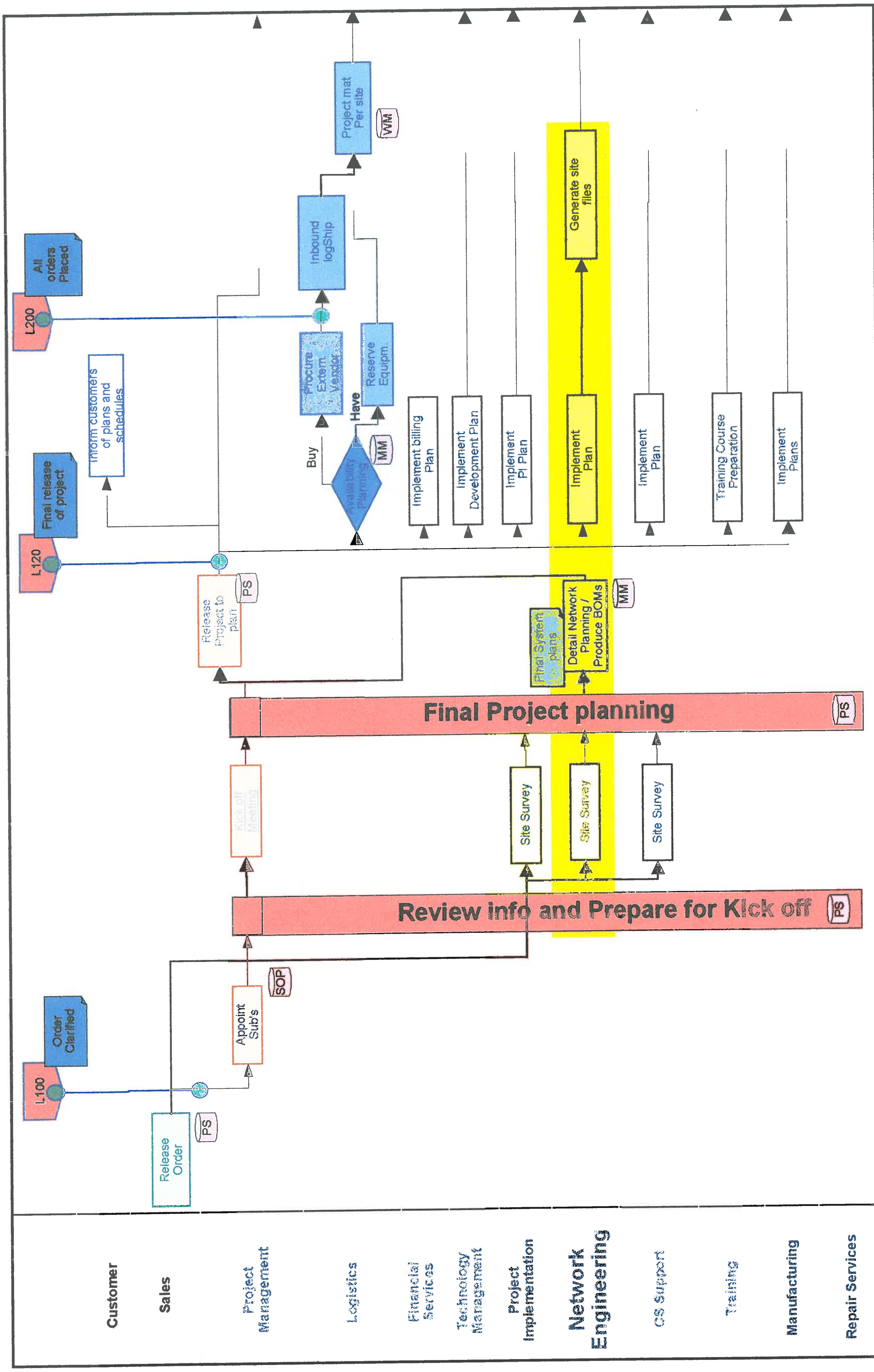


Figure 9-6 NE interaction in the Supply Chain process (2)

9.3.3.3.3 Business processes for NE

The NE services value chain is considered a high level process overview, with the Supply Chain interaction process being of intermediate detail. For each of NE's value chain services, detail business processes were identified. The following three figures are the detail business processes for NE. The arrows with descriptions at the bottom axis indicates relation to the value chain services.

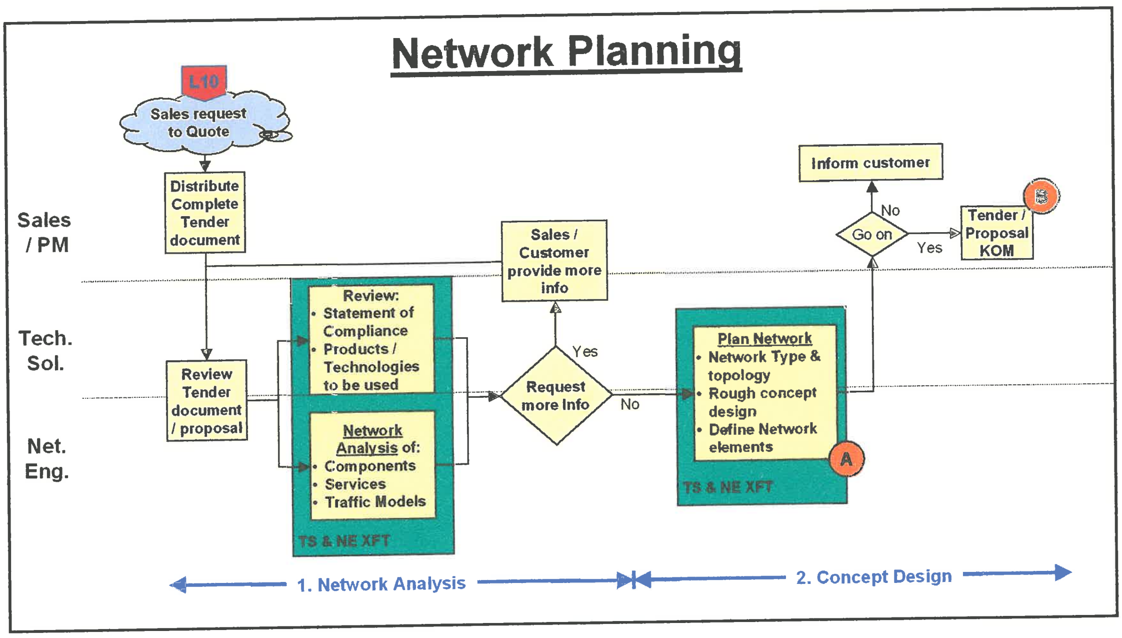


Figure 9-7 Detail NE business process (1)

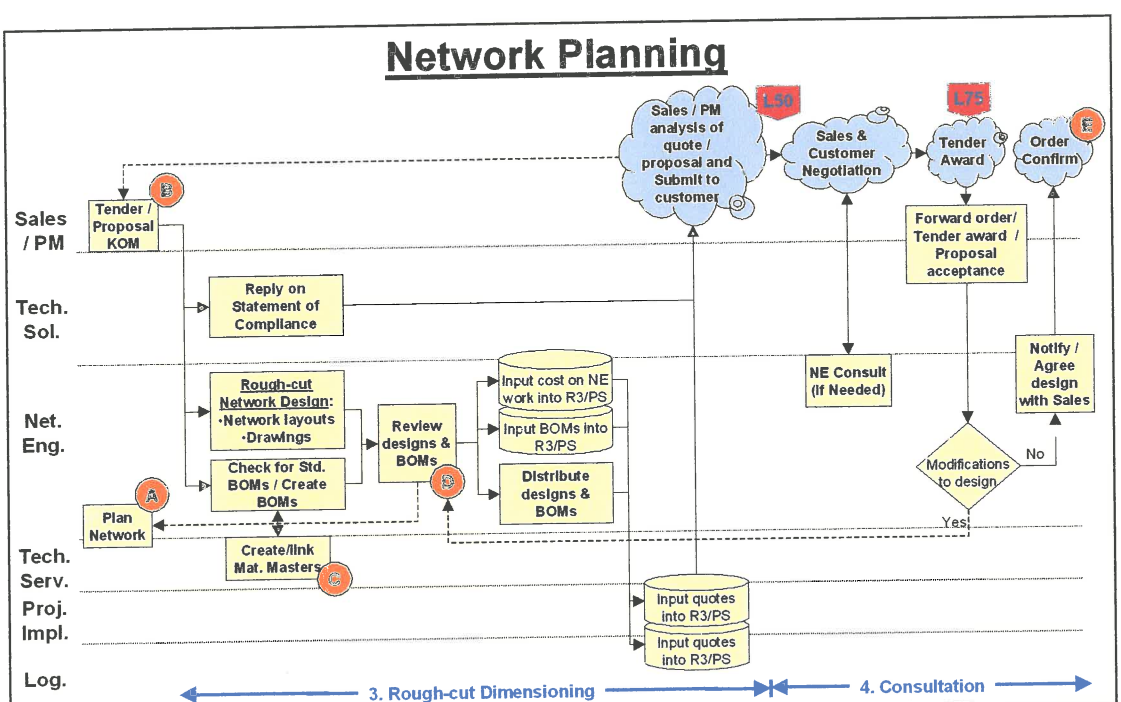


Figure 9-8 Detail NE business process (2)

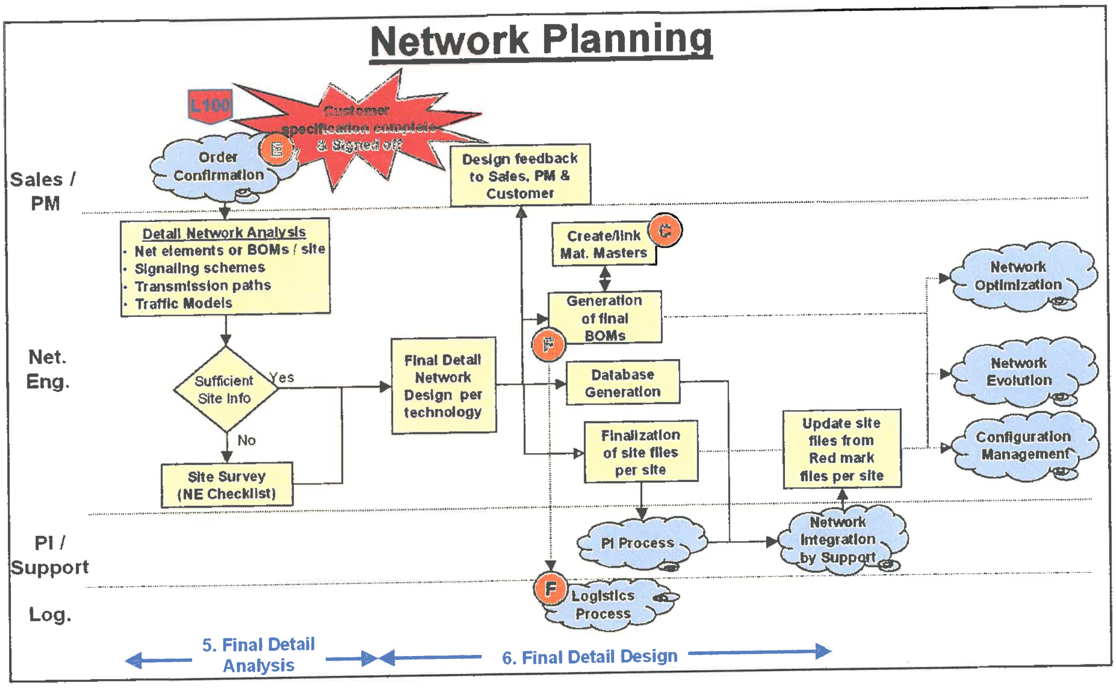


Figure 9-9 Detail NE business process (3)

9.3.3.3.4 The Matrix organisational structure required for NE

The organisational chart of NE has a matrix structure to support project interaction and teamwork. NE will mainly consist of four sub-departments, each specialising in one of the types of network technologies. Network Engineering generalists will then operate over all four sub-departments to serve projects with network solutions based on various combinations of technology. Figure 9-10 is an illustration of this organisational structure.

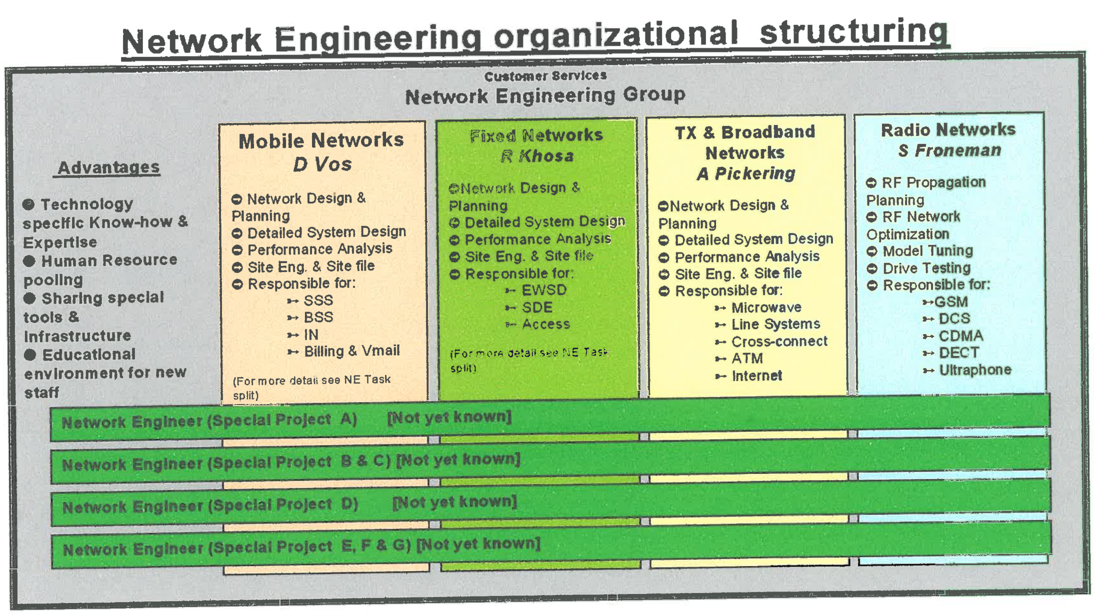


Figure 9-10 NE's matrix type org chart.

As a generic job description for all engineers within NE, the following skills and experience are required:

- **System Engineering.**
  - A Sound knowledge of System engineering and engineering management.
  - A BSc. Eng. or Nat. Dip. and extensive System Engineering Experience.
- **Network knowledge.**
  - A sound knowledge of Telecommunication Networks and Technologies.
- **Systems Operation.**
  - Sound knowledge of:
    - Business processes related to Network Operation.
    - Maintenance concepts for networks.
- **Configuration and data management.**
  - Sound knowledge of Configuration and data management.

9.3.3.4 Detailed Engineering phase for the NE enterprise.

To populate the detail engineering perspective of the NE architecture, tools and techniques from the BPR, Best Practices and Balanced Scorecard elements were used. Entity-Relationship and data flow models are used for information flow and application requirements. RACI charts define the roles and responsibility interfaces, and detail task descriptions combined with workflow descriptions act as working procedures for NE staff. The final piece of detail to complete NE's architecture is the KPI's relevant to the enterprise, composed into a NE dashboard.

9.3.3.4.1 Data model and flow indicating applications used by NE

Figure 9-11 is an Entity-Relation diagram of the data components with which NE works. It illustrates how customer specification are converted into network dimensions, then into equipment BOMs and material masters. The main outputs from this data process are in the form of customer quotes and installation files.

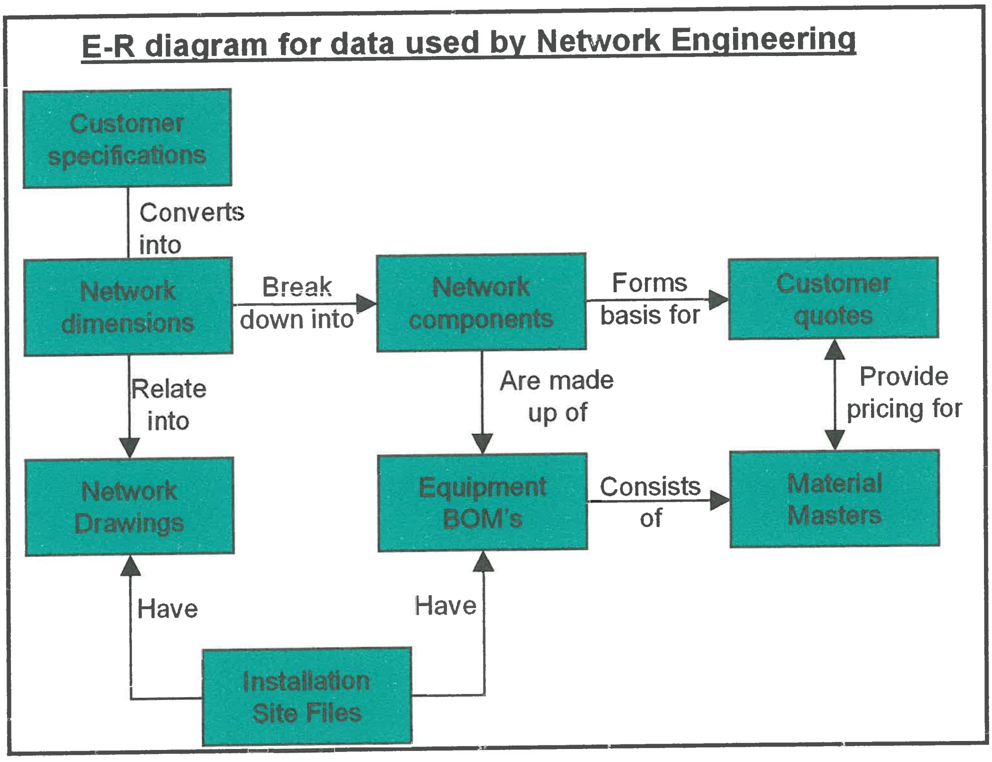


Figure 9-11 Entity relation diagram for NE's data model

The following figure is an unorthodox data flow diagram that illustrates the various applications used by NE. Network dimensioning activities are mainly done on the Leo tool set (all the "con-" tools), which produces the BOMs. These BOMs are downloaded into SAP R3 via "Export" software, and in SAP R3 the BOMs are used as material masters in customer and project related data.

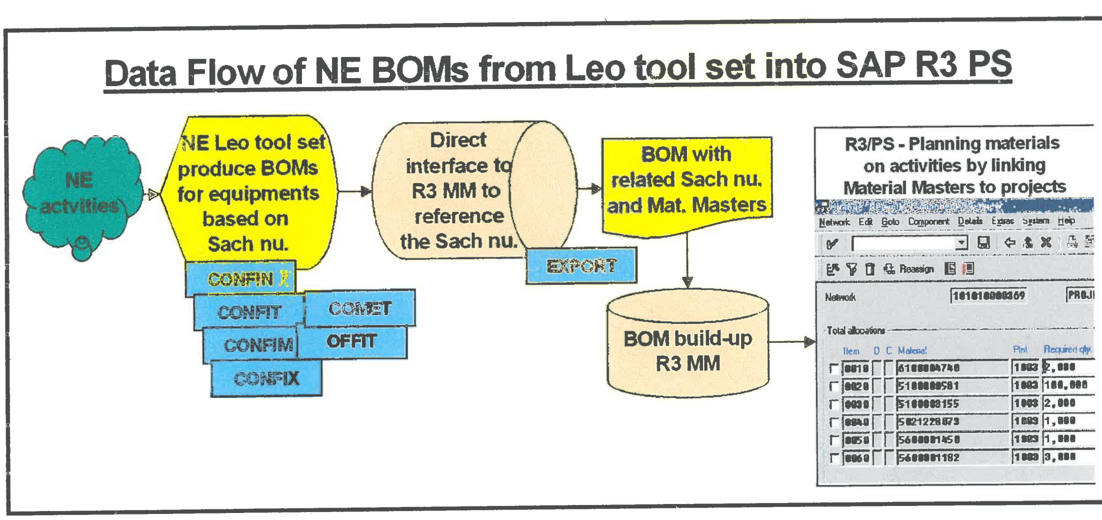


Figure 9-12 Data Flow from applications used by NE

9.3.3.4.2 NE RACI charts

Figure 9-13 and 9-14 are RACI charts for NE specific tasks. Most importantly it indicates at which points accountability is passed to and from NE. The activities are segmented according to NE value chain services as indicated on the left axis of each chart.

RACI: Network Planning

Phase	Activity	Sales	Customer	PM	SPM	Tech. Sol.	Net. Eng.	Logistics	Proj. Impl.	Sup/TAC2	Cust. Train	Conf. Man	Tech. Man.
Network Analysis	Sales requests for quoting				A/R		C						
Network Analysis	Distribute Tender Docs for review	A/R											
Network Analysis	Review Tender Info / request				A/R	R	R						
Network Analysis	Review SOC, Technologies					A/R	C						
Network Analysis	Network Analysis					C	A/R						
Network Analysis	Request for Netw. Info / analysis				A/R	R	R						
Concept Design	TS & NE XFT Concept Design					A/R	R						
Concept Design	Decide to go on & Tender KOM	A/R				I	I						
Rough-cut dimensioning	Reply on SOC					A/R							
Rough-cut dimensioning	Rough cut dimension / design						A/R						
Rough-cut dimensioning	Create / assign Std BOM						A/R						R
Rough-cut dimensioning	Input BOM in R3						A/R						R
Rough-cut dimensioning	Input NE quote in R3 PS						A/R						
Rough-cut dimensioning	Distribute BOMs/Designs						A/R						
Rough-cut dimensioning	Input logistics quotes							A/R					
Rough-cut dimensioning	Input PI quotes								A/R				
Rough-cut dimensioning	Sales quote to customer	A/R											

Figure 9-13 Network Engineering RACI chart (1)

RACI: Network Planning

Phase	Activity	Sales	Customer	PM	SPM	Tech. Sol.	Net. Eng.	Logistics	Proj. Impl.	Sup/TAC2	Cust. Train	Conf. Man	Tech. Man.
Consultation	Contract Negotiation	A/R					C						
Consultation	Tender award	R	A/R				I						
Consultation	Check for design modifications						A/R						
Consultation	Order confirmation	R	A/R				I						
Detail Analysis	Detail Network Analysis						A/R						
Detail Analysis	Site Survey						A/R						
Final / Detail Design	Final Detail Design						A/R						
Final / Detail Design	Update BOMs						A/R						R
Final / Detail Design	Finalise Site Files						A/R						
Final / Detail Design	Database design						A/R			C			
Final / Detail Design	Procurement & Logistics							A/R					
Final / Detail Design	Project Implementation								A/R				
Final / Detail Design	Red mark & return Site Files						C		A/R				
Final / Detail Design	Network Integration									A/R			
Final / Detail Design	Update Red marked Site Files						A/R		C				
Net. Opt.	Contract trigger Net. Optimisation	A			R		R						
Net. Opt.	Network Optimisation						A/R						

Figure 9-14 Network Engineering RACI chart (2)

9.3.3.4.3 Detail task and workflow descriptions for all NE activities.

DETAIL TASK DESCRIPTIONS		*DETAIL WORKFLOW DESCRITIONS*			
Tasks	**Task Descriptions**	**Data entity / Document**	**R3 module / system**	Responsible person	**Required input Data**
Review Tender document / Proposal	Receive RFI / RFP / RFQ for Network Review customer Requirements Highlight requested dimensioning details. Reach consensus on general traffic parameters and SW versions to be used.	Notified with a Request Form Notified with actual doc. Or copy of doc. Notified by email Order on Export/R3 Request form	R3 PS / SM Export Confin	A/R: SPM; Sales C: NE	Customer requirement as per Tender / RFI
Network Analysis (preliminary)	• Network Requirement & Performance • Prelim. Path analysis • Prelim. Network analysis Determine: *Equipment to used *Relevant frequencies *Capacity calculations Analyse the customer request. Look at the global network impact & set questions to the request.	• RIFU • ICS Telecom • DMLE • Radio info • TEMS Link planner • Radio / Optic info • Parameter models	R3 Export Confin Tornado Planet Mapinfo	A/R: NE	• Link info. • Existing Network & system info • Customer Material List • Initial project assumptions • Rollout criteria
Request for more Network information	• Contact Sales • Contact Customer All inputs are necessary. Questions can be sent to the requesting party on detail that is not included in the request, but which is necessary to do the dimensioning.	Search Request forms to: • Sales • Customer		A/R: SPM R: NE, Tech. Sol	• Network Interconnect info • Path info • Site info (Location, suitability / Acquisition probability) Network Planning info
Techn Sol & NE team conceptual design	• Path Profiles • Link Budget • Network Nodes A general network layout and configuration is established by looking at the given traffic parameters, subscriber forecast's	• Customer • Tools • RFI / RFQ / RFD • Technical Sales		A/R: Tech. Services	Customer Req Link Info Radio info Path, site & Network info
Rough-cut dimensioning of Networks	• Determine network capacity needed • Determine the Network Elements to be used (Power required; Equipment lists for BOMs) • Rough Network layout in Tool The amounts of Network elements are calculated. Their positions are determined and a high level dimensioning of the network elements are done	• NE Webpage • Map info		A/R: NE	• Network Interconnect info • Path info • Site info • Network analysis / planning info • Survey documents

Table 9-1 NE Detail task and workflow descriptions (1)

DETAIL TASK DESCRIPTIONS		*DETAIL WORKFLOW DESCRITIONS*			
Tasks	**Task Descriptions**	**Data entity / Document**	**R3 module / system**	Responsible person	**Required input Data**
Create / Assign BOM's & link to R3 PS network	Creation of BOM's from SOW: • Use SW Tool to derive standard BOM • Use System manuals to derive additional add-on's • Use Andrews catalogue data to derive antenna info. • TM create MM (site specific) in R3 BOM's are created for each site and each network element for that site. BOM input into R3 is done by an Excel / CONFIT upload to R3.	• CONFIT • R3 • System Manuals • ANTDES	• Confit / Confin / Confim / Confix • Excel • R3 -MM • R3 - BOM	A/R: NE R: TM	• SOW • Survey sheet • PD Files • System components & Modules to be used
Distribute Network Designs & BOMs	• E-Mail NE & Sales All high level network element dimensioning is given in the format of performance descriptions(PD's), which can be used to price the network. The summary of all NE tasks are given in a file called a HLNDD.	• HLNDD • R3 BOM E-Mail	• R3 MM • Excel • E-Mail	A/R: NE	BOM Document. Contact persons within Sales & NE
Input NE cost estimates into R3 PS project	NE related R3 PS Networks must be updated & maintained for NE project activities and costs	•R3 PS Networks	R3 PS	A/R: NE	R3 PS project
Check for design modification during contract negotiation	• Add changes to original Rough Cut dim. Doc. Any small change in one network element might have an impact on other network elements. Negotiation on any changes should be checked by NE to evaluate the impact	• Already existing BOMs (R3 / Excel) & Drawings	• Confit / Confin / Confim / Confix • Excel • R3 -MM • R3 BOM	A/R: NE	• Original doc. • Modification to original doc. • Request for further info
Detail Network Analysis	• Same as preliminary network analysis • Analyse site info & site surveys • Plus Detailed info such as Specific Radio frequencies • Detailed Network layout etc. A review of all PD's must be done after doing the dimensioning of the network in more detail. Set suppliers have to be chosen. All lower level designs per network element have to be defined.	• Map info • Site info • Model tuning		A/R: NE	Survey documents Initial Network Analysis Prelim. Network design Map Info doc.
Perform a Site Survey	• Travel arrangements • Arrange contact persons • Acquire Site info, locations, survey forms • Travel from site to site • Fill in SS. Tick sheets • GPS readings • Take pictures of all sites • Req. Maps	• Tick sheets • Names of contact persons • Prelim network analysis doc. • GPS, RIFU, DMLE, • Camera photos • Maps		A/R: NE	• Travel data • Site info • Customer info • Location of cartographic office • Names and numbers of contact persons

Table 9-2 NE Detail task and workflow descriptions (2)

DETAIL TASK DESCRIPTIONS		*DETAIL WORKFLOW DESCRITIONS*			
Tasks	**Task Descriptions**	**Data entity / Document**	**R3 module / system**	Responsible person	**Required input Data**
Final Detail Network Design per technology	• Use collected data from site visit and rough cut dimensioning info. • Create link budget and path profiles. • All high level designs should be used as a basis. A lower level breakdown can then be done to suite specific network needs. • Produce detail drawings of floor plan and site layouts	• Detailed Network analysis doc. • Network dimension doc. • MAPINFO • Gathered info from SS sheets • RIFU / DMLE / ICS / TEMS LP	• Confit / Confin / Confim / Confix • Tornado • Export • Excel • R3 -MM • R3 - BOM	A/R: NE	• Site Survey info • Detailed Network analysis doc. • Network dimension doc. • Network Element data
Update BOMs	• Any changes to be added to existing BOM • Updates to BoMs after being reviewed by TM and Sales • Reload BoMs into R3	• R3 - BoMs	R3 - MM R3 BoMs	A/R: NE	SOW final Issue PD Files
Finalise Site Files	• Creation of file per site, with technical diagrams	• Site File	A/R: NE	• SOW final Issue • PD Files • Final Network design & drawing • Final BOM	• Installation teams to install equipment • Copy to be red-marked
Database design	Received MSI Radio info or Joborder or change request - Create relevant database or scripts for implementation		A/R: NE	• MSI radio data • Vodacom joborder	Supply database or script to OMC or relevant people
Update red marked Site Files	Update Changes to red-marked areas on Site Files from Installation teams	• Network design • Site File		A/R: NE	Red-marked files from PI

Table 9-3 NE Detail task and workflow descriptions (3)

Tables 9-1, 9-2, and 9-3 are detail task descriptions of each NE activity within its business process flow. (figures 9-7, 9-8 and 9-9) The task descriptions are combined with workflow descriptions to indicate the flow of information and control during the NE activities. Explanations are at operational level, with reference to the documents and systems used, and appropriate responsibility for each task. Thus these tables can be used by NE staff as procedures.

9.3.3.4.4 Key Performance Indicators linked to the NE Dashboard.

The last part of the detail engineering perspective for the NE architecture is the Key Performance Indicators (KPIs) defined for this function. It provides a feedback loop to the NE strategy by grouping the KPIs into a dashboard that is based on the Balanced Scorecard approach:

- Financial KPIs measure NE related turnover and costs.
- Business Partner KPIs measure NE's accomplishment of customer service.
- Internal KPIs measure efficiency based on optimal staff levels and quality findings.
- Organisational learning KPIs measure staff development and satisfaction in NE.

The intention of the dashboard KPIs is to provide a "bottom-up" measurement of NE's overall operational success.

Network Engineering dashboard					
Objective	**Measure**	**Track Freq.**	**Baseline**	**Target 1999**	**Report**
Financial					
Measure NE business financially	Measure Project quotes (quoted cost versus actual cost's)	Monthly	R 182,332,000.00	R 208,000,000.00	**Willie Du Plessis**
Measure turnover per NE service offering	Costs/Man Hrs per service offering booked to sales.	Monthly	R 242.00	R 200.00	**Willie Du Plessis**
Measure amounts of overheads booked to projects	Unproductive (overhead) costs versus productive costs.	Monthly	N/A	R 2,650,000.00	**Willie Du Plessis**
Reduce Excessive overtime	Cost Control System	Monthly	R 786,000.00	R 407,500.00	**Willie Du Plessis**
Business Partners					
Customer expectations exceeded	External/Internal customer surveys for network optimisation,planning,expansion offered	Quaterly	54% service level rating	68% service level rating	Willie Du Plessis
Diversity of services (Measure number of services available for selling)	Measure number of services	Quaterly	4	4	Willie Du Plessis
Measure referals from previous projects/ customers	Number of customers requesting Network Planning,Optimisation,Evolution and Expansion	Quaterly	N/A	?	
Internal					
Reduce the Staff Turnover	Percentage of staff leaving NE group	Quarterly	30%	20%	**Willie Du**
Support Affirmative Action	% Black and gender(W/F) representation (JG 1-10)	Quarterly	20%	30%	**NS**
Reduce Excessive overtime	Cost Control System		27%	14%	
Staff Dialogue completion	% of NE staff with completed dialogues	Yearly	70%	85%	**NS**
ISO Quality status - Internal	Findings per Audit (Internal)	Quarterly	26	5	**NS**
ISO Quality status - External	Findings per Audit (SABS)	Half-yearly	2	0	**NS**
Organisational Learnings					
Measure types of training per year/employee	Management training, Technical skills and self development	Half-yearly	36%	60%	**PA**
Quality of Service from Network Engineering Department	Doug Eatwell Survey	Annual	22 findings	16 findings	**NS**
Empower our Employees	Employee Satisfaction Questionnaire (ESI)	Annual	45%	55%	**HS**
Transparency	Employee Satisfaction Questionnaire (ESI)	Annual	50%	60%	**HS**
Communicate Effectively	Employee Satisfaction Questionnaire (ESI)	Annual	47%	57%	**HS**
Supervision and Management	Employee Satisfaction Questionnaire (ESI)	Annual	43%	53%	**HS**
Development & Training	Employee Satisfaction Questionnaire (ESI)	Annual	47%	57%	**HS**
Recognition,Reward & Benefits	Employee Satisfaction Questionnaire (ESI)	Annual	51%	61%	**HS**
Job content & Satisfaction	Employee Satisfaction Questionnaire (ESI)	Annual	43%	53%	**HS**
Information not accurate for confidentiality purposes					

Table 9-4 NE Dashboard & KPI's

9.3.4 Case Study Conclusion

This case study illustrated how concepts from five of the elements discussed in this dissertation were integrated into a BA/EA for a NE function within Sietel. The need to create the NE function was a result from strategy re-alignment by Sietel and formed part of its re-engineering effort. The elements of relevance for NE's architecture were:

- Business Architecture meta-models and approaches which were used to create a framework for defining the NE function.
- BPR modelling tools and techniques were mainly used to populate the NE architecture.
- Strategy deployment concepts with KPIs linked to a dashboard (in the Balanced Scorecard format).
- Economic Value Adding principles utilised to define a Business Case.
- Best Practices were built into the architecture by ensuring NE's processes support workflow management, teamwork and customer value concepts.

The elements not illustrated in this case study, namely project management and implementation drivers, are management activities that is not directly applicable for integration into these initial phases of a BA/EA. To ensure successful operation of NE though, these elements would be required to implement NE's architecture (the construct, operation and management phases of the PERA structure).

Even though this case study BA/EA does not explain the total re-engineering effort NE went through, it is an example of an outcome from the BPR process. Of course an architecture is only a documented blue print of the real enterprise, which in practice must be operational and realise the opportunities for which it was created. The advantage of such a BA/EA is that it sets a documented basis which can be used as a guideline for operation and continuos improvement.

9.4 Dissertation Contribution

This dissertation took an approach to the Business Process Re-engineering philosophy of analysing critical interacting elements that contribute to its success as a management philosophy. A chapter was devoted to each element and it was discussed from theoretical and practical perspectives.

The first element addressed the challenge that BPR, or any Change Management project is faced with: to make explicit links between operational improvements and financial benefits. Economic Value Adding opportunities were defined for this purpose and a Benefits Case methodology described to identify opportunities, define targets and track Key Performance Indicators to realise financial benefits.

In chapter three the Balanced Scorecard as a management philosophy were discussed and reference were made to how it complimented BPR. Through aligning organisational strategy with BPR initiatives, both philosophies support each other towards creating effective structures.

Various BPR techniques and methodologies was studied in chapter four, and discussed with specific reference to the approach followed in the Sietel Case study. This methodology with its tools and interventions can be summarised in the following re-engineering approach:

1. Identification of the re-engineering opportunity (as performed in the A&D phase for Sietel)
2. Analysis of the current business processes.
3. Designing of the new business processes.
4. Implementation and embedding of the designed processes.

Best Practices and Benchmarks should be part the BPR methodology, but because of the sheer volume of best practice ideas, it was discussed in its own chapter. This chapter concluded that the main role of Benchmarks is to serve as reference during 'As-Is' analysis, and to serve as a gauge for establishing an aspiration for the organisation. While Best Practices are most useful when focussing attention during 'To-Be' designs and implementation phases.

Basic Project Management principles were reviewed in the sixth chapter, with specific reference to its elements and how it is applied in various areas of the industry. The Project Management elements that were evident in the Sietel case study was also mentioned and discussed. The chapter concluded that the situational management style, resource orientated utilisation, and configuration management change control techniques of Project Management provided the ideal structure for managing a re-engineering process.

It is well known and proven that most management philosophies experience their worst criticism when it has to be implemented. Chapter seven looked at various critical success factors for implementation in the form of "Do's and Don'ts" lists, but also suggests that successful BPR implementation depends on five implementation drivers. Application of sufficient skill and energy to these drivers will determine BPR success:

1) Assign appropriate ownership to re-engineered processes.

2) Campaign the objectives and later the results from re-engineering.

3) Plan and resource the implementation phase properly and manage it as a business project.

4) Measure Key Performance Indicators regularly and make the results visible.

5) Utilise Information Technology tools as enablers for the new processes.

The last element examined were that of Business / Enterprise Architectures. These are meta-models already existing, and depending on the type of business needed to be engineered, an applicable model can be selected, and the businesses or enterprises can be developed using the frameworks.

As a final word, this dissertation took a thorough approach to BPR with its critical components. Once again it is stressed that this is not an all encompassing handbook for BPR, but rather a toolbox with various BPR tools that can be used selectively. In the Network Engineering case study this approach was demonstrated through the "plug-and-play" business architecture that selectively utilised various of the elements from this toolbox to design and implement an important new function in the Sietel organisation.

This field is by no means exhausted in what there is to be learned from it, and future researches that could emanate from this study are:

- Scrutinising of the various types of EVA opportunities mentioned and searching for more examples of strategies and methods for linking operational improvement projects to financial benefits.

- Critical Success Factors for implementation of management philosophies, and the testing of the 'driver frameworks' still requires research that the business industry can benefit from (especially with the focus on IT enablers).

- Business Architectures is still a field that is in its 'early days' and can only benefit from experience sharing and meta-model testing. To link and quantify tangible business benefits to Business Architectures is one of its main challenges to resolve.

The CD ROM accompanying this dissertation is a collection of related research articles and contains a library of training presentations that can be used by aspirant BPR practitioners.