

**LEARNING FROM SYSTEMS FAILURE:  
A CASE STUDY APPLICATION**

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# DECLARATION

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I, Oliver Thoma, the undersigned, hereby declare that the work contained in this dissertation is my own and original work submitted to the University of Cape Town for the Degree Masters of Science in Engineering Management, and has not previously, in its entirety or in part, been submitted at any University for the purpose of a degree.

Signed by candidate

OLIVER THOMA

28/02/1999

Signed

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# ABSTRACT

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## The Research Approach

The thesis as a whole concerns the identification and resolution organisational issues and details research that was undertaken in a manufacturing company producing light access equipment, *Castor & Ladder incorporating Forlezer (C&L inc. Forlezer)*. The content itself is based on ‘systems thinking’ which endorses a holistic approach to problem solving – as opposed to the traditional reductionist or mechanistic approaches – and it is hoped to demonstrate the value of adopting a Systems Approach in resolving problems of an organisational nature.

Particularly, the aim is to incorporate the consideration of underlying issues i.e. ‘soft’ problems pertinent to organisational dynamics, into a coherent and rigorous problem solving approach. In this regard, the approach taken focuses primarily on generating a holistic perception of the contextual ‘problem situation’ faced by the organisation. The view held is that in order to achieve effective solutions, a critical requirement is to first gain comprehensive understanding of the situation and its complexity.

From a research perspective, the intention is to first enrich the perceived problem situation and then only to develop a concern (or hypothesis) that adequately presents the true issues at hand. Next, the aim is to develop the relevant theory applicable and necessary to the understanding and resolution of the situation, and to subsequently apply this theory to the context. In observing the outcome, the validity of the concern, as well as the theory is verified.

To effectively test the hypothesis developed, a research framework is developed that incorporates a philosophical as well as an inquiry framework, forming the main components of the theoretical content. In applying these frameworks the aim was to generate the understanding needed to adequately address the situation at hand.

Clearly the consideration of contextual ‘hard’ issues is essential, however the thesis focuses primarily on the application of ‘soft’ systems methodologies to the data gathered during the research process. Through this application, the aim is to provide the rationale for possible answers to the situation, based on the hypothesis developed during formulation of the concern.

The thesis concludes with an evaluation of the entire research process, reflects on the outcome in terms of the relevance of the concern or hypothesis developed and the applicability/validity of the outcome as well as the knowledge gained.

Essentially the thesis thus involves four main areas or parts. Part I concerns the development of the problem situation, Part II incorporates the theoretical content, Part III concerns the application of the theory in the context and Part IV evaluates the outcome of the research process. The specific theory and data used and gathered are in turn presented in appendices for more detailed reference.

## Introducing the ‘Problem Situation’

The Management of the Manufacturing Division in view of poor present and past financial performances initiated the research undertaken at *C&L inc. Forlezer*. Management had been aware of a problem and over a period of three years had looked at various aspects, which had however resulted in few improvements. Having had to reduce the factory workforce by 22% in 1996 in order to reduce costs and remain competitive, it was felt (two years later) that action needed to be taken to improve the company’s overall performance, which was continuously deteriorating.

Reflecting on prior research undertaken, it was evident that Management had made little use of the research’s outcome, be it due to lack of confidence in the practicality of the research or a lack of urgency.

Consequently, the company was facing a reducing market share and the lowest amount of incoming orders in its history – in short the viability of the Division was under serious threat. This was mainly due to the ever-increasing competition especially in respect of competitive pricing as well as the prevailing economic conditions in South Africa. In this regard, previously held accounts that had consistently contributed to a continual flow of orders, had been lost to competitors on account of narrow price margins.

To regain their competitive advantage, Management realised that the overall cost per ladder had to be reduced. Of major concern in this regard was the fact that 70% to 80% of the company’s market was located in the Johannesburg (Gauteng) and Durban (Natal) areas – 1500km away. Whilst the company’s factory was situated in Cape Town, their strongest competitor, *SA Ladder*, was located centrally in the Johannesburg market. The difference in geographical location alone, was resulting in an additional 15% transport cost for *C&L inc. Forlezer*, which their major competitors did not have.

In addition to the eminent threat of a reducing market share, the Manufacturing Division had recently come under pressure from their Cape Town Sales Branch, which shared the factory premises.

In particular, the Sales Branch was utilising various available storage areas scattered throughout the factory, which were far from optimal in terms of materials handling or control, as well as providing insufficient space for the Branch’s needs. In view of intended future expansions to their operation, which would require additional stock to be held, a proposal laying out the additional

space requirements was put forward to the Company Board as well as the Manufacturing Division, suggesting a relocated factory floor layout.

The proposal did however not take into consideration that the existing layout included vast inefficiencies, and was in effect aimed at optimising the requirements of the Sales Branch without an in depth consideration of the Manufacturing Division's requirements.

In view of these developments, Management initiated a project to address the arising concerns. It was felt that in order to absorb the high transport overheads, the productivity of the Manufacturing Division had to increase. This was to be achieved by improving the material flow through the factory and the individual production lines. It was estimated that a redesign would increase the throughput on some of the production lines by up to 3 times their current capacity. The primary aim was therefore to redesign the factory layout and the individual production lines, whilst still accommodating the requirements of the Cape Town Sales Branch.

In light of the above situation however, it was apparent that the company faced a far more complex problem than a simple redesign of the factory layout. It was also realised that the Manufacturing Division can be conceptualised as a complex system, consisting of interacting parts and that an understanding of the dynamics between these parts was essential. Hence a Systems Approach based on the body of knowledge known as 'Systems Thinking' was used, the literature review of which is presented in Appendix A.

Chapter 1 of the main body uses these systems concepts to define and describe the system in consideration, being the Manufacturing Division. The chapter aims to provide a clearer understanding of the complexity of the system and forms the foundation for researching the emergent 'problem situation'.

In this regard, the internal and external parameters influencing the system were considered to provide insight into the underlying dynamics of the system through an analysis and synthesis thereof. The analysis involved taking the system apart, understanding the behaviour of the parts and aggregating this understanding of the parts into the understanding of the whole. The synthesis in turn involved identifying the containing whole, understanding the purpose of the containing whole and disaggregating the containing whole to explain the role of the system.

## **Formulating the Concern**

Having performed an in-depth analysis of the Manufacturing Division, its parts and the containing whole, it was evident that the potential problem areas were not restricted to the system's operational level. Unlike the perception held by Management that the resolution to the problem lay in a simple factory layout redesign, it was clear that the situation also involved deficiencies at a strategic and normative level.

Although the layout was far from optimal and therefore a good starting point for an overall improvement of the productivity, it was evident that underlying 'soft' issues, such as the organisational 'fitness', managerial approach and the human dynamics within the system were far greater areas of concern. However in this regard Management were reluctant to address these issues.

Chapter 2 elaborates on this aspect and discusses the concern. The extent to which Management was prepared to deal with 'soft' issues became a major part of the concern. A tendency to ascribe all problems to the workforce, which according to the Management was "unmotivated, poorly educated and more interested in politics than work", was clearly detectable. Yet, even though Management was aware of the 'worker-problems' they felt this to be an issue entirely unrelated to the companies poor performance and was to be dealt with separately.

In their opinion, the performance would be adequately addressed by improving the factory layout, as this would result in improved productivity, enable them to reduce their cost per ladder and thus increasing their competitiveness. From a systems perspective this was perceived to be a very short-sighted goal, which would not adequately deal with the underlying issues on a long-term basis.

In view of the contextual urgency requiring immediate action from Management, it was imminent that the redesign of the factory layout be addressed. The various deficiencies were easily identifiable and measurable and thus solutions could be found. However this 'hard' approach had to be incorporated into a long-term vision aiming to ensure the organisational viability. This bigger picture needed to incorporate all contributing factors to the problem situation, especially the 'soft' ones. Only once all factors had been isolated and understood, a long-term solution to the unclear problem could be found. The view was expressed that goals should be set at an operational, strategic and normative level, and both short- and long-term solutions realised.

The main concern emerging from the discussion in Chapter 2 was that if the Management did not take a more holistic approach to the problem, the improvement project would result in a systems failure. This concern was applicable at every level of goal realisation, be it operational, strategic or normative. Thus even if Management chose to focus on an improvement at the operational level only, by redesigning the layout and ignoring the remaining issues, this goal was bound to fail if not approached systemically.

Based on the emergence of this concern, a hypothesis was formulated stating that organisations faced with an unstructured, problematic situation, in which the underlying causes are not clearly identifiable, need to take a holistic systemic approach to problem solving. In particular soft issues arising out of the human, organisational and managerial dynamics need to be identified and understood in their entirety. An understanding of the complexity and interdependence of these dynamics is vital for ensuring the system's viability and achieving effective solutions. If this approach is not adopted, the resolution of a complex problem will invariably result in a systems failure – al be it that this failure only expresses itself in the long-term.

## Theoretical Content – Developing the Research Framework

To effectively address the situation, it was apparent that both ‘hard’ and ‘soft’ issues needed to be taken into consideration. The main hard issues involved at *C&L inc. Forlezer* were easily identifiable, essentially involving industrial engineering applications such as the optimisation of the factory layout, the production lines and the various operational and control processes involved in the manufacture of ladders. In respect of the underlying ‘soft’ issues however, these were not as clear although, in view of the concern expressed, of far greater importance.

Due to the general complexity of the human, managerial and organisational dynamics involved and the difficulty in surfacing underlying problems caused by these dynamics, a rigorous systemic problem-solving framework or ‘research plan’ was developed. The framework, which details the theoretical content of the thesis is comprised of a philosophical framework presented in Chapter 3 and an inquiry framework presented in Chapter 4.

The approach taken was to view the solution to the problem situation as being applicable at three levels, being – operational, methodological and philosophical. The simplest level, the operational level, deals primarily with the solution of ‘hard’ problems. This level incorporates all techniques and tools enabling or facilitating the resolution of problems that are quantifiable, measurable and fairly insensitive to human complexity.

The methodological level deals with problems that cannot conceptually be resolved at an operational level. This refers specifically to the ‘soft’ issues emerging out of the operational context due to the human dynamics and complexities affecting the operational level. At this level various problem-solving methodologies are applied.

When difficulties in resolving ‘soft’ issues at a methodological level are experienced, the problem solving process is taken to a philosophical level, where the underlying assumptions and beliefs of the methodologies used are questioned.

To this end a philosophical framework was developed which elaborates on the nature of scientific inquiry which is perceived as being in pursuit of truth. The framework builds on the philosophical fields of *epistemology* - dealing with the nature of knowledge, *metaphysics* - dealing with the nature of reality and *axiology* - dealing with values (Section 3.2, Chapter 3).

These domains influence the thinking, perceptions, and ultimately the competence to understand and resolve a problematic situation. A clear understanding of the concept of ‘truth’, how it is arrived at and its subjectivity with respect to all stakeholders involved in a problem situation is thus paramount to mastering soft contextual situations.

The essence of arriving at the truth in turn is the inquiry process. The nature of inquiry itself involves a constant cycle of questioning the truth (Section 3.3, Chapter 3). This cycle moves from an established belief to a newly held belief through a process of experiencing surprise, causing doubt and thus further inquiry. In this way current belief systems are adjusted.

As problem solvers, the ultimate concern involves the action undertaken and the consequences thereof, and thus the research framework developed has a strong underlying pragmatic approach (Section 3.5, Chapter 3). In this regard we are aware of the fact that the truth may never be completely attained, and that real world pressures require action arising from decisions based on 'incomplete' truths. By application of scientific inquiry an effective method for approaching the truth is incorporated due to the fact that scientific inquiry endorses verisimilitude (Section 3.4, Chapter 3). The pragmatic implication is that the more accurate the approximation of the truth, the more likely the prediction of the correct consequences, which increases effectiveness. To achieve verisimilitude the philosophical framework therefore endorses the scientific method (Section 3.7, Chapter 3).

To further increase the rigour and efficiency the framework incorporates Critical Thinking (Section 3.6, Chapter 3), a process that aims to reduce the amount of external surprise and consciously increase verisimilitude through aimed, critical inquiry.

The philosophical framework (Chapter 3) thus forms a foundation for the development of an inquiry framework (Chapter 4), which was used to address the problem situation. Central to the inquiry framework is the application of a research methodology guiding the actual inquiry process.

Initially the intention had been to perform action research, the outcome of which results in the direct implementation of research findings. To effectively achieve this, the necessary power to implement such changes is however required. In the given context at *C & L inc. Forlezer*, the necessary backing was not given by Management for effective action research and thus a more appropriate observer-participant research methodology was required. The method most suited for this application was the case study research methodology (Section 4.2, Chapter 4) which can be divided into six separable stages (Section 4.2.2, Chapter 4).

The first stage considers the unstructured problem situation, the second stage the formulation of the research goals and any underlying assumptions that may restrict or define the case context. During the third stage, the actual research plan or is developed, whereupon the required data is collected in the fourth, in order to affect an application of the designed research plan during the fifth stage. The sixth stage concludes the research process with an evaluation reflecting on the outcome of the research.

To enrich the problem-solving framework developed, various systems methodologies were incorporated specifically to deal with the underlying complexity affecting the situation at *C&L inc. Forlezer* (Section 4.3, Chapter 4). In particular the Systems Approach (discussed in detail in Appendix A) was incorporated to enhance the development of the problem situation, including consideration of organisational and managerial issues. To ensure an enriched understanding of the 'hard' contextual problems, relevant theory pertaining to the manufacturing operations environment was reviewed (presented in Appendix B).

Addressing the 'soft' underlying issues the two main systems methodologies reviewed were the Soft Systems Methodology (SSM) and the Viable Systems Model (VSM) - reviewed in detail in Appendix C and D respectively.

The SSM was used to gain an understanding of complex human-related problem situations and thereby learn one's way to a solution. The methodology is based on the participation and consideration of all stakeholder perspectives, from which deficiencies are highlighted and a debate initiated that is aimed at resolving the contextual problem. In turn, the VSM is a cybernetic organisational model modelling the web of regulatory mechanisms that an organisation requires to cope with the complexity of real-world tasks, the application of which again reveals contextual deficiencies that are contributing to the problem.

## Application of the Research Framework

The main aim in applying the developed research framework was to identify the various organisational issues, both 'hard' and 'soft', that had resulted in the problem situation. Most importantly it was hoped to gain a comprehensive understanding of the problems in order that effective future and further action could be undertaken in order to address the developed concern.

The first two chapters of the thesis initiated the development of the situation and the research goals, where the Systems Approach was used to structure the understanding of the system by consideration of purpose, parts, environment, constraints, worldviews and dynamics. In turn the research goal was formulated in a hypothesis aimed at addressing the concern at hand.

Chapters 3 and 4 then present the actual design (stage 3) of the framework, which essentially documents the relevant theory used to identify and resolve the situation. Relevant data was assimilated in accordance with the convergence of multiple sources of evidence required for the validity of the case study research methodology (presented in Appendix E).

From the data gathered it was evident that the system exhibited deficiencies particularly in terms of the human, organisational and managerial dynamics and not only in terms of the factory layout. However, the Management at *C&L inc. Forlezer* showed little interest in dealing with the 'soft' issues as they were convinced that the resolution of the 'hard' issues would adequately resolve the situation (Chapter 5).

As such Management was intent on consideration of the redesign of the factory layout only. However, like the entire problem situation, the redesign was also not approached systemically. In this regard it was reiterated that if the redesign itself was to be approached holistically, then the issues arising out of the human, managerial and organisational dynamics could not be ignored.

Due to the apparent urgency perceived by Management to affect changes before the arrival of their seasonal peak order period, it was decided to commence with the redesign as the first phase to an overall improvement project – nevertheless taking all ‘soft’ issues into consideration to ensure a holistic solution in terms of the new layout.

To facilitate this, a ‘rich picture’ was developed (Section 5.2, Chapter 5) using the SSM. In this regard, a logic-based as well as a cultural-based analysis was performed; the logic-based stream dealing with the current problem context (Sections 5.2.1-5, Chapter 5) and the cultural stream with the underlying human dynamics (Section 5.2.6, Chapter 5) influencing and being influenced by the current context. The application of the SSM was however limited by the lack of backing given by Management, and as such it became more and more eminent throughout the application of the research that the outcome would result in a systems failure.

Irrespectively, the application of the methodologies revealed critical insights into the problem situation, both in terms of issues relating to the factory layout and the inefficiency of the operations function, as well as the ineffectiveness of the organisational structuring, dynamics and managerial approach.

From the logic-based analysis it was apparent that the emergence of the problem situation was due to the lack of vision and associated policy, the incapability to adapt to change and the lack of long-term application within the organisation. Management itself exhibited a severe lack of understanding and interest in the systems dynamics and operational context and was not equipped to deal with the human element beyond its authoritarian mechanistic paradigm (Section 5.2.4-5, Chapter 5).

The stream of cultural inquiry of the SSM, in turn revealed insight into the social and political systems governing the situation, as well as analysing the intervention itself (Section 5.2.6, Chapter 5). In terms of the final outcome of the research, the cultural stream of analysis provided a useful perspective as to why the research situation was eventually forced into consideration of a systems failure.

The application of the VSM provided insight into the ‘organisational fitness’ in terms of the organisational structure and the activities at the normative, strategic and operational levels. From this consideration it was apparent that Management was predominantly preoccupied with goals at an operational level, neglecting normative parameters.

In this regard the organisation was found to be deficient in its policy and intelligence functions. Further, it was found that the system had poorly developed channels of communication in place, especially between responsibility levels and organisational parts. In turn there was no common vision across the spectrum of stakeholders and therefore the organisation was facing ‘soft’ human related problems, surfacing mainly in the lowest operational level as labour discontentment.

In redesigning the factory layout (Section 5.3, Chapter 5), the understanding gained during the development of the 'rich picture' was put to use, especially in view of the 'hard' issues identified. In particular, the redesign was approached with a view to optimising the system in its entirety and not just the Production Department, as Management had intended to do.

In this respect, Management did however not approach the actual implementation systemically, and as alluded to above, the final outcome did not contribute successfully to the resolution of the problem situation (Sect 5.4, Chpt 5). Management had not achieved the successful relocation of the factory floor, and in fact had not even achieved a detailed systemic plan for successful relocation. The relocation of certain areas was undertaken on an add hoc basis and it was apparent that the outcome would not constitute an 'optimal' solution.

## Evaluation of the Research Outcome

The research undertaken at *C&L inc. Forlezer* was initiated in light of an emerging threat to the organisation's long-term viability due to a complex problem situation that had manifested itself in a loss in market share and reducing orders. Management concluded that the only viable way to regain its competitiveness was to increase the productivity of the Manufacturing Division, which was to be achieved by redesigning the factory layout. The problem situation however proved far more complex, and it was clear that the organisational structure, managerial approach and human dynamics were creating underlying problems that needed to be addressed in a systemic manner.

In this regard, Management chose to ignore these issues despite the necessity of their consideration in order to achieve a comprehensive holistic long-term solution. Consequently the outcome of the research contributed little in terms of resolving the problem, and thus was considered to be a total systems failure. The failure was applicable both in terms of the intended redesign of the layout as well as in addressing the 'soft' problems (Section 6.1, Chapter 6).

To maximise the learning process in terms of the research work undertaken, Chapter 6 reflects on the systems failure and what brought it about. Specifically the failure to affect changes systemically was considered (Section 6.2, Chapter 6) as well as the inherent causes of failure in general (Section 6.2, Chapter 6). In this regard the main psychological causes identified were – the inability to effectively handle complex situations due to 'economising' and handling problems reductionistically, the difficulty in dealing with temporal or non-linear configurations, the inherent human tendency to self-protect, and a lack of anticipation of possible future problems arising.

Having gained some comprehension of why failures arise, the prevention of future failures was discussed (Section 6.3, Chapter 6) and the situation at *C&L inc. Forlezer* reflected upon. Emerging strongly from the discussion is the realisation that a comprehensive understanding of the contextual situation and its complexity is essential.

The importance of breaking away from a reductionist problem-solving paradigm is equally critical, as well as the necessity to monitor and adapt to changes in the contextual environment.

Finally the validity of the research is reflected on (Section 6.5, Chapter 6). This includes confirmation of the validity of the concern as well as the 'answer' developed. Reflecting on the hypothesis developed it is apparent that the lack of systemically approaching the problem situation at *C&L inc. Forlezer* resulted in a systems failure. Based on the understanding gained of the contextual situation, it is concluded that the usefulness of the framework developed was confirmed, even though the actual improvement to the situation was minimal. It is believed that, given the required support, the systemic problem-solving approach can be successfully used to achieve effective solutions.

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# PART I

## DEVELOPING THE PROBLEM STATEMENT

The thesis as a whole is concerned with identifying and resolving organisational issues and details research that was undertaken in a manufacturing company producing light access equipment, *Castor & Ladder incorporating Forlezer (C&L inc. Forlezer)*. The aim of Part I is to describe to the reader within what context the research work was undertaken. In this regard, the initial 'problem situation', which led to the analysis undertaken, is further developed. The choice of the words 'problem situation' as opposed to 'problem statement' is deliberate, as the problem was not clear-cut and easily identifiable.

Chapter 1 briefly presents the company's background and current situation at the time of commencing with the research. It should be noted that although the development of the initial problem statement as presented in Chapter 1 appears 'linear', it was in fact an iterative process based on an inquiry framework developed in the theoretical content section of the thesis.

In the development of the 'problem situation', the system in focus is defined and emerging concerns elaborated on. The underlying reasoning for developing a problem statement is that a problematic situation can only be effectively addressed once it has been understood in its entirety. From a management perspective, the critical skill is to be able to identify the real issues underlying a complex situation. It is not sufficient to only address 'hard issues' by looking for facts that are clearly definable and quantifiable. The skill involves considering the various influences of human dynamics - an area that has traditionally received little attention due to its 'soft' nature.

In Chapter 2, a brief 'problem statement' will emerge as seen by the company's Management who initiated the research. However, it will be shown that this in itself forms part of the 'problem situation' as the Management was only prepared to address certain problems, which it felt were relevant. From this will emerge a concern as to whether the Management is in fact addressing the problem holistically and thus whether the solution can be effective. A hypothesis is formulated that is tested by the application of the underlying theory in the real world situation experienced. Ultimately the hypothesis aims to verify the belief held, that in order to achieve coherent effective solutions, a systemic approach to problem solving should be adopted.

# CHAPTER 1

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## 1.1 Introducing the System in Focus – *Castor & Ladder inc. Forlezer*

The introduction of the system in focus, a manufacturing organisation, relies on the theory presented on systems thinking in Appendix A. Essentially, as stated by Flood and Jackson (1991, p5) systems thinking developed as an alternative to mechanistic thinking, and proved itself not only for explaining complex biological, but also social phenomena. As opposed to viewing problems in isolation, the movement considers the containing whole, realising that this “whole” is more than just the sum of its individual parts.

Chapter 1 thus aims to provide a systems view of *C&L inc. Forlezer* by taking into consideration the “*what*”, the “*why*”, the “*how*” and the “*who*” as in Section A.3 (Appendix A) where the properties of the system are explicitly discussed. These properties involve the system identification and definition, the purpose, the constraints, the worldview relevant to the system and the system dynamics and self-organisational tendencies. In this regard the properties of the system were uncovered by reflecting on the questions presented in Section A.4 (Appendix A).

At the time the research was undertaken in the Manufacturing Division of *C&L inc. Forlezer*, which forms the topic of this thesis, the organisation was part of the *Klipton* Group, who own and are represented by companies throughout South Africa. The Group’s hierarchical organisational structure is illustrated in Section E.1 (Appendix E) and illustrates that the Group is split into two umbrella organisations, *Klipton Industrial* and *Klipton Security*, with the organisation *Castor & Ladder* falling under *Klipton Industrial*. In turn, *Castor & Ladder* operate through two separate companies - *C&L inc. Forlezer* and *Sapco*. A third company *Forlezer Hire* depicted in Section E.1, was closed down at the beginning of 1996 due to unsatisfactory low return on capital employed and the poor quality of business. *C&L inc. Forlezer* markets light material handling and access equipment, whilst *Sapco* markets pneumatic tools and lifting equipment.

*C&L inc. Forlezer* is further sub-divided into the Manufacturing Division which constitutes the factory, and the Sales Division which constitutes the various sales branches distributed throughout the country (as listed in Section E.1, Appendix E).

The factory is located in Paarden-Eiland, Cape Town, whilst the head offices for the sales branches are located in Johannesburg. The premises in Paarden-Eiland also locate the Cape Town Sales Branch, which shares the building with the factory.

The company manufactures roughly 150 different products consisting mainly of aluminium ladders and scaffolding, which are marketed under the *Forlezer Ladders* brand name. This is due to the historical origin of the factory, which used to be an independent company – *Forlezer Ladders* –

supplying its associate company - *Castor & Ladder* - who in turn, distributed the ladders in the market. When the factory was purchased by the Klipton Group, the *Forlezer* factory and *Castor & Ladder* were combined and the company *Castor & Ladder incorporating Forlezer* formed. Since its origin the company has been associated with the large ladder manufacturer Werner in the United States and several of the products manufactured locally are made according to Werner patents. For these specifications, the Group pays royalties.

The company has in the past, built a reputation of quality and reliability based on the Werner designs and the *Forlezer* name and had, prior to initiation of this study enjoyed an undisputed market share. With sales branches situated nationally, the company has had a share in practically the whole domestic and commercial market. The factory in Cape Town produces the entire range of products manufactured by the company and is the only production facility available. From here all products are distributed and transported by truck to the various sales branches.

## 1.2 The Manufacturing Division – A Systems Definition

The system under consideration for the purpose of this thesis was the Manufacturing Division i.e. the factory in Paarden-Eiland. This section aims to define the system and bring into perspective its boundaries, structure, function, constraints, the existing dynamics and pertaining worldviews, as well as organisational and managerial issues that were identifiable. The theoretical background pertaining to each of the following sections is discussed in Appendix A in order that the reader may understand the derivation.

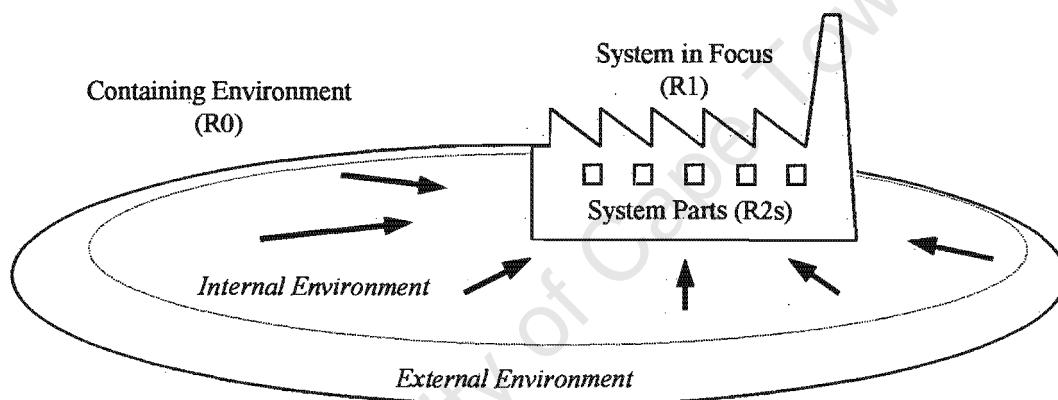
### 1.2.1 The System in Focus - The Operations Function

Principally the relevant system R1, being defined as the factory, forms the basic operations function of the organisation *C&L inc. Forlezer* and performs the overall value adding activity that results in the products and service that make the company viable. The logic behind focusing on the factory was that the basic operations function forms the core of the business, without which the company cannot operate. (A further perspective on the core value-adding function is given by the discussion on Operations Management in Appendix B). In this regard, the Management of the system expressed concerns that this area was not as efficient and effective as it should be, which lead to the initiation of the research.

Essentially the factory converts processed aluminium of different profiles and varying lengths into various types of ladders used for both industrial and domestic applications. The system's primary raw material input is extruded aluminium as well as various components, which are assembled during the manufacturing process.

The transformation achieved concerns the value added to the input to form the output, which is the completed ladder (figure A.2, Appendix A). This transformation of raw extruded aluminium into ladders is achieved by the interaction of various ‘departments’ within the factory, which are mainly distinguished by their purposes within the factory as opposed to being entirely separate entities.

These departments form the system parts (R2s) which are responsible for achieving the systems overall transformation process (Section A.4.1). The containing environment (R0) of the system is split into the ‘internal environment’ of the Klipton Group, in particular the relationship of the factory to the sales branches, as well as the ‘external environment’, which involves the market i.e. customers and competitors, as well as the suppliers. Graphically the system definition is presented in Figure 1.1 above.



**Figure 1.1** The System in Focus

### 1.2.2 The System Parts - How the Operations Function is Constituted

The factory floor comprising the system can be divided into six ‘departments’, which constitute the system parts (R2s) achieving the overall transformation of the system. In itself, each part contributes to the successful performance of the operations function and has its own purpose, input, transformation and output, as discussed in further detail under *Section 1.6 – The Dynamics of the Parts*, where system dynamics are considered.

A detailed description of each of these parts and the complexities or problems experienced, is included in Section E.1 (Appendix E). Figure E.3.1 in Section E.3 (Appendix E) also provides a plan view of the original factory layout depicting the various departments and production lines. The ‘departments’ concerned are:

*i) The Raw Materials Store*

Where the bulk of the raw material in the form of extruded aluminium profiles used in the manufacturing process is stored.

*ii) The Finished Components Store*

Stores all accessories and additional components that are assembled to the basic ladder skeleton.

*iii) The Cutting Department*

Where the raw material is cut to size for the assembly lines.

*iv) The Tool Room*

The main support function to the factory floor, responsible for tool setting, machining, maintenance and repair works, as well as the production of specials and components.

*v) The Production Department*

This department consists of six production lines manufacturing the company's 150 odd products. The individual production lines concerned are called the ALFLO, LAS/QS, SPL/FM, Fibreglass, Upright and Stecalloy lines.

*vi) The Finished Goods Store*

Where the finished goods are stored prior to being dispatched to the sales branches.

### **1.2.3 The Containing Environment - Setting the Scene**

The context within which the factory is relevant is formed by the containing environment, the dynamics of which directly influence the system. A distinction has been made between the internal and the external containing environment for ease of relating this context, however both form part of the general external containing system, which directly influences the defined system in focus.

The difference is simply that the internal environment as defined, forms part of the greater organisation containing the system in focus thus having a direct interest in the survival of the system, whereas the external environment may not.

*i) The Internal Environment*

The internal environment referred to in this context is the Klipton Group, which is the 'greater' organisational structure of which *C&L inc. Forlezer* is a part. Clearly if the Manufacturing Division forms part of a greater organisation, it will be influenced by the policy set by this body. The general policy set by the greater organisation determines significant influencing factors such as – the manufacturing policy, the amount of autonomy granted to the division, the dynamics between divisions, the general modus operandi of management, the financial policies etc.

Reflecting on the existing internal environment, one of the main policies set by the Group is that the factory be operated on a recovery basis, supplying only the various sales branches distributed

throughout the country. This means that the factory supplies the various sales branches at cost and does not have the choice to supply directly to the end market at a profit. The Sales Division's national distribution network has sales branches in Johannesburg, Bloemfontein, Cape Town, Durban, the East Rand, Pietermaritzburg, Port Elisabeth, Pretoria and Richards Bay. These branches form the link to the actual end market in the external environment. The ladders and scaffolding produced by the factory are however only a portion of the products that the sales branches offer. Other products such as castors, gravity rollers, mounties, conveyors, various storage solutions and trolleys are sourced externally from other manufacturers.

The factory is thus not its own cost centre operating on a profit margin and aims solely to recover the fixed and variable costs it carries in manufacturing the ladders. In turn, the sales branches are active in the end-user market, and in this manner, the Group profit is generated. The interaction between the factory and the sales branches operates on a first-in-first-out ordering basis, with national orders being co-ordinated from the sales branch head office in Johannesburg. In case of the factory needing funds for anything beyond recovery, such as upgrading plant and equipment or launching a new product, a budget has to be prepared and presented to the Klipton board motivating the additional capital.

A further internal environmental factor physically influencing the Manufacturing Division is the Cape Town Sales Branch, which is also located at the premises in Paarden-Eiland. In this regard, the sales branch utilises sections of the factory floor for storage of its own stock. This storage configuration involves six separate and distinct storage areas spread throughout the factory, which are depicted in Figure E.3.2 (Section E.3, Appendix E).

Specifically, the storage space is located on erected mezzanine levels above the FC Store and the LAS/QS production line, in a section of the old Hiring Department, on the actual factory floor and on the 1<sup>st</sup> floor of the administration building, as well as in a storage facility external to the factory. The section of the factory floor allocated to the sales branch is located behind the FE Store and is completely fenced off, although access to the production lines is possible through a gate. Further access to the store is gained from the front of the building and the storage area is linked to the sales branch's show room area situated on the ground floor of the administration block of the building. The branch storage area extends to the first floor of the administration block. The external store in turn is shared by both the factory and the sales branch for storage of very slow movers, such as certain sections of scaffolding, flag poles and trolleys.

## ***ii) The External Environment***

Having gained some insight into the internal environment influencing the Manufacturing Division, the external environment forming the periphery to the system will be discussed. The external environment is comprised of all factors influencing the viability of the Manufacturing

Division beyond the boundaries of the Klipton Group. In particular this includes the following relevant categories – the market or end user (ultimate customer) the product is aimed at, the competitors in the market, the suppliers on whom the Division is dependent on and macro economic influences.

- *The Market*

Taking the systems definition into consideration it would appear that the Manufacturing Division's market is formed by the various sales branches. However, this market exists only because of the organisational policy and it is evident that the sales branches are merely a link to the real market. It is important thus, not only to consider the sales branch requirements but also to create a clear understanding of what actually drives the end-market.

In this regard, the 'real' market is comprised of both the industrial and domestic sector within the boundaries of South Africa. The market itself is static in terms of new product development, however fluctuates seasonally with the demand increasing into the summer months and slowing in winter. According to the Managing Director (MD) of *C&L inc. Forlezer*, over the last six years there have been sufficient 'base' orders to keep production up and running throughout the year. During peak season orders are however erratic and can fluctuate by up to 5 times the average order quantities.

The company has established itself as a reliable supplier of high quality products, mainly due to the association with the American *Werner* designs and the *Forlezer* brand name. Recently however, this association has been insufficient to guarantee steady orders and gradually it has started to lose some of the standard accounts that were held for several years.

In particular, the Management referred to having recently lost a large wholesaler and distributor account based on a few cents cost per ladder. By way of this development, it would appear that the deciding criterion the market is interested in is the price of the product. Although the criteria quality and service cannot be neglected, these are considered by the market as 'being given'.

Currently the company estimates its market share to be 50% however it is not clear what this estimate is based on. Due to the distribution network formed by the sales branches the company is however the biggest national ladder distributor, with approximately 70% to 80% of this market being located in the Johannesburg and Durban areas.

- *The Competitors*

The main competitor is *SA Ladder (Pty) Ltd* who is the only other ladder manufacturer represented nationally. This competitor is located in Johannesburg and their main distribution is in the Johannesburg market, although recently they have made inroads into the Cape Town market. *SA Ladder* has vastly improved the quality of their product and has become extremely competitive

in terms of pricing although their range of products is not as extensive as that of *C&L inc. Forlezer*. In addition, *SA Ladder* focuses only on the manufacture and distribution of ladders, whereas *C&L inc. Forlezer* (the sales branches) are involved in a broader range of access and storage equipment.

In the past, *C&L inc. Forlezer* were far superior in terms of the design, variety, strength and quality of their ladders. During recent benchmarking tests performed by the Manufacturing Division, similar competitive products were tested to failure in accordance to SABS standards. From these tests it was however evident that although C&L ladders were still slightly better than other available brands on the market, the difference had been reduced to such an extent that pricing was now becoming the decisive factor.

In addition to *SA Ladder*, a competitor called *L-Deck* manufacturing mainly scaffolding is also active in the Johannesburg market. According to the Management this competitor is however far smaller than *SA Ladder* and at present not cause of much concern in terms of both price and quality. In the Cape Town area the main competitors are *Krupp & Co* and *Moir Industrial Ladders* as well as *Mecoladder*. Again these competitors are far smaller than the *C&L Manufacturing Division* and are more focused on specialised applications - *Moir Industrial* supplying heavy-duty ladders and *Mecoladder* catering for the fruit picking industry.

A much greater future threat is the ever increasing competition from Asian countries, in particular the Republic of China. Although not established yet, Chinese competitors have started infiltrating the local market with the tactic of flooding the market with very cheap sub-quality ladders.

- *The Suppliers*

An important part of the external environment are the suppliers of the raw material used in the transformation process. In this regard, the main supplier is *Hulett Aluminium (Pty) Ltd* who manufacture and supply the extruded aluminium profiles used as the stiles and rungs in the production of ladders. According to the Management, this is the only reliable extruded aluminium supplier in the Western Cape, who are also the biggest producers of extruded aluminium in the area. In the past various other suppliers have been tested, the main competitor to *Hulett Aluminium* being *Wispeco (Pty) Ltd*, however the price, quality and service have not been satisfactory.

However, although *Hulett Aluminium* have an extrusion plant in the Western Cape, the plant is limited in terms of its output, having the facility to only produce smaller extrusion profiles. The bulk of the required profiles therefore are delivered from Pietermaritzburg, where their main plant is situated.

The various extrusion profiles required by the Manufacturing Division are ordered on a weekly basis with the supplier lead-time being 2 to 3 weeks. This requires a provisional production schedule four weeks in advance, based on pending orders. Minimum order quantities per extrusion

profile are by weight and are set at 60kg. Below this, the supplier does not consider it to be cost effective to extrude. The various profiles ordered from *Hulett Aluminium* are ordered according to length, with only the fast movers being ordered to the approximate size required for manufacture. The sizes are delivered 5mm to 15mm longer than ordered, to allow for deformation of ends whilst punching extrusions to size. The remaining profiles are ordered in 'common' lengths typically between 6 and 9 meters, and are cut to size according to order requirements. This is done to allow for flexibility and prevent slow moving profiles being tied up in raw material inventory for months.

For example, a certain profile X may be needed to produce a 2m step ladder. If the full 60kg minimum order quantity were to be ordered for profile X, this would be the equivalent of 120 lengths. In the event of 40 lengths being required and the product being a slow mover, the remaining 80 lengths could sit in the FE Store for more than a year, tying up capital unnecessarily.

To prevent this a longer length is ordered (6m or 9m) which accommodates a wider spectrum of products, however also results in a higher % wastage. To illustrate, if a 5m ladder is now needed this results in either a 1m or 4m off-cut which may or may not be reusable. In this regard, the Division has only recently correctly programmed an accurate Bill of Materials (BOM) into their computerised IMPACT Management System used for the correct costing of the ladders.

At the time of the study, the supplier was delivering 5 tonnes of raw material per week, however in the past during peak seasonal periods, as much as 12 tonnes were being delivered. The suppliers themselves punch up to 30 tonnes of extrusions per day.

- *Macro-economic Influences*

This is a broad category of factors influencing the system in focus, mainly in view of the economic and political environment affecting the stability of the South African economy. The aim is not to provide any specific detail as this justifies an independent study topic in itself. Nevertheless, the macro-economic influences are a serious consideration pertaining to the constraints limiting the system.

In particular, the local economy in general is declining, which clearly influences the demand for ladders. With the country's political turmoil, increasing crime rate, high comparative labour costs and amended labour relations act, foreign investment is decreasing and the growth of the economy stagnating. With less foreign investment, there is also less direct growth activity such as building and expanding industries. In turn this has a direct bearing on the ladder market due to the fact that from a commercial application point of view, ladders are used in building and industrial applications. Further, the trade unions are stimulating wage levels unjustified by comparative productivity, thereby reducing the demand for labour and decreasing the amount of jobs available. These affects clearly are diverse and far-reaching, the least of which resulting in less consumer spending especially on less essential commodities such as ladders, due to less disposable income per capita.

Additionally, South Africa is entering the global market and being affected by entirely new dynamics. Reduction in trade barriers for example has brought home the fact how poorly competitive the local industry is, and foreign competitors pose a clear threat to the ladder industry.

### 1.3 The Purpose

As discussed in Section A.4.2 (Appendix A), each system has a purpose that aims to make the system viable for its stakeholders and the surrounding context. The perception of this purpose varies, depending on the relevant stakeholders. For the *C&L inc. Forlezer Manufacturing Division*, the stakeholder perspectives are held by the containing organisation (Klipton Industrial), the Sales Division, the Division employees and the Management of the Division.

As is often the case in organisations with an uneducated workforce, there is a significant difference in the perception held by the workforce and that of the remaining organisation of what the system in focus actually aims to achieve. In general each stakeholder will tend to interpret the system's purpose to suit their particular need. This influences the actual intended purpose of the system depending on who has the most power in the situation. If the actual purpose intended for the system is not explicitly understood and agreed upon, this may result in severe limitations to the system as well as potentially creating misunderstandings and conflict amongst stakeholders.

In sharing and creating an awareness of these individual stakeholder perspectives, and understanding the goals they pursue and why, an appreciation for the common purpose can be achieved - which is vital for the synergy of the system. The interpretation of the purpose of the Manufacturing Division as seen by the various stakeholders involved (in simplified form) follows. It should be noted that this was based on the researcher's perceptions, gained from the various discussions held with the stakeholders and the general interactions observed, which are clearly subject to interpretation. Difficulty in clearly defining each stakeholder's perception was experienced due to the stakeholders being unfamiliar with the systems language being used. Further, the actual interest and support shown by the Management to uncover this understanding limited this approach.

- *Klipton Industrial*

The Group's expressed purpose is to maximise the return for its shareholders. To do this the purpose of the Manufacturing Division is perceived as supplying the Sales Division with a product that sells using the minimal amount of capital to achieve this. Further, due to the factory operating on a recovery basis, the purpose is to recover all fixed and variable costs incurred in manufacturing and supplying the product, whilst maximising the capital employed in the process. This purpose pursued by the Group is founded in an 'owner's' perspective who in the event of unsatisfactory results has the power to close the system down.

- *The Sales Division*

The Sales Division, consisting of the individual sales branches, perceives the purpose of the Manufacturing Division as existing only to satisfy their demand – i.e. to supply orders as quickly as possible at the highest quality for the end-user. It should be noted that in the past there was no explicit perception that the Manufacturing Division should manufacture more cost effectively. It was a given assumption that the Division was producing the ladders in the cheapest manner possible. However, with the increase in competition in the market place the focus has shifted from a quality and brand name driven market to a price driven market. Consequently, the purpose of the Manufacturing Division has shifted to the manufacture of the same product, only more cost effectively.

Because the sales branches are not completely dependent on the sale of ladders, it is also perceived that the Manufacturing Division is responsible for producing relevant products that are in demand. The sales branches are thus concerned only with keeping their own customers happy and in this regard, their purpose is to sell ‘no matter what’. The Sales Division enacts the stakeholder position of ‘customer’ for the Manufacturing Division.

- *The C&L Management*

The purpose of the operations function as perceived by the Management, is to supply the sales branches according to the orders received whilst operating the factory with the least amount of ‘problems’ – that is, to successfully convert the raw material input into the required output whilst ensuring that the system (factory) remains operational and under control. An espoused purpose is to also provide employment and contribute to the South African economy/cause. In this regard, the Management embodies the ‘actor’ in the system who is responsible for achieving the real system purpose.

- *The Employees*

The employees understand the purpose of the Manufacturing Division to be a system that exploits their hard work as much as possible for the sake of enriching the Management and owners of the company. The employees view themselves as ‘victims’ of the system whom, other than being paid for their hard work, gain very little.

Having presented the various perceptions held by the individual stakeholders, the actual purpose making the system viable is considered. It will be illustrated that although amongst the ‘educated layers’ of the organisation there is minimal misconception about the overall purpose, there is a general lack of understanding amongst the ‘uneducated layers’. Although the current purpose appears to be sufficient, there is a clear lack of vision ensuring the future viability of the system.

The purpose of most manufacturing organisations is the production of a product that satisfies a need (i.e. there is a demand for the product) in the most efficient and effective manner possible. This is done typically to maximise the profit or return on investment or to ensure growth and therefore wealth.

However, with the increasing importance of job satisfaction, individual rights (as represented by the unions), environmental and social awareness on the one hand, and the realisation of long-term survival and viability by way of actualising value potentials on the other, organisations can no longer ruthlessly pursue the singular goal of making money (Espejo and Schwaninger, 1993). Although this is undeniably an essential aim of most organisations, consideration has to be given to the other underlying complexities affecting systems - in particular the human aspect and the developing social awareness of an already over-burdened planet with limited resources. It may be argued that the latter more so than the former is of no true significance yet in South Africa. However, the progressively thinking organisation will realise that this will be an inevitable influence on any system's purpose in the future.

The fact that the systems purpose must ensure the future survival of the system, becomes even more significant when considering the dynamic adaptability required to continuously adjust to the changes forced upon it by an ever-changing environment. Expressing the system purpose is thus not just a matter of stating that it has to manufacture ladders. Rather, the purpose must include consideration of how it intends ensuring that manufacturing ladders will sustain the system's existence. Moreover, other considerations must be taken to ensure its own viability in view of the stakeholders affecting and affected by the system. In pursuing a purpose, all four perspectives held by the relevant stakeholders are thus important.

Concerning *C&L inc. Forlezer*, it is apparent that the Holding Group ultimately is only concerned with the bottom line. If the system does not supply a product to the Sales Divisions that sells and therefore generates income, it ties up Group capital 'unproductively' which is not considered a worthwhile investment. The purpose as understood by the Group, or rather as enabled by the Group, appears to lack any long-term vision striving to ensure that the system remain a 'worthwhile investment'.

Acting as the potential client of the system, the requirements of the Sales Division clearly influences the purpose of the Manufacturing Division, for the client ultimately makes a system viable by creating a need. Thus, the purpose of the system is rightly construed to be the manufacturing of ladders for the sales branches - by both the Sales Division as well as the Management of the system.

However, as is evident from the emergence of the problem situation, the purpose neglects slightly to take the 'bigger picture' into consideration. For if the purpose of a system is dictated by the client, this purpose has to take into consideration that the client's need is never cast in stone and

changes over time. Moreover, since the sales branches are not the end-users, the actual purpose should more accurately be viewed as satisfying *the end market and its trends* via the Sales Division.

Similarly in view of this dependence on the end-user, the Sales Division should take into consideration the purpose of the Manufacturing Division as catering for the supply of products to the end-user, with their own role being the 'profit-making link' between the manufacturer and the market. Instead of perceiving the Manufacturing Division as being a support function to their cause (that of selling access equipment), the Sales Division should perceive their own existence in support of the Manufacturing Division, simply generating the income for the Group.

In stating that the purpose of the Manufacturing Division is to provide ladders for the end-market via the sales branches, it must be made explicit that this must be done in such a manner that ensures the continued viability of the system. In view of the current market trends, this automatically means that the ladders have to be manufactured in the most efficient and effective manner to ensure cost competitiveness, quality and service. This broad purpose can then be broken down further by asking the question:

*If the purpose of the Division is primarily to supply ladders that meet a specific market demand as well as to ensure future viability, what other aspects influencing this market and the systems viability, must be taken into consideration?*

Consideration of this question will lead not only to addressing the cost effectiveness, but also the 'softer' issues generally not associated with the purpose, which do however directly affect its achievement. In particular this involves addressing the employee perspective of the system's purpose, which clearly affects worker moral and work ethics. The owners and The Management of the system need to acknowledge that the system purpose also has to address the employees' needs (and all other underlying needs) in order to achieve the 'greater purpose'.

## **1.4 Constraints Limiting the Manufacturing Division**

The identification of constraints inhibiting the performance of a system is an essential part to effective problem solving. Constraints are either externally created by factors originating from the external environment or internally created within the boundaries of the system.

The constraints imposed externally are mostly beyond the direct influence of the defined system and are created by the environmental circumstances to which the system is subjected. This does however not imply that they should be accepted. External constraints can often be resolved by shifting system boundaries for example, and all potential opportunities for elimination of constraints must be considered.

Internally created constraints are mostly due to ineffectiveness and are thus a primary area for system improvement. Internal constraints typically include both 'hard' and 'soft' problems. It will be demonstrated by the thesis, that both areas need to be considered when trying to address constraints. In view of achieving potential improvements to a problem situation, the concern should thus first focus on resolving internally created or perceived constraints, as this is the area of highest leverage to affect improvements or changes.

#### 1.4.1 External Constraints

In this particular instance the main external constraints that identified are:

1. The current economic situation affecting South Africa. Clearly with the local economy facing a recession and the various factors affecting foreign investor's interests, in general the economy is not sustaining its growth. This in turn is affecting the consumer market. Increasing unemployment and living costs are resulting in people being 'out of pocket' and therefore the demand for commodity items such as ladders is low.
2. Consequently the shift in the market trend from quality and brand name products to cost competitive products is inevitable. This market trend could however have been anticipated, as this trend has not only been observable in the ladder industry but almost everywhere.
3. One of the main external constraints imposed on the Manufacturing Division by the 'greater organisation', Klipton Industrial, is the manufacturing policy of operation on a recovery basis. This is resulting in two major constraints. Firstly, because the Manufacturing Division is not a profit centre, only a cost centre, there exists no real desire to minimise costs and produce ladders either as effectively as possible or to drive the companies market initiative further. Secondly, the Division has little power to act on its own initiative and further develop and improve.
4. Related to the above constraint created by the organisational structure is the limited capital investment approach adopted by the Group.
5. A further environmental constraint limiting the system's performance, are the existing competitors. Because of these competitors, the system faces the current problem situation, however the only way to reduce this constraint is by offering a better product than the competitors, or by diversifying and finding other markets.
6. The fact that the Division is dependent on one raw material supplier, or rather that there is only one current supplier catering for the Division's raw material needs is also construed to be an environmental constraint. In this regard, the Division only has bargaining power in terms of the potential profits that the supplier could earn. With no competition the supplier can dictate the

prices as well as the 'terms and conditions' of supply. For instance, the supplier requires a minimum order quantity of 60 kg with respect to any extrusion profile ordered. This is resulting in the manufacturer having to order common lengths to maintain some degree of flexibility, as well as causing excessive waste.

7. One of the additionally perceived environmental constraints is the limited availability of space in the factory. This is however directly linked to the poor factory layout which is an internally created constraint that is easily removed.
8. A final external constraint affecting the system is the geographical location of the factory. The Division is far removed from the mainstay of their market, which is located in Johannesburg. Additionally the location of the factory is far away from the main extrusion mills of *Hulett Aluminium*, thereby resulting in limitations in terms of raw material requirements.

#### 1.4.2 Internal Constraints

The internal constraints form the main discussion in the latter part of the thesis and thus are only briefly presented here. The main constraints identified are:

1. The inefficient layout of the factory, mainly in terms of the production lines in the Production Department as well as the various parts comprising the Manufacturing Division.
2. The level of understanding and education amongst the workforce. Most of the line workers have no more than a standard 8 qualification.
3. General discontent of the workforce.
4. Poor management-union relationships and consequently poor worker-management relationships.
5. Generally an insufficient organisational and managerial structure, the effects of which are further discussed under Sections 1.8 – *Organisational and Managerial Issues*.

### 1.5 The Worldview Pertaining to the Manufacturing Division

The principal worldview pertaining to the system is derived out of the manufacturing context, or more specifically the Operations Environment. For the readers further reference aspects of this context are discussed in detail in Appendix B (Section B.1). Historically the manufacturing environment has endorsed the maximisation of profits as much as possible, however in recent times this approach has changed.

Organisations can no longer exploit the individual for the sake of profit maximisation. One need only consider the world-wide unionisation, which has transformed worker rights in the last half

century. This view is presently very relevant in the South African context and particularly in the system being considered.

An actual view governing the system is that the Manufacturing Division provides an opportunity for employment in an environment where work is not easily available. The nature of the work does not require skilled artisans, and thus there is no dependence on a skilled workforce. Employees achieve the required level of competence under the supervision of a foreman and through hands-on experience. Consequently, there exists the perception that workers cannot find meaning in their work and thus the only motivational factor perceived is through setting daily production targets, which, when they are achieved, allow the worker to earn more. There is no focus on educating, promoting or increasing the skill levels of the workforce, which is contrary to most progressive international manufacturing organisation's views that the worker is the organisations most valuable asset.

This worldview is clearly not shared by the work force, who perceived the organisation as having an obligation to take care of its workers. There also is an underlying consent governing this worldview that the historical and political past of South Africa is to blame for the general demise of 'the people'.

Significant in this regard, is the general worldview within manufacturing organisations that a large labour force is expensive, unreliable, inefficient and unproductive in comparison to the fully automated technologically advanced production facility. Providing labour intensive production facilities is not of benefit to the organisation, as it is more expensive, produces more complications in terms of human dynamics and is subject to human variation and error.

Within *C&L inc. Forlezer* there is a distinct lack of a shared 'meta-language', i.e. an appropriate language used to communicate about the manufacturing environment. In this regard one of the leading meta-languages applicable is the subject matter of Factory Physics, a topic dealt with in Appendix B (Section B.3) as part of the literature review. As alluded to by the name, Factory Physics is concerned with the science of factories and defines parameters that clearly describe the fundamental behaviour of manufacturing systems. It enables efficacy within a manufacturing environment through effective communication, whilst promoting common understanding. The problem is that it is a complicated and involved topic as manufacturing in its own right is.

## 1.6 The Dynamics of the Parts

The section concerns the analysis of how the output of the Manufacturing Division is achieved. Essentially this involves looking at the individual parts and identifying what role they play in producing the transformation process. Again a Systems Approach is taken, whereby the required inputs, transformations and outputs of each part are identified. More comprehensive detail is included under Section E.1 (Appendix E).

*i) The Finished Extrusion Store*

The purpose of the FE Store is for the storage and control of the various extrusion profiles required in the manufacturing process. Storage is arranged according to profile type however, as mentioned in Section E.1 (Appendix E), this storage is unstructured and inefficient. The store receives the extrusion profiles from the supplier, *Hulett Aluminium*, on a weekly basis according to orders generated by the factory's computer controlled inventory control system. The raw material is delivered in minimum order quantities and offloaded in random heaps in the designated goods receiving area of the store. The offloading happens under the supervision of the Production Supervisor, who checks the delivered quantities and profiles against the orders.

Subsequently the material has to be sorted and stored in randomly allocated vertical storage spaces in the store. This involved unnecessary movement of the raw material from a vertical position, to a horizontal storing position, and back to the vertical whereupon the material is issued to the production floor.

The output required from the store is the efficient supply of the required extrusion profiles and lengths to the production floor. The raw material is issued either directly to the Production Department (if the profile is already of the required length) or to the Cutting Department, in accordance with the daily production schedule requirements. The material is moved from the store to the cutting or manufacturing department on worktables mounted on wheels.

*ii) The Cutting Department*

The purpose of the Cutting Department is to cut the various extrusion profiles to the required length as specified by the production schedule. The local transformation achieved is the supply of the correct extrusion length to the Production Department, and thus the input is the uncut profile, the output the cut profile. A further purpose is to cut and supply specific profiles required by the FC Store as finished components.

The flow of material itself from the FE Store through the Cutting Department and onto the production floor of the Production Department is disjointed often involving excessive travelling and carrying. The extrusion lengths arrive at the Cutting Department on mobile worktables, are off-loaded on the cutting tables, and upon completion stacked back onto the worktable or stored in crates. From here the material is gathered by the production line operators and either carried or the worktable pushed to the appropriate line.

*iii) The Finished Component Store*

The FC Store provides all the components that are required for the completion of the ladders during the manufacturing and assembly process. The purpose of the store is therefore to supply the necessary components needed by the Production Department in accordance with the weekly

production schedule. To effectively supply the Production Department, the FC Store has to reorder, store and issue the relevant components.

Typically, these components are issued when the line supervisor requests the needed components for the particular product currently being manufactured. The required components are filled into bins that are carried back to the assembly areas by the supervisor or operator collecting the components. Mostly this involves two or more trips, or two or more operators for collection, as all the required components cannot be carried by a single person in one go.

There is no direct control or record of the amount of components being issued, other than regular stock takes and comparisons with the theoretical stock carried on the computerised inventory system.

#### *iv) The Production Department*

As implied by its name the purpose of the Production Department is the actual manufacturing of the ladders. The inputs required by the Production Department are the extrusion profiles supplied, cut or machined to the correct length as well as the finished components used. The transformation is achieved by a series of operations performed by the various line operators designated to the individual production lines. Broadly speaking this process can be divided into two categories. One involves the 'machining' operations to the stiles, rungs and ferrules, the other the 'assembly' operations of all the remaining components (such as rubber feet, hinges, hooks etc.) to the ladder.

The basic operations performed by the production lines during the manufacturing process are the following:

- The cut rungs, stiles and ferrules are received from the Cutting Department in the correct length. The stiles that are delivered to length from the supplier are received directly from the FE Store. Where machining on any of these parts is required, in particular on the square rung profile, the parts are received from the Tool Room.
- During 'machining', holes for the rungs are either drilled or punched into the stiles of the ladder. Where possible holes for other attachments and finished components are 'machined'.
- On certain products or production lines, the stiles or profiles are bent, pressed or expanded using the appropriate jigs.
- The ferrules are deburred in the tumbling machine after which they proceed to the crimping machine.
- The cut rungs also proceed to the crimping machine, where the ferrules are crimped to the rungs. (The ferrule is added to the rung in order to allow the rung to be joined to the stile and performs a strengthening function.)

### 1.8.3 Control

The control within an organisation deals with the ability to set appropriate goals, detect errors and correct them. This involves monitoring and action. As observed during the inquiry into the problem situation and as is to be expected due to the lack of policy, this area is poorly developed. The Management appear to have the perception that control involves mainly the monitoring of the workers, which it does authoritatively.

### 1.8.4 Intelligence

As with the control aspects discussed above, the intelligence of the system is also underdeveloped. The ability to make sense of and model the organisation and its environment is critical for its survival and adaptation to continuous change. The mere fact that the problem situation under analysis has developed is an indication that the organisational intelligence is ineffective.

### 1.8.5 Understanding the Environment (Context)

Contextual understanding requires management to have an in-depth knowledge of the system in its entirety. Based on this understanding management is required to effectively guide the system on three levels – the short, medium and the long term. The extent to which the Management is doing this in the Manufacturing Division is questionable. In turn, the Management's understanding of the system and its environment is questionable.

As in the discussion on the organisational issue of intelligence above, it can be argued that if the Management in fact had a clear holistic understanding, the situation that is faced would not have emerged. In part, this is one of the main aims of the thesis, to uncover the context and create a better understanding in order that effective problem solving can be achieved.

As will become apparent in Chapter 2 on the discussion of the problem statement, one of the main concerns in view of the understanding that the Management have of the context, is the apparent lack of insight into the 'softer' underlying issues that principally are generated by the interaction of humans within a system.

However even in terms of 'hard' factual issues, there appears to be insufficient knowledge and understanding. This is particularly in reference to the operations environment. Although faced continuously with the dynamics of a manufacturing environment the MOPs required to effectively understand and control this environment are lacking. The complete lack of the appropriate meta-language needed to describe and understand the production environment verifies this assumption.

### **1.8.6 Enabling the Organisation**

Enabling the organisation is management's primary function. Within the limitations of the external constraint imposed upon the system, the extent to which management achieves this objective determines the efficiency and effectiveness of management itself.

Again, the extent to which the Management of the Manufacturing Division is achieving this is questionable. The finger is quickly pointed at the factory workers blaming them for being unmotivated, uneducated and more involved in union activities than concerned with their jobs. Clearly this is no easy problem to resolve, however other than use this situation as an excuse, little has being done.

A good example in this regard is the lack of initiative that was shown by the Management after the completion of the numerous other studies undertaken on the system. Despite factual evidence of deficiencies in various areas, Management had not acted on a single problem area identified. Consequently the current problem situation has developed to the extent that the system is now forced to act if its existence is to be sustained.

### **1.8.7 Settling Socio-technical Disputes**

The main socio-technical dispute facing the Management is the cross-functional relationship between the Cape Town Sales Branch and the Manufacturing Division, and to a lesser degree the inter-departmental relationships.

### **1.8.8 Resolving Socio-political Conflicts**

It is evident from the amount of union activity in the system, that the Management is not resolving conflict but creating it. The 'us-them' approach that the Management has adopted towards the workers is the main cause of this conflict. In turn this is again related to the understanding the Management as well as the employees have of the context and the extent to which the Division is enabled.

# CHAPTER 2

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## 2.1 Developing the Concern

Having presented the Manufacturing Division as the system in focus in the previous chapter and having presented the context in which the problem situation emerged, the aim of Chapter 2 is to now focus specifically on the eminent concern underlying the situation.

The concern is what makes the research undertaken for the thesis relevant, and is derived from the contextual situation. In addressing the concern the aim is to address the problem situation. Primarily the concern identifies and clarifies the real problem within the broader context. In this regard, a hypothesis is derived that reflects on the concern, which will be tested within the parameters of the research undertaken. Ultimately in the conclusion stages of the thesis, the adequacy of the concern developed will be reflected on, as well as the validity of the research.

Clearly the adequacy and validity will depend on the extent to which the concern addresses the situation. For the scope of the thesis, the concern may adequately address the situation and the research undertaken be valid, but the problem may nevertheless not have been 'solved' in that the required action may not have been implemented. Depending on the contextual circumstances and the complexity of the problem, the actual solution to the problem/s may need to be further addressed.

What is assumed however, is that if the concern is adequately addressed within the research context that the thesis focuses on, an in-depth understanding of the actual dynamics governing the problem situation will be gained which will allow clear understanding of what is actually causing the problem. In turn, these individual causes can then be addressed in time, which will then in turn lead to the resolution of the problem.

The concern itself is developed by first considering the Management's perspective of the situation and how to resolve it and then reflect on this from the developed perception of the 'problem situation' in Chapter 1. The reason this comparative approach is adopted is because the Management had initiated the research based on a preconceived idea of what the problem was. However, Management may not have identified the correct problem, or may only be addressing a certain part of a far bigger problem. This in turn is a direct reflection on the understanding that Management has of the situation and therefore their capability to effectively resolve the situation. To do this it is paramount that the correct concern thus be developed.

## 2.2 An Overview of the Problem Situation

In view of the poor current and past financial performance, the Management of *C&L inc. Forlezer* over the past three years had undertaken a quest to increase productivity in the hope of retaining competitiveness. Having previously had to reduce the factory's workforce in 1996 by 22% due to the same problem in order to reduce costs and remain competitive, the Management realised that action needed to be taken to improve the company's performance. Numerous aspects were looked at and in a joint venture with the School of Engineering Management of the University of Cape Town, several research projects were launched.

Having initiated this first step however, at the time the current research was undertaken, very few problem areas that had been identified from the prior projects had been addressed. For instance, despite a completed project in which the process flow and production methods had been analysed and found to be vastly inefficient, especially in as far as the factory layout was concerned, the Management had undertaken no further action.

Not surprisingly, due to the ever-increasing competition the company was now facing a reducing market share threatening the company's viability, which was cause for much overdue concern. The direct reason for this was due to the fact that the company's main competitors, *SA Ladder*, had caught up in terms of quality and was offering better prices. *SA Ladder* has gradually increased their market share in the Johannesburg area as well as penetrating the Cape Town market, both of which to date had been dominated by *C&L inc. Forlezer*. To regain their competitive advantage, the Management thus realised that the overall costs per ladder had to be reduced.

Of major relevance in this regard was the fact that 70% to 80% of the company's market is located in the Johannesburg (Gauteng) and Durban (Natal) areas, whilst the factory is situated in Cape Town (1500 km away). This is directly resulting in an additional 15% transport cost per ladder, which competitors in the Johannesburg and Durban areas do not have. In the past, the company has built a name of quality and reliability particularly in view of being associated with the Forlezer brand name. Even though the trade name Forlezer still has the status quo of a quality product, the Management realised that in today's market, quality no longer was an advantage/commodity but a prerequisite. There thus existed a very real need to offer competitive prices as well as good service and quality in order to remain a market leader.

The only alternative as far as the Management was concerned, beyond closing down the factory and moving to Johannesburg, was to increase the Manufacturing Division's productivity. The aim was to increase the throughput on the production lines to the extent that the 15% transport overheads are absorbed. In particular, it was felt that some of the production lines could increase their output by up to three times their current capacity. The MD of the company arrived at this figure after having visited the Forlezer factory in the United States of America and compared similar production lines and their output with the local ones.

In addition to the eminent threat of a reducing market share, the Management came under pressure from the Cape Town Sales Branch. The poor layout of the various 'departments' contained within the Manufacturing Division were directly affecting the branch, sharing the factory premises. In particular, the Sales Branch was utilising various available storage areas located throughout the factory, which were far from optimal in terms of material handling.

The Sales Branch was planning an expansion of their operation, which required additional stock to be held. In view of insufficient storage space and knowing that the actual factory layout was inefficient, a proposal was developed, laying out their additional space requirements. This proposal was put forward to the Klipton board of directors and the Management of the Manufacturing Division suggesting a relocation of the factory floor layout as presented in Figure E.4.1 (Section E.4, Appendix E). In response the board decided that the additional space requirements were to be accommodated by the Manufacturing Division if a feasible solution could be found which did not interfere with the production processes.

As a result of these developments, the Management of the Manufacturing Division again initiated a project aimed at solving these problems. The Researcher's involvement was arranged in a similar manner to previous projects, with the Management providing a brief setting out their concerns and aims as presented in the following section. It was however made clear to management that the scope of research would have to fall within the parameters for fulfilment of a Masters thesis.

### **2.3 Perception of Problem Situation by Management**

From the interaction during the initial stages of the research undertaken, it became evident that Management were not considering the problem situation within its context, but were looking for single isolated causes. It was also evident that the Management already "knew" what the cause was and how to address the situation.

In this regard, the opinion was held that the main cause for the demise faced by the Division was due to the poor layout of the production lines which together with the line operators, was to blame for the low productivity. The problem, according to the Management, would thus easily be addressed by redesigning the layout of the production lines. At the same time, in view of the demands made by the Cape Town Sales Branch, the actual design of the factory layout could be analysed and, "two birds killed with one stone".

Management was convinced that by reorganising the lines, the throughput on some of the lines could be tripled, although this assumption could not be quantified. It was argued that in tripling the throughput, the overall costs per ladder would be reduced, and the 15% transport overhead adequately absorbed. Again this argument had not been quantified, and the % absorbed was unknown and unsubstantiated.

The 'worker problems' were ascribed to the generally poor level of education of the workforce, and as this had 'always been a problem and would always remain a problem', it was considered a waste of time analysing these underlying issues.

In this regard, it was felt that the workforce was unmotivated, uncommitted, and only interested in their bonuses and union empowerment. In the past, the Management felt it had done everything in its power to motivate the workforce and explain to them what role they played within the organisation. This however, had had no effect and with the lack of interest clearly all efforts were currently pointless, especially in view of the present problem situation faced by the company. According to the MD unless the workers were rewarded for 'every single thing', it was impossible to make them buy into the company. Although upon initiating the project, the MD advised that he had even gone as far as inviting the union representatives to lunch and explaining the company's predicament, he had had nothing but opposition.

Again, in view of the seriousness of the company's present position, it was decided by Management to initiate the project with a view to improving the factory layout whilst involving the workers as little possible until such time as the layout plan had been completed. Upon completion of the plan it would then be presented to the union and argued appropriately. The MD of the Manufacturing Division, setting out the aims of the improvement project gave the following initial briefing:

1. Due to the increasing competition and the threat to the factory's viability, the total costs per ladder had to be reduced. The primary cost factor of concern was the 15% transport cost incurred by transporting the ladders from Cape Town to Johannesburg. To achieve a reduction in price, there were two alternatives. One was to close down the Cape Town factory and relocate it to Johannesburg, the other to increase the productivity and efficiency of the manufacturing process, thereby reducing the overheads. In view of the expenditure involved with moving an entire factory, the only perceived viable option was the later.
2. Several of the production lines were known to be inefficient. These lines were to be analysed and redesigned, the aim being to remove all unnecessary operations and allow for the shortest possible material flow through the lines. Specifically the aim was to triple the throughput on the ALFLO line, perceived as the 'bread and butter' line.
3. In view of additional space required by the Cape Town sales branch, the entire production floor layout was to be investigated and if needed, redesigned. The area locating the current raw material store was provisionally allocated to the sales branch, however it was to be investigated whether this was a feasible solution.
4. In rearranging the layout, the reinvestment had to be minimal or else the factory could just as well be relocate to Johannesburg.

5. The relocation of the production lines and departments was to be completed over the seasonal four-month 'quiet' period (from July 97 to October 97) so that when orders started increasing again the factory could benefit from the improved productivity.

The instructions given in the brief clearly reflected Management's primary concerns and demonstrated their understanding of the problem situation. From the outset, it was however very clear to the Researcher that the problem situation involved more than a simple redesign of the factory layout. Prior to continuing with the research, it was thus necessary to consider the underlying concerns that should guide the research direction, in order to ensure its validity.

Based on the development of the problem situation and the insight gained during the definition of the system in focus in Chapter 1, various concerns were surfaced during the early research stages, which eventually forced the Researcher to consider the potential of a systems failure. The main concern emerging was that the Management was not open to tackling the problem situation holistically/systemically even though it claimed to be doing so. In particular the concern involved the preconceived perceptions and attitude of Management towards the underlying 'soft' problems encountered. It was evident that the mental model held by the Management and used to think about the organisation and to manage it, was highly inappropriate. In this regard, various mental models and their characteristics are discussed in Section A.2 (Appendix A).

It became clear at this stage of the research that it would be guided more by theoretical content based on a Managerial analysis, as opposed to actual implementations (action research) in view of the lack of interest the Management expressed and the commitment to affect real change.

## 2.4 The Emerging Concerns

Taking into consideration the context of the problem situation and the Management's perception of the problem situation, it became evident that the mental model predominantly embraced reflected the mechanistic approach as is discussed in Section A.2.1 (Appendix A). In this regard, the operations function exhibits typical mechanistic traits.

To maximise efficiency, the operations and responsibilities have been broken down at the shop floor level into their smallest possible components and provision been made to keep information flows to a minimum. Consequently the operations performed are mundane and demotivating, job satisfaction poor. The general attitude of the Management towards the workers is that they are easily replaceable and they are not considered an asset to the organisation.

The organisation itself is typically hierarchically structured, with the Klipton Group having total external autonomy over the Manufacturing Division. Consequently the group has imposed policies relevant to their own interests, which are not necessarily in the interest of either the system in focus

or the containing system. Further the system is not attributed with a purpose of its own, but only that of the 'greater organisation'. The individuality of the workers or even the workforce as a whole is not recognised, and the aim appears not one of developing the workforce but controlling it. All these signs characterise the mechanistic model.

Although Management claims to have 'tried everything' this has been done from its own perspective and there seems to be little understanding or empathy with respect to the background and origins of the workers. There is also a strong tendency to blame the workers for everything without reflecting on blame ascribable to Management itself. In terms of Flood and Jackson's (1991) political metaphor (Section A.2.4, Appendix A), the situation between the Management and the workforce is typically coercive.

As postulated in the discussion on the mechanistic model, the organisation exhibits an inability to learn and change in accordance with its environment, which is why the current situation has emerged. Even after having undertaken the initial research projects due to the awareness that a problem was developing, Management was unable to act, illustrating the dysfunctionality typically associated with the approach.

In terms of MOPs, the enterprise appears to be mainly driven by short-term return on investment and profit maximisation, again typical of the mechanistic view. Faced with a reducing market share and the severe threat to the systems viability, which had been eminent for at least two years – since 1996 when 22% of the staff were laid off to reduce costs – the system was only now *reacting* and attempting to regain its former state. During the period of 1996 to the current period the system had simply been *state-maintaining*, clinging to its past position (figure A.1, Appendix A). As with a machine that is operated without any preventive maintenance and only repaired once it has broken down, Management were content with maintaining the systems state until forced to act.

In view of this mental model held by the Management, and their perception of the problem situation as discussed in Section 2.2, the main emerging concern when viewing the situation in terms of a systems approach (as discussed in Appendix A) is that Management was adopting a reductionist approach to a socially complex problem. Quite clearly where the situation involved numerous 'soft' philosophical issues requiring attention, Management was only concerned with addressing the obvious 'hard' factual problem of optimising the factory layout. Therefore even if the Management correctly addressed the redesign of the factory layout in view of 'hard' quantitative measurable variables, without taking the underlying 'soft' qualitative issues into consideration, the improvement project would at best be a short-term solution.

Based on the above concern, the Researcher emphasised that the redesign be systemic and all aspects affecting the problem situation be investigated in order to ensure a long-term solution. In light of various deficiencies in the organisational and managerial dynamics as well as the views expressed by the Management concerning the workforce, it was emphasised that these 'softer'

issues had to be taken into consideration to avert another research failure. Nevertheless, the Management expressed their reservations that these were 'very delicate' subjects best not addressed within the framework of the above-presented context.

It was subsequently explained that if the Manufacturing Division as a whole was to be analysed to identify potential problem areas, the human dynamics governing the behaviour of the system could not be neglected. This included looking at organisational and managerial issues affecting the performance of the Division, as well as the underlying human dynamics. It was again highlighted that the scope of research at a Masters level was beyond consideration of only a factory redesign.

Seemingly pressurised by their current deteriorating situation, the Management agreed to reflect on the situation as a whole, using the redesign as a "first phase" to the resolution of the problem. It was however evident that the Management was intent on only focussing on the issue of redesigning the factory layout. It was also evident that Management perceived a sense of urgency to affect changes, or to be seen doing something. In this regard, the concern was expressed that the redesign be approached systemically within the scope of the overall research aim, taking the factory in its entirety into consideration before implementing changes.

## 2.5 The Reasoning Processes

Based on the above discussion on the emerging concern the next step was to formulate in more concrete terms, the research approach to be taken. The process of deciding on the appropriate research approach involves reflecting on the underlying reasoning processes relevant to scientific inquiry. According to Peirce (Minto, 1982, p154), there are three fundamental reasoning processes which are utilised within the framework of scientific inquiry being – *abduction*, *deduction* and *induction*. In each case the inquirer makes an inference, which leads from an initial premise to a derived conclusion. Peirce's insight was that in any of these reasoning processes one always deals with a case, a rule and a result, defined by Peirce as follows (Minto, 1982, p155):

'A *Case* - an observed fact that exists in the world'

'A *Rule* - a belief about the way the world is structured

'A *Result* - an expected occurrence, given the application of the *Rule* in the *Case*.'

Thus depending on where the inquiry is started, i.e. with a rule, case or result, determines which reasoning process is applicable. As stated by Minto (1982, p155) in any complex problem-solving situation, it is likely that all three forms of reasoning will be utilised in some form of rotation, as is the case in this thesis. To better understand the logic underlying the thesis the individual processes are briefly discussed.

### 2.5.1 Abduction - The Explanatory Hypothesis

Abduction is the process of developing a plausible conjecture or explanatory hypothesis. Typically, and especially within a managerial context, this process commences when the inquirer is faced with an unexpected result. Within the managerial context of this thesis this unexpected result is an unsatisfactory situation containing problem elements which are not clearly identified.

The inquirer aims to infer a case by proceeding from the observation of the undesirable situation (*the result*), through an investigation into the cause of the situation and based on his current knowledge (*the rule*), to a set or single hypothesis (*the case*) explaining or exposing the unsatisfactory result. The cycle is depicted in Figure 2.1.

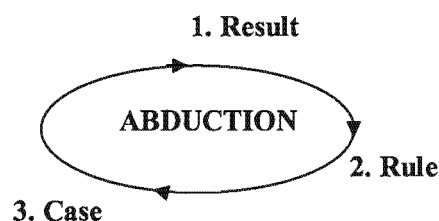


Figure 2.1 The Abductive Cycle

Practically, Peirce suggests that these hypotheses should be experimentally verifiable, be economic in terms of time and money, take into account the effect of other scientific projects and add value by ensuring that the research is based upon intelligent, structured questions (Reilly, 1970, p38-45).

### 2.5.2 Deduction - Inferring a Result

Deduction in turn is the process of deducing experimental predictions from the 'abducted' hypotheses and testing whether the predictions materialise. In the deductive phase the inquirer may use the postulated hypotheses to predict results, consequences or an outcome. As in the current thesis, this process is usually followed in the hope that the postulated hypothesis will alleviate the unsatisfactory situation and therefore resolving consequences are deduced. Thus in the deductive phase, rules are developed, used and applied to the given case (the unsatisfactory or desired situation) and the results predicted (Figure 2.2).

It should be noted that Peirce argues that virtual prediction is an experiential consequence, deduced from the hypothesis and selected as a consequence, independent of whether or not the inquirer knows the truth (Reilly, 1970, p59-62). It is a process of testing the value of the hypothesis. The inquirer must realise that this process is only a tentative explanation and therefore

the process is posed more as a question or a plausible suggestion. The outcome of deduction i.e. the 'truth' of the result, is reached not by reasoning, but by experience and must generate observable predictions.

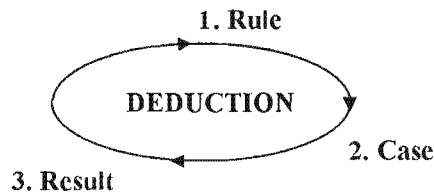


Figure 2.2 The Deductive Cycle

### 2.5.3 Induction - Inferring a Rule

The process of induction proceeds from a case and given result, to the formulation of a rule. It is the process whereby the predictions made in the deductive phase are tested. Typically some action is initiated (forming the *case*) and the *result* observed. Based on these observations and whether the unsatisfactory situation has been alleviated or not, certain *rules* may be derived depending on what proportion of the consequences generated by the postulated hypotheses are verified (Reilly 1970, p71). In this final stage, the settlement of belief is embodied in experiential observation, from which emerge new 'rules' i.e. beliefs or theories.

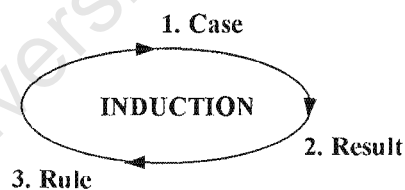


Figure 2.3 The Inductive Cycle

Peirce stipulates that during induction the characteristics of the object or event being tested for, must be pre-designated and the observable qualities be named (Reilly, 1970, p65). Also, the inquirer must ensure statistical inference, in that a representative sample selected for testing probably exhibits a given characteristic in about the same relation as the whole class from which the sample is drawn. In other words a random and fair sample of test must be undergone to correctly induce any theory from observed results (Reilly, 1970, p67). This relates closely to the validity considerations of the research undertaken.

## 2.6 Developing the Hypothesis

Having reviewed the relevant reasoning processes used during scientific inquiry, the present section identifies the various reasoning processes applicable to the structure of the thesis. To commence with, the Management of *C&L inc. Folezer*, due to the manifestation of an undesirable *result*, initiated the research undertaken for this thesis. This initiation of an inquiry constitutes the first step in the abduction cycle of this thesis. Based on the knowledge of the current situation at the time of initiation, further inquiry was undertaken during the first part of the thesis by definition of the system in focus and consideration of the emerging concern. This inquiry led to the following assumptions about how the system works – in essence the *rules* of the abductive phase:

- The predominant mental model shaping the management processes in the Manufacturing Division was based on a mechanistic approach. Accordingly there was a tendency to only react to a changing environment in an attempt to maintain a previously held state.
- The problem solving approach adopted by Management was predominantly reductionist, hence the existing desire to focus only on the redesign of the factory layout and corresponding production lines.
- The problem situation was complex and the problem not clearly identifiable.
- The problem situation involved underlying problems founded in the organisational, managerial and human dynamics governing the system.
- A Systems Approach is relevant and applicable to the situation as it provides a better understanding of the ‘problem situation’.

From consideration of the above the following hypotheses emerged:

- If an effective long-term solution to the problem situation was to be found, a systemic approach to problem solving had to be adopted.
- Within the context of the thesis, this may not result in the immediate resolution of the problem situation, however it would generate the understanding required to effectively achieve the resolution in an ongoing improvement project.
- A non systemic approach at any level of applicability, be it for resolving simple ‘hard facts’ or more complex ‘soft issues’, would result in a form of systems failure.

These hypotheses were formulated as follows and constitute the main assertion making the research viable:

*Faced with an unstructured, problematic situation, in which the underlying causes are not clearly identifiable, an organisation needs to take a holistic systemic approach to problem solving. In particular it is important that soft issues arising out of the human and managerial dynamics are identified and understood in their entirety, as well as taking organisational structure and processes into account. An understanding of the complexity and inter-dependence of these dynamics within an effective organisational structure is vital for ensuring the system's viability and achieving effective solutions. If this approach is not adopted, the resolution of a complex problem will invariably result in a systems failure – al be it that this failure only expresses itself in the long-term.*

By applying deductive reasoning, this hypothesis is reformulated as a *rule* from which the deductive cycle is initiated:

*Understanding the dynamics of human and managerial interaction as well as the influence of the organisational structure and processes in a complex unstructured situation is vital for effective problem resolution. C&L inc. Forlezer are faced with a complex problem situation in which the causes are not clearly identifiable. To successfully resolve the situation, the Management of C&L inc. Forlezer has to take a systemic approach to problem solving or else be faced with a systems failure.*

The formulated rule is then tested back in the *case*, which forms the essence of the research work undertaken. The case is the company's situation, and the rule tested by the development and application of a systemic research framework for the resolution or identification of the issues concerned.

The deductive cycle comprises both the development and formulation of the required systemic framework for effective problem resolution (Chapters 3 and 4). In applying this research framework, the outcome or *result* predicted is an in-depth understanding of the 'problem situation' from which (depending on the contextual situation) effective actions for the resolution of the situation can follow.

The application itself forms the inductive cycle, which theoretically aims to test the validity of the research approach. In this regard, the theoretical framework is applied to the situation forming the '*case*' and the outcome of this application the observed '*result*'. Based on the observations and reflecting on the validity of the research, the general applicability of the original hypothesis is tested.

# PART II

## THEORETICAL CONTENT

Part II aims to develop a conceptual framework for understanding and resolving the ‘problem situation’ presented in Part I. Part II embodies the theoretical content of the thesis, which is applicable at three levels of recursion at which thought processes take place, namely the operational level, the methodological level and the philosophical level.

The operational level concerns ‘hard’ factual problems, the resolution of which is dealt with on the basis of logic using various quantitative and analytical techniques. When problems are experienced within the operational level which are not resolvable using these techniques, the problem solving process moves up to a higher level of recursion or thinking, being the methodological level. At this level, the encountered ‘soft’ problems are typically dealt with using methodologies termed *soft systems methodologies*. Finally when problems are encountered at a methodological level, a philosophical approach is needed that questions the very essence of our thought processes.

Within the scope of the thesis, which concerns more the resolution of organisational and managerial issues affecting *C&F inc. Forlezer*, the operational level is not considered in any detail other than during the application in Part III. It is argued that management generally adequately deals with the resolution of problems at an operational level, in fact, often deals with it too well. Typically management focuses only on the operational level, mainly because it concerns the day to day running of a system where it is easier to achieve results.

The ‘softer’ dynamic issues or long-term strategic issues are less adequately dealt with as in the case of *C&L inc. Forlezer* which is what the thesis aims to focus on. For the purpose of the thesis, the operational level was analysed to exhume certain underlying problems and in this regard the redesign of the actual factory layout at *C&L inc. Forlezer* is included. The intention however was that this forms the first step in a ‘bigger picture’, a continuous improvement cycle, which concurrently strives to reveal the underlying ‘soft’ issues in order that a truly systemic solution is arrived at.

Part II thus develops a research framework effectively aimed at dealing with the underlying ‘soft’ issues that were identified during the discussions on the problem situation. The approach taken was to first develop a philosophical framework in Chapter 3, in which the nature of the inquiry process itself is reflected upon, and then, in Chapter 4, to develop an inquiry framework for guiding the actual research process.

# CHAPTER 3

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## 3.1 The Philosophical Framework

As can be seen from the hypothesis formulated in the previous chapter, the concept of comprehensively understanding a problematic situation is perceived as critical for achieving effective problem solutions. Understanding leads to identification of real and specific problems (as opposed to problem areas) which in turn allows for successful corrective action to be taken. As a whole however, the understanding achievable by any individual is limited by his/her perception of a situation, the knowledge at his/her disposal pertaining to the situation (including experience) and his/her own personal belief and value system.

The aim of this chapter is to present a philosophical framework that questions the understanding of any problem situation and reflects on the actual problem solving process we as researchers are likely to use. The reason being that in order to fully comprehend and deal with concepts introduced by the methodologies that are used in this thesis, there is a need to relate the underlying philosophies that the methods of enquiry are based on. In developing a philosophical framework the effective aim is, as problem solvers, to make explicit any assumptions and beliefs which operate in the periphery of our conscious thought processes which influence our perceptions, decisions and actions.

There exists a need to question the basis of our knowledge and understanding so as to gain more insight into its validity. The fundamental nature of the inquiry process itself needs to be questioned in order to establish its coherence, validity and rigour. By doing this, it is hoped to attain a level of understanding, which is over and above dealing with problem solving at a purely methodological level where the research for the thesis is undertaken. A starting point is thus to consider the main aspects of philosophy.

## 3.2 The Aspects of Philosophy

The three cornerstones of philosophy pertinent to the development of a philosophical framework are *epistemology*, *metaphysics* and *axiology* (Buttler, 1968). Respectively these philosophical topics deal with the question of knowledge, the nature of reality and the importance of values. The aim is to show that the three areas form the foundation for the conceptualisation of what has been termed the 'truth', which ultimately is the requirement for effective problem solving. For, in general, most knowledge, values and perceptions of reality are unequivocally accepted, taking them for granted without checking the content or context thereof i.e. verifying their truth content.

A philosophical framework therefore needs to aid problem solvers in the description and understanding of their values, reality and knowledge and those of the other stakeholders concerned, as well as providing an awareness of their implications. A brief discussion on the issues of knowledge, reality and value and the significance in terms of developing a philosophical framework follows.

### 3.2.1 Epistemology – Dealing with the Question of Knowledge

Epistemology deals with the question of knowledge, the inconclusive nature thereof, how it is acquired and how we judge its validity. *How does mankind know what is real? How do we come by knowledge, what are its instruments and how can we be sure it is true, not erroneous or illusion?*

When taking aspects of knowledge into consideration in a contextual problematic situation, the realisation can be made that the effective resolution of any situation is dependent on the relevance and truth content of the knowledge at disposal. Considering that knowledge comprises the ‘tool’ we utilise to help in analysing, understanding and resolving problems, it is crucial that we be critical thereof.

At a methodological level the researcher operates in acceptance of the knowledge at his/her disposal, utilising the methodologies to solve issues in the operational level. However s/he has to be very aware of the outcome of any intervention. When the application of methodologies does not lead to any satisfactory solutions/progress, there is a need to question the fundamentals of this knowledge. This would include an awareness of whether the assumptions about both the situation and the methodologies are correct, whether the correct methodology is being utilised in view of the problem at hand and whether it is being applied correctly.

Contextually the aspect of knowledge also has far-reaching managerial implications, for each manager and individual being managed, acts and thinks according to the knowledge at his/her disposal. And indeed each manager and individual holds his/her own assumptions about how knowledgeable he/she is. This has direct bearing on every situation, for few people operating in their domain will admit or be aware of the fact that their knowledge to successfully deal with arising issues is incorrect or insufficient. In this regard, the manager’s task is doubly complicated, for not only is he/she responsible for the awareness of his/her own limitations, but also those in his/her employ.

### 3.2.2 Metaphysics – Dealing with Reality

In dealing with problems of reality, metaphysics addresses questions of the nature: *What kind of world is this that we live in? What kind of structure does the universe have? Is there a core*

*existence that cannot be disputed and what is it?* When speaking about reality the generally properties ascribed to it are (Buttler, 1968, p18 *et al*):

- That it is solid and enduring, self-subsistent, not depending on anything else to maintain its existence.
- That it is bound by no limits of time, and is therefore eternal.
- That it is also infinite, knowing no limits of space as well as time.

The relevance of these considerations is that no matter who one deals with, every individual and individual situation functions out of its own particular reality. The specifics of each reality will therefore uniquely influence the dynamics in any situation, and in order to deal with these sometimes extremely powerful underlying motives, an awareness of their existence is necessary.

Again from a management perspective this awareness is critical. Certain situations may seem indisputably real, like the threat to an organisation's viability. However the consequences of this reality, or the need to change it, may be perceived entirely differently. For example, to the factory worker at *C&L inc. Forlezer* potential unemployment due to retrenchment will be much more of a reality than loss of market share due to poor quality work. Yet over an extended period of time the latter will result in the same outcome as the former. The point made is that an awareness of individual realities of the various stakeholders in a problematic situation, as well as a more 'holistic' reality of the situation itself is essential for dealing with the dynamics of such a situation.

The question of individually perceived realities also has significant bearing on socio-political issues within an organisation. Differing belief systems and ideologies form the essence of different cultures, and are partially founded in metaphysics. Thus a framework which takes this into consideration will assist in resolving potential socio-political dispute discussed in Section A.7.4 (Appendix A).

### 3.2.3 Axiology – Dealing with Values

This field of philosophy distinguishes between the realm of being (or not being!) and looks at the realm of value and of what importance it has. While the existence aspect of the things entering into our experience is important, much of our experience is made up of the value and worth which is somehow attached to these things. The main theories of value dealt with by the field of axiology are (Buttler, 1968, p29 *et al*):

- Ethics - Distinguishes between immediate and ultimate values, deals with the moral good in ones immediate experiences as determined by the ultimate and eventual good which one conceives to be the end and goal toward which all ones life is lived.

- Aesthetics - Concerned with beauty or the appreciation thereof.
- Religion - Values influenced by our view of metaphysics, generally encompassing worship, affirmation, fellowship, assurance and hope.
- Society - Recognising that individual man cannot live in isolation but must be related to others and their norms.

In a similar fashion to differing belief systems, differing value systems influence the behaviour of individuals. An awareness of these differences will provide insight into personal motivating factors such as job satisfaction, aspiration etc.

In essence the whole purpose of taking the three major fields of philosophy into consideration, is ultimately to better understand the notion of 'truth'. However, before dealing with this notion more specifically, the actual method of uncovering or discovering the 'truth' should be looked at more closely. This method of course is inquiry, an issue each problem solver is intricately involved with. The following section considers the nature of the inquiry process, before moving on to discussing what the aim of inquiry is.

### 3.3 The Nature of Inquiry

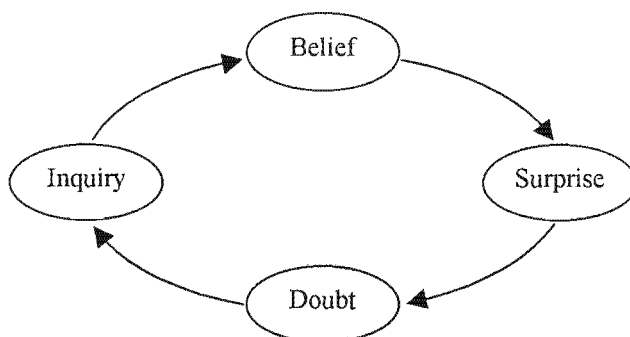
Every thinking individual carries with them a set of beliefs or *Weltanschauung* (Section A.5.4, Appendix A) about the way the world functions, which are used incessantly during all interactions with this world. These beliefs are forged predominantly by the knowledge held of the world, the perception of reality and the values to which we aspire. Intricately related to this are experience and learning, factors that enable us to adjust our belief systems. Experience is a form of 'forced cognition' which impinges upon us and consequently results in learning hence the saying that one learns from experience.

To learn from experience however, the expected outcome either has to be predicted on the basis of our beliefs or has to differ from the experienced outcomes. When experience does conflict with these beliefs the result is doubt. And doubt, as per Misak (1991, p48) essentially involves a struggle to escape in order to regain belief. Misak (1991, p47) characterises the nature of inquiry as a struggle to rid oneself of doubt and attain a state of belief. This cycle, identified by Peirce (Nov, 1877) is depicted in figure 3.1 below.

The cycle commences with a fundamental acceptance of a belief. The belief, which is founded in experience, knowledge, values and a perception of reality, is useful to the individual, providing stability in terms of both structure and order amidst an ever changing world (Misak, 1991).

When encountered by unexpected results however, this structure and order is threatened and comfort zones are disrupted. Surprise is experienced, which triggers an uneasy mental state of

discomfort prior to further questioning which results in doubt. Peirce (Nov, 1877) identifies that with the creation of genuine doubt, further investigations are again undertaken, a process which he calls inquiry.



**Figure 3.1** The Path of Inquiry as Characterised by Peirce

He attributes an eagerness for learning the truth to the dissatisfaction which doubt causes in man. Peirce further describes doubt as ‘an uneasy and dissatisfied state from which we struggle to free ourselves and pass into the state of belief’ (Misak, 1991, p53). Reilly (1970, p16) states that ‘the scientist’s theoretical doubt usually begins in surprise. But, whether surprising or not, the origin of doubt is always external’. What he means is that surprise manifests itself in our experiences, otherwise we would be unable to compare results and observations to theory. In other words, doubt is a process generated when our experiences (which are external) in relation to our belief systems do not correlate.

Passing from a state of doubt to one of belief is achieved by taking an inquiry process beyond doubt. In this regard, Peirce warns against using specious methods of inquiry (Misak, 1991, p55) to prevent manifestations of false beliefs. Superficially they are plausible, but ultimately contribute little to the purpose of uncovering the truth. Specifically Peirce mentions three methods:

- a) *tenacity* - holding onto ones current beliefs come what may,
- b) *authority* - beliefs produced by an authority like a state or a religion, and
- c) *a priori* - adopting beliefs which are agreeable to reason.

Tenacity, Peirce argues will not work, because ‘doubt will be sparked when one notices that opinions differ from one’s own’. Authority will similarly be subject to doubt ‘when one notices that those in other states or religions believe different things’. Finally, beliefs produced by a priori methods will eventually be doubted when it is seen that ‘what the experts take as being agreeable to reason shifts like a pendulum and is really a matter of intellectual taste’ (Misak, 1991, p57).

Peirce further argues that on this conception of inquiry, only pragmatically legitimate hypotheses can be the subject of an inquiry. Misak (1991, p49) states that beliefs must manifest themselves in a set of expectations or predictions, for if they are not there can be no inquiry whether they are upheld or refuted by experience.

### 3.4 The Aim of Inquiry - Approaching Truth

From the discussion in the previous section, the aim of inquiry can be seen as the settlement of belief. Because of the very nature of the inquiry process, Misak (1991) argues that in settling a belief it is accepted as the truth. If it were not, one would continue with the inquiry until doubt has been satisfactorily settled by the replacement of old beliefs with new ones.

Inquirers aim to generate beliefs that fit with experience. When we replace a belief which has come into doubt, the new belief is accepted as a better one; we assume learning has improved our perception of the real world. The only way we can affirm the truth is by way of making valid predictions, which are not refuted by experience.

In this regard Peirce states that an expectation is expressed by a subjective conditional: - if  $x$  is true, then if one was to do  $y$ , the result expected would be  $z$  (Misak, 1991, p42). Thus he argues, in the event that  $H$  is true we would expect the following: - if we were to inquire into  $H$ , we would find that  $H$  would encounter no recalcitrant experience. We therefore predict that if we diligently continued our inquiry about  $H$ , it would not, in the end, be overturned by experience. Therefore,  $H$  is 'true' and would be believed. Conversely if  $H$  would be believed after such a prolonged inquiry, then  $H$  would not have been overturned by experience; it would not have been put to doubt. A true belief therefore is a permanently settled belief, and it is only when these settled beliefs are shaken, that further inquiry is stimulated (Misak, 1991, p 41).

However when we have attained a certain belief this does not signify the close of inquiry. Rather, as Reilly (1970, p15) states, thought relaxes when belief is reached, but the 'rest' is only momentarily. Belief is not only a stopping-place; it is also a new starting-place for thought.

From a scientific perspective, we constantly strive towards uncovering what is perceived to be more of the truth. Science itself has dedicated itself to this feat, striving towards 'theoretical knowledge, intellectual purport' (Reilly, 1970, p21). The modus operandi to achieved this is again the inquiry process. Through inquiry, we are constantly broadening the field of our knowledge, changing our perception of reality and adjusting our values.

In this regard, truth is a concept centrally founded in epistemology, metaphysics and axiology. The whole concept of knowledge for example is based on what we as humans have found to be true. In fact, one of the definitions of knowledge in the philosophical sense as given by The Concise Oxford Dictionary (ninth edition, 1995) is '...true, justified belief, certain understanding, as opposed to opinion'.

Truth can never be fully known, and therefore our knowledge as problem solvers is fallible. The essence of concern here is to adopt a pragmatic approach to the development of uncovering the truth, which often is untenable. Because complete truth is unattainable we resolve ourselves to the development or uncovering of an ever greater truthfulness as discussed by W. H. Newton-Smith (1981, p183) called the 'Thesis of Verisimilitude'.

The inquiry process thus approaches the truth in an ever-changing spiral of new beliefs, potentially without ever reaching the 'ultimate truth'. However, the consequence of this is that our theories increase in truth content, thus answering more questions (Newton-Smith, 1981, p200). Practically the implication is that inquiry should never end, for the more we inquire the closer we may get to the truth. However the effort is weighed against the success, for there is a point beyond which further detailed inquiry is no longer feasible in return for the rewards gained.

With regards to knowledge, pragmatism elevates the use of things above the knowledge of things (Buttler, 1968; Misak, 1991). Its concern tends towards the practicable rather than the theoretical as we are faced in real life with managerial situations that need solutions. Theory however is vital to provide the understanding needed to achieve effective solutions.

This means our concerns are more with cause and effect and the application of theories that are increasing in verisimilitude which, by virtue of their practical consequences, assist with increasing effectiveness in problem solving. Pragmatism aims to connect the knowledge of the meaning of a hypothesis with knowing what experiential consequences to expect if the hypothesis is true (Misak, 1991). Considering that this knowledge is gained through the inquiry process as well as through experience, we need to adapt our perception of the inquiry cycle to incorporate the importance of consequences of our inquiry.

As discussed in the previous section, the path of inquiry is characterised as a continuous repetitive process of *belief - surprise - doubt - inquiry - belief* etc. In this cycle, surprise is the force of experience that acts as a trigger in stimulating further inquiry by creating doubt (Misak, 1991, p22). Peirce describes experience to be anything that is forced upon us; anything that is compelling, surprising, brute or impinging (Misak, 1991, p74). He argues that there are two kinds of experience - 'ideal' and 'real'. The latter is sensory experience and the former is more an intellectual perception.

Peirce puts his point (Misak, 1991, p23) about the breadth of experience by saying that everyone inhabits two worlds, the inner (or ideal) and the outer (or real). We react with the outer world through the clash between it and our senses, and we react with the inner world - 'the world of mathematics, logic and reasoning' - by performing thought experiments. Inquiry, Peirce says, has two branches; one is inquiry into 'outward fact' by experimentation and observation, which he terms *Inductive Investigation*; the other is inquiry into 'inner truth' by inward experimentation and observation that is *Deductive Reasoning* (Misak, 1991, p23).

The origin of inner and outer experiences is what is of importance to the philosophical framework. More often than not, external experience (founded in observation) is beyond our control and the implications are often more extreme than internal surprise. Internal surprise is subtler in that it depends on a mental deductive reasoning process and is frequently the product of poor thinking.

The point in making is that poor deductive reasoning processes can easily result in unwanted 'external' surprises due to the fact that the foundation for thought and the underlying assumptions are incorrect. Therefore, rigorous 'inner' reflection is vital. This thought process will also result in genuine doubt should the situation arise. A manner in which we achieve this rigour is through critical thinking, to be discussed in the following section.

### 3.6 Critical Thinking and Underlying Assumptions

Critical thinking involves calling into question the assumptions underlying customary, habitual ways of thinking and acting and then being ready to think and act differently on the basis of critical thought (Brookfield, 1987). It reflects on the assumptions underlying our and others' ideas and actions, and contemplates alternatives. As a means of reflective learning it can be described as 'the process of internally examining and exploring an issue of concern, triggered by an experience, which creates and clarifies meaning in terms of self, and which results in a changed conceptual perspective' (Boyd and Fales, 1983, p100).

Assumptions are seemingly self-evident rules about reality that we use to help seek explanations, make judgements, or decide on various actions. They are the unquestioned givens that, to us, have the status of self-evident truths (Brookfield, 1987, p 44). Yinger (1980, p 16) describes how these assumptions are used as the basis for implicit theories, which are the unexamined or unconscious theories that allow us to structure, interpret, and make sense of the world.

These assumptions form subconscious frameworks of understanding which influence our daily decisions, judgements, and actions in every way. Because these frameworks are different for each individual, we need to create an awareness of them in order to understand the individuals justification for his/her actions, reasoning etc. These underlying assumptions govern certain situations, especially the dynamics of potential problem situations. Again, particularly from a managerial perspective, it is vital that these assumptions are surfaced in order to prevent misconceptions about the cause and effect of problems. Critical thinking follows the following path (Brookfield, 1987):

1. *Identifying and challenging assumptions* - central is the identification of assumptions that are taken for granted, and that are then examined for accuracy.

2. *Challenging the importance of context* - all assumptions have the purpose of interpretative frameworks that are founded in different value and belief systems, which have to be taken into consideration. The process of identifying and challenging assumptions results in a major shift in our way of thinking which develops our contextual awareness.
3. *Imagine and explore alternatives* - aids in gaining better understanding and acquiring more valid assumptions. With the creation of awareness due to step 1, the alternatives are informed i.e. new convictions are arrived at after a period of questioning, analysis, and reflection.
4. *Engaging in reflective scepticism* - considering and imagining alternatives leads to the development of a particularly critical cast of mind. Universal truths of statements, policies or justifications are not taken for granted simply because of the authority ascribed to the source of this supposed truth.

By adopting a critical thought process, the rigour of the inquiry cycle in the research framework is increased. Through the uncovering of assumptions a more solid basis for 'inner' deductive reasoning is created (Misak, 1991, p23). This is due to the fact that underlying beliefs are generated and arrived at through a critical process of questioning, analysis and reflection, and as such will naturally contain a higher truth content than a belief system based on generally accepted 'truths'. Our beliefs are thus less prone to external surprises as we constantly challenge and invoke the existence of false assumptions up front, before arriving and accepting a belief system.

In Peirce's construct of the pragmatic inquiry cycle, an unexpected experience, be it internal and ideal or external and real, is the trigger that results in surprise. Surprise in turn is what creates doubt and doubt results in further inquiry which, leads to a new or modified belief. The area of overlap is in the production of doubt. However critical thinking aims to reduce the amount of external surprises through promoting more rigorous inner deductive reasoning, thereby enabling the inquirer to reach a higher level of verisimilitude much sooner than the non-critical inquirer.

Thus critical thinking ties in with the inquiry cycle at the point of creating doubt as well as in support of belief. Because critical thinking involves the recognition of assumptions, underlying beliefs and behaviours, it means that we can give justifications for ideas and actions that are subject to reflective scepticism (testing universal applicability and validity against each individual's experiences).

The departure with pragmatism rests with the support by Peirce for the scientific method of inquiry whereas critical thinking supports a mental generation of a structure of possibilities extending beyond the empirically known world. The process of critical thinking can be applied throughout the process of inquiry to assess and challenge assumptions within the context of inquiry.

### 3.7 The Scientific Method

Thus far in the development of the philosophical framework, the nature of the inquiry process and its aim in light of practical implications has been considered. This section aims to discuss specifically the mechanism that drives inquiry which is the scientific method, and *how* it pursues truth.

The first question to be answered is *why the scientific method?* Peirce declares that historically there have been several ways in which man has pursued the truth, of which he lists the method of tenacity, the method of authority, the a priori method and the method of science (Misak, 1991, p55). As discussed in section 3.3, he construes the first three methods as specious inquiry methods, which do not aid in the true settlement of belief.

Peirce adopts the fourth with the reasoning that it sets a public standard of truth and that it is free from dependencies of individual fancies and caprices (Reilly, 1970). It is also the only one of the four methods, which presents any distinction of a right and wrong way. His reasoning can be better understood with a view specifically linked to the pragmatic consequences of the scientific method.

The scientific method has arguably been one of the most contributing factor to current human knowledge and progress, and has been the most efficient and effective way of approaching and uncovering the concept that we humans have termed the 'truth'. It has aided mankind as no other method has in his continuous quest for knowledge and truth. Further it has provided an effective means for the settlement of belief which as discussed above, is the aim of inquiry.

By way of the inquiry process and the direct conclusions/observations/findings thereof we learn, we adjust and broaden our knowledge, and ultimately we attain new beliefs or settle old ones. For this reason, actual inquiry has to be rigorous and rational. A means to this end is the scientific method, which is seen as a generator of *logic of justification* (Newton-Smith, 1981). The main function of the scientific method is two fold:

- a) the production of theories for true explanatory purposes or making predictions, and
- b) specified principles for comparing theories against a given evidential background i.e. the 'framing and testing of conjectures' (Reilly 1970, p31).

The method in itself is very powerful because it is based on observation and thus founded in experience, which is compulsive. Reilly (1970, p25) states that this experience is the necessary beginning for all knowledge, since there is no human knowledge that is not based on observations.

In a lecture delivered in Harvard (1869), Peirce described this process of observing as 'perception assisted by thought and by the aid of analysis'. The aim is to join experience with reasoning to attain beliefs that would always stand up to experience. Inquirers aim for settled belief, but this is equivalent to belief that responds to and coheres with experience and/or consensus.

Following the observation of a fact (understood or not) the scientific method progresses with the formulation of some explanatory hypothesis. This hypothesis aims to explain the observation (experience) and, once it has been postulated, is then further tested by scientific inquiry in order to establish its verisimilitude or truth content. The results of these tests are then compared to the theoretical results predicted by the hypothesis and in this manner the truth content is established (Reilly, 1970).

It is clear how this coincides with Peirce's construct of pragmatism. The truth content of a theory is determined mainly by its 'practical' consequences, in that if a theory is true, its predictions will hold true. In turn this implies some sort of practicality in that the theory is useful for predicting certain outcomes. The method is depicted in figure 3.2 and is further discussed below.

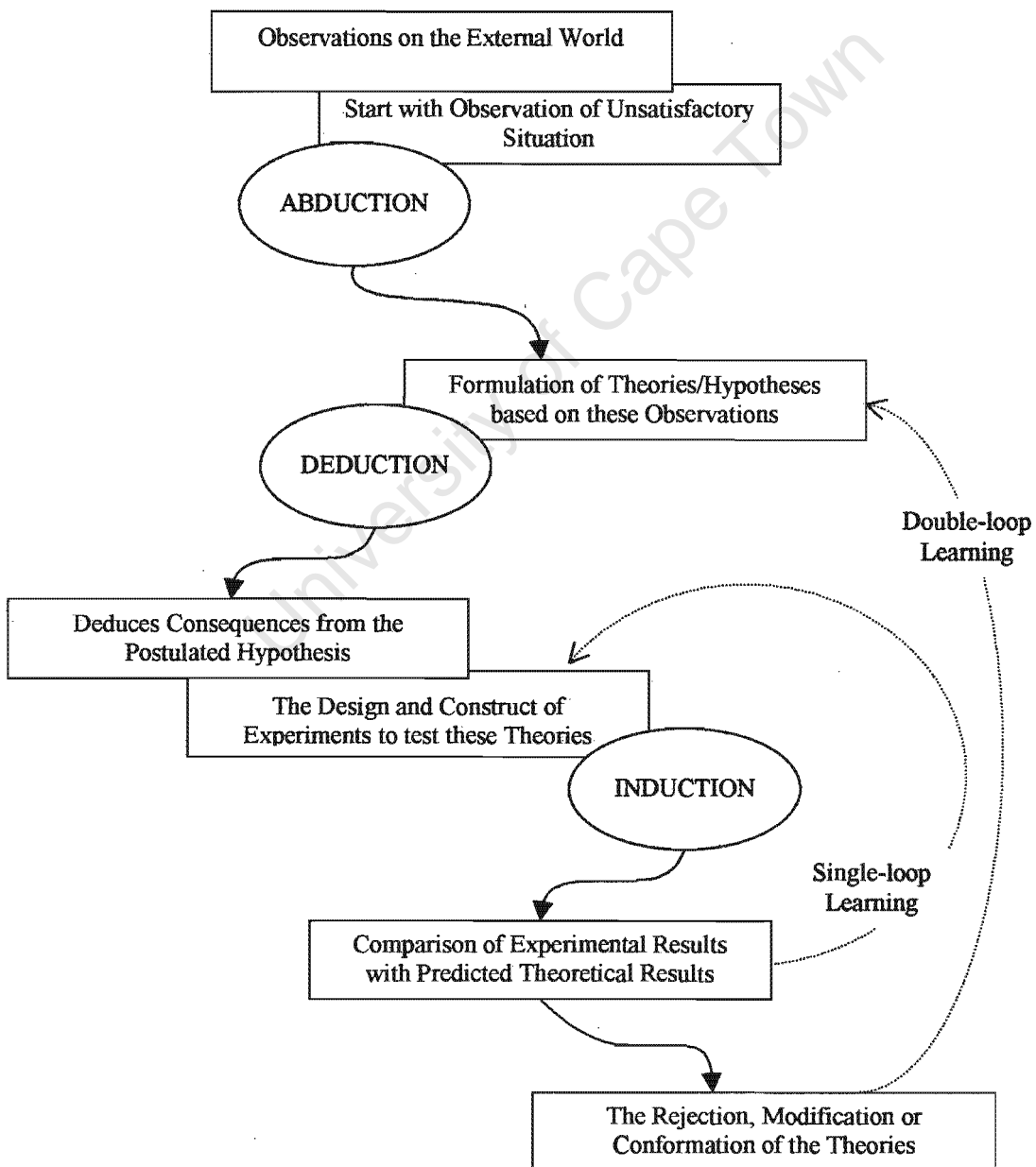


Figure 3.2 The Scientific Method of Inquiry

Scientific inquiry does not end after the first comparative cycle where predicted results are compared to results obtained. This constitutes single loop learning. Once the actual results have been compared with the predicted ones, the method reflects on the validity of the original hypothesis and if need be, the hypothesis may be modified or even completely rejected. In this manner the scientific method encompasses double loop learning whereby it re-evaluates the original theories and propels verisimilitude.

The actual inquiry itself follows the cyclic process of *abductive*, *deductive* and *inductive* reasoning which was discussed in Chapter 2. Figure 3.2 positions these reasoning processes graphically.

As a whole the testing of hypotheses, whether successful or not, aids the process of science and in this case management, in two ways. Firstly the new experiences gained in the testing phase become the basis for new, more accurate hypotheses with greater verisimilitude. Secondly, the inquirer becomes more apt and qualified to select a better hypothesis. Through the inductive process, knowledge of scientific hypotheses is advanced, not only by their evaluation, but also by aiding in their correction (Reilly 1970, p72-75).

In a broader context this is also how beliefs are modify or adjust. Through the above described inquiry process, the scientific method undergoes double loop learning which broadens/develops our knowledge basis, questions our reality and adjusts our values.

### 3.8 The Relevance of the Philosophical Framework to Management

When considering the relevance of the framework to management we need to step back and consider why the framework was developed. In developing a philosophical framework the initial aim was to make explicit the underlying assumptions and beliefs in aid of attaining a level of understanding over and above dealing with problem solving at an operational and methodological level.

According to the *Conant-Ashby Theorem* which states 'every good regulator of a system must be a model of that system' (Clemson, 1984, p217), management is able to regulate only those aspects of a situation/unit which have in some sense been modelled.

Thus in order to question underlying beliefs or assumption in any given situation, a philosophical framework had to be developed. From a management perspective this can be taken a step further where the aim is not only to exhume personal beliefs and assumptions but even more importantly those governing a problem situation. In doing this, the concern is specifically with the *consequences* of these underlying issues.

### 3.8.1 Management and Knowledge

Management, like science and philosophy, is interested in knowledge. Even more so however, it is interested in the consequences of knowledge or the lack thereof, whereas philosophy is concerned more with absolute knowledge.

According to *Ashby's Darkness Principle*, knowledge of any situation cannot be complete and managers are often required to effectively manage situations without full knowledge (Clemson 1984, p204). By consciously questioning the underlying philosophies, assumptions and beliefs of a given problem situation and the consequences thereof, management will be in a better position to understand and control the situation.

Furthermore, in conjunction with *Godel's Incompleteness Theorem*, 'the language framework of a given organisation is always incomplete in the sense that decision situations arise that cannot be adequately expressed within that framework and therefore cannot be resolved within that framework' (Clemson, 1984, p207).

Each organisation or organisational unit develops its own framework, including a more or less specialised vocabulary (meta-language), set of assumptions, and a general outlook on the world and itself (*Weltanschauung*). Godel's theorem shows that undecidable propositions will arise within this framework. In order to resolve these, it is required to move to a meta-level to deal with these undecidable issues. This, as briefly indicated in the introduction section, is one of the main reasons for developing a philosophical framework.

Also, according to the *Law of Requisite Variety*, if management is to control the infinite variety that influences and possibly causes problematic situations, it needs to amplify the variety in the regulator or attenuate the variety of the regulator (Clemson, 1984, p217). Because the real world proliferates so much variety, models must be made which reduce this variety and present the decision-maker with only the appropriate information. A grasp of the philosophical influences is a fundamental means to this end.

### 3.8.2 Management and Reality

This aspect deals specifically with the consequences of underlying beliefs and values. A manager at the end of the day must achieve his desired objective, be it to improve/solve a conflicting situation or to alleviate any other problem. His actions and those he elicits from the various stakeholders are, in reality, all that count and no theory alone will stand without the desired achievement of results. It is therefore crucial in view of developing a useful framework that an awareness of the reality of the situation is ensured and that it delivers the desired results.

### 3.8.3 Management and Values

The value systems of those who are involved in any given situation, i.e. the actors, customers or owners of the situation, determine to a large extent the behaviour of the individuals. Being aware of and questioning these values will bring to the fore deeper insight into why people act in the manner that they do. In gaining this understanding managers will be more competent in eliciting the desired responses required from people in order to control and alleviate the situation. Specifically such an awareness deals with the following typical questions:

- What personal life goals do individuals have?
- Which underlying forces/influences do they experience which they need to obey?
- What are their social constraints or expectations?
- What differences of values exist between the different stakeholders?
- How are these differences resolved/settled/accommodated?
- What consequences do these differences have?

University of Cape Town

# CHAPTER 4

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## 4.1 The Inquiry Framework

Before any problem solver, be it a manager, consultant or student commences with any research process, it is important for him/her to understand the nature of the research to be undertaken. S/he needs to be clear on the underlying reasoning processes, i.e. the abductive, deductive or inductive phases to be engaged in, as well as the type of research applicable to the situation. Of equal importance is a rigorous inquiry pattern or framework to guide the research. The aim of this chapter is to present the appropriate research methodology and to illustrate the inquiry process followed in this thesis. The chapter completes the deductive phase of the thesis. The result is a theoretical framework believed to be useful in addressing complex social problems. In terms of the concern developed regarding the situation at *C&L inc. Forlezer* it is believed that the application of the framework will lead to an adequate level of understanding of all issues in order to address the problem situation successfully.

## 4.2 The Research Strategies

There are numerous research strategies that can be employed, depending entirely upon the circumstances under which the inquiry is undertaken. Gill and Johnson (1991) present the different types of research as summarised:

- *Experimental Research* - The researcher tests theories/hypotheses systematically - usually under laboratory type conditions.
- *Quasi-experimental and Action Research* - Similar to experimental research, but focusing on real-life events. Action research focuses on problems and leads to some sort of action, causing an effect, which is monitored under controlled conditions. Studying the effects of the action continues the research.
- *Survey Research* - Research material is obtained from surveys, such as an analysis of the information gathered from a questionnaire.
- *Ethnographic Research* - Material is obtained from observation and semi-structured interviewing.

Depending on the situation an inquirer is confronted with and the influence s/he has over the situation, different research methodologies will be more suited for achieving desired objectives. Yin (1994, p4) identifies three conditions determining the use of different methodologies, namely the type of research question posed, the extent of control an investigator has over actual behavioural events, and the degree of focus on contemporary as opposed to historical events. The most important step to be taken, according to him, is defining the fundamental type research question.

A basic categorisation scheme for the types of questions posed, is the familiar series: “who”, “what”, “where”, “how”, and “why” (Yin, 1994, p5). He further identifies five major research strategies: experiments, surveys, archival analyses, histories, and case studies. Specifically the extent to which the inquirer is involved (i.e. has control) and whether the research concerns a current situation, determines the type of research strategy most suited for application, Yin (1994, p6) suggests the choice of research methodology as presented in table 4.1 below.

Strategy	Form of research question	Control over behavioural events?	Focuses on contemporary events?
Survey	who, what, where, how many, how much	No	yes
Archival analysis	who, what, where, how many, how much	No	Yes/no
Historic	how, why	No	no
Experiment / Case study	how, why	Yes	yes
Case study	how, why	No	yes

**Table 4.1** Contextual Situations for Different Research Strategies

Originally, the research undertaken for the thesis was intended to be action research. For the successful completion of action research however, the researcher requires the authority and power to implement changes and initiate action. As the author was not in any position to affect action, clearly the successful achievement of action research hinged upon Management providing the required backing and enabling the suggested changes.

It was however very soon evident that this would not be the case, as the Management were not committed to systemically analysing and resolving the problem situation, but preferred rather to focus

on certain 'hard' issues only. Reflecting on the research conditions at *C&L inc. Forlezer*, the basic research question was formulated in the how/why context, with little or no control over the situation and a focus on contemporary events. It was thus decided that the case study research methodology as presented by Yin (1994) was the most applicable to the situation.

It should be noted, that in certain areas, the research was involved in minor implementations, which would fall more appropriately under action research as presented by Bennett and Oliver (1988). The general situation was however such that the research was forced into an observational context and that the outcome of the research would constitute more an analysis trying to explain the problems as opposed to direct implementation of solutions as in action research.

### 4.3 Case Study Research

Yin (1994) identifies the importance of the case study method as a rigorous research method applicable particularly when striving to understand complex social phenomena. He claims, in brief, that the case study allows an investigation to retain the holistic and meaningful characteristics of real-life events (Yin, 1994, p3). Principally he distinguishes between three main types of case study applications, being exploratory, descriptive or explanatory (Yin, 1993). These applications are however not mutually exclusive – an explanatory case study for example often requires exploratory elements prior to deriving explanatory theories.

In particular, the application of the research at *C&L inc. Forlezer* was aimed at providing an explanatory case identifying the underlying issues that had caused the contextual situation the company was in. In this regard, real life observations were compared to predicted outcomes based on the relevant systems theory. As per Yin (1993, p20) this pattern-matching in case study analysis permits case studies to test multiple-variable, complex causal explanations within a single study.

The results of the research will therefore be an evaluation based on the situation, from which an understanding in aid of proposed changes will emerge. Before commencing with the description of the actual case study methodology developed, the validity of the method is briefly reflected upon in more detail.

#### 4.3.1 The Validity of the Case Study Method

Before continuing with the development of the research framework the validity of the case study methodology needs to be considered. We first need to establish what is meant by a case study. Yin (1994, p13) offers the following definition –

*'a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when, the boundaries between phenomenon and context are not clearly evident.'*

The situation is such that the researcher deliberately wants to analyse the contextual conditions due to the relevance of the phenomenon s/he is trying to understand where the context is too complicated to simply identify and separate these phenomenon.

By comparison an experiment deliberately divorces a phenomenon from its context, in order that attention can be focused on only a few variables. A history deals with the entangled situation between phenomenon and context, but usually with *non*-contemporary events. The survey in turn can try to deal with phenomenon and context, but the ability to analyse the context is extremely limited. The surveyor, for instance, constantly has to limit the number of variables to be analysed to fall safely within the number of respondents that can be surveyed.

Yin (1994, p13) states that the case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points. Consequently the method relies on multiple sources of evidence, with data needing to converge in a triangulating fashion. In this regard results benefit from the prior development of theoretical propositions to guide data collection and analysis.

This definition signifies that the case study as a research strategy comprises an all-encompassing method - with the logic of design incorporating specific approaches to data collection and to data analysis. In this sense, the case study is not merely a data collection tactic or a design feature on its own, but a comprehensive research strategy.

The methodology also allows for variation within case studies. These include both single- and multiple-case studies; limitations to quantitative evidence as well as exclusion of direct, detailed observations as a source of evidence. Yin (1994, p14) remarks that the case study strategy should not be confused with "qualitative research", which follows ethnographic methods and seek to satisfy two conditions: the use of close-up, detailed observation of the natural world by the investigator and the attempt to avoid prior commitment to any theoretical model.

In terms of evaluative research, case study research offers several different applications. The most important is to explain the causal link in real-life interventions or outcomes that are too complex for the survey or experimental strategies. A second application is in the description of an intervention and the real-life context in which it occurred. Case studies can illustrate certain topics within an evaluation, again in a descriptive mode. Further, if the intervention being evaluated has no clear, single set of outcomes the situation can be further explored using the case study methodology.

For the purpose of this thesis, the aim as stated, is to explain the underlying problems that are causing the threat to the viability of the *C&L inc. Forlezer* Manufacturing Division, i.e. to establish some form of causal link resulting in the problematic situation.

### 4.3.2 The Case Study Research Methodology

Having established the validity of the case study method as a viable research method, the different stages comprising the methodology as developed in this thesis are presented. In holding with the Systems Approach (Appendix A), each stage is considered as a 'systems part' with input, transformation and output. The stages include a description of the situation, the underlying goals and the assumptions, the design of an adequate research framework, the collection of data and application of the framework, and finally the evaluation of the application process. The various stages forming the methodology are illustrated in figure 4.1 and are discussed in further detail in the remainder of this section.

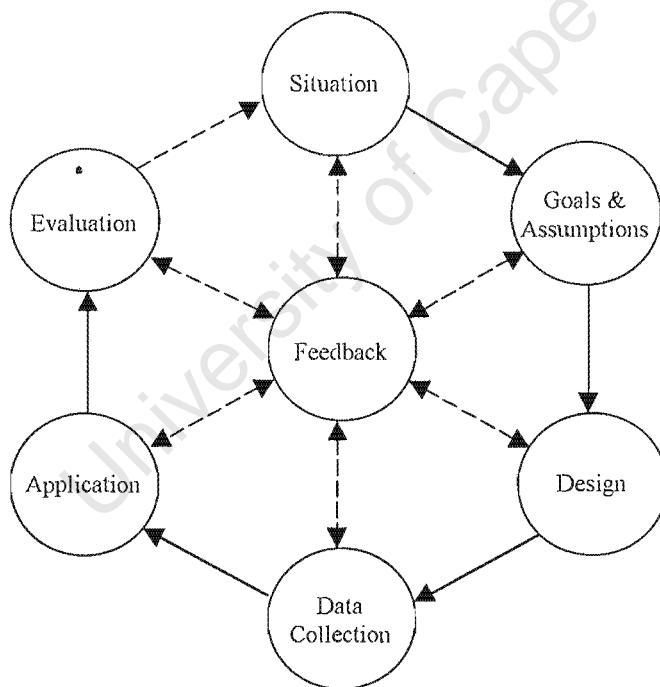


Figure 4.1 The Main Stages of the Case Study Research Methodology

#### i) The Situation - (Stage 1)

The situation refers to the context of the study. This context contains the unstructured situation, in which one or several problems need to be addressed or analysed. It is important that during this stage, the correct problem areas be identified as the process of recognising and comprehending what

what the actual problem is, contributes considerably to its solution. Further it should be noted that this process is iterative, not linear, and during the entire research cycle the initial perception of the situation is revisited as one becomes more and more aware/familiar with the real situation. As with double loop learning, newly found information is compared to the initial picture, which in turn is modified in order to ensure the relevance and validity of the research - a process, which is channelled through the feedback loops.

To gain a high level of insight into the problem situation, the Systems Approach (Appendix A) is applied (Chapter 1). This enhances the first stage of the research methodology with a coherent rigorous approach for defining the boundaries of the research and provides a holistic approach that ensures the multiple perspectives required for a more complete understanding of the situational dynamics.

The initial situation in itself has to be regarded as unstructured, i.e. the inquirer at this stage, does not subscribe to any particular view or bias. The intention is to consider the problem situation in a non-judgemental manner so, as not to prejudge the inquiry – all factors need to be brought out into the open. The Systems Approach then enables a true to real-life structuring of the situation based on the actual system dynamics. Structuring the situation involves a rigorous process of obtaining multiple perspectives from all stakeholders concerned, picking up problem areas and creating convergence of the multiple perspectives to address individual issues.

Clearly the perception of these dynamics are to some extent relative to the perceptions and interpretations of the inquirer, especially if s/he encounters a socio-politically difficult scenario. However, the Systems Approach is very aware of the necessity to maintain a 'higher level view', and where the perceptions of individual stakeholders cannot be openly elicited, the area becomes a conscious concern. In essence the situation can be summarised as follows:

**Input:** An unstructured context containing unidentified problems or issues which need resolving.

**Transformation:** The transformation achieved is the structuring of the situation for the identification of potential problem areas.

**Output:** The output is a structured perception of the problem situation reflecting the views of the various stakeholders.

## **ii) Goals and Assumptions - (Stage 2)**

In the first stage discussed above, the situation is structured within the context of a dynamic system to the extent that potential problem areas are identified. The second stage addresses these

problem areas through the formulation of a concern that is directly related to the research being undertaken, as was done in Chapter 2.

In this regard, the goal is to gain more understanding into the contextual problem situation. Should the study be based on contemporary issues, as in the case of *C&L inc. Forlezer*, the goal aims to ultimately address this concern, or to contribute in some manner to the resolution of the concern. Unlike action research, this goal does not necessarily include implementation of action during the research cycle, however from a pragmatic perspective, as per the philosophical framework, the case study researcher aims to achieve more than pure understanding. The understanding must lead to further consequences, which may in turn well include some action. As discussed under the validity of the case study method, this limitation is inherent to the methodology due to the 'participant-observer' relationship where the researcher has no power to affect changes.

Stage 2 includes the formulation of a hypothesis, in accordance to the scientific method, for the explanation/prediction of events/issues pertaining to the problem situation. The setting of research goals inevitably requires identification of the problem in some form or other (explanatory hypothesis), in order that data can be collected and it can be tested whether in fact the problem identified is relevant.

Throughout this process, assumptions have to be made about the situation as well as the stakeholders involved, as it is impossible to know everything. It is critical that all underlying assumptions are surfaced and stated. As addressed in the development of the philosophical framework, our thought and reasoning processes are founded in a certain perception of knowledge, reality and values - all of which influence our ability to solve an unstructured problematic situation. The stage has the following inputs, outputs and transformation:

**Input:** The structured problem situation of Stage 1, which becomes the cause for concern.

**Transformation:** Involves the formulation of a hypothesis that reflects the research concern.

**Output:** Goals and assumptions have been defined by the formulation of a hypothesis that in some manner is to be tested through the research cycle.

### **iii ) Design - (Stage 3)**

Based on the goals formulated in Stage 2, the design stage aims to guide the inquiry/research by providing an adequate research structure enhanced by the relevant theory. The third stage reflects on the appropriate method of inquiry/research and the relevant theoretical content for the understanding and resolution of the problem situation.

This theoretical content pertains both to the broader body of knowledge generally applicable to the case study context, as well as the relevant theory content applicable to the dynamics within the

applicable to the dynamics within a system concerns the 'soft' issues typically associated with humans and their interaction. For example, the theoretical content relevant to *C&L inc. Forlezer* concerns:

- a) The relevant theory pertaining to manufacturing environments, i.e. the body of knowledge of Operations Management and Factory Physics applicable at the operational level.
- b) The relevant theory pertaining to the case study methodology, the systems approach and the soft systems methodologies used to resolve problems primarily at a methodological level (but not excluding any problems encountered at the operational level).

As Yin (1994, p28) states 'in this sense, the complete research design embodies a "theory" of what is being studied....The simple goal is to have a sufficient blue print for the study, and this requires theoretical propositions.' Thus the design stage develops a framework for understanding the general operational environment and context as well as the applicable theory for problem solving. Stage 3 is where consideration is given to the methodologies to be incorporated into the inquiry framework, as dealt with in the following section.

The design stage provides the logic linking the structuring of the situation of the first stage and the emergence of goals in the second, with the data to be collected in fourth stage and the application of the theory in the fifth. Depending on the goals of the research (i.e. which areas require further understanding or possible resolution), the design stage decides what data is needed to facilitate the application and evaluation stages later on in the cycle and *how* this is to be achieved. For this reason, the development of the relevant theory takes place prior to the collection of any data in order that the correct data is gathered. The design process in essence limits the case study to within a manageable framework, for otherwise the researcher runs the risk of an endless study. The design stage has the following inputs, transformation and outputs:

**Input:** The input involves the goals and assumptions based on the structured situation as well as the relevant theory required for the achievement of these goals.

**Transformation:** The development of a theoretical framework applicable to the contextual situation thereby guiding the research process.

**Output:** A blueprint for the application of the research.

#### **iv ) Data - (Stage 4)**

The objective of collecting data is to provide the information from which issues are identified and certain conclusions drawn. Also it serves a substantiating function for the validity of the inferences

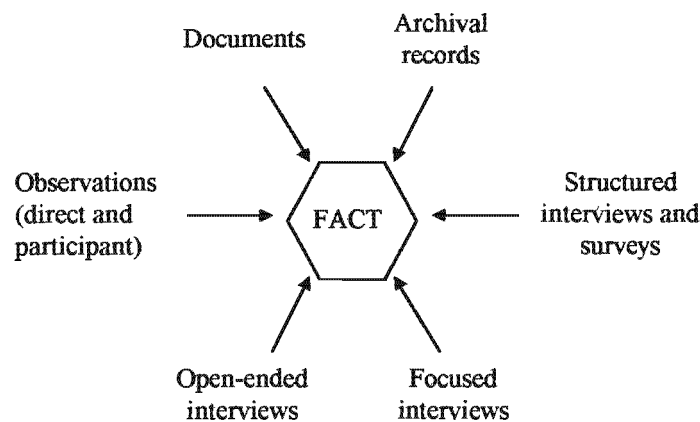
made. The nature of the data to be collected depends on the goals and assumptions of the project as well as the time available for the project. The ‘soft’ nature of the data to be collected in a case study requires higher skills than in experimental or survey based research. These include (Yin, 1994, p56):

- Asking relevant questions.
- Being a good ‘listener’.
- Being adaptive and flexible as new undiscovered issues/situations arise.
- Having a firm grasp of the issues being studied.
- Conducting research from an unbiased non-opinionated perspective.

Usually the data is collected from an observer perspective, or *participant-observer* as in the case of this thesis, which is why the researcher has no influence over the situation. The actual data itself can be collected from some of the following sources – organisational documents, archival records, interviews, direct observation, participant observation, physical and cultural artefacts.

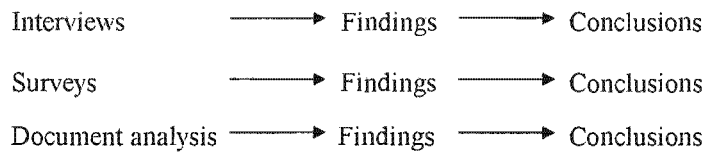
Various strengths and weakness of these sources of evidence have been tabulated in Appendix F as per Yin (1994, p80) as well as further expanding on these based on own experiences. Throughout the data collection process, the following three principles need to be addressed to ensure construct validity and reliability – the use of multiple sources of evidence, creation of a case study database, and maintaining a chain of evidence (Yin, 1994, p34).

In the use of multiple sources of evidence it is critical that convergence on the *same* facts is attained - a process which Yin (1994, p91) terms triangulation – as illustrated in figure 4.2. In this manner different perspectives are taken into consideration and the topic is addressed as holistically as possible, thereby ensuring research validity.



**Figure 4.2** Convergence of Multiple Sources of Evidence

The distinction between true triangulation and simply just having multiple sources that nevertheless address different facts can be presented graphically as in figure 4.3 (Yin, 1994, p93).



**Figure 4.3** Non-convergence of Multiple Sources of Evidence

Creation of a case study database requires that a database be developed which is separate from the actual case study report. Too often the case study data are synonymous with the evidence presented in the case study report, and the critical reader has no recourse if s/he wants to inspect the database that led to the case study conclusions. Separating the two will lend to the case study's credibility and reliability. A case study database may be compiled of study notes, relevant documentation, tabular materials and narratives. The database for this thesis is included in Appendix E.

Maintaining a chain of evidence allows an external reader/observer to follow the derivation of any evidence from the initial research questions to ultimate conclusions. The data stage has the following input, transformation and output:

**Input:** Again, based on the concern of the research and the corresponding problem areas identified with the aid of the research framework, the input consists of a blueprint for the data collection.

**Transformation:** The transformation achieved is the assimilation of raw data to be used in the following stage as a foundation for the generation of information.

**Output:** Provides relevant information required to substantiate the goals and assumptions made in the second stage.

#### v) *Application – (Stage 5)*

The data assimilated during the fourth stage is meaningless in terms of gaining any clear conclusive understanding or potential explanations for the cause of problems without the application of the relevant theory. In other words the data needs to be used and interpreted to transform it into useful information, thereby generating an understanding that will assist in achieving the research goals. This is achieved by way of applying the relevant theory that was incorporated into the research framework developed in the design stage.

The data collected is analysed by means of interpretation. This process is guided by the theoretical propositions pertaining to the case study. The actual analysis of the data depends on the

form that the data is in, and to what extent the data is qualitative or quantitative. The 'softer' the data available, the more subjective the process. For this reason, the three principles for data collection - multiple sources of evidence, a case study database and a chain of evidence, are critical. Some of the analytical techniques applicable, which aim to address the internal and external validity of the case study, are pattern-matching, explanation-building and time-series analysis (Yin, 1994, p106).

*Pattern-matching* compares empirically based observations with predicted outcomes. The predicted outcomes are based either on theoretical propositions or on other observed patterns.

In *explanation-building* the case study data is analysed by building an explanation about the case. This explanation is done by stipulating causal links reflecting some theoretically significant propositions i.e. - the case study evidence is examined, theoretical propositions are revised, and the evidence is examined from a new perspective in order to establish cause and effect relationships.

In *time-series analysis* the events over time are traced in detail and logical deductions made. The essential logic underlying a time-series design is the match between a trend of data points (a pattern) compared with a theoretically significant trend specified before the onset of the investigation, versus some rival trend, also specified earlier, versus any trend based on some artefact or threat to internal validity. A lesser mode of analysis falling under the time-series category is repeated observations. What makes the use of repeated observations a lesser mode of analysis is that the analysis is not likely to reflect all of a case study's concerns.

The application of the theory to the collected data provides the research with the means of identifying and/or verifying the true causes of the problem situation. With this then comes the understanding required to suggest potential solutions to the problems by addressing the originating causes. Depending on the goals set during Stage 2, the application will verify or disprove the hypothesis developed during the emergence of the research concern.

Another very important aspect of the application stage as identified by Yin (1993, xiii, p4) is that in applying the theory the vehicle for generalising the case study's results is generated. If theoretically predicted outcomes are verified, the theory can be used to make general statements about the specific case. In summary:

**Input:** The input to the application cycle is the structured situation together with the corresponding theory applicable.

**Transformation:** The data and theory are combined to provide the insight and understanding that is required to reveal the underlying causes of the problem situation.

**Output:** Resultant findings that either address the research concern or indicate that the problem/situation has been misinterpreted.

**vi) Evaluation - (Stage 6)**

The final stage of the research cycle reflects on the entire process undertaken. The main aim is to verify the validity of the research and therefore its findings. This is done by reflecting on - the relevance of the original concern, the validity of the answer addressing the concern, the rationale behind the development of the answer as well as the validity of the data used to substantiate the answer.

With the completion of the previous stage, the outputs, as stated, are the research results which will have either adequately addressed the underlying concern or not. The evaluation stage determines if the research goals were achieved by reflecting on the outcome.

Depending on the circumstances and outcome, this stage may then lead to a modification of the previous stages to further optimise the learning. This learning constitutes double-loop learning as per the scientific method and is one of the central aims of the evaluation stage.

During the evaluation stage, the purpose for undertaking the research is reflected upon – be it *explanatory* to provide the required understanding into current or past events in aid of possibly initiating change, *exploratory* to gain an understanding or reveal underlying factors, or to illustrate a situation i.e. *descriptive*. The evaluation further reflects on the personal learning and achievement of the researcher. In conclusion:

**Input:** The results or observed outcome of the application.

**Transformation:** The verification/refutation of the validity and relevance of the research findings and whether the concern has been sufficiently addressed within its context.

**Output:** The conclusion of the research cycle. The output of the evaluation stage may lead to the acceptance or rejection of the research findings. Recommendations or options for further action or research may transpire.

**vii) Feedback**

The feedback loops integrated into the research framework ensure that no single stage is approached in isolation. The aim is to continuously revisit initial assumptions and perceptions as more and more of the situational truth or reality is uncovered. The feedback aims to maximise the learning process and enhances the validity of the research.

## 4.4 Enriching the Framework

The intended aim at the beginning of Part II was to develop a conceptual framework for the understanding and resolution of unstructured problem situations. In Chapter 3 the philosophical foundation for this framework was presented and thus far in Chapter 4 the actual inquiry process itself to be followed to achieve the desired understanding of the contextual situation at *C&L inc. Forlezer* has been developed.

However, although the validity of the case study methodology has been established the research strategy in itself is not sufficient for dealing with the complexities at the operational or methodological level. To improve the inquiry process and provide the research with the relevant theoretical content, the various stages of the research method are supplemented and enriched by the contextual operations theory, the systems theory as well as the systems methodologies for application during the inquiry process.

To start with, the importance of an initial inquiry that deals with the situation as an interacting system comprised of interacting parts cannot be overemphasised, wherefore the entire research cycle is commenced with and based on the systemic description of the situation i.e. *the Systems Approach*. Also the theory pertaining to the relevant worldview on – *Operations Management, Factory Physics* and *Work Systems*– are incorporated into the design to ensure a sound understanding of the processes at the operational level. Finally to enhance the inquiry when dealing with ‘soft’ social dynamic problems, the appropriate systems methodologies – *SSM and VSM* – are incorporated into the framework.

Whilst the detailed literature reviews on all this pertaining theory has been included in appendices and will be referred to during the ensuing discussion, a brief overview is provided to give the reader insight into its applicability. In particular the applicability within the research framework will be discussed. Even though it may appear as if the methodologies are applicable only in the areas described, it should be noted that in forming part of the theoretical content and reality (*Weltanschauung*), the methodologies shape our way of thinking and are therefore continuously applicable. In this section the intention is simply to highlight the particular areas in which they are most useful and how they fit into the framework.

### 4.4.1 The Systems Approach

The Systems Approach is presented in Appendix A and has been applied in a comprehensive manner in Chapter 1. The approach is based on the body of knowledge known as Systems Thinking (pertaining to systems theory) and is an approach to the study of physical and social systems which

enables complex dynamics situations to be understood in broad outline (Bullock *et al.*, 1988). This is promoted by the use of systems questions that aim to sweep relevant perspectives into consciousness preventing premature labelling of the problem as a ‘this’ problem or ‘that’ problem (Strümpfer, 1990).

Incorporated into the approach are specific perspectives relating to managerial and organisational issues. Again the aim is to gain a general feel for the *problematique* through conversation and sharing perspectives. Clearly the Systems Approach is used throughout the research cycle, however the approach is particularly relevant to the first and second stages of the cycle where the situation is to be uncovered and consequently the concerns expressed.

#### 4.4.2 The Theory on the Operations Environment

The operations environment is construed to be the primary value adding function within the contextual situation being researched. Wild (1989) categorises all value adding as changes in utility, of which he identifies four. The principal change in utility at *C&L inc. Forlezer* is a change in form utility, which corresponds to the manufacturing environment.

In order to adequately deal with problems perceived at the operational level of a manufacturing environment, the corresponding contextual theory applicable (i.e. the corresponding worldview) is incorporated as a periphery to the entire research. In particular, the theory reviewed is the theory of Operations Management, Factory Physics and Work Systems, as discussed in Appendix B.

The *Operations Management* theory deals primarily with the ‘running’ of the value-adding function and looks at the nature and role of Operations Management (Section B.1, Appendix B). *Factory Physics* is the body of knowledge concerning the physical operational environment itself (Section B.2, Appendix B). It concerns the ‘hard’, factual issues involved in production environments and how these are interrelated. Finally, *Work Systems* as opposed to factory physics, deals with understanding and intervening in task-related issues by looking specifically at the human networks in relation to their activity networks (Section B.3, Appendix B). As such it deals with the human activity system and by *work system* refers to work as a system of meaningful activity.

Although no direct application of this theory may be evident, understanding the theory is vital to communicate with the stakeholders active in this environment. This relates to the discussion concerning the relevant *Weltanschauung* (Section A.4.4, Appendix A) as well as the meta-language used within the system. In conclusion, the operations theory is included as a background to the inquiry framework in order to facilitate the entire research process.

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#### 4.4.3 The Systems Methodologies

As previously stated, the systems methodologies are incorporated into the framework in order to deal with the 'soft' issues that traditionally have been poorly dealt with or completely neglected. These methodologies are particularly appropriate in poorly defined 'messy' situations lacking structure and clarity. In this regard two areas are of primary concern – firstly the actual human dynamics governing the situation and secondly the organisational and managerial dynamics. The two methodologies dealing specifically with these areas are the *Soft Systems Methodology* (SSM) and the *Viable Systems Methodology* (VSM).

Briefly, the SSM (discussed in Appendix C) is designed to deal with problems situations wherein the problems are not clearly identifiable, taking especially into consideration all the stakeholders and their influence and perception of the situation. Relying strongly on participation, the methodology promotes shared understanding and perception of all stakeholders in a situation. The various perceptions are modelled as true representations of the understanding individuals have of the system and these models are then superimposed on ideal models of the system. The revealed differences or discrepancies then subsequently lead to more debate, better understanding and readjustment of perceptions.

In this manner the methodology aims to facilitate the initiation of purposeful action that agrees with all stakeholders and improves the 'mess'. The methodology incorporates a logic-based stream of inquiry (Section C.2.1, Appendix C), which produces systemically desirable changes, as well as a cultural stream of analysis (Section C.2.2, Appendix C), which produces culturally feasible changes – thus efficiently and effectively dealing with situational human dynamics.

In turn the VSM (discussed in Appendix D) is used for modelling and analysing the structure and functioning of an organisation. Based on cybernetic principles the model presents the regulatory mechanisms that are essential to every organisation in order to cope with the complex and dynamic real-world tasks faced by the modern organisation. It is a conceptual model of the organisation's management information system and is a tool with which to assess the implications of alternative policies.

data. However two areas of application within the case study research cycle should be explicitly mentioned. The application of the methodologies is vital in particular during the initial Situation stage in order that ‘soft’ problem areas can be detected, and in the actual Application stage in order that the problems can be resolved.

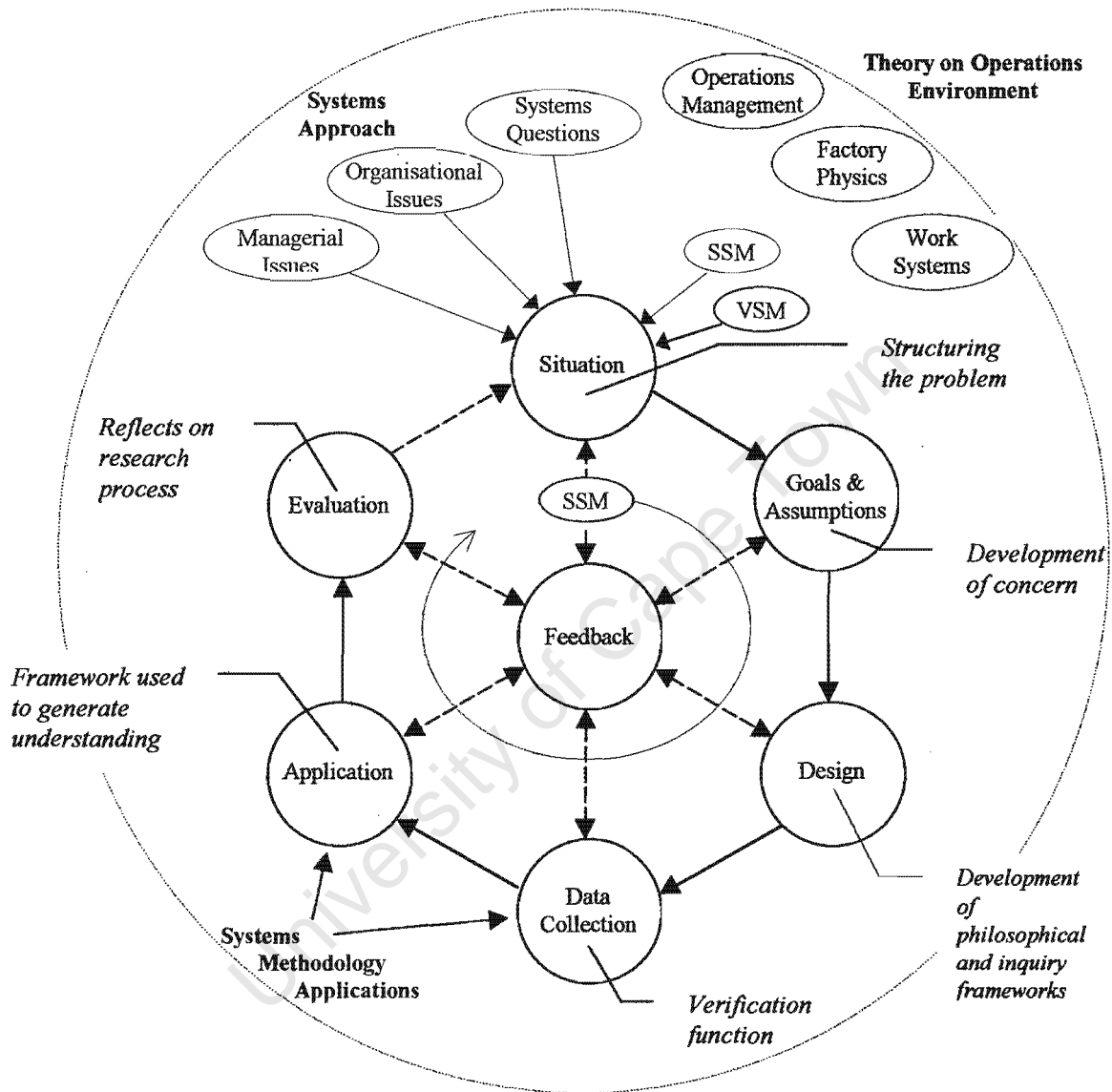


Figure 4.4 The Inquiry Framework

#### 4.5 Using the Framework – Completing the Deductive Phase

The development of the inquiry framework for application in the real-life context dealt with, completes the deductive phase. As discussed in Chapter 2, in the deductive phase ‘rules’ are used and applied to a given ‘case’ in order to predict certain results. In this regard, the rules pertain to the relevant theory incorporated into the philosophical and inquiry framework, which is used in the

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### *i) The Situation*

As previously mentioned, critical to the understanding of the situation is the concept of treating the problem situation holistically without trying to label the problem. For this multiple perspectives of the situation as perceived by the stakeholders are needed. To ensure that the situation is approached holistically, the Systems Approach is incorporated as a starting point. However, although the approach provides a coherent rigorous definition of the system in consideration and reveals adequately its dynamics, it is insufficient in dealing with ‘soft’ contextual issues. Thus the framework is supplemented with additional systems methodologies that cover these areas, in particular the SSM.

The first major step in the SSM is that it collects all stakeholders perspectives of the unstructured situation and develops a ‘rich picture’ i.e. a picture reflecting all issues of concern, not just those of a specific or privileged group that may be driving the inquiry or have the most influence over the situation. At this stage the outcome of the SSM will be a structured overview of all the issues involved specifically identifying problem areas. In turn these problem areas can be further analysed and understood in conjunction with the application of the other methodologies.

In particular the VSM and VSD will reveal organisational deficiencies in areas such as policy, control, intelligence, co-ordination and communication. Work Systems will lead to an interpretation of the social culture, human interactions and work activities as well as socio-political and -technical issues. In combination these methodologies will reveal managerial attitudes, styles and issues. Taking the theory on Operations Management and Factory Physics into consideration will facilitate the identification of ‘hard’ contextual problems influencing the situation.

**ii) Goals and Assumptions**

Having identified the problem areas as expressed in a 'rich picture', a better or clearer understanding of the true concern will emerge. The inquirer is now able to more accurately and realistically define goals to further address the situation. By making use of the philosophical framework to aid in uncovering any underlying assumptions, which have not been surfaced by the SSM, the Goals and Assumptions stage is adequately enriched.

**iii) Design**

This stage establishes the first part of the deductive cycle in that this is the research area where the relevant theory is incorporated into the framework for application in the contextual situation. Thus in essence the design stage reflects on how the 'rule' is applied to the 'case'. It does this by linking the perceived situation and the corresponding concern, with the required data needed during the application to understand and improve the problem situation. In developing conceptual models, the theoretical content of the methodologies is utilised in order to enrich this development process. The methodologies may also, via the feedback channels, supplement the actual framework design where clear deficiencies have been picked up in methodological areas. For example, as was the case at *C&L inc. Forlezer*, in the event that it is clear from the situational analysis that some of the problem areas directly arises out of organisational inefficiencies, the VSM will guide the design process.

**iv) Data**

In the same sense as the methodologies were used to further uncover the situation and highlight the problem issues, they are also used to collect meaningful information needed to achieve the goals and assumptions and to provide the proof of information for the application stage. A large proportion of the data will be gathered through the application of the Systems Approach, which provides information on the system, its parts and its containing environment.

Consideration of the Operations Management and Factory Physics theory will further lead to the required hard data. The SSM in turn provides the soft data needed in that it elicits views from individuals and groups on how matters are perceived, and then compares these to ideal perceptions.

**v) Application**

Having identified problems within the situational context, the appropriate methodologies are applied in order to further understand and ultimately resolve the problem. If faced with hard

quantitative problems, these are quite easily resolved using tools and techniques provided by Operations Management and Factory Physics.

The issue is more complicated regarding 'soft' problems, however adequately dealt with by the SSM. As discussed in detail in Appendix C, having identified the problems in the real world the SSM continues with the perception of the situation in the systems thinking world. In other words the focus moves from the situational reality into a theoretical context. The methodology identifies relevant systems contained within the real world, as perceived consciously or subconsciously by the stakeholders, and then develops ideal models of how these systems should be structured. The outcome then is a conceptual model of the relevant system, which is independent of the actual situation. These conceptual models, when compared to the real situational systems, reveal differences and reality in perceptions and lead to constructive adjustment of either the systems or the perceptions.

As far as organisational deficiencies are concerned, the VSM aids in identifying these and thereby reveals the areas needing attention. The outcome of the application stage should lead to the identification of specific deficiencies and recommendations that will either directly lead to solutions, or will provide the necessary insight to undertake further research/ action, that then in turn will adequately address the situation.

#### *vi ) Evaluation*

The evaluative stage no longer concerns the deductive cycle but rather the inductive cycle. The stage reflects on the application of the theoretical content in the real life context and observes the actual results achieved. In other words, the application of theory in the situation i.e. the 'case', produces real observations, the results. Based on the outcome of these results, the evaluative stage then aims to infer explanatory rules for these results. This is discussed in more detail in the evaluation section of the thesis.

## PART III

# APPLICATION OF THE THEORY IN CONTEXT

The aim of Part III is to apply the theory developed in Part II within the contextual situation in an attempt to address the concern developed in Part I, where the problem statement was developed. The application forms the first part of the inductive phase where the developed framework is used in the contextual situation – forming the ‘case’ and the outcome thereof forming the ‘result’.

Essentially, the application is achieved by putting the research framework to use. The application follows two streams of inquiry – a ‘hard’ quantifiable approach dealing primarily with the redesign of the layout, and a ‘soft’ empirical stream addressing the human and organisational issues identified. The redesign of the layout was based predominantly on the facts uncovered through direct observations during the Systems Approach and based on the relevant theory on Operations Management and Factory Physics, as well as Work Systems to a lesser degree. The application of the theory is backed by the data collected throughout the research process, which is presented in Appendix E.

Addressing the human, managerial and organisational dynamics involved the application of the system methodologies. In this regard, clearly the researcher’s ultimate aim was to effectively resolve the problem situation by way of implementing certain actions. However, as will be seen, this was not effectively achieved at *C&L inc. Forlezer* due to the lack of participation and backing required from top management.

As discussed in Chapter 3 (Section 3.1) the contextual situation in this thesis forced the researcher into application of the case study methodology as opposed to action research which was the initial intention. Consequently the research was entirely dependent on the participation of the Management at *C&L inc. Forlezer* in order to achieve any implementation. Without the necessary power or backing needed the systems methodologies were not applied to their full potential.

In particular, the SSM was not followed through its seven stages developed in Section C.2.1 (Appendix C), as the methodology is highly dependent on participation. Nevertheless, the methodology was an invaluable tool during the analysis, specifically for identifying ‘soft’ problem areas of a managerial nature. Similarly the VSM proved to be a successful diagnostic tool for assessment of the organisational dynamics.

# CHAPTER 5

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## 5.1 Application of the Framework – Addressing the Problem Situation

As alluded to in the introductory paragraph above, the application of the relevant theory is based on the framework developed in the previous chapters. The aim was to adequately address the concern developed in Chapter 2.

From the initial research undertaken, it was evident that the Management at *C&L inc. Forlezer* had adopted a reductionist approach to the eminent threat of a reducing market share, and were intent on focusing only on addressing the ineffective layout of the factory. The Management expressed the opinion that the problem at hand involved mainly the actual redesigning of the production lines and the re-allocation of the various other departments in an attempt to accommodate the Cape Town Sales Branch's space requirements.

The proposal (Section E.4, Appendix E) and layout (Figure E.4.1, Appendix E) as presented by the Sales Branch was to be taken into consideration to see if 'it could be accommodated'. As can be seen from the proposed layout in comparison to the initial layout (Figure E.3.1, Appendix E) it was suggested that the FE Store be moved into the available area where the Hiring Division had kept its stock (prior to the group closing down the Division). In turn the Sales Branch would then utilise the existing FE storage space.

Management however stipulated that before this proposal was accepted in any way it was to be determined whether this was feasible. Priority was to be given to the redesign of the lines and the corresponding space that would be required for them. Then the reallocation of the remaining departments was to be considered in terms of the remaining available space, whereupon, if it was determined that there were no adverse effects for the Manufacturing Division, the Sales Branch was to be accommodated.

From the Researcher's perspective this was felt at best, to be a short-term solution to a complexly structured human-dynamics problem. Additionally it was felt that Management was not even correctly addressing the relevant hard issues. The following points were made to the Management in respect of the approach to the redesign:

- Considering the redesign of only the Production Department, with no consideration of whether the remaining space would be sufficient for the other departments was pointless with respect to potentially maximising the Divisions productivity. The rearrangement of the departments should not only be determined by whether sufficient space was available without the FE Store area.

- Rather, consideration also had to be given as to whether a more optimal layout could be achieved in terms of the general functionality of the entire Division and its parts.
- Thus the entire system should be taken into consideration to enhance overall effectiveness and improve the system's dynamics. It was argued that the output of the whole was greater than the parts and thus it was meaningless to only optimise the Production Department without considering the other departments.
- In considering the overall layout of the factory, each department was to be considered in terms of its internal processes and the overall output required by other departments. Inefficiencies within each department should be identified and changes incorporated into an overall design aimed at long-term future sustainability.
- Consideration should specifically be made to accommodate the Sales Division requirements, as they were part of the 'greater organisation' and their effectiveness was equally important.
- Consideration should also be made of underlying soft issues as previously discussed. In this regard, it was stressed that soft issues *had* to be identified at this stage and taken into consideration, for if any 'soft' issues having a significant impact on the layout were ignored, this would only result in emerging problems at a later stage. It was thus paramount that all issues were identified up front, so that their influences could be incorporated and accommodated in the new layout. In this manner the actual process of redesigning the layout *had* to be systemic. In the event of a 'soft' issue appearing to influence the layout but the Management not being certain whether or not it was significant, further inquiry was to be undertaken until it was apparent, that the issue could be dealt with at a latter stage.
- In dealing with the hard issues, the planning and implementation of the layout also had to be systemic. In this regard it was stated that it was important to produce a detailed layout plan *before* any implementation was effected. The plan should contain the exact layout of each individual line and the location of individual machines, as well as the exact location and dimensions of the remaining departments and their 'systems'.
- The design of the actual detailed layout plan was beyond the scope of the research as the focus was more importantly on achieving an overall system solution based on an in-depth understanding of the problem situation.

The key to effectively addressing the problem situation was thus to identify the actual dynamics of the complexities governing the situation and what their causes were. The hypothesis that was formulated in Chapter 2 in this regard was that, when faced with an unstructured, problematic situation, in which the underlying causes are not clearly identifiable, a holistic systemic approach is required. The approach has to take into consideration the human, managerial and organisational dynamics as well as the organisational structure, which form an intricate part of the problem.

In light of the hypothesis, a reductionist approach would thus not lead to a satisfactory resolution. It was felt that the reducing market share was not singly traceable to an inefficient layout and thus addressing only this issue would not result in the long-term resolution of the problem. Although the Management agreed with this argument, it was felt that immediate action was required and that, as the Division was heading into the expected seasonal low-order period, it was the ideal time for implementing action.

Based on the apparent urgency of implementing a redesign before the end of the Divisions 'quite period' it was agreed upon to commence with the redesign of the factory and production line layout with the intention of identifying all 'soft' issues. Those essential in the consideration of a successful redesign should then be included, whilst others could be addressed at a later stage. The approach intended was one of thinking globally and initiating action locally, i.e. taking a holistic view of the problem situation whilst accommodating the current temporal needs. Effectively this constituted a 'bridging' compromise that was to ensure that progress was made; however, such compromise was to be recognised as such and not made a matter of course to then neglect the soft issues.

The 'soft' issues were taken into consideration through application of the SSM as well as the VSM. Stage 1 of the SSM process (Section C.2.1, Appendix C), involves finding out about the situation in which a problem is perceived and includes the gathering of information through observation and through informal interviews with the participants of the perceived problem situation. The methodology starts with the problem situation unstructured and by consideration of the perceptions of individual stakeholders, aims to sweep all perspectives into consciousness to then emerge with a problem situation expressed (Stage 2). In this regard, the Systems Approach was effectively used to assist in structuring the problem situation, particularly clarifying the 'hard' issues. The outcome of Stage 2 of the SSM was a 'rich picture' relating all issues of concern.

It must be noted up front, that the Management limited the participation in the actual processes undertaken to the Management of the Manufacturing Division, i.e. to the Managing Director, the Production Supervisor and the Production Engineer. This was contrary to the suggestions and efforts of the Researcher to include representatives of all stakeholders, and clearly was contrary to systems principles that strive to take the 'whole' into consideration. Regardless of this limitation, information was assimilated in accordance with the concept of '*convergence of multiple sources of evidence*' discussed in Chapter 4 (Section 4.2.2, *Stage iv*), by undertaking focussed interviews, open-ended inquiry, discussions, direct observation or participation in certain processes. In particular, informal discussions were held with the Cape Town Sales Branch and with the line operators to enrich the perspective of these stakeholders.

In this regard however, it must further be stated that the Management restricted the interaction in particular with the line operators. Due to the apparent 'political instability' of the situation, it was requested that the workers not be directly interviewed, informed or involved in the improvement

process. The main motivation for this was that less involvement of the workers would cause less 'trouble', and as time was of concern to Management, it was decided to complete the layout and then present it to the workers and the union. It was pointed out to the Management that this may be an incorrect approach that would result in more distrust and opposition due to the lack of participation. Additionally participation could produce valuable contributions and would ensure successful implementation of any layout.

In view of the lack of participation, the application of the remaining stages of the SSM was thus also limited. As the Management were more concerned with the redesign and not in the solution of 'soft' problems, the Researcher was forced to utilise the methodology more as a means to analysis than to actually implement soft problem solutions. However, even in this limited application, the methodology proved to be beneficial especially in respect of uncovering systems dynamics. In this regard both the logic-based stream of analysis and the stream of cultural analysis as presented in section C.2 (Appendix C) are reflected in the application. The application of the VSM in turn, based on the literature review in Appendix D, was used to revealed fundamental organisational deficiencies that by necessity are linked to various managerial deficiencies. The application of the VSM was combined with the organisational and managerial issues identified during the Systems Approach, in aid of providing underlying insight into why the issues were arising.

## 5.2 Developing the Rich Picture

As mentioned previously, from the data gathered a 'rich picture' presenting the perception of the problem situation as held by all stakeholders is developed, which is the topic of this section. The development is guided by the Systems Approach, the SSM and the VSM, taking into consideration the Manufacturing Division as a whole (R1), the various departments i.e. the system parts (R2s) and the circumstantial environment (R0). The identifiable managerial and organisational issues are also taken into consideration, as well as the human dynamics. The discussion also includes consideration of the relevant Operations Management and Factory Physics Theory presented as general background information in Appendix B. The main aim in developing the 'rich picture' was to create a structured perception of the problem situation in order that meaningful and constructive action and further applications could be suggested to Management, as it was evident that difficulties would be experienced in directly implementing certain 'soft solutions'.

The issues identified within the broad categories discussed below lead to the development of the 'rich picture' presented in Section E.5 (Appendix E), which models the problem situation. Where relevant, i.e. where an issue has been clearly understood simply by way of gathering data, the issue is briefly discussed in terms of what potential action should or could be undertaken. This demonstrates the concept that understanding the problem situation contributes significantly to its solution.

### 5.2.1 The Manufacturing Division

The section as a whole discusses pertinent problem issues identified during the course of the research. In particular the focus in the ensuing sections relates to the 'soft' issues. The discussion follows a similar layout to the Systems Approach as used in Chapter 1, as well as including consideration of the Division as the operation function S1 in the VSM (Section D.4.2, Appendix D).

#### *i) The Purpose*

As identified in Chapter 1 (Section 1.3), there exists a misalignment between stakeholders in the perceived purpose of the system. There is no shared awareness of an overall purpose and individual stakeholders are pursuing their own needs first. This is resulting in the emergence of a host of 'underlying' problems.

The strongest influence is clearly the perception held by the 'greater organisation' that the systems purpose is to maximise return on investment by way of maximising the recovery. This short-term measure is outdated and counter-progressive. With the view of maximising the return on capital employed, little money is spent on research and development or production technology and this automatically inhibits the growth and adaptation of the system. This perception of the purpose thus indirectly affects the actual operation and performance of the system, a fact that the group does not appear to be aware of, or simply does not care about.

Also, the systems purpose clearly neglects the importance of the human in the system. This has created a complete misalignment in terms of the espoused purpose perceived by the stakeholders. This misalignment is particularly noticeable between the workforce and the remaining stakeholders. The problem is an old one – the worker perceives the owner to be making all the money at his expense or without any spin-offs for himself. The result is an 'us-them' split, which contributes to emerging problems such as excessive union activity, mistrust towards the Management and general discontent.

The origin of this misalignment lies in the fact that the level of education of workers and the interaction with Management is low. No action has been undertaken to build a common vision. Workers at *C&L inc. Forlezer* have not been drawn into the system by way of participation, team building or furthered education and there is a general lack of understanding.

The difference in perceived purpose held by the Sales Branch has indirectly affected the Manufacturing Division's capability to communicate with the end market, which indicates a problem in the intelligence function as identified by the VSM (Section D.4.2, Appendix D).

To ensure that the Division produces in the most effective and efficient manner and continuously strives to remain viable, the individual perspectives of stakeholder groups have to be incorporated into the overall perceived purpose at some level. These perspectives are what make the system viable to the individual and therefore s/he buys into it.

This may appear to be contradictory, for how does one consolidate the ‘owner perspective’ of maximising the return with the ‘victim perspective’ of being exploited? The answer lies in shared understanding and accommodation of both views. In particular this requires the Management and the owners of the system to allow the workforce to achieve a level of satisfaction and self-fulfilment in order to increase their tolerance with respect to the organisation’s overall aim of making money. If the workforce is accommodated in the purpose of the system, they will be more willing to listen to the argument that making a profit is vital to ensure their own future.

*ii) The Parts*

Details of the various problem areas identified within individual parts are provided in Section 5.2.2 in a focused discussion on the internal dynamics of each department. As a whole, the system parts have clearly not been set up to maximise their synergy, which is even noticeable upon visual inspection of the factory floor. The Production Department is not distinguishable from the remaining departments except for the various stores. There appears a lack of control and overview. The machining and manufacturing of rungs, which involves crimping and tumbling operations for example, are clearly distinguishable machining operations that should be completely separated from the Production Department. The system parts thus need to be looked at using principles such as ‘one-piece-flow’ and other Operations Management optimisation techniques. This is discussed in more detail in Section 5.3 on the development of the layout.

*iii) Constraints*

The main external and internal constraints are clearly identified in Sections 1.4.1 and 1.4.2 of Chapter 1. The internal constraints concern mainly the poor layout, worker and managerial problems, as well as the organisational structure. These issues are dealt with more specifically under ensuing sections.

In terms of the external constraints, the geographical location is of most significance. In view of 70% to 80% of the market being located in Johannesburg, it is not feasible to operate the factory in Cape Town. There appears to be no explanation as to why the factory was originally located in Cape Town other than that the organisation had absolutely no competition and thus the transportation costs could easily be absorbed. The current argument for not relocating the factory to Johannesburg is that relocation is too expensive. However, unless the organisation expands its market or distinguishes its product, this move will be inevitable if the company wants to survive. This issue is discussed in more detail in Section 5.2.7 where consideration is given to the feasibility constraint governing Operations Management strategies.

The geographical location is also not ideal in terms of raw material suppliers, as the main aluminium forging plants are located in the Pietermatizburg area, far closer to the Johannesburg

market than the Cape Town market. Thus inherently the availability of raw material in the Western Cape is more expensive in that the raw material suppliers also carry an overhead cost of transporting the material down to the Cape. The organisation thus needs to seriously consider its long-term viability. Product distinction is difficult in the ladder industry, and it is difficult to create niche markets in an area where the goods manufacturing process is relatively simple.

Effectively there are only two possible solutions barring the relocation to Johannesburg. Primarily the organisation needs to expand its market as much possible, so that it is not centrally concentrated in the Johannesburg area. This aspect is further discussed under Section 5.2.3 – *The Systems Environment*, below. The other is the reduction of the transport overhead. In this regard, Management is correctly addressing the internal productivity constraints such as the poor layout. However, it needs to do more. All possible transport alternatives need to be investigated. The transportation of ladders for example requires a large volume to weight ratio. Potential consideration of combining the transportation with a low volume to weight ratio product should be given. In this manner the Division could be apportioning transport overheads with other local manufacturers who have to transport goods to the Johannesburg market.

A further critical constraint imposed upon the Manufacturing Division relates to the policy of operating the Manufacturing Division on a recovery basis. Within the organisational structure it is not clear why the Klipton group has chosen to run the factory on this basis, however the results are evident. By way of this constraint, the operations function is limited to operate within the limitations of the Sales Division and the Klipton group.

The Manufacturing Division for example does not tender for large contracts within its own right. All sales, regardless of quantity, are channelled through the Sales Division. Clearly the Sales Division will need to cover its own overheads as well as the cost of manufacture incurred by the Manufacturing Division, thus increasing the price per ladder. Considering that the organisation is losing large tenders by very narrow price margins this is significant.

Furthermore, it is relevant to note that the sales branches do not only stock the ladders manufactured by the Manufacturing Division, but also source other products. It thus makes sense that if there is a slump in the ladder market; the sales branches will concentrate on those products that are selling. This has a direct impact on the viability of the Manufacturing Division.

There is no pressure imposed by the policy making body of both the Manufacturing and Sales Divisions that ensures that the needs of the ladder market are not 'neglected'. Although in the general interest of the sales branches to push the ladder products, they are not dependent on it. It thus makes more sense to allow the factory to deal directly with the end market, at least to an extent and to allow them to undertake their own marketing campaign.

The dependence on the sales branches brings with it another problem. If the link to the market is through the Sales Division, the timely adaptation and change to shifting market needs are dependent

on the recognition of these changes by the Sales Division. This in turn has to be effectively communicated to the Manufacturing Division, an area that is clearly lacking within the organisation.

Allowing the Manufacturing Division to operate as its own profit centre would bring with it other benefits. The pressure to perform would be directly on the Division, who could not blame the Sales Division for inadequate marketing etc. Generating its own profits would allow the Manufacturing Division more leverage to invest in new technology, research and development and would force it to become more competitive<sup>1</sup>.

#### iv) *The Espoused Worldview*

From the observations made of the manner in which the Management perceives the workforce, it is evident that the adopted worldview is simplistic and mechanistic. Workers are not regarded as an asset to the company, and it can be argued that consequently little has been done to make them an asset. Directly related to this worldview is the incentive scheme initiated by Management. Money is viewed as the only effective motivator for the workforce, as they are not interested in the greater whole of the organisation, have no pride in their work and are also not interested in promoting themselves. Unfortunately in this regard, the blame is laid all too quickly on the workforce.

Furthermore, the lack of existence of a meta-language within the Manufacturing Division, especially amongst the Management, is cause for concern. The level of understanding immediately has to be questioned and it becomes evident why the system has a general lack of MOPs. In addition, with Management not being in command of a meta-language, little understanding and education can be promoted amongst the workforce who from the outset will have difficulties coming to grips with this topic. In fact, the meta-language imparted on the employees needs to be far simpler, but nevertheless based on common Factory Physics principles.

Clearly, the misalignment of worldviews and lack of understanding of the meta-language contributes to the poor performance of the system. Without the explicit emergence of the actual worldviews governing all stakeholders' perceptions, there will always be a lack of understanding. Without this understanding there will always be a lack of co-operation and motivation amongst employees, besides the fact that the learning culture of the system will be seriously impaired. This soft area needs further consideration and the Management needs to critically assess the underlying causes of these dynamics.

#### v) *The Operations Function*

In accordance with the VSM presented in Appendix D (in particular Section D.4.2, part i), the Manufacturing Division constitutes the organisations *operations function*, i.e. that part of the

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<sup>1</sup>The above discussed ideas stem from Ackoff's discussions on '*The Organisation as a Market Economy*' (Ackoff, 1994, p142 *et al*).

organisation concerned with the implementation and value adding transformation. In accordance with the Systems Approach, the function consists of operating elements (the departments) that contribute towards achieving the output i.e. the system parts.

In a viable system, these operating elements are autonomous, regulated by some form of 'localised management' embedded in the larger management system. The elements are linked to management by vertical communication channels through which they provide feedback and receive instructions. In this manner, higher management achieves variety reduction and can focus on relevant issues requiring attention at that level of hierarchy. This concept termed 'variety engineering' is discussed in Section D.3.2 (*part ii*), Appendix D).

Superimposing this structure of the operations function onto *C&L inc. Forlezer*, it becomes evident that there exists no such localised management. The Management has been unable to delegate responsibility or break down organisational goals in order that lower responsibility levels deal with the complexity at that level.

Also, the operations function exhibits little use of natural self-regulation tendencies and feedback principles, both useful and essential for effective operation. Instead the Management at *C&L inc. Forlezer* undertakes to perform everything themselves, disregarding the necessity of variety reduction and amplification. Consequently Top Management is concerning itself with irrelevant detail that should be handled by Lower Management. The continuous monitoring and reordering of stock is a prime example. If the Management were to delegate this responsibility to the store man, it would not have to do the counting and reordering on a weekly basis itself.

The point being made is that by way of the structure of the operations function, Top Management is continuously busy making decisions concerning the day to day operation, a task that actually does not fall within the scope of Top Management.

### **5.2.2 The Various Departments**

A detailed analysis of the system parts is presented in Section E.1 (Appendix E). During this analysis attention was given mainly to the 'hard' issues that could be identified as this forms the core of the research concerning the redesign of the layout. It should however be noted that during this research process the main underlying 'soft' issues were identified, mainly due to the direct involvement and interaction with the system. In turn these 'soft' issues were then further analysed by application of the SSM during the soft stream of inquiry.

### **5.2.3 The System Environment**

In discussing issues emerging from consideration of the environment, it is first and foremost apparent that the Division has a limited perception of its environment. This is perhaps clearest when taking into consideration the existing knowledge and awareness of the market and its

competitors. Very little information is available in terms of both. Even though the Manufacturing Division, by way of the organisational structuring, does not deal with the end-market, no information appears to be filtering back into the system via the sales branches. The market is perceived as static, focally situated in Johannesburg because the major proportion of the country's industry and population are located here.

The possibility and necessity of spreading or expanding the organisation's market to absorb the high transport overhead seems not to have been considered. Being located in one of South Africa's main harbour cities should for example count considerably in favour of exporting to other African countries. However, catering for other areas of ladder application, besides domestic and industrial has not been considered. Analysis of the competitors reveals that there are potential local markets that have not been tapped into. In this regard, *Mecoladder* supply only the fruit-picking industry, which is represented in the Eastern and Western Cape. However, *C&L inc. Forlezer* do not offer a single ladder aimed at agricultural applications.

A further illustration of the poor perception of the environment is the delayed reaction to the viability threat. The organisation as a whole should be in tune with the market, its trends, and its own position in the market as well as that of the competitors. In view of emerging economic difficulties, the shift in the market to price-competitiveness over and above other attributes could well have been predicted. Realising that the competitors are gaining ground is key to spurring further development. Faced with a recession, the company should have adopted an aggressive marketing campaign, but the high return-on-investment, low capital investment approach by the group prevented this.

Efforts in terms of the raw material suppliers are also questionable. Despite the fact that the Division orders several tonnes of extrusions per week, there has been no drive to arrive at some form of compromise advantageous to both organisations. The supplier insists on minimum order quantities, regardless of the amounts required by the Division. The supplier also does not deliver extrusion profiles to the exact length required for manufacturing. The Management claims that because the aluminium is soft, the end profiles are often damaged or bent during transport and thus delivered slightly larger in order that they can be cut cleanly to size. Ensuring that the supplier correctly packages the profiles for delivery could prevent this. Consideration should at least be given to the potential saving of not having to cut all profiles to size, in terms of labour, time and % waste. Also, the Division deals with only one supplier. It would be in the Division's interest to investigate whether raw material could not be sourced from another supplier who potentially would offer the service required.

In general the impression is that the organisation is incapable of, or that Management couldn't be bothered to come up with problem solutions. The environment and its constraints are accepted and the system managed around these constraints. Again, this is due to Management's preoccupation with the daily operations of the system.

The above identified issues arise out of a direct lack of an intelligence function (Section D.4.2, part iv, Appendix D), which has the purpose of interacting with the external environment and gathering pertinent information needed to sustain the viability of the organisation. In particular the intelligence function aims to adapt the organisation to external threats and changes, a process that evidently was not effectively achieved at *C&L inc. Forlezer*. In this regard, the organisation should have realised well in advance that the competitor was increasing its market share and should have established why. Taking into consideration the existing organisational structure, the intelligence gathering process falls largely within the scope of the Sales Division, as this is the area of direct interface with the end market.

However, the Sales Division forms a separate entity from the Manufacturing Division and little feedback between the two exists. The communication and co-operation is insufficient, even though they are dependent upon each other. Consideration of the VSM thus clearly reveals that the intelligence function is lost in the current organisational structuring, as proven by the emergence of the problem situation.

#### 5.2.4 The Organisational Issues

When dealing with the organisational issues it should be kept in mind, that the organisation should provide the framework within which management operates to effectively achieve the intended organisational goals. At this top level of recursion the most important aspect is ensuring the systems viability, which means being effective above all else. The expedience in which this is achieved (i.e. efficiency) and the manner in which this is achieved (i.e. efficacy) can then be charged to management's responsibilities.

In considering the underlying organisational issues, the VSM was used as it presents an organisational model that by way of its construction, inherently incorporates all vital regulatory mechanisms required to sustain the continued viability of an organisation (Appendix D). These are the mechanisms of policy determination, intelligence, control and co-ordination.

##### *i) Policy and Organisational Identity*

The policy making function, defines the basic purpose of the organisation, and by way of setting policy, guides the decision making processes at every level of interaction within the system and external to the system (Section D.4.2, part v, Appendix D). The policy function represents the organisation, and embodies the balance between future change and current stability. Within the system in consideration the policy function is presented both by the 'greater organisation' as well as by Top Management. In respect of *C&L inc. Forlezer*, the 'greater organisation' sets the general guidelines, whilst based on these, Top Management of the Manufacturing Division sets the manufacturing policy.

As discussed in Appendix B (Section B.1.1) the policy of an organisation defines the modus operandi for achieving its purpose. At *C&L inc. Forlezer* this modus operandi is poorly defined. Besides being limited by inappropriately set policies – such as locating the factory in Cape Town when 70% to 80% of the market is in Johannesburg and operating the factory labour intensively – the overall manufacturing policy of supplying on a recovery basis to the Sales branches appears to be ineffective.

In this regard Lockyer (1983, p8) writes,

*'it is not uncommon to find that corporate policy has been set without adequate consideration of the abilities of the production function, and the consequential results frequently bring chaos and frustration...To often it will be found that Board decisions are taken in the absence of sound production information, yet those decisions have to be executed through the production function'.*

This appears to be the case at *C&L inc. Forlezer*, as it is evident that numerous corporate decisions have resulted in the complete inability of the Manufacturing Division to determine its own future and continue developing. In particular this refers to the recovery policy, the geographical location and the organisational structure.

What little policy is apparent is furthermore poorly communicated and not explicit. Top Management may have an understanding of policy, however this is not shared throughout the organisation. Immediately this creates a division between the informed and uninformed, resulting in a lack of common ground. It is apparent that the Management themselves have little policy in place to guide decision-making. This is concluded from the lack of effectiveness of the Manufacturing Division and, in fact of the entire organisation.

There is also a complete lack of organisational identity amongst factory operators. For them, working at *C&L inc. Forlezer* is 'just another job to get food on the table'. Especially amongst the workers, there is a severe lack of vision, poor motivation, sense of job security or sustained future viability. This lack of vision is also detectable at a managerial level. The vision offered by Management in the form of a mission statement was to be the best ladder manufacturer in South Africa supplying at the right time, cost and quality.

This is however a general vision held by most manufacturing organisations. The question immediately arises, which organisation can afford not to fulfil the primary requirements of time, cost and quality? Irrespective of the vision offered, the company has a very long lead time and is not competitive in terms of cost. These primary requirements are discussed in Appendix B (Section B.1.1). There is also poor perception as to how this vision is to be pursued and achieved. There is no further breakdown into primary business activities, integration or perception of key strategies or reflection of the organisational core values.

The vision projected by the company furthermore completely neglects the importance of the individual worker, or any human dynamics for that matter. A manifestation of this organisational issue, is the managerial approach to union activity. Instead of adopting its policy to accept, accommodate and co-operate with the union, the union is opposed as best possible within the legal limits.

Primarily these issues arise due to the lack of strategic and normative thinking present within the organisation (Espejo and Schwaninger, 1993, p49 *et al*). Management is concerned mainly with decision making at the operational level, which is evident by way of its focus on efficiency. In this regard, Espejo and Schwaninger (1993, p40) claim that

*'the role of efficiency has been overestimated, leading to a neglect of higher-order levels of effectiveness. To put it in more precise categories: short-term thinking has frequently driven out a long-term orientation'.*

The consequences are shrinking time horizons and a growing preoccupation with short term returns, as embodied by the organisations policy of return on investment and minimal capital investment. It is vital in this regard, that the organisation and the Management of *C&F inc. Forlezer* consider the higher levels of systemic effectiveness/fitness i.e. the systems capability and legitimacy (Espejo and Schwaninger, 1993, p56).

#### *ii) Intelligence*

As discussed during consideration of the systems constraints (Section 5.2.1, part iii), it is evident that the organisation and thus the Management has given this aspect the least attention. The intelligence function is charged with ensuring the viability of the operation, which can only be achieved by interaction with the environment. Not only does the Manufacturing Division have a severely limited understanding and awareness of its containing environment, but it appear that the entire greater organisation has a poor handle on the operational context. There is a complete misalignment in terms of who should perform this function.

This is apparent by the fact that the Manufacturing Division charges the Sales branches with this responsibility in accordance to the organisational structure and policy, however on the other hand does not ensure that the required information is received. The organisation has set up no parameters forcing the Sales Division into performing the intelligence function and no communication channels for the interaction of the two Divisions. Alternately, by way of the intended organisational structure and policy, the Manufacturing Division has been limited in performing this function itself.

Therefore there exists a poor direct link to the external environment, which in turn explains why the problem situation had developed in the first place. Without this link, it stands to reason that

Management cannot possibly make effective decisions, and thus it is explicable that there exists a pre-occupation with the operational level – Management is unable to effectively/efficiently deal with strategic or normative decisions without this information.

*iii) Control*

Consideration of the intended purpose of the control function (Section D.4.2, part iii, Appendix D) reveals deficiencies mainly in terms of a distinct lack of an auditing function regulating and monitoring the state of the internal environment. Consequently information flows from and to the higher functions, such as policy and information, is lacking.

The result is a preoccupation with control at the operational level accompanied with an inability to control issues at a strategic and long-term level. This is verified by the organisation's preoccupation with solvency and profit (Espejo and Schwaninger, 1993). It is evident however, that despite the focus on controlling the operational level, this is not being achieved effectively.

Mainly this is attributable to the lack of clear MOPs throughout the system. In fact the only observed measure in place is a daily target rate set by Management. This MOP is however not based on the knowledge of the actual throughput, capacity, work in progress levels and the required cycle times per product (Section B.2.1, Appendix B). No work or time studies have been performed to establish these measures, and the targets are set based on past performance.

Due to this apparent lack of having determined essential operations criteria, such as where the factory bottlenecks are and what their bottleneck rate is, as well as an intuitive lack of understanding of Factory Physics laws the factory itself is a highly inefficient area. In this regard, a more comprehensive discussion on Factory Physics is included in Appendix B. It should be noted, that this field in itself warrants a further in-depth study in respect of the system in focus, which however falls beyond the scope of the current thesis.

*iv) Co-ordination*

Inevitably, due to the poor policy and structure, the co-ordination is heavily dependent on the system's self-organising tendencies and thus although achieving the current required output, is not the most effective. Critically this organisational function is lacking in terms of maximising the system productivity. Very little co-ordination by the 'greater organisation' between the Sales Division and the Manufacturing Division is evident.

In view of the fact that the Sales Division is intended to be the direct link to the end-market, and thus vital to the survival of the Manufacturing Division both in terms of selling the product and interacting with the environment, this is cause for serious concern. Especially in view of the potentially conflicting interests of the two Divisions, co-ordination by *Klipton Industrial* or the group is vital.

The managerial co-ordination of the *C&F inc. Forlezer* system involves the central activities of capacity management, activity scheduling and inventory management (Section B.1.2, Appendix B). Again, these activities are not achieved via established computational techniques based on exact Factory Physics knowledge, such as actual throughput, capacity and cycle times but rather informally through the competence of the Production Supervisor who has 15 years of experience. Although Management have an IMPACT software programme that could perform these functions optimally, the software has not been put to full use, as certain parameters and performance measure required by the programme are not accurately known.

The co-ordination function is vital to enable the system to achieve its goals both efficiently and effectively. Principally this involves nothing more than information flows. Within any organisation it is vital that these information flows are established both top-down and vice versa to ensure healthy communication. As communication is an attribute the system desperately lacks, it is inevitable that no effective co-ordination can exist.

### 5.2.5 The Managerial Issues

In taking the managerial issues into consideration, the three primary areas of focus were the efficiency and effectiveness achieved, and the efficacy provided by Management in light of the perceived organisational goals at *C&L inc. Forlezer*. These three parameters are introduced in Section B.1.1 (Appendix B) within the context of Operations Management. The managerial issues were again considered in accordance with the Systems Approach (Section A.6, Appendix A and Chapter 1).

#### *i) Contextual Understanding*

As identified during the initial stages of developing the problem situation (Chapter 1) it is clear that the Management does not have a clear perception of the actual operational context, both internal to the system as well as externally. Arguably it therefore stands to reason that Management cannot possibly ensure maximal effectiveness and also cannot be providing the optimal efficacy.

Internally the main deficiency identified is the lack of intuition and knowledge pertaining to the relevant theory of the operations environment as discussed in Appendix B, externally the lack of perception of the environment as discussed in Section 5.2.3 above. Additionally there is a distinct lack of interest or perception of the 'soft' human related problems affecting the manufacturing system. To illustrate these points, reference is made in particular to the discussion in Section 2.2 (Chapter 2) on the managerial perception of the problem statement.

The poor understanding of the contextual situation is the cause of numerous problems. To start with it is evident that the Management has not and does not effectively perform the role of Operations Management, both in terms of the *design and planning* and the *operation and control* of

the Manufacturing Division as discussed in Section B.1.2 (Appendix B). In particular areas such as operational capability, process flows, work methods, work systems, work measurement and the determination of remuneration systems and work standards have been neglected. With this lack of basic information necessary for effective and efficient performance of the *operation and control* functions Management is inherently limited in performing in these areas.

As previously mentioned, the lack of knowledge of Factory Physics parameters is the cause for the lack of critical performance measures, as well as an intuitive understanding of what state the factory floor is in. In other words, trouble shooting becomes difficult when Management is not clearly aware of performance indices or other signs (such as high WIP levels) that allude to existing problems. In this regard, the laws of Factory Physics as discusses in Section B.2.3 (Appendix B) provide valuable insight. Also the Management has a poor perception of the influence of variability and complexity on the system which has a direct impact on systems productivity. Externally Management is not sufficiently informed of market trends, customer requirements, the competitors and its own position.

#### *ii) Enabling the Organisation*

As discussed in Section A.7.2 (Appendix A) enabling the organisation is management's primary function. In this regard management has to provide the system with the ability to achieve its goals in the most effective and efficient manner. There are numerous ways in which this is achieved; however a detailed discussion at this stage is beyond the scope of the application.

It should suffice to say, as can be concluded from the misaligned contextual understanding, that the Management at *C&L inc. Forlezer* is not maximising the system's performance capabilities. Besides the poor organisational framework provided, the fault lies primarily with a lack of visionary leadership, a lack of clear strategic and normative goals, poor perception of the containing whole and the underlying espoused mental model held by Management.

In this regard, reference is again made to Section A.2.1 (Appendix A) concerning the discussion on the mechanistic mental model. By way of the manner in which the Management approached the problem situation – considering only the 'hard' factual layout aspects and neglecting other relevant issues – it is apparent that Management holds this mental model. The consequences thereof are further discussed in Section A.2.1 (Appendix A), the main concern being that Management is neglecting to take the complexity of the entire situation into account.

In particular the Management's autocratic dictatorial style has resulted in a direct 'us-them' split between Management and the workforce, which is counterintuitive to enabling the organisation. Effectively if Management does not enable the workforce by ensuring continuous growth and learning, delegating responsibilities and creating a positive organisational culture all improvement attempts will fail. A prime example was the limited interaction with the workforce imposed upon the research process.

Without eliciting participation and revealing all underlying problems and limitations experienced by each individual stakeholder, the function of effectively enabling the system, especially in light of a constantly changing environment, will not be achieved.

*iii) Settling Socio-technical Disputes*

Again the successful fulfilment of this function hinges upon a clear understanding of the entire system and its dynamics, which has been shown not to be the case at *C&F inc. Forlezer*. Fortunately this appears to be one area in which minimal conflict is detectable. Nevertheless this does not imply that Management should be ignorant of any potentially emerging issues. This is particularly relevant in view of redesigning the factory layout and potentially improving the production facilities and technological status. In this regard it was evident that the workforce was highly suspicious and unsettled regarding the layout for these exact reasons. Improvements in technology potentially imply improvement in skill levels or redundancies, both of which constitute undesirable change within the *C&L inc. Forlezer* system.

*iv) Resolving Socio-political Conflict*

This appears to be the weakest area of the Management within the *C&L inc. Forlezer* system. It is apparent that instead of resolving the conflict, Management is in part creating conflict. The 'us-them' approach that the Management has adopted towards the workers appears the main cause of this conflict. Instead of considering the workforce as the organisation's most valuable asset and continually striving to 'invest' and 'improve' this asset by team building, learning and promotion, the Management has broken down the trust completely and view the workforce as 'a necessary evil'. The interaction with workers is directly and openly authoritative and top-down with little communication and explanation regarding decisions and actions taken. Again the actual redesigning process is a primary example. Due to the differences in power, political orientation and even social background, the Management proceeded with the redesign without consultation or involvement of the workforce. Consequently the project received union opposition from the outset.

In particular the poor communication between the Management and its work force is a primary concern. As discussed in Section 1.3 (Chapter 1), the workforce perceives the purpose of the system as being only beneficial to Management and the owners of the company. This perception has been created because Management has ignored the needs of the individual and the communal workforce. The factory floor worker feels that his/her contribution is irrelevant and that he has no part in the system.

Due to this approach, there is a complete lack of trust towards Management and therefor the union has a high level of leverage, as all workers feel that the union is the only body guarding their interests. This perception is verified by the attitude the Management has towards the union which

is, the less the Shop Steward and the union know the less trouble they can cause. This situation is so strained, that the MD and the shop steward are openly hostile towards each other.

### 5.2.6 The Human Dynamics

In taking the problem situation into consideration the human dynamics involved cannot be neglected. These dynamics involve the interaction of the various actors within the system, whose combined contribution affects the overall output of the system.

The contributions are achieved by human activity systems (Hoebeke, 1994) formed by all humans in pursuit of some purpose, as discussed in Appendix B (Section B.3). In the Manufacturing Division, these human activity systems are typically formed by various groups of people who have a common goal – Management being a prime example. The designated teams operating on each individual production line provide a further example of these activity systems. However, it is not always obvious where and how activity systems have been formed and how they interact. To effectively understand the contextual dynamics, Management requires an awareness of the activity systems.

To illustrate, the Tool Room operators form a particular activity system that aims to ensure that the machinery used by the Production Department is functional. This motivation however does not just stem from their job description or from Management. The Tool Room operators are also under pressure from the requirements of the human activity systems of the line operators, who will not achieve their bonuses if the required machinery is not operating. If Management were aware of this pressure which often results in conflict, the parameters causing it could be removed (for example, different incentive structures).

Because there is no awareness or concern for the interrelated dynamics, the functional activity systems defined by Management are in fact of no real priority to the actors within these systems i.e. the factory floor operators. The perception of enriching the company owners at the workers expense for example, results in the workers partaking in activity systems that guard their own interests, despite the Management's objections. For this reason, one of the most powerful activity systems present is the workers union.

Clearly, there are thus underlying activity systems that are not explicit but often far more influential. Typical examples are social or political activity systems. These activity systems are often counterproductive to the desired activity system.

In this regard, Checkland and Scholes (1990) identify a 'stream of cultural inquiry' applicable within the SSM to assist in consideration of the situation as a culture, which is endemic to human dynamics. The 'stream of cultural inquiry' is reviewed in Section C.2.2 (Appendix C), the application of which follows.

*i) Social System Analysis*

The social systems analysis identifies the roles, norms and values of the people and stakeholder groups within the system. Even general consideration of these elements provides critical insight into the system dynamics. The perceived role of Management by both the Management itself and the workforce, for instance is not one of enabling or providing the necessary support, but rather of ruling and being in charge. Consequently the expected norms involve awaiting instructions, being policed, continuous monitoring and the enforcement of rules.

With such espoused norms, it is logically explicable that the average worker shows little initiative and why the Management is preoccupied at an operational level with the daily running of the system.

Based on differences in social status, cultural upbringing and background, there is clearly also a difference in morality and ethics. This naturally brings with it barriers to communication, understanding, tolerance and differences in appreciation – areas to which Management as the more educated, privileged stakeholders should be sensitive.

By performing a social systems analysis it becomes clear how difficult it is to create common ground in this area. It also becomes apparent that without a social 'levelling', by firstly exhuming all perceived roles and then clarifying and defining actual roles, Management will not progress past the antagonistic worker-manager relationship. Synergy also has to be created between the defined role and enacted norms. This is a major area in which Management has strayed in the eyes of workers. For instance the Management is severely criticised for continuously 'shifting the goal post' when setting daily target for bonuses.

Clearly this area is immensely complex and cannot be extensively covered within the scope of this thesis. It is however apparent that the social situation needs addressing in order to provide a stable constructive platform for future development.

*ii) Political System Analysis*

Closely related to the considerations of the social system, the political analysis deals with the presence, use and abuse of power within the situation. The political activity especially regarding the exertion of power is high within the system. This is a clear indication of an authoritarian/dictatorial management style.

Where differences in opinion are not settled or arbitrated appropriately the resultant effect resorts to the use of power to force one of the parties to abide by the others opinion. Clearly these types of dynamics are extremely counterproductive, which is very visible within *C&L inc. Forlezer* especially in consideration of the worker motivation and high level of union activity.

The main concern in this regard, is the clear power battle between the union representatives and the Management. Both parties openly oppose each other and utilise their political power to its full

potential. Management on the one hand uses its authority to achieve objectives, whilst the unions use affirmative power and strike action. Both sides have neglected to appreciate that the political tool should concern the process of accommodation of differing interests, without detriment to the system. Again it is evident that this issue needs to be effectively resolved in order for the organisation to progress.

A further point to be made is the power that was exerted by Top Management in respect of the research undertaken. The Managing Director, who effectively had the power to enable or prevent for example the successful use of the SSM, did not appear to be interested. Consequently the backing provided was not given, and the SSM limited in its application. This is a good example of 'power abuse', as it was apparent that Middle Management were interested in the approach.

### *iii) Analysis of the Intervention*

From the onset, it was apparent that the results of the project would depend on the interest and backing shown by Management. As mentioned in Chapter 2, the research methodology initially intended was action research, which however had to be changed because it became apparent that the required backing for implementation would not be provided.

Throughout the intervention, the importance of taking the problem situation in its entirety into consideration was stressed. This was however not successfully achieved in that the Management insisted that the redesign of the layout was the primary issue at hand and that all other issues were less important. It should be noted that this perception appeared to be primarily held by the Managing Director, and not necessarily by Middle Management (i.e. the Production Engineer and Supervisor) who were far more receptive to a systemic approach, as discussed above in the political systems analysis.

By analysis of the intervention insight is gained by swapping roles of stakeholders (Section C.2.2, *i*), Appendix C). Taking this approach in respect of the MD who was perceived as blocking vital areas of inquiry as the problem owner, it becomes apparent that as the problem solver it was easier for him to achieve a new redesign of the layout, rather than for example solve his personal problems with the shop steward. Furthermore it becomes apparent when considering the 'greater organisation' as the problem owner, that the MD was under pressure to perform, and that effecting visible changes to a reputedly known bad layout was an active way to demonstrate performance.

The analysis reflects on the intervention itself, providing insight into why the intervention potentially is successful or results in failure. At *C&L inc. Forlezer* the potential of opposition from workers and the union in respect of the intervention was eminent. The poor Managerial perception of the situation and the inability or unwillingness to take the human dynamics into consideration, led to serious doubt as to whether the concern as expressed in Chapter 2 would be adequately addressed. By way of analysis of the intervention, it became increasingly more evident that if the Management did not take a holistic approach to problem solving at every level, the result would be

a systems failure in respect of the initial aims set by the intervention. It was also clearly evident, in terms of the implementation of the factory layout, a predominantly 'hard' area, that a lack of systemic consideration would not produce an optimal factory layout within the set four-month period.

### 5.2.7 Operations Management and Factory Physics – Related Issues

Concerning the Operations Management theory, there are three critical areas for concern identifiable – a) the evident lack of consideration of the feasibility constraint, b) poor implementation of Operations Management requirements and c) a lack of support functions for the operations environment (Appendix B).

Concerning the system's feasibility constraint (Section B.1.1, Appendix B), it is eminent that the long-term viability of the system is in jeopardy and at present the location of the Manufacturing Division is not feasible. Should 70% to 80% of the market remain in the Johannesburg area, the reality is that regardless of what is undertaken to absorb the non-value adding transport costs, this will always be in addition to the major competitor's costs, *SA Ladder*. Considering the ever-increasing competition in local and global markets, this overhead will become increasingly difficult to absorb. Management is under the illusion that an increase in productivity will resolve this issue, however it neglects the simple fact, that the competitor will not remain static. The fact that *SA Ladder* are increasing their market share and directly competing with *C&L inc. Forlezer* for market dominance is a clear confirmation thereof.

It has already been established that the company can no longer distinguish itself in terms of quality or service, as the competitors have caught up in these areas. Also, the company can no longer rely on the association with a well-known brand name. In view of increasing current economic hardship, cost is becoming the prime consideration in the market; quality and service are prerequisites. As long as the factory is removed from its market, all the competitor has to achieve is to marginally match the Divisions productivity to automatically gain a competitive advantage. The Division will thus have to undertake action to bring itself closer to the market.

As discussed in section 5.2.3, the option is either to expand the market such that it is no longer concentrated in the Johannesburg area, or simply to relocate the factory. Management argued that the capital investment would be too great for a relocation, however reference is made to the 'pay me now pay me later' law of Factory Physics (Section B.2.3, Appendix B). One way or another the Division will have to pay to sort out the existing problems, be it preferably to implement the optimal solution, or by having to close down due to continued ignorance. Furthermore, the organisation tends to neglect the potential of 'starting afresh' should the factory be relocated. Not only could this opportunity be used to find the spatial facilities to implement the optimal layout, but also issues such as the labour intensive, inefficient production methods could be addressed.

In as far as point b), referring to the Operations Management requirements is concerned; the lack of a clear manufacturing policy has already been identified. This is a direct consequence of the lack of general policy as discussed during the consideration of the organisational issues (Section 5.2.4). Consequently, when faced with conflicting hierarchical sub-objectives typically faced by an operations environment as illustrated in Figure B.5 (Section B.1.2, Appendix B), such as *low unit costs versus high customer service*, Management is unable to make clear decisions. More specifically however, the three main activity areas of Operations Management, *Capacity Management, Activity Scheduling and Inventory Management* (Section B.1.2, Appendix B) are not under control in the system.

Finally the operations function lacks clear organisational support services that form a vital support platform required for effective operation, as graphically depicted in figure B.6 (Section B.1.2, Appendix B). In this regard, particular need for a marketing and sales support function, as well as a human resource function is identified. A marketing function is vital to enable the system to establish a direct link to the section of its external environment that it is trying to target. A human resource function in turn is necessary to ensure that the human resource is not neglected, as is the current situation.

In summary, the above discussion focussed on the development of the problem situation, taking both hard and soft applications into consideration. From this the 'rich picture' presented in Section E.5 (Appendix E) is derived which clearly shows that the problem situation is far more involved and complex than simply requiring a redesign.

As stated at the beginning of the chapter, in terms of implementation within the time span involved, priority was given to the systemic consideration of the layout redesign, within the broader context of the expressed problem situation. The following section details the actual process followed in commencing with a systemic redesign. The focus in this regard is more on documenting the overall approach taken, as opposed to all the detail involved in arriving at an actual final detailed layout plan. The suggestions made and the actual outcome achieved are discussed, from which it will become apparent whether the approach was successful.

### 5.3 Development of the Factory Layout

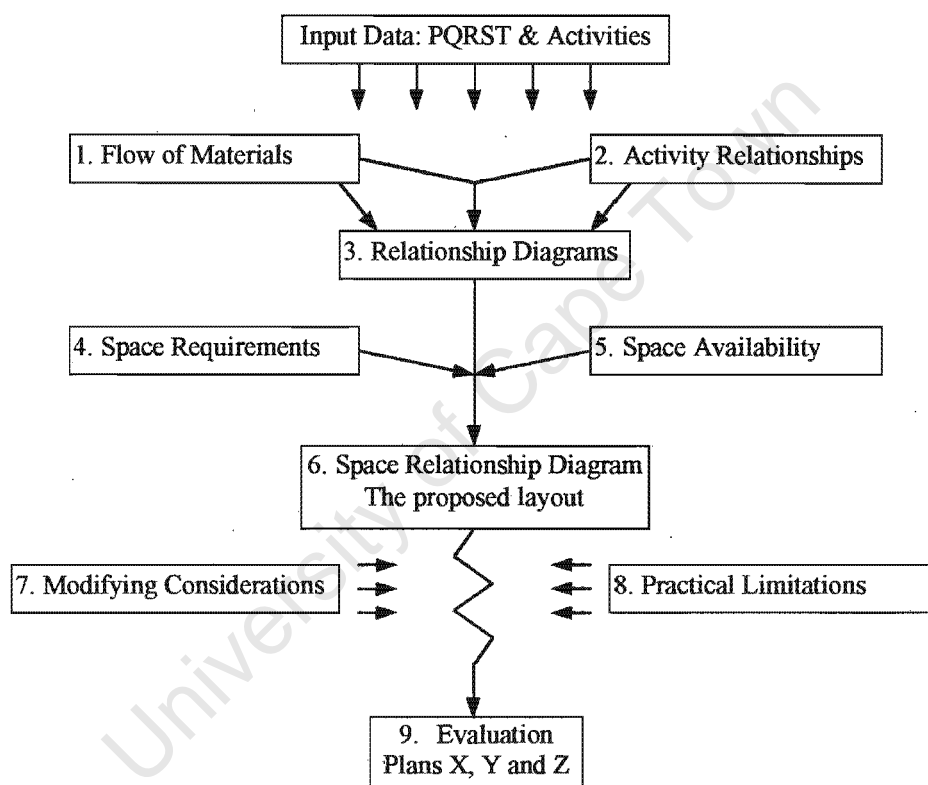
In redesigning the factory layout, the understanding gained during the development of the 'rich picture' was put to use, especially in view of the 'hard' issues identified. In particular, the redesign was approached with a view to accommodating the system in its entirety. This included the requirements of the Cape Town Sales Branch, the layout of the various departments within the Manufacturing Division in respect of each other and the layouts within the departments especially regarding the Production Department. The six production lines in the Production Department were analysed, again in respect of each other and individually. The entire redesign was orchestrated by

developing a systematic plan for implementation based on systemic considerations. The suggested plan is presented and discussed below.

It should be noted that the full details of the analyses performed of each line are not included. However, the process followed for each line is illustrated by inclusion of the full analysis of the ALFLO line, the main production line in the Manufacturing Department.

### 5.3.1 The Layout Plan

The process that was followed in developing the layout plan as suggested by Muther (1973, 2-2) is illustrated in figure 5.1 below.



**Figure 5.1** The Schematic Layout Plan

This model was developed from very simple logic comprising four phases:

- 1) *Phase I – Determining the general location and area.* This involves determining geographical location as well as which area within a factory will be utilised or available.
- 2) *Phase II – Establishing the general overall layout.* This involves bringing together the basic flow patterns and the areas allocated to various departments in such a way that the general size, relationships, and configuration of each major area is roughly established.

- 3) *Phase III – Exact detail of layout plans.* In detailed planning, the actual placement of each physical feature of the area to be laid out is established, which should include utilities and services.
- 4) *Phase IV – Implementation.* Once the detail has been set on paper, the actual actions required to effect the layout need to be planned and converted into action.

In this regard it should be noted that the parameters concerning *Phase I* were predetermined by the contextual situation although it was evident that the location was a primary constraint. The focus in terms of the application at *C&L inc. Forlezer* was thus primarily on *Phase II* and to a lesser degree *Phase III*. Figure 5.1 diagrams the steps used in developing the layout at *C&L inc. Forlezer* which are further discussed in the ensuing sections.

### 5.3.2 The Input Data

The input data primarily takes into consideration all 'hard facts' and deduced information required to systematically developing a redesign. The required information was generated during the development of the problem statement and the assimilation of the data, and is presented in the relevant discussion of Section 5.2 and Appendix E. The key input data required involves consideration of the *Product*, the *Quantity*, the *Routings* or processes, the *Supporting services* and lastly the *Time* available (Muther, 1973).

#### i) *Product-Quantity Considerations*

To start with the primary input data for any layout plan concerns the consideration of the two basic elements, the *Product* being made and the *Quantity* or volume required. The relationship of the two, to a large extent determines the type of layout scheme to be considered, i.e. on the one hand by mass production conditions, on the other by job-order or job-shop methods (Muther, 1973, p3-2) or a combination or variation of the two.

Typically mass production layouts are suited to large volumes of few products and vice versa for job-order layouts. At *C&L inc. Forlezer* the existing layout was geared towards mass production on the six production lines. Performing a *product-quantity* (P-Q) analysis confirmed the appropriateness of the type layout as discussed in Section E.1 (Appendix E), concerning the Production Department. In as far as the new layout was concerned, only the quantity was to change with an expected increase of 3 times the current throughput.

Having decided that the existing general layout format was in agreement with the P-Q requirements, the next overall conceptual step was to determine the general location of the various department within the factory, termed *activity-areas* (Muther, 1973).

*ii) Existing Layout*

The existing overall factory layout is presented in figure E.3.1. In light of the fact that the layout plan involves the redesign of the current layout and not a completely new redesign, the current layout was used to establish the required flow of materials (step 1) and the activity relationships (step 2). Thus new production processes and interrelated production activities as such were not required. The focus was rather on the critical consideration of existing processes and flows, as will be discussed in the ensuing sections.

*iii) Identification of Activity-Areas*

The term 'activity-areas' was specifically chosen instead of departments to break the preconceived paradigm of accepting the existing departments. As stated by Muther (1973, p3-9) often the division of space into departments or activity-areas is taken for granted. It is convenient to plan a new layout using current departments. However inherently this may result in an opportunity for improvement being overlooked if the existing area identifications are not challenged.

Specifically the activities required to achieve the product output were taken into consideration. Besides the manufacturing process required, these were established to be the receipt and storage of the raw extruded aluminium profiles, the manufacture and storage of finished components used, the cutting and machining required/possible prior to material flowing through the production lines, the maintenance and set-up support and the storage of the finished product.

Thus the designated departments identified were much in accordance with the existing departments, except for the creation or merger of the cutting department into a pre-production machining department, discussed in more detail in Section 5.3.3. It was perceived possible to combine the raw material store with pre-production machining, as the machining/cutting is directly performed on the raw extrusion profiles and therefore transforming the profiles 'locally' would minimise current transport waste. Further consideration was given to the possibility of additionally incorporating the manufacture of finished components with its storage function, to separate this responsibility completely from the factory floor and thus facilitate control, however this was not possible due to unavailability of machinery.

*iv) Future Projections and Product Changes*

Clearly in developing a new layout any future changes have to be anticipated and considered. Regarding the increased productivity goal set by the Management at *C&L inc. Forlezer* the direct impact in terms of increased raw material and finished goods storage requirements is significant. Firstly Management was of the opinion that on certain lines, in particular the ALFLO, the throughput could be tripled. Although this assumption was not held to be realistic within the existing system, as was discussed in Section E.1 (Appendix E – concerning the ALFLO line) it

should nevertheless be taken into consideration. Any increase in productivity would require either more storage space of raw materials and finished goods, or more efficient receipt of raw materials and dispatch of finished goods as well as consideration of the logistics of hypothetically having three times the amount of material flowing through the factory.

Additionally, Management mentioned the possibility of diversifying the Manufacturing Divisions products by increasing the variety of fibreglass ladders as well as producing other products other than ladders. In this regard, the Management was urged to do the required investigation and take the appropriate decisions prior to undertaking and implementing a new layout, for changes in this regard could easily render the current new redesign redundant should these possibilities materialise. The matter was however not pursued any further by Management. Again the approach was counterintuitive and non-systemic, but Management stated that should these ideas materialise, it would only be in 'a couple of years' at which stage the required modifications could be made!

### 5.3.3 The Flow of Materials

Consideration of the flow of materials through the system involves consideration of *Routings* and forms the core concern of layout planning. It is critical to find the 'big 3' (Ishiwata, 1992, p12), being waste, irrationality and inconsistency. In undertaking the improvement of a layout, the standard work simplification check presented below is useful (Ishiwata, 1992, p13). This check challenges each step in a process or material routing as follows:

1. *Eliminate* – whenever possible
2. *Simplify* – the easier, shorter etc the better
3. *Combine* – can operations or actions be combined
4. *Change sequence* – rearrange to facilitate flow

Muther (1973, p 4-1) identifies a further step for improving routings – *improve detail* i.e. can the method of performing the operation or action or its equipment be improved (technically and technologically). In this regard, the input of the actual operators performing the operations is invaluable, as they often see the 'obvious' due to their continual interaction with the process. The fourfold purpose of making improvements originally identified by Mogensen (Muther, 1973, p4-1) is also useful:

1. To make work easier
2. To improve products or services
3. To work faster
4. To produce goods or services less expensively

Taking the above guidelines into consideration, the flow considerations within the *C&L inc. Forlezer* system were applicable at two levels. One in terms of *Phase II* where the general flow of material through the entire Manufacturing Division was considered, the other in terms of *Phase III* concerning the individual production line flows.

Accepting that any unnecessary transportation of raw material constitutes waste in terms of non-value adding effort and handling, the primary objective of step 1 in *Phase I* was to achieve the shortest logical routing through the factory. This routing concerns all system parts and their interaction in terms of material flow to achieve the required overall output as effectively as possible.

Logical linear sequencing in order of outputs required would thus start with the receipt of the raw aluminium extrusion profiles into the FE Store, from where the pieces are then drawn for manufacturing of the ladder. As identified by Muther (1973, p3-6) within a grouping of more or less similar products an attempt at removing completely from the mass production area any jobbing work is highly beneficial. Characteristically, jobbing work requires differences in arrangement and separate equipment, which are separable from mass production lines. In this regard, reference is made to Figure E.3.1 (Section E.3, Appendix E) illustrating the rung manufacturing, tumbling and machining areas. Within the Production Department specifically, the rung manufacturing process constitutes jobbing work using both the machining and tumbling processes that effectively can be removed.

Thus it makes sense that, prior to proceeding onto the production lines of the Production Department, the stiles be cut to size and any general machining common to numerous production lines be performed in a Cutting/Pre-machining Department. In particular this would apply to the manufacturing of the rungs, which can be completely separated from the production lines. Subsequently the stiles and rungs proceed to the Production Department where the necessary 'machining' processes specific to each product type are performed and the stiles and rungs combined. Once combined, the various finished components are 'assembled'.

The 'machining' and 'assembly' operations on the lines form a separate, more detailed process analysis (*Phase III*). The finished components are added only at the latter stages of the production lines during the 'assembly' processes and therefore ideally the FC Store should be located in the vicinity of the assembly areas. Once completed, the ladders are temporarily stored and then proceed into the Finished Goods Store. In terms of material flow the Tool Room uses raw material from the FE Store to manufacture finished components for the FC Store. The logical sequencing would thus be from the FE Store, through the Tool Room into the FC Store and then onto the lines where required.

Similarly to the above, detailed material flow and process analyses were performed for each of the six production lines in accordance with *Phase III*. The analysis was undertaken to determine the most effective sequences of moving materials through the necessary processes involved. The aim was to achieve progressive flow through the production lines, always advancing toward completion

with the minimum amount of detours or counterflow. To illustrate, a process analysis performed of the ALFLO line is included in Appendix E (Section E.6), which includes diagrams illustrating the existing layout and flows (Figure E.6.1). Having determined the sequencing to optimise the material flow through the Manufacturing Division, the next step involved taking the dynamics of the parts into consideration.

#### 5.3.4 Activity Relationships

Besides consideration of material flows, the interrelation of the various departments and the necessary *Support services* required has to be taken into reckoning. The support services have to be integrated with the flow in an organised systemic way. This integration results from consideration of the system dynamics justifying the location of certain departments or lines close to each other or to certain producing or operating areas.

Commencing with the location of the FE Store it was evident that the receiving area and the actual store had to be combined. Because the extrusion profiles stored in the FE Store are invariably cut to length, consideration was given to the location of the cutting machinery as close to the FE Store as possible. For this reason it was suggested that the cutters actually be located within the FE Store. In light of the fact that besides cutting, there are other common machining processes relevant to all lines, it was suggested that any common pre-machining process also be located to this area. In this regard, the main pre-machining operation that was clearly separable from the Production Department involved the rung manufacturing process and consequently it was suggested it also be moved into the Cutting/Pre-machining Department.

According to the flow considerations of Section 5.3.3 ideally the FC Store should be located close to the assembly areas at the end of the production lines. However, taking into consideration that the finished components involved are all small and light, and thus easily transportable, the location of the FC Store was weighed up against other non-flow considerations. In particular these included the control of the components in terms of receiving and storage facilities, as well as the dependence on other departments. Specifically this involved the Tool Room, which manufactures numerous finished components, and thus the proximity of the two departments to each other was considered more important. Due to the involvement of the Tool Room with the Cutting/Pre-machining Department, which in turn had been located close to the FE Store, it thus made sense to locate both raw material stores close to each other. This would also automatically facilitate the control of incoming material, as this function could be centrally located for both stores.

Furthermore, consideration was given to the fact that the Tool Room is charged with the maintenance, repair and set-up of the entire factory and in particular the Production Department, whilst also being required to manufacture components and 'specials'. Thus on the one hand the Tool Room requires its own operations area located in the proximity of the FC Store for the

manufacture of the required finished components, on the other hand it should have easy and direct access to all production lines. It thus had to be located in an area close to the raw material stores as well as in an area that would accommodate its own space requirements, whilst in some manner ensuring access to the lines. An additional complication arose in that the Tool Room is required to varying degrees of involvement by some of the production lines. In terms of the Finished Goods Warehouse, the only consideration was the actual flow of the manufactured goods into the warehouse and the dispatch areas.

Regarding the location of the individual production lines, both in respect of each other and their involvement or dependence upon other departments, the following criteria were stipulated:

- a) To locate the lines with the highest intensity flow (greatest volume) closest to the FG Warehouse.
- b) To locate the production line manufacturing the heaviest, most cumbersome products closest to the FG Warehouse.
- c) To locate the lines in accordance to decreasing dependence on Tool Room set-ups or assistance from the Tool Room.
- d) To locate lines sharing any machinery next to each other.

Consideration of these criteria reveals typical conflict in objectives characteristic of Operations Management (figure B.5, Section B.1.2), which had to be balanced. Points a) and b) for instance directly oppose each other. Within the Production Department, the importance of effectively accommodating the fast movers was considered to be of higher priority than the cumbersome products, mainly due to the volumes produced but also because of the fact that the latter products constitute less in terms of turnover accrued by the Sales branches. The approach adopted was that the busiest and most profitable line be allowed most efficiency and therefore be positioned closest to the FG Warehouse. Priority was thus given to the ALFLO, LAS/QS and the SPL/FM lines, which are the busiest in decreasing order, with the Fibreglass and Stecalloy lines being the least busy. Additionally the potential tipping of the throughput on the ALFLO line had to be considered.

A complication perceived in this regard was the possibility of diversification of the Fibreglass line mentioned by Management. Clearly this future development would be relevant. Given the scenario for instance that the variety of products manufactured on the Fibreglass line was increased and met with the appropriate demand, the volumes would increase in accordance.

Taking into consideration that the manufacturing process of fibreglass ladders is more complex and the product more bulky, as well as the fact that the margins are higher on these ladders, the impact would be significant. A more detailed investigation in this regard was required in order that future changes could potentially be accommodated in the redesign, prior to implementation. In a

similar vein, Management stated that the Stecalloy product would possibly be reduced in the future, perhaps even stopped which equivalently would affect the layout.

The above are primary example of the concern developed in the hypothesis in Chapter 2 that a systemic approach is required to achieve effective long-term solutions. Emerging issues concerning the future market have a direct bearing and influence on the layout, proving that hard issues cannot be taken in isolation if an overall effective solution is required.

In reference to point c) above it was established that the Upright and Stecalloy lines require the most interaction with the Tool Room and ideally should therefore be located in its vicinity. In particular the Upright line is directly involved with the manufacturing of 'specials' produced by the Tool Room, wherefore the two effectively should not be separated. The Stecalloy line on the other hand only requires various set-ups to be performed, a constraint that could be removed by training line operators to perform this function. Again this has bearing on 'soft' issues that should be contemplated during the redesign process.

Finally consideration of point d) revealed that all lines essentially form autonomous units except for the 7 tonne press shared between the ALFLO and Fibreglass line, and a drill situated in the SPL/FM line which was utilised for drilling the back stile of one of the ALFLO products (Process analysis, Section E.6). Besides the logistical implications of excessive transport in the form of detours or re-routings and unnecessary handling between the lines; from a Factory Physics perspective the shared machinery constitutes potential bottlenecks, as the flow of two lines merge at these points. Upon further investigation the following potential solutions were suggested.

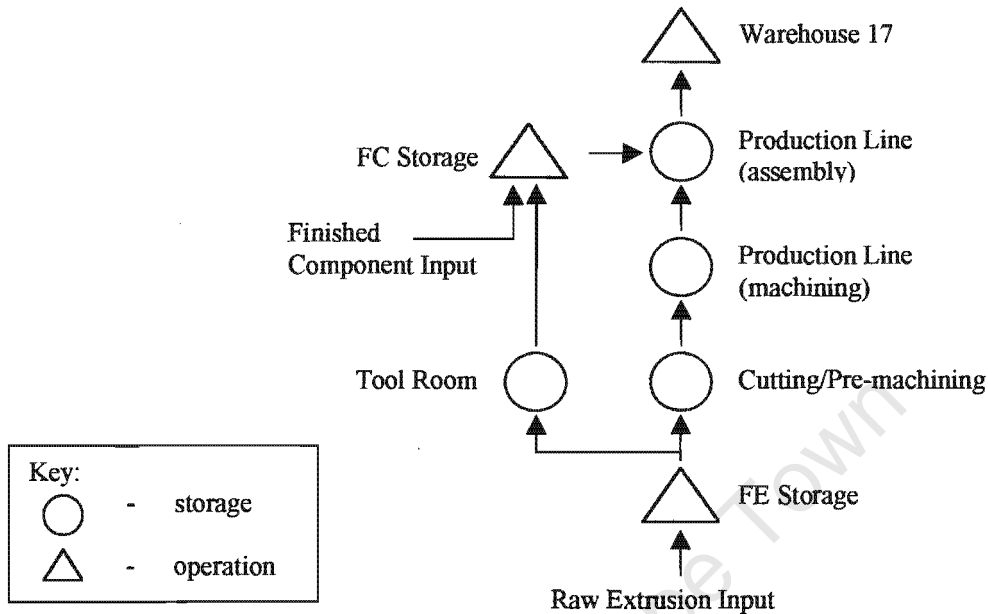
The use of the 7 tonne press (forming part of the Fibreglass line) was required for punching holes for the assembly of locks and rail closers on the ALFLO extension ladders. The ALFLO line itself operates a 60 tonne press for various punching operations. Upon consideration of the punching process, it was determined that the manufacture of a punching tool specifically for this purpose was possible. Whilst requiring additional set-up time, the saving in terms of transport to and from the Fibreglass line as well as the removal of a bottleneck, constituted an overall improvement.

In as far as the drilling on the SPL/FM line was concerned, the process analysis performed on the Stecalloy line revealed excess capacity, allowing the removal of a drill to the ALFLO line. Potentially this 'frees' any of the production lines from interdependence upon another line, therefore allowing the free arrangement within the Production Department.

### 5.3.5 Relationship Diagram

The third step in the layout plan involves the generation of relationship diagrams. The purpose of the diagrams is to essentially combine the above thoughts and analyses on paper and effectively model the ideal sequencing of processes and activity relationships. This process of modelling is

vital in terms of bringing together steps 1 and 2 and moving towards the modelling of a practical layout. In this regard figure 5.2 illustrates an example of a relationship diagram for the interaction of the departments of the Manufacturing Division.



**Figure 5.2** A Relationship Diagram for the Manufacturing Division

The relationship diagrams are continuously refined until the diagram represents the theoretically ideal relationship of the activities, independent of the area required for each and before taking any modifying considerations into account (Muther, 1973, p6-10). The diagrams are also generated for differing levels of recursion. The relationship in respect of the production lines for example would have the lines arranged in the following decreasing priority in respect of closest location to the FG Warehouse – 1<sup>st</sup> ALFLO, 2<sup>nd</sup> LAS/QS, 3<sup>rd</sup> SPL/FM, 4<sup>th</sup> Upright, 5<sup>th</sup> Fibreglass and 6<sup>th</sup> Stecalloy.

### 5.3.6 Space Requirements, Availability and Relationship Diagrams

Having produced a theoretical layout the next step involves consideration of the actual space required for the layout, based on actual space availability. The determination of the space required was undertaken by producing a scale model of the factory parameters and the various departments. In this regard, the existing space occupied by the various departments in particular the FE and FC Stores, FG Warehouse and the Tool Room were used as a starting point. For each of the production lines, the existing machinery was reproduced in the form of scaled models (presented by colour-coded pieces of cardboard) and a layout arranged according to the relationship diagrams developed, within the existing space perimeters of the factory.

The output of this process was a relevant space relationship diagram modelling a suggested layout based on existing parameters and the above given considerations. The model did however not take any modifying considerations or potential improvements into consideration. Practically speaking, the space relationship diagram represented the optimal arrangement given no changes to the existing parts.

### 5.3.7 Modifying Considerations and Practical Limitations

This area presents a high leverage area for improvement whilst ensuring practical applicability. During this stage the importance of taking the Systems Approach, operations theory and potentially related soft issues into consideration cannot be overemphasised. Any related issue affecting the layout or being affected thereby, could produce adjustments that otherwise would be neglected. The consequences could result in inherent ineffectiveness or inefficiency being built into the layout, which in the long run could trigger newly emerging problems similar to the current situation faced. Clearly the participation of all stakeholders in this process is vital as different perspectives and perceptions will identify and recognise different aspects for improvement. Some of the areas clearly identified were:

#### *i) Cape Town Sales Branch Requirements*

In view of the fact that the main motivation for initiation of the redesign was due to the additional space requirement of the Cape Town Sales Branch, the layout had to accommodate their needs. In this regard, reference is made to the layout proposal formulated by the Sales Branch presented in Section E.4 (Appendix E). Specifically these were to:

- Create a combined store for the Sales Branch that was separate from the factory.
- Allow for an increase in the existing storage space due to the expansion of the Branch's activities and want of increased service levels.
- Allow for ground floor storage of most items to reduce unnecessary material handling.
- Provide a goods receiving and dispatch area removed from the main road where the Branch is currently forced to load and unload.
- By increasing the available storage space, the Sales Branch could effectively expand their showroom, as planned.

Clearly the main requirement was to provide the Branch with a storage area close to their showroom. As correctly suggested by the Branch, the ideal location was where the current FE Store was situated. From figure E.4.1 (Section E.4, Appendix E) it can be seen that the Branch also suggested taking over a section of the Production Department. The area suggested was however found not to

be feasible due to the existing space requirements of the corresponding production lines located in this area. It was suggested to rather prove the space down the length of the Production Department as illustrated by figure E.3.3 (Section E.3, Appendix E) which presents the initial overall improved layout.

### *ii) Increase in Throughput*

With a potential increase in throughput, consideration had to be given to the actual flow intensity on the lines and increase in finished goods output. In this regard Management stated that they would increase the size of FG Warehouse to accommodate higher stock levels. This was in accordance with Management's intention to increase service levels by ensuring more safety stock in the FG Warehouse. Consequently the Management decided that it would reduce the current raw material stock.

It should be noted that this managerial decision was held to be non-progressive and incompatible with current operations theory. Modern JIT systems promote minimum inventory levels based on pull systems, as opposed to the suggested push system hybrid planned by Management. Higher safety stock allows for more inefficiency in terms of productivity due to the provision of buffers. Instead the approach was argued that Management should be focussing on reducing cycle times by improving productivity and increasing throughput, as per Little's Law discussed in Section B.2 *et al* (Appendix B).

### *iii) Storage Systems and Inventory Control*

From the systems analysis of the parts, in particular the three stores located in the Manufacturing Division, it became evident that each part should further be considered in detail and the internal efficiency and effectiveness improved. Particularly the raw material storage in the FE Store was considered. It was suggested that horizontal storage racks facing directly onto the Cutting/Pre-machining Department and the Production Department replace the vertical storage system. The delivered extrusion profiles could then be loaded directly into the storage system, which would eliminate unnecessary material handling. Horizontal storage would ensure much improved visibility and therefore inventory control, as the amount of profiles are directly visible and can be counted without requiring any handling.

Further it was suggested that the individual shelves be identified in accordance with the code identifying the profile on the BOM, as generated by the IMPACT system, thereby further enhancing the control. Individual shelves could be varied in depth to accommodate the different stile lengths required (at least for the fast movers). This would ensure that the correct lengths be stored providing a 'fool-proof' storage arrangement. Additionally the profiles could easily be colour coded per production line to further assist in the inventory control.

Similarly, concerning the FC Store, it was suggested that the components be stored in a more structured order (and not add hock), be it according to production line, product types or component types and also be identified in accordance with their BOM code. Further transparent bins were suggested for easy determination of stock levels, together with colour coding for increased control.

Consideration of the FG Warehouse revealed the necessity for a formal storage system locating a certain type product in a designated location, both to improve inventory control as well as the dispatch process. With the provision of a ground floor storage area to the Cape Town Sales Branch, both the mezzanine levels above the LAS/QS line and the original FC Store were available. Due to insufficient space in the designated store area it was suggested these be utilised to provide a 1<sup>st</sup> floor storage facility for the light small ladders produced by the Division.

In order to affect any of these changes Management were required to provide detailed information about the amount of inventory to be held and the required storage dimensions. The aim was to produce the modifications 'on paper' to check the feasibility and determine the space requirements.

#### *iv) Material Handling*

From the process analyses performed it was apparent that the actual material handling between departments and workstations required improvement. In this regard, the transportation of the extrusion profiles between various departments and through the individual production lines was labour intensive and inefficient, involving a lot of lifting and carrying.

Consequently it was suggested that the Division implement a trolley system for the supply of raw material to the lines, and utilise roller tables for the transportation of ladders between workstations. With the Cutting Department being located directly in front of the FE racking system, the profiles could be cut directly onto trolleys for supply to the individual lines. It was suggested that at least two trolleys be run for each line. Whilst any one particular trolley was busy supplying material to a line, the others could be reloaded. Further the trolleys should also be used to supply the assembly areas with the required finished components. Ideally each trolley should be loaded a day in advance according to the specified daily production schedule for the following day.

Upon commencement of a day's production, the required trolley would run to the line, dropping off the required raw material. The various stiles would be dropped into special racks feeding onto a roller table or directly into the first machine (any one rack having numerous compartments for different product types). Next the trolley would run to the rung assembly machines and drop off the required rungs.

Finally the trolley would supply the assembly area, dropping off required components sorted into bins according to quantity, type and sequence required as specified by the daily production schedule. The drop-off locations for the bins themselves should be optimised in accordance with ergonomic considerations.

Furthermore, the capital investment required for this improvement would be minimal, as most components or material needed to improve the conveyance system is either manufactured or sourced by *Klipton Industrial* (for example conveying rollers). The trolleys themselves could be designed and made by the Tool Room using available raw material.

v) *Work Methods*

Though not vital in terms of optimising the overall layout of the Division, it was evident that individual workstations, especially on the production lines, required further work method studies. This was particularly evident in the assembly area, where operators 'organised themselves' in a very ad hoc manner. In most cases the worktables provided for the assembly processes are nothing more than trestles. Consequently operators store finished components to be assembled randomly on the floor or in shelves behind them. It was noted that provision should rather be made to place component bins into holders on the work tables or trestles for easy ergonomic access, instead of having to bend or turn around each time to retrieve components needed for assembly.

vi) *Site Conditions and Operations Surroundings*

Finally, during the production of the proposed layout, the actual site conditions were taken into consideration. The factory overview was poor, with departments being indistinguishable, the floor dirty and passages between lines blocked with boxes or bins of WIP or components. Little detail appeared to have been given to how the operators were to move through the lines and in between workstations. Although space was evidently a problem, attention should be paid to these issues during the detailed finalisation of the plan.

In conclusion, simply by way of consideration of the above issues identified, it was evident that at this stage of the process the participation of all stakeholders was vital. Not only are conceptual modifications converted into practicality by putting them on the table, but also potential flaws or further improvements are identified, right down to the needed detail required at this stage.

For example during an informal discussion with the line supervisor of the Stecalloy line, it was discovered that a certain drilling procedure involving the use of a separate drilling machine was redundant. The supervisor pointed out that the sequential operation in the production process involved two consecutive drilling operations, in which he had to move each ladder from the one machine to the other. The actual reason for this was because two different jigs were being utilised to precisely locate the position of the holes being drilled, not because two different drill bits were being used. As pointed out by the supervisor, it would surely be easier to modify the jig on the first drill, rather than move the material to the jig on the second drill. Although somewhat simplified, this point serves to illustrate the benefit of involving all stakeholders, especially the line operators.

Unfortunately the Management did not endorse this approach. Instead of involving the entire shop floor, the Management expected the research to provide an optimal layout based upon theory, which it felt, could then easily be adjusted in accordance to the practical limitations that would be encountered. It was anticipated that regardless of the involvement, the project would be met with resistance in any event and thus it was considered better to confront this issue at the very last when all 'answers' could be provided to a disgruntled workforce. Clearly this attitude defeated the entire objective of a Systems Approach.

In this regard it must be concluded that the Management was the greatest 'practical limitation' encountered. Not only was the ultimate redesign not systemic, but simple requirements for the actual completion of a detailed design were not delivered by Management, an aspect discussed in further detail in the following section where the actual implementation achieved during the research period is discussed. Before commencing with this, the general improved layout, developed as far possible considering the practical circumstances that surrounded the research is presented in figure E.3.3 (Section E.3, Appendix E). It must be noted, that the layout only presents the general areas allocated to all system parts, and was not completed to include the detailed positioning and spatial requirements of the individual machines.

#### **5.4 The Actual Implementation**

Upon initiation of the research, Management attributed the manifestation of the problem situation to the poor layout of, in particular the production lines. Consequently during the course of the research, their main concern appeared to focus upon the layout of the lines, with little consideration of the remaining departments.

Initially the only reason consideration was given to relocating the departments was due to the proposal that the FE Store be relocated in order that the Sales Branch could utilise this space. Although it soon became apparent that in order to accommodate the Sales Branch, a complete relocation of the existing FE and FC Store, the Cutting Department and the Tool Room would be necessary; little consideration was given to using the opportunity to achieve an overall layout improvement.

Stuck in a mechanistic conception of the system, Management was happy to consider only the rearrangement of the production lines and to 'reshuffle the departments as best possible'. Although, during the initial discussions the Management had agreed that the aim should be the overall optimisation of the entire Division, the backing and commitment was not shown during the development of the layout. Repeatedly concepts were discussed with Management, the logic and relevance explained and the appropriate course of action suggested however no results were forthcoming. In general the Management took little heed of advises given and proceeded as it wished. It was evident that suggestions were palmed off as 'too theoretical and not practical' even

though all suggestions were based on observed facts, openly discussed and mostly agreed upon by Management itself. Consequently some of the suggestions made were adopted, others not. Mostly suggestions were not accepted, and no logical reasons or motivations were given.

As discussed in Chapter 2, Management had set out with the intention of completing the implementation of a new layout within the seasonal 'quiet period' between July to October. It was made clear to Management that although the time constraint was important, in order to ensure a coherent long-term solution, it was more important to actually achieve a holistic understanding of the problem before implementing action. Rather than enforce half a solution in a set time period because Management had procrastinated for so long, it was urged that the quality of the solution should be the determinant. In this regard it was stated that implementing a solution without prior consideration and planning would not constitute an effective solution, as well as more than likely result in a greater time delay till the problem was resolved.

Concerning the layout, it was emphasised that a detailed plan was necessary before any action was initiated. As previously discussed, the intention was to take both 'hard' and 'soft' issues into consideration and include all stakeholders concerned. However, Management was neither interested in the actual 'soft' issues or any 'soft' applications. This was demonstrated by the approach adopted towards involving the union and work force in the redesign process. Even though the soft systems analysis revealed the importance and benefit of including the stakeholders, Management chose to neglect the approach. The opinion was held that in this manner the required relocation would be brought about in the swiftest manner.

Furthermore, the relocation of some departments was initiated prior to the completion of *Phase II* of the layout planning process, despite discussions that for successful relocation the detail emerging from *Phase III* was actually required. Specifically, Management initiated the relocation of the FG Warehouse before the relevant relationship diagrams, as well as the space requirements for the remaining departments had been determined. Effectively once Management had made the decision to increase the minimum stock levels in the FG Warehouse and reduce the raw material stock held in the FE Store, the implementation was initiated.

However, at the time it had not been determined exactly how much inventory was to be held and where individual products were to be stored—very much like building the roof of a house prior to knowing where the walls will be. During this process, interesting dynamics were observed.

Top Management had made the decision to start implementing the relocation due to the apparent urgency and limited time available. In turn the responsibility was 'delegated' to Middle Management, i.e. the Production Supervisor who was supposed to allocate and arrange the storage space per product, and the Production Engineer who was supposed to build the required mezzanine structure and support brackets for storage of the various ladders. In turn Top Management pledged to supply the exact stock figures to Middle Management, as this information was required to determine the exact spatial requirements.

To initiate implementation in the interim estimated figures were provided. The relocation period of the warehouse was set at three to four weeks. The period that passed before the actual figures were made available to Middle Management i.e. the Production Supervisor was two weeks. In the interim, Top Management was pressurising the Production Engineer because no activity in terms of erecting the storage system could be seen. The result was that the Production Engineer was forced to proceed with an implementation that was not based on actual figures.

Needless to say, by the time the relocation of the warehouse had been completed almost double the allocated time had transpired and numerous readjustments had had to be made. Had the layout of the warehouse been correctly planned and modelled this would not have happened and the time to implement would more than likely have been within the set three week period.

Throughout the entire implementation process, the Top Management adopted an ad hoc approach in the line of, "let's move the machinery into the designated area and then we'll be able to see what the best arrangement will be." Consequently during the intended period from July to October in which the Management had aimed to complete the implementation of a redesign, *Phase III* had not been completed. Other than having relocated the FG Warehouse, which in fact constituted little more than extending the department and installing a storage racking system, no other implementation had been successfully completed.

It was also evident that numerous of the suggested improvements to be incorporated in the redesign had 'temporarily' fallen by the way. In this regard the Top Management advised that it was concerned with first relocating the system as it was and then the improvements could be considered.

In short, the Researcher is of the opinion that the systemic approach to achieving an improved layout was not endorsed and invariably the project had resulted in a systems failure. From a research perspective it was thus decided to reflect on the entire process and on what constitutes systems failure, in order to maximise the learning at least from a personal perspective. This is the topic of the next and final chapter.

# CHAPTER 6

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## 6.1 Reflecting on the Outcome of the Research

To reflect on the outcome of the research undertaken, it should be called to mind what the initial aim of the research work was. Being faced with a reducing market share, the Management at *C&L inc. Forlezer* had realised a threat to the organisation's viability and had initiated the research to address what they felt to be an inadequate factory layout. During consideration of the problem situation it however became evident that this was only a part of a more complexly structured problem, which Management was not addressing correctly.

In this respect, Chapter 2 concluded with the formulation of a hypothesis that embodied the research concern. The concern was expressed that the underlying dynamics of human, managerial and organisational influences had to be taken into consideration to effectively deal with any complex socially structure problem situation. To achieve this, a systems approach was required, taking both 'hard' and 'soft' issues into consideration. If this approach was not adopted, a systems failure was hypothesised.

In order to illustrate the validity of the hypothesis and concern developed in Chapter 2, this section provides a brief temporal overview of the further developments at *C&L inc. Forlezer*. As stated in the previous chapter, upon completion of the research undertaken, neither the implementation of the layout itself had been successfully achieved, nor had any of the 'soft' underlying problems been addressed. Due to the sudden 'urgency' developed by Top Management to start the implementation, the required thought and detail needed had not been given to the actual layout plan and consequently the result was far less effective, than if the needed attention had been given before rushing into action.

Consideration of the effects of ignoring the soft issues over a longer time period revealed far worse consequences. Due to the fact that the plan had not been completed, the Management had not presented or discussed anything with the union although action had already been initiated. Consequently over the ensuing three month period between approximately November 97 to January 98, the organisation faced increasing union involvement which eventually resulted in strike action. Leading up to this was the increasing uncertainty and mistrust amongst the work force.

Additionally the organisation experienced an all time low in orders during their actual 'busy period' and the operation was reduced to a three-day week. This trend was experienced throughout the entire ladder manufacturing industry.

However, the organisation was ill equipped to deal with such a slump. Consequently another 20% reduction in the work force was unavoidable, which resulted in further union opposition. In February 98 *C&L inc. Forlezer* was sold by the Klipton Group, apparently due to the fact that it was not showing the required returns.

## 6.2. The Failure to Change *C&L inc. Forlezer*

The failure at *C&L inc. Forlezer* is an example of the consequences of responding too slowly to increased competition within an industry group as well as not anticipating changes in the operating environment. Effectively the inability to affect change in an ever-changing, fast-paced world in which competitive relationships are never static poses a serious threat to systems viability. Succeeding in such a competitive and changing environment demands the reshaping of organisations to meet today's challenges and competitive realities.

According to Reynierse (1994, p41) any change process requires the essentials of a strategy-driven approach, top-down involvement, organisational assessment, clarification of core values, work force participation and 'downstreaming' the work force.

Primarily the change process has to be strategy-driven. Essentially this incorporates long-term goals, the required vision and a framework that establishes the context to provide competitive advantage - activities which concern the medium- and long-term time horizon. Espejo and Schwaninger (1993) also identify this necessity for consideration of medium- and long-term time horizons.

At *C&L inc. Forlezer* the focus was primarily on short-term efficiency measures such as solvency (income, expenditure) and earnings (revenue, cost) which are important at an operational level, however are insufficient to ensure organisational capability and legitimacy. In this regard Espejo and Schwaninger (1993, p51 *et al*) identify value potentials such as customer problems, problem solutions, competitive position and experience at the heart of organisational capability; whilst viability and development in respect of system structure, culture, dynamics and philosophy constitutes the organisational legitimacy. These areas were all identified to be largely deficient, in fact often completely lacking at *C&L inc. Forlezer*.

Top-down involvement requires the CEO or Top Management to 'live' the change. In this regard, the MD at *C&L inc. Forlezer* was involved, however due to the limiting mental model held and the lack of managerial understanding, the vision required to drive the change process was distorted. The focus was directed mainly at addressing an inefficient layout in an actually ineffective system. The focus should thus rather have been on first gaining an understanding of the nature of the problem situation and its underlying dynamics. This step is closely linked with Reynierse's (1994) identified need for 'organisational assessment' as being essential to successful change. For this exact reason the research framework incorporated the Systems Approach as it

performs this vital task of assessing the organisation in respect of its internal dynamics as well as its current circumstance. Yet the Management did not endorse this approach.

Similarly, the system lacked the establishment of a clear value system. Reynierse (1994, p41) states, 'when they are integrated with a company's business strategies, core values help provide a focussed mission'. When core values are unclear the question arises whether in fact the organisation can have any competency in general. Typical examples of core values are shareholder value, business results, commitment, competent people, customer focus, technological leadership and so forth. Throughout the organisational structure at *C&L inc. Forlezer* little evidence of core values was found. From a lacking mission statement, poor vision, right through to personal leadership the only evident values were short-term measures – low capital investment, high ROI, maximum profit.

Reynierse (1994) also identifies work force participation as essential to the change process. Quite clearly, at *C&L inc. Forlezer*, the required work force involvement and participation had been blocked. Consequently it was inevitable that the required shared understanding, vision and commitment generated by complete participation was lacking. Not surprisingly, what Reynierse (1994, p43) classifies as 'culture carriers' – which promote core values and focussed missions – were also lacking. These include inspirational leadership, communication, training and personal recognition.

From a pragmatic point of view, Kotter (1995, p60) identifies the key to successful transformation as commencing with the establishment of a great enough sense of urgency, which prior to the development of the current critical situation was a critical factors missing at *C&L inc. Forlezer*. In particular this urgency is needed before the manifestation of problem situations.

Thus the requirement is not an urgency to act irrationally but rather an urgency to become aware of the changes affecting the organisational viability. In turn this requires serious consideration of changes in the organisation's competitive situation, market position, technological trends, and financial performances before it becomes too late to effectively manage changes.

According to Kotter there are mainly three factors inhibiting the successful creation of 'a sense of urgency'. Foremost it is underestimated how hard it is to drive people out of their comfort zones. Then it is often overestimated how successful the transformation efforts have been, and that such efforts take time and hard work. Consequently the required commitment and endurance fails due to lack of patience. Finally, there is a fear of offending people, or stepping on toes.

To illustrate, whilst *C&L inc. Forlezer* was already experiencing difficulties two years prior to the initiation of the current research effort, when 22% of the workforce had to be laid off to reduce costs, no urgency was created to affect change. Even though it should have been evident then already that the company was losing its competitive advantage, nothing serious was undertaken until the Sales Division applied internal pressure for change due to their inadequate storage

requirements. And even then the initiation of change was not geared towards addressing the real issue at hand. Whilst the reality actually would have required an investigation well in advance of the two year period between the 22% layoff and the current reducing market share threat, Management still hadn't realised that the problem was manifested deeper than simple inefficiencies in the layout. The very fact that the actual implementation process of a new layout failed proves this. Thus whilst the Management was convinced that the problem was due to 'hard' issues, fact is that the underlying 'soft' issues had to be addressed.

Furthermore, Clement (1994, p33) states that when striving for organisational improvement one must deal with cultural and behavioural obstacles – particularly the firm's culture, the leadership of the change effort, and the existing network of power. In this regard, Clement identifies a mistake often made in trying to directly change the organisational culture, instead of rather focussing on the work itself. Essentially this requires co-ordination, commitment and developing the needed 'competencies' – requirements which had not been well addressed by the Management at *C&L inc. Forlezer*. Reflecting on the research undertaken it is apparent that no consideration whatsoever was given to either cultural or behavioural aspects, despite the continued insistence to consider 'soft' issues.

As identified by Clement (1994, p35) management leadership is 'probably the most critical element in any organisational change effort'. Without this leadership, the required vision that makes any change meaningful will be lacking. To effectively lead, Management has to openly communicate and demonstrate visible commitment and support for change. For this reason management leadership is considered by Reynierse (1994, p35) as a primary culture carrier. Expected behaviour should be modelled and support generated by participation and development of subordinates. Kotter (1995, p62 *et al*) suggests to successfully achieve initiated changes Management has to form the required 'guiding coalition' and then to create, communicate and empower the required vision. This is also what Reynierse (1994, p41) refers to by his top-down involvement.

At *C&L inc. Forlezer*, no vision was in place at all, no leadership shown and the change effort was not spread throughout the shop floor by involving the work force. The Management was entirely convinced that the problem would be resolved by way of an overall redesign. Ironically this lack of support directly influenced Management's attempt at redesigning the layout, even though the actual changes required were minor in that Management was focussing on only 'hard' issues.

From the above discussion on the failure at *C&L inc. Forlezer* it is evident that the Management is primarily at fault for the poor performance of the system. Clearly the efficacy Management can provide is directly related to the organisational structure and culture present, however it is not up to the existing structure and culture to change a deficient managerial approach, but rather vice versa.

The effectiveness of Management is what counts, for it has the power and responsibility to ensure the viability of the system it is managing. At *C&L inc. Forlezer* it would appear that the Management does not possess the required effectiveness. There is an inherent lack of understanding, and from an evaluation perspective it is useful to consider the underlying psychological reasons that in general contribute to failure. Only in understanding these reasons can future failures be prevented.

### 6.3. The Logic of Failure<sup>1</sup>

Dörner (1989) provides a useful and valuable account on the logic of failure. Essentially Dörner (1989, p185-189) ascribes failure to four main categories of psychological reasons, being the tendency to economise complex situations, an inability to handle non-linear configurations, an inherent tendency to self-protect and a lack of anticipation of problems not yet experienced.

In essence the tendency to economise arises from the fact that human thinking is slow and limited, and cannot possibly absorb all complexity of the surrounding world. Consequently, in order to cope with complex situations, the tendency exists to ignore or reduce the complexity by reacting in various ways. Often instead of clarifying complexities, one 'particularly important' issue is chosen and becomes the focal point of all consideration (Dörner, 1989, p55). At *C&L inc. Forlezer* for instance, Management honed in on the poor layout of the production lines equating this with the poor productivity, in the process neglecting all other related 'hard' and 'soft' issues.

A variance of this behaviour is to treat a complex situation according to set rules, which eliminates the need to deal with the complexity of reality. This 'methodism' (Dörner, 1989, p170) treats a new situation like an old one due to the associated comfort and familiarity with a known course of action. However, mostly these rules are static and neglect the fact that each situation is uniquely influenced by its own dynamics.

Related to this issue, is the tendency to plan, make decisions and act without consideration of the side effects and long-term repercussions of our actions (Dörner, 1989, p187). Locating the Manufacturing Division in Cape Town where it is far removed from its market, excluding workers from the redesigning process and not taking 'soft' dynamics into consideration are examples of this manifestation.

Taking into consideration the above arguments, the existence of the traditional reductionist paradigm is easily explained. Taking systems apart and considering parts in isolation reduces complexity. The mental effort required is far less taxing than trying to deal with interrelated dynamics and emergent properties.

This difficulty in dealing with complexity also explains the poor understanding exhibited in respect of non-linear configurations, such as temporal or exponential developments (Dörner, 1989,

p109). Typically such events are dealt with by way of linear extrapolation. This is a major problem throughout humanity, illustrated by the existing global problems such as overpopulation, pollution, the ozone depletion, the greenhouse effect, famine and so forth. Allowing the development of a reducing market share is a manifestation of poor temporal projection at *C&L inc. Forlezer*.

The other main psychological cause of failure is the natural tendency for self-protection – ‘the need to preserve a sense of our own competence’ (Dörner, 1989, p69). This is especially relevant in a working environment where humans are held accountable and are under constant pressure to perform. The associated emerging effects are again manifested in a multitude of forms.

The main result is that people in charge make sure that they are seen to be ‘doing something’. Be it that action is immediately undertaken, or that planning, information gathering and structuring processes are pursued indefinitely, as long as people are partaking in activity their sense of competence is preserved. It therefore also stands to reason that the focus will fall on what is known and not on the unknown, as the ability to perform or at least the perception of performing is far greater when dealing with familiarity.

Unfortunately this results in ad hoc approaches to problem solving, focusing on singular goals, goal degeneration and neglect of long-term effects. The tendency explains the existence of methodism and reductionism. General goals are quickly set, however they are not analysed and broken down into partial goals. Consequently because the pursuit of the general goal must be perceived, however because no clear perception exists of what the goal implies or how it is to be achieved, ‘repair service’ behaviour ensues (Dörner, 1989, p58).

The result is the search for things that are malfunctioning, and once found, the immediate goal is to fix what has been found. In turn pursuit of the general goal is neglected, or the goal adjusted to suit the activity. When the desired results are not achieved, this self-protecting tendency typically results in the blame being passed. Either other parties are accused of not performing in some manner, or the circumstances are at fault.

Reflecting on the research experience at *C&L inc. Forlezer* this self-protecting tendency was one of the main contributors to the systems failure. Faced with the emerging problematic situation, the Management clearly reacted in a manner that served to reinforce its own competence. The problem was directly ascribed to an inefficient layout and an uneducated workforce with no consideration given to other potential underlying problems. Effectively the inefficient layout was a known factor to Management, as it had been previously established.

Also, with the redesign of a new layout concerning mainly ‘hard’ factors, the goal was clear and relatively non-complex, thus providing a needed sense of security and being in control. The action was thus chosen for its obviousness or ease rather than for its importance or effectiveness. An additional manifestation of self-protection is the tendency to leap into action under time pressure.

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<sup>1</sup> Heading adapted from Dietrich Dörner’s (1989) book *The Logic of Failure – Why Things Go Wrong and*

This phenomenon was clearly exhibited during the planning of the layout. Although it stood to reason that action should not be taken before the required detail had been provided, Top Management insisted that implementation commence.

The lack of anticipating potential problems, a further reason identified by Dörner (1989, p189) for systems failures, was again a clear contributor to the situation at *C&L inc. Forlezer*. The potential threat to the systems viability should have been picked up well in advance of the current situation faced. Also it was known that the layout of the factory was inefficient, and thus the consequences of this should have been considered. In this regard, Dörner (1989, p60) states that we are captives of the present moment; the thought of possible side effects may overburden us and therefore we chose to deal with the present.

In summary, it is concluded that failures to affect effective changes to problem situations result out of a direct lack of understanding of the problems being faced. In particular this understanding concerns the complexity governing situations in terms of their dynamics and emergent properties. Consequently this intransparency results in the poor formulation of goals and setting of incorrect priorities. If a situation is understood in its entirety, it can be dealt with in its entirety and thus no tendency to economise will exist. Likewise, if a problem is understood, it is easier to set clear goals and in turn arrive at meaningful action, given that the necessary planning is undertaken.

For this exact reason, the majority of the research was spent on analysing the problem situation at *C&L inc. Forlezer* and generating a 'rich picture'. Having thus gained an understanding of the logic behind failure, the question naturally arises as to what can be done to prevent failure. This topic is discussed in the next section, however a detailed account falls beyond the scope of this thesis.

## 6.4. Preventing Failure

From the above discussion, it stands to reason that the starting point for initiation of effective measures lies in gaining a comprehensive understanding of the situation at hand. Yet, when exactly can one be sure that the situation has been adequately understood? The Management at *C&L inc. Forlezer* certainly thought it understood the problem. The issue is further complicated by the fact that at times a detailed understanding is required, at other times not.

The complexity and seriousness of the situation and the goals to be achieved should, in turn, guide the level or detail of understanding required of any particular emerging problem situation. The intensity of understanding can vary depending on the level of abstraction one engages in, which in turn is determined by temporal objectives and responsibilities (the goals). By way of an example, the understanding required of the Manufacturing Division at *C&L inc. Forlezer* at a normative level requires a much higher level of abstraction, than the understanding at an operational level which

Be that as it may, the required level of abstraction can only effectively be determined if an overall perception of the current system status being dealt with exists. This perception has to cover the entire temporal spectrum, incorporating both long-term as well as short-term goals, for any measure implemented in the short-term that consequently will affect the long-term, will only be 'spotted' if such understanding of the long-term exists. Generally the difficulty experienced with temporal configurations, as discussed in the previous section, results in a poorer understanding of the effect on long-term measures. Thus it is important that in particular, the influences on these measures be understood.

A central key to the improvement of our capacity to understand starts with a reflection on the underlying assumptions and belief systems held by individuals. In this regard the mental models and paradigms out of which we operate have to be swept into cognisance. However, an awareness alone is insufficient. We need to consider the consequences of the perceptions or *Weltanschauungen* held and how these shape our thinking processes.

Particularly, the traditional reductionist approach and our tendency to methodism has to be critically considered. The world around us is made up of a multitude of interrelated systems and sub-systems, yet we as humans have not learnt to think in terms of these interrelations. Further, we need to maximise our learning potential by way of double-loop reinforcement. Whilst learning from experience is an adequate way of learning, reflection prior to undertaking action and after implementing action is far more important. Simply put, we need to think more and act less, and once we have acted we need to consciously review the outcome of these actions.

The other critical consideration involves the necessity of addressing and dealing with complexity. Although absorbing and processing all information and interrelationships within an environment is impossible, critical relationships have to be identified and possibly even amplified. In particular, the human and systems dynamics have to be taken into account and emerging 'soft' issues must be dealt with.

Essential to dealing with complexity is the awareness that situations are both unique and dynamic. We need to understand that in dealing with a problem situation we are dealing with a process as opposed to a moment in time. Accepting that the nature of our world is not static also aids in a further requirement to prevent failure – adapting to change. In order to adapt to change, one needs to be aware of what is changing and what the impact or implication for the system in consideration will be, especially over time.

In general, if an organisation or system is open to change and has developed an effective understanding of itself, its dynamics and its environment, as well as having a learning culture, the development of serious viability threats should be unlikely. Even in the event of an emerging threat, the system will be well enough equipped to handle the situation, as it should be able to set clear goals that lead to the resolution of the situation. In setting clearly defined and understood

clear goals that lead to the resolution of the situation. In setting clearly defined and understood goals, a further important step in preventing failure is accomplished. Also vital in this regard is the required planning needed to achieve these goals i.e. first thinking before acting.

In terms of resolving the problem situation at *C&L inc. Forlezer* it is evident that the organisational structure and managerial approach require further analysis and improvement. The organisation's focus on operational goals and neglect of strategic and normative goals is inadequate to sustain long-term viability. In this regard a critical organisational assessment is required, the outcome of which must produce a clearly defined value system.

In turn the appropriate mission statement and vision can be formulated, based on values identified. From a managerial perspective leadership is required. Cultural and behavioural aspects need to be addressed, in fact the entire organisational culture needs to be transformed. Organisational 'competencies', participation and motivation need to be developed, and the required support given. Union issues have to be addressed and a common foundation for all stakeholders cast. All the above are complex 'soft' issues which require urgent attention. In as far as the 'hard' issues are concerned, further work-methods, time and motion studies are required. General MOPs need to be established and effective control systems installed. The manufacturing policy should be revised and raw material and finished goods levels reviewed.

In essence the Division is far from resolving its problems, which this brief overview shows. However, with the wrong managerial and organisational approach, a more precise account was not possible. Needless to say, it is clear that a multitude of problems exist that are in fact mostly not even related to the poor factory layout, which was the manifestation of the problem perceived by Management.

## 6.5. Reflecting on the Validity of the Research

The intention of this section is to determine the adequacy of the concern and answer developed in this thesis, as well as to establish to what extent the theory and observations can be accepted in terms of general applicability. Ultimately the aim of undertaking any research process is to arrive at valid propositions, inferences or conclusions (Trochim, 1997, p39) which are useful within the research context and therefore verify the general applicability of theories, hypotheses or constructs used.

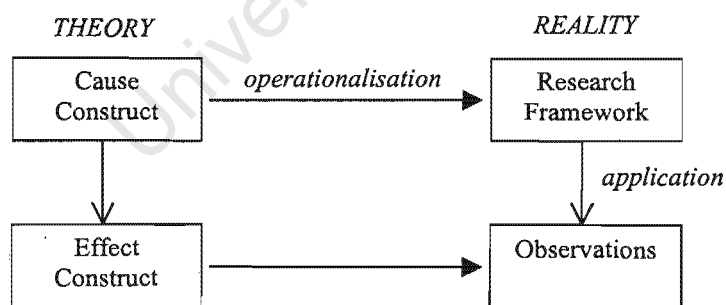
Essentially this process involves the application of theory, which is used to produce an observed outcome. Trochin (1997, p39) on a discussion on validity, identifies two realms in which researchers operate, theory and observation, between which they are 'continually flitting back and forth'. Within the theory domain he distinguishes between cause constructs and effect constructs. He states that when we are investigating a cause-effect relationship, we have a theory of what the cause may be, and similarly, on the effect side, we have an idea of what we are ideally trying to

effect or measure. This cause-effect construct leads to inferences on which for example the hypothesis of a thesis is formulated.

In this particular thesis for example, the system *C&L inc. Forlezer* was faced with an unstructured, problematic situation. To effectively address this situation, a holistic systemic approach was suggested which embodies a *cause construct* in that the lack of a systemic approach was resulting in the failure to understand and thus adequately deal with the situation at hand. In turn, the *effect construct* was embodied by suggesting that the Systems Approach be adopted, and in particular, the 'soft' issues arising out of the human and managerial dynamics as well as the organisational structure be considered.

The cause and effect constructs in turn are then translated into reality, a process that Trochim (1997, p39) refers to as operationalising to 'describe the act of translating a construct into its manifestation'. A 'program' is developed to address the cause and refers to what the researcher does, which is then tested by way of the observations made (operationalisation of effect construct). In this regard the 'program' developed in this thesis concerns the development and application of the inquiry framework, aimed at dealing with the problematic situation in a systemic manner. The observed outcome is the operationalisation of the effect construct and verifies whether the situation has been correctly addressed or 'effected'. Graphically this is illustrated in figure 6.1.

Consideration of the above allows an assessment of the research validity, based on the various types of validity identified by Trochim (1997, p40), being conclusion validity, internal validity, construct validity and external validity. These types of validity are discussed in context of the validity concerns relating to the thesis as follows.



**Figure 6.1** Cause and Effect Relationship in Research Process

### 6.5.1. The Validity of the Concern

Reflecting on the relevance of the concern developed in Chapter 2 in view of the observed systems failure outcome, verifies what Trochim (1997, p40) terms *conclusion validity*. Conclusion validity reflects on the relevance of the relationship between the cause and effect variables, and whether there is a link between them.

Essentially this concerns the inferences that can be drawn, given a certain situation or construct, and in this thesis is formed by the postulated hypothesis. In this regard, the hypothesis (construct) formulated in Chapter 2 expressed the concern that *C&L inc. Forlezer* were faced with an unstructured, problematic situation exhibiting ‘soft’ problems arising out of human, managerial and organisation issues – the cause construct. To effectively deal with this situation and ensure the system’s sustained viability, it was hypothesised that a system’s approach should be adopted to gain an understanding of the complexity and interdependence of the dynamics governing the situation – the effect construct. The concern was formulated, that should such an approach be ignored, the resulting effect could be a systems failure.

Applying conclusion validity to the hypothesis of the thesis, a consideration would for example be whether a systemic approach would result in identification of underlying causes. Alternately a different formulation could be whether a lack of consideration of ‘soft’ issues arising out of human, managerial and organisational dynamics inhibits the achievement of effective long-term solutions, i.e. results in systems failure. The fact that the outcome of the research was a form of systems failure would therefore suggest adequate conclusion validity and therefore also confirm the validity of the concern.

In terms of *internal validity* the reflection is not as transparent. Internal validity assumes that there is a relationship between cause and effect construct, and considers whether the relationship is indeed causal. Effectively the question is whether a non-systemic approach that neglects system dynamics and complexity always result in systems failure?

There could be other circumstantial or causal reasons for a result in systems failure. The argument in favour of internal validity in this regard, is that the application of the Systems Approach and methodologies in this instance revealed significant evidence explaining why a failure had resulted. This was only possible by way of the understanding gained in applying the adopted approach, and therefore, had Management allowed it, the approach could also have prevented a failure.

The lack of using the Systems Approach however, resulted in a direct failure, wherefore it can be argued that the link is indeed causal. It would thus appear that the concern also reflects internal validity, however this may only be applicable to this particular instance and not on a general basis.

### 6.5.2. The Validity of the Answer

The validity of an answer is established in two ways. Firstly a valid answer has to address the concern expressed in other words it proposes a way of dealing with the concern which in itself is useful. Secondly the way in which the answer was arrived at determines its validity. This mainly concerns the relevance of the theory used and the data collected to substantiate the answer. Reflecting on the concern reveals that the crucial element in this regard was to gain an

understanding of various 'hard' and 'soft' issues at hand, because without a clear perception of the problem situation little effective action can be undertaken. Consequently the inquiry framework was developed, based on a philosophical framework as well as the case study research methodology and incorporating systems concepts and methodologies.

The validity of including the philosophical framework is evident when considering that the application at the methodological level failed. A philosophical consideration of the logic of failure consequently reveals valuable insight into the underlying reasons for failure, the *why*, as opposed to simply considering *what* failed. In turn, the validity of the research methodology was discussed in Section 4.2.1 (Chapter 4), which was chosen due to the contextual circumstances.

The validity of the Systems Approach cannot be doubted. The approach is effectively used to deal with complex unstructured problematic situations due to its inherent consideration of 'wholes' and their interaction. Traditionally the approach had been used in the consideration of 'hard' issues only, however with the emerging importance of human dynamics, has been adapted to include 'soft' considerations.

In particular the Soft Systems Methodology was incorporated into the inquiry framework to adequately deal with these dynamics. To gain more understanding into the organisational structuring deficiencies, the Viable Systems Model was included in the framework. Finally, due to the fact that the contextual environment concerned the manufacturing operations function, the relevant theory on Operations Management and Factory Physics was included to ensure understanding of any 'hard' issues.

Essentially the framework thus provided the necessary content validity in terms of the theory required to adequately address the problem. The fact that by applying the framework the necessary understanding was gained by the researcher, verifies the *construct validity* requirement identified by Trochim (1997, p89). According to Trochim construct validity is an assessment of how well one has translated ones ideas or theories into actual programs or measures. In developing an inquiry framework that effectively can deal with the unstructured complexity of both 'hard' and 'soft' issues, exactly this was achieved.

Furthermore the issues derived were based on the necessary observations made and data gathered. Because the data was assimilated using the Systems Approach, which inherently incorporates multiple systems perspectives, the validity of the data can also not be doubted, even though Management limited the gathering of some of the data. Further, interpretation of the data is undertaken during the application in Part III, and thus conclusions are based directly on observations made. In terms of construct validity requirements, the theory and observations are thus explicitly linked.

The main problem the thesis has in terms of validity is regarding *external validity* – concerned with generalisation of the causal relationship. To establish clear external validity, the current

research findings would have to be compared to other research projects that have failed and establish whether a similar lack of systems perception was inherent to the situation. Thus the 'failure findings' require further testing. It is however argued that the fact that the outcome mirrors the psychological reasons identified by Dörner (1989) suggests external validity as well.

It should however also be remembered that not all types of validity are prerequisites to the overall research validity. Clearly situational circumstances also effect and limit the research process, and therefore not all validity types may be achieved.

### 6.5.3. Self Critique

Reflecting on the process undergone as a Researcher acting from a consulting perspective, the main body of this thesis is an analysis and critical exposition of the shortcomings of Management. Clearly within an operational context it is rare that any one party can be criticised or solely blamed for systems shortcomings. In this regard, the Researcher would like to stress that the focus was on Management mainly in view of their leading role in organisational development and change implementation, as well as the fact that the Researcher himself is operating from an 'operations management' paradigm.

In as far as the research contribution to the systems failure is concerned, the Researcher is of the opinion that the potential lack of work experience and exposure to diplomatically difficult and politically charged situations was a major difficulty – particularly in terms of credibility and acceptance by Management. As per Klotter (1995, p60) the fear of offending the Management as well as the inability to create a proper sense of urgency was a primary concern. The difficulty as identified by Clement (1994, p33) in dealing with cultural and behavioural obstacles, in particular the leadership of the change effort, further proved a major stumbling block.

## 6.6 Concluding the Analysis

Although the research project can be classified as a systems failure, an enormous amount has been learnt from the experiences made. In terms of affecting any changes at *C&L inc. Forlezer*, little overall improvement to the situation was achieved. However, from a learning perspective due to being faced with this failure, the researcher gained critical insight into the nature of failures and their causes as detailed in sections 6.2 and 6.3.

It is questionable whether the Management in fact viewed the outcome as a failure, other than the fact that the desired time constraint was not achieved. More importantly however, is the fact that the outcome was not due to the inadequacy of the approach suggested, as was discussed in the above validity considerations, but due to the fact that the Management was not open to a new approach.

In this regard it can be concluded that a systemic approach to problem solving by all decision-makers is long overdue. The complexity and speed at which circumstance changes, and the focal shift to include the human as an intricate, necessary and perhaps as the most important part of organisational systems, requires such an approach. The fact that reductionism cannot adequately deal with problem solving, especially in view of trying to achieve long-term solutions, requires the paradigm shift to 'holistic perception'. In this regard, the signs for the need of effective systems management surround us. Nature provides the most striking example – wherever man has intervened in this system he has caused havoc and disaster until such time as he has realised that he is dealing with a complex system dependent on a multitude of variables.

Particularly important is the emergence of 'soft' systems considerations as embodied by the Soft Systems Methodology. The move demonstrates the realisation that individuals hold (and always will hold) different worldviews, or paradigms which uniquely influence their perception of the world and thus their actions. From a philosophical and psychological point, this factor has to be appreciated simply from the perspective of generating more understanding and tolerance amongst humans, an attribute that the world is in dire need of.

In terms of achieving organisational effectiveness, this requirement was clearly demonstrated by the outcome of the research at *C&L inc. Forlezer*, where there was a complete lack of shared perspective. In this regard, the opinion is held by the researcher, that the SSM as used contributed greatly to the structuring and understanding of the problem situation, which is embodied by the 'rich picture' developed in Chapter 5. Taking into account that the full benefit of the methodology was not derived, as the issue based conceptual models could not be generated, the value of incorporating 'soft' systems considerations cannot be doubted.

Reviewing the literature on Systems Thinking, systems theory and systems methodologies, has in short resulted in the researcher being far less overwhelmed with the undefined, complex nature of real-life problems. In this regard, the process undergone has far better equipped the researcher to assess a situation with an open-mind, whilst still enabling a structured approach or way of tackling issues at hand. In view of the fact that the researcher is emerging from a tertiary educational institution with the hopes of becoming an effective manager, the thesis has offered an invaluable platform for further future development.

# APPENDIX A

## The Systems Thinking Approach

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### A.1 Introduction - The Concept 'System'

The aim of this appendix is to present the underlying body of knowledge on which the entire research undertaken in this thesis rests. All investigations undertaken are based on the body of knowledge known as "Systems Theory". This may sound simplistic to some, others may have difficulties in even imagining what this discipline of academia entails. Be that as it may, the concept of systems has been around ever since man has pondered his surroundings. In fact any phenomenon exhibiting any form of structure or organisation has been conceptualised as forming part of some 'system' of sorts, even if the system itself has not been understood. The Concise Oxford Dictionary (7<sup>th</sup> edition) offers the following host of definitions for the word system:

1. Complex whole, set of connected things or parts, organised body of material or immaterial things.
2. (Phys) group of associated bodies moving under mutual gravitation.
3. (Biol.) set of organs or parts in animal, body with common structure or function.
4. Method, organisation, considered principles of procedure, classification; body of theory or practice pertaining to a particular form of government, religion."

As can be seen, these definitions all have in common a set or group of entities that interact to form a bigger whole. It thus follows that an essential binding element that all systems have in common, is that the output of the system, produced by the interaction of the entities forming the system, is greater than the sum of the individual contributions by the entities. Bullocket *al* (1988, p842) define a system as 'group of related elements organised for a purpose'.

Kauffman (1980, p1) provides the definition that 'a system is a collection of parts which interact with each other to function as a whole'. The idea 'system' however is more than this - it gives birth to the concept of the whole being greater than the individual parts. In this regard, Ackoff (1994, p23) provides a good illustrative example by way of a car. He argues that if a system were the product of its components, one should be able to construct the 'best' car by gathering the 'best' components from individual manufactures and assembling them. However, the 'best' gearbox' manufactured by Ford will not necessarily be compatible with the 'best' motor made by Mercedes

chassis manufactured by Audi will not fit the 'best' seats made by Rolls-Royce and so on. According to Ackoff's (1994, p18-21) definition a system is a whole that contains two or more parts that satisfy the following five conditions:

1. The whole has one or more defining functions - in other words each system has an overall purpose.
2. Each part of a system can affect the behaviour or properties of the whole.
3. There is a subset of parts that is sufficient in one or more environments for carrying out the defining function of the whole; each of these parts is separately necessary but insufficient for carrying out this defining function.
4. The way that the behaviour or properties of each part of a system affects its behaviour or properties depends on the behaviour or properties of at least one other part of the system.
5. The effect of any subset of parts on the system as a whole depends on the behaviour of at least one other subset.

A point Ackoff (1994) makes, is that a system as a whole cannot be divided into independent parts, as the essential properties of the system are not present in its individual parts and are lost when it is taken apart. Also, the essential properties of the parts are lost when separated from the whole due to the fact that the parts are interdependent and each part's behaviour affects the other. The performance of a system is thus not the sum of the performance of its parts taken separately, but the product of their combined *interactions*.

Another good example of a system is a soccer team. If the team i.e. the system, does not function as a whole in pursuing their common goal (to win) it will in all likelihood fail regardless of how many individual stars the team has. The performance of these individual stars is invaluable if they perform within the boundary of the system, however if they pursue their individual interests (e.g. seeking glory by trying to take on the opposition by themselves) the result will be detrimental to the team as a whole. In this regard, Checkland (1981) describes the central concept 'system' as embodying the idea of a set of elements connected together which form a whole, exhibiting properties which are the properties of the whole, rather than the properties of its constituent parts.

When taking these 'systems properties' into account in light of problem solving within a system, a logical deduction would be that in order to successfully deal with 'systems problems' an approach is needed that looks at these properties and the dynamics causing them. The emerging field of science that does this is Systems Thinking, which essentially is nothing more than a mental model of how reality is constituted and how to deal with and think about this reality.

Before discussing the emergence of Systems Thinking in further detail, the concept of mental models is looked at, as they in themselves are a central feature to Systems Thinking.

## **A.2 Mental Models**

To effectively resolve any problematic situation, a clear understanding of the situation is needed by the problem solver. The achievement of understanding however, is steadily becoming a more difficult task in light of an age of accelerating change, increasing uncertainty and growing complexity. As discussed by Gharajedaghi and Ackoff (1984, p289 – 300) to think about any complex situation requires an image, concept or mental model that simplifies the complexity and makes the situation intellectually tangible.

Flood and Jackson (1991, p7) identify 'systemic metaphors' which are filters of thought that are placed over complex pictures to handle complexity. The form these mental models or metaphors take directly influences the understanding of and the dealings with complex situations. Before questioning this understanding the appropriate mental model adopted therefore needs to be surfaced. Traditionally the two models used to think about complex social systems, like organisations, have been the mechanistic and organismic models, which have however done little in terms of gaining understanding.

In this regard, Gharajedaghi and Ackoff (1984) identify the hierarchical relationship of information, knowledge and understanding. Information presupposes neither knowledge nor understanding, knowledge presupposes information, and understand requires both information and knowledge. Gharajedaghi and Ackoff argue that understanding is not gained from a mechanistic or organismic mental model, but rather from a social systems model. The social systems model, is the underlying mental model of the Systems Approach used to gain a better understanding of the problem situation in Chapter 1. To gain some understanding of the implications of the various models, a brief discussion follows.

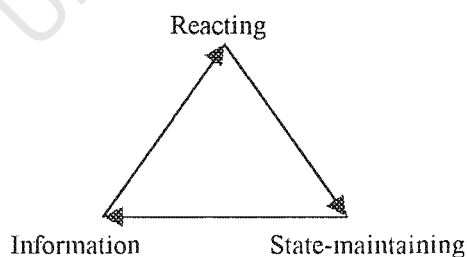
### **A.2.1 The Mechanistic Model**

The mechanistic model conceptualises the world as a machine that can be broken down into its constituent parts to gain understanding of the whole. This reductionist approach deals with system dynamics in terms of cause-effect relationships and consequently disregards the interaction of the system with the environment. According to Gharajedaghi and Ackoff (1984) the main proponent of the mechanistic model is the so-called classical or traditional school of management, which strives for efficiency and tries to construct social systems that behave mechanically.

Mechanistically modelled organisations are structured hierarchically and are centrally controlled by a complete autonomous authority (synonymous to the system owner). This authority can affect any part of the system without itself being affected, thus making it an external controller. Enterprises, conceptualised as machines, like machines, are attributed with no purpose of their own, and are believed to have the function of serving only their owners' purpose. As per Ackoff (1994, p8) 'their principal purpose is to obtain an adequate return on their investment of time, money, and effort' which requires profit maximisation.

The work to be performed in such a system is analytically divided into different tasks and the people who perform those tasks are regarded as replaceable parts of a 'machine'. Typically workers of the system are limited to gaining only the information need to do their jobs and a great deal of emphasis is placed on company policy, allowing little or no freedom or decision making on the part of the workers. In general, the members of the workforce in a mechanistically conceived system have little education and therefore relatively low levels of aspiration (Ackoff, 1994, p9).

The result of course, is a bureaucratic structure that is incapable of learning and adapting. In an environment characterised by an increasing rate of change, uncertainty and complexity, this inflexibility results in the system becoming increasingly dysfunctional, eventually being faced with serious threats to its long term viability. Mechanistic systems are operational at the information level. To function, the system only needs information – remembering that it is not attributed with a purpose of its own other than that of its owner. Consequently the system can only be *reactive* in that it reacts to certain information within its environment (cause-effect syndrome). Typically mechanistic systems are *state-maintaining* and *react* to changes so as to maintain their current status (Gharajedaghi and Ackoff, 1984). Figure A.1 summarises the perspective in a triadic relationship.



**Figure A.1** Properties of the Mechanistic Systems

### A.2.2 The Organismic Model

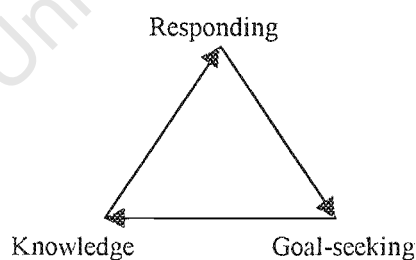
With the general failure of the mechanistic system by World War I, the conception of enterprises moved towards a biological one – being increasingly thought of as organisms rather than machines (Ackoff, 1994). Being a slightly more evolved mental model, the organismic model moves away from

the closed system, mechanistic model to an open system model. It considers the organisation as a system being open to its environment that operates under homeostasis, meaning that it endeavours to maintain a constant internal stability in order to maintain the properties of the whole organisation (Gharajedaghi and Ackoff, 1984).

In the organismic model, profit no longer has the top priority. Ackoff (1994,p10) states that profit, 'like oxygen for a human being, is thought of as a means necessary for the *survival and growth* of the enterprise, not the reason for it'. Thus organismic management has survival as its purpose, striving for growth as necessary for survival.

The model conceptualises the parts of a system as organs with essential functions but no purposes of their own. Their only reason for existence is their service to the whole. Their environments are seen as purposeless and passive providers of necessary inputs to, and outputs of, organisms. An organismic approach by management tends to be more permissive than a mechanistic approach, focussing on meeting assigned goals, leaving choice of means by which these goals are to be pursued to the parts that have responsibility for their attainment (Gharajedaghi and Ackoff, 1984, p300).

The model however fails to see that systems have purposes of their own and display choice. An effective system requires agreement among its parts and between its parts and the whole. The organismic model, like the mechanistic model, places more attention on efficiency than on effectiveness. An organismically conceived system devotes itself to making the best of a future, which it believes to be uncontrollable but predictable. The fact is however that in our current business environment characterised by change, increasing uncertainty and growing complexity, the ability to accurately predict is virtually impossible.



**Figure A.2** Properties of the Organismic System

The organismic model is operational at a knowledge level. This enhances its ability to not only react, but to *respond* to its environment. Knowledge provides the insight that allows the system to respond, and essentially an organismic system is *goal-seeking*. If a goal-seeking system has memory it can learn to pursue its goals more efficiently wherefore the focus often falls on efficiency. Again the properties of the model are diagrammed in figure A.2.

### A.2.3 The Social Systems Model

Ackoff (1994) describes the evolution of the social systems model as consequential to the increase in worker competence and skill due to continuing advances in mechanisation in the post World War II eras. With workers becoming more skilled and learned, they were not as easily replaced; with government and union protections not as easily disposed of. Corporate management became aware of the need to take into account the concerns, interests, and objectives of the people who are part of the system.

The development of the social systems model presents the first step in the evolution of Systems Thinking discussed in the Section A.3. The critical realisation in this development, in the words of Gharajedaghi and Ackoff (1984, p293) is that;

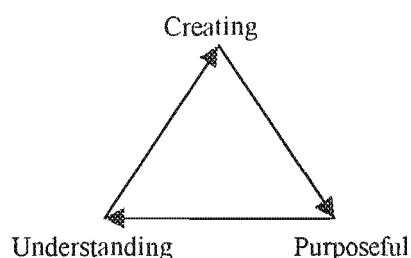
‘A system is a whole that cannot be divided into independent parts; the behaviour of each part and its effect on the whole depends on the behaviour of other parts. Therefore, the essential properties of a system are lost when it is taken apart; for example, a disassembled automobile does not transport and a disassembled person does not live. Furthermore, the parts themselves lose their essential properties when they are separated from the whole; for example, a detached steering wheel does not steer and a detached eye does not see.

The social systems model represents the first model that takes both the holistic properties of the system as well as the individual properties of its parts into consideration. It recognises that the performance of the system is not the sum of its individual parts, but rather a product of their interaction. Therefore, effective management of a social system requires the management of this interaction, both internally amongst its parts and externally with its environment. To effectively achieve this, *understanding* is required.

As per Gharajedaghi and Ackoff (1984, p294) ‘to understand a system, its structure, processes and functions have to be examined’. This can however not be achieved simply by analysis i.e. breaking down the individual components for consideration. Analysis reveals only structure not function i.e. knowledge of how a system works and not why it works the way it does. To gain this understanding a synthetic approach is needed to complement analysis. This synthesis is an important facet of the application of Systems Thinking discussed in Section A.4.

The main purpose of social systems as identified by Gharajedaghi and Ackoff (1984) is development. Management should facilitate this development by serving the purposes of the system, its parts, and its containing systems. As there will inevitably be conflict in interests, one of the main functions of management is the resolution or dissolution of conflict to allow development.

Social systems are perceived as *purposeful* (Gharajedaghi and Ackoff, 1984, p297). Because an understanding of the system, its parts and its environment is promoted, the system has the ability to not only learn and adapt, but also to *create*, as illustrated in figure A.3.



**Figure A.3** Properties of the Social System

#### A.2.4 Other Models

Flood and Jackson (1991, p7) identify three further models, or metaphors – neurocybernetic, cultural and political. Effectively the neurocybernetic metaphor has evolved from the social model, being slightly more enhanced by cybernetic principles. The metaphor forms the basis for a systems methodology called the *Viable Systems Model*, which is presented in the research framework of Chapter 3 and discussed at length in Appendix D.

The cultural and political metaphors identified by Flood and Jackson (1991), deal with cultural and political issues. The cultural metaphor recognises corporate culture as a useful way of promoting the organisation as a collectivity with employees who have a shared reality and aligned vision. In particular the metaphor recognises the people in enterprises being of different backgrounds, norms, values and beliefs, and that they have a vital role to play.

The political metaphor assesses the political character of a situation in terms of interests, conflict and power. The relationship between people in an organisation are described as being either unitary, pluralist, or coercive depending on the degree of competitiveness and pursuit for power (Flood and Jackson, 1991, p13). Participants of a unitary relationship have compatible values and beliefs, with common interests and objectives. Conflict is rare and power is replaced by conceptions such as leadership and control. Pluralist participants have diverging group interest, which are however compatible within the mutual focal point of the organisation. Conflict is inherent, but compromise is possible. Power is viewed as the medium through which conflict of interest can be resolved. Finally a coercive relationship is characterised by opposing and contradictory interests, often caused by differing value and belief systems lacking understanding and a common focal point. Conflict is inevitable and power is used to enforce decisions.

### A.3 The Emergence of Systems Thinking

The aim of this section is not to provide a historical account of the development of the Systems Thinking movement, but rather why it has developed and why its application is so useful. Historically mankind has, in order to answer all questions, devised a learning system for inquiry about his environment, which has developed into the method of science. He describes the pattern of human activity that characterises science as - *reducing* the complexity of the variety of the real world in experiments whose results are validated by their *repeatability*, from which knowledge is built by the *refutation* of hypotheses (Checkland, 1981, p57). In this sense, science is reductionist, coping with variety by simplifying it and looking at aspects in isolation. Thus 'scientific thinking' is almost synonymous with 'analytical thinking'.

The method of science has proven to be one of the strongest contributing factors to knowledge accumulation and thus progress. 'Softer' sciences may strongly contest this statement, however the scientific method by way of hypothesising, testing and confirming or refuting theories forms the best common ground for establishing fact. This is not to imply that the importance of other 'softer' issues of human knowledge and existence, such as beliefs, culture, morals, religion, values etc are discounted or considered non-factual.

Rather, the importance of addressing these human related issues should be highlighted, as these are mostly poorly dealt with in problem solving. This exactly, is one of the criticisms that can be levelled at the scientific method – it has no manner to deal with the subjectivity of human values and belief systems.

Because science is so poorly equipped to deal with such issues, there is a general tendency to ignore them or class them off as insignificant. Thus when faced with resolving complex issues, particularly where human dynamics are involved, the scientific method reaches its limitations.

By way of its approach to problem solving, the method also deals poorly with the complexity that is inherent in most everyday situations. One need only consider the approach it has taken to dealing with explaining nature itself to illustrate this point. The complex interaction of natural phenomenon exhibited by nature are separated and dealt with in isolation. Schools teach science, biology, geography and chemistry as separate subjects although these topics are all interrelated. Clearly this has to be done to an extent in order to cope with the existing complexity of the world, however few attempts have been made to synthesis this analytical approach.

The result of course is an ingrained reductionist problem solving approach typical of the mechanistic mental model, where the tendency is to view problem areas in isolation and not regard the situation in its entire complexity. This approach to problem solving neglects the interdependence of the parts comprising a system and the emergent properties thus created and leads, at best, to

temporary solutions. This is because all aspects influencing and creating the problem have not been considered and thus the problem is likely to simply resurface elsewhere in a different form.

From this inability to deal with an array of complex interrelated problems, the Systems Thinking proponent has emerged. Arising out of the need to deal with complex systems which mechanistic thinking fails to do, the systems perspective recognises multifarious interactions between all the elements making up a complex system (Flood and Jackson, 1991). Mechanistic thinking perceives a system as an aggregate of parts in which the whole is equal to the sum of the individual parts, in Systems Thinking a system is a complex and highly interrelated network of parts exhibiting synergistic properties - the whole is greater than the sum of its parts.

With the ever increasing complexity and competitiveness of modern business and organisations, the need has arisen to solve problems holistically, i.e. to deal with problems at a systemic level. This means looking at and resolving a potential problem situation within the context that created it, and not isolating the part in which the problem seems to have manifested itself. Systems Thinking aims to do just that, by way of adopting a Systems Approach to problems solving. Bullock *et al* (1988, p842) provide the following appropriate definition:

'A Systems Approach is an approach to the study of physical and social systems which enables complex and dynamic situations to be understood in broad outline. It is a conceptual tool, the user of which may also receive scientific assistance from *Operational Research*. The approach is valid whether the topic is a heating system, a postal system, a health or education system, a firm, an economy or a government.....In management contexts, the systems approach concerns itself with growth and stability in the system under a range of possible futures, unpredictable perturbations, and alternative policies.'

Checkland (1981, p5) defines Systems Thinking as an alternative to the natural science paradigm; that is the use of systems ideas and concepts used to try and understand the world's complexity. He identifies systems as a subject that can be thought of as a meta-discipline whose subject matter can be applied within virtually any other discipline. He also claims that because systems ideas provide a way of thinking about any kind of problem, Systems Thinking itself is not a discipline.

This is echoed by Flood and Jackson (1991, p3) who state that in the modern Systems Approach, the concept "system" is used not to refer to things in the world but to a particular way of organising our thoughts about the world. By constructing various systemic metaphors which can be used to interrogate the "real world" insight is provided and creative decision making and "problem solving" promoted. It must be noted that systems thinkers do not suggest replacing the scientific method, for in fact it forms an inherent part of the thinking processes used to analyse problem situations as

discussed in the main body under the considerations of the philosophical framework (Chapter 3, Section 3.7). It has simply been realised that there are limitations in a reductionist approach to problem solving and in this regard Systems Thinking has emerged to assist where the scientific method is weak. Huse (1980), cited by Wilson (1990), summarises the essence of Systems Thinking as follows:

'In a world that is rapidly changing, organisations need to become more adaptable and to better learn to manage change. From a systems point of view, change is enormously complex and can come from inside or outside the boundaries of the system. A major key to manage change is proper diagnosis of problems and situations, keeping in mind that the performance of the whole is not the sum of the individual parts, but is a consequence of the relationship of the performance between the parts. Thus problems can not be solved separately, since they are interdependent.'

#### A.4 Application of Systems Thinking

Practically the implications of Systems Thinking are that when experiencing a problem in a certain area of an organisation or part thereof, it is not sufficient to simply look at that specific problem area or part in isolation. Instead, the entire environment and system in which that part operates needs to be looked at due to the fact that everything is interrelated.

Thus although the perceived problem area is the starting point and may even be the area of focus, there is a need to further uncover the entire problem situation in order to make sure that a satisfactory holistic solution is found. To uncover such a situation a Systems Approach is used which, not only attempts to clearly identify and define the system in consideration, but also aims to perform an analysis and synthesis of the system and its context as depicted in figure A.4 below (Ryan, 1996).

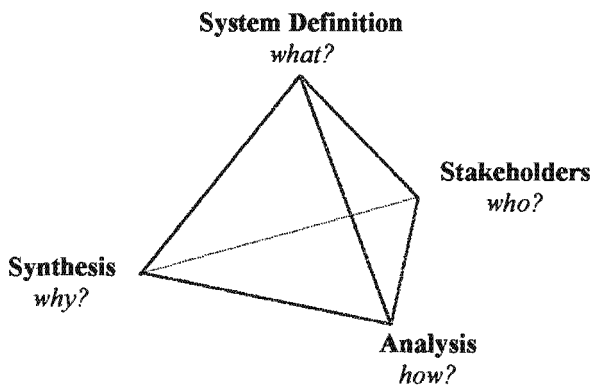


Figure A.4 Triadic Relationship Illustrating the Systems Approach

#### Figure A.4 Triadic Relationship Illustrating the Systems Approach

As derived from Ackoff (1994), analysis is achieved by taking the system apart, understanding the behaviour of the parts and aggregating this understanding of the parts into the understanding of the whole. Synthesis in turn is achieved by identifying the containing whole, understanding the purpose of the containing whole and finally disaggregating the containing whole to explain the role of the system. Also useful in this view is a stakeholder analysis to determine who the customers, actors and owners of the system are. These triadic relationships are presented in figure A.4. In the ensuing sections, the above triadic relationships are unfolded into systems properties that are essential for the understanding of systems dynamics.

### A.5 Properties of a System

Having presented the ideas of Systems Thinking and its application in the previous sections, this section provides a more detailed account of what comprises a system and how it functions. In introducing the properties used to describe systems, the framework for applying Systems Thinking is further developed. Various concepts that are inherent to systems as well as their relevance are discussed in the sub-sections below. Numerous questions, which help in gaining an understanding into a problematic situation, are developed and these questions were used to guide the initial inquiry during the development of the problem statement in the first part of the thesis.

#### A.5.1 System Identification

Every system is defined by a boundary. Although it is almost always possible to expand a system boundary by incorporating it into a bigger system, in reality it is necessary to define the system in consideration at an appropriate level of recursion. As stated by Bullock *et al* (1988, p842):

‘to identify a system it is necessary to distinguish its boundaries, to be aware of its purposes, and to define the level of abstraction at which it is to be treated. Systems may turn out to contain recognisable *sub-systems*, sub-sub-system, and so on’.

The aim is to clearly define the subject matter under consideration taking into account what the actual system is, what parts it is constituted of and what the containing system is i.e. of what bigger system it forms a part of. To illustrate this, the system in consideration is defined as R1. Within the

system, which is defined as R0, and forms the containing environment. The containing environment forms the broader context into which R1 fits. This model is presented in Figure A.5 below.

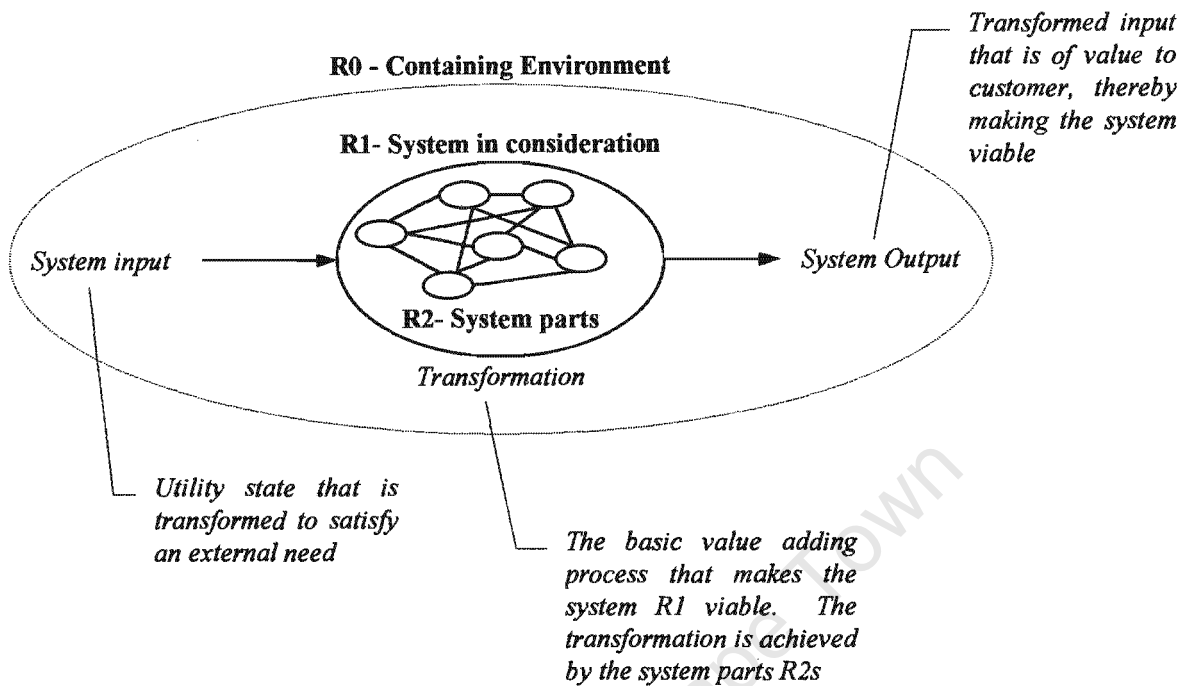


Figure A.5 Recursion in Systems

R1 constitutes a self-sufficient entity that is dependent on the interactions of its parts (R2's) and influenced by the external environment (R0). It has a *purpose* that makes it viable within its containing environment, achieved by means of a *transformation process* performed by its parts. The transformation refers to the activities whereby resources are combined and changed in such a way that a service is created or a product manufactured. Wild (1989, p4) identifies four basic transformation processes being – manufacture, service, transportation and supply.

By means of this transformation within the system R1, the *system inputs* undergo value-adding processes, which produce a *system output* which is of value to the system's customers. In addition to the system inputs, resources are required to achieve the transformation. These include 'hard' resources such as assets (like land), labour, capital, technology, raw material and consumables, as well as 'soft' resources.

Typically these soft resources are overlooked as they are less obvious – they include managerial and administrative skills, technical know-how, vision, commitment, wisdom, solidarity, cultural memory, historical awareness, environmental sensitivity and ethical consciousness. The big distinction between system inputs and resources are that although resources contribute and are vital to

the transformation of the system inputs, they themselves do not undergo any direct change in utility and thus do not leave the system as an output. Typical questions asked during an intervention are thus:

- *What is the system in consideration? What are the inputs/outputs?*
- *What are the relevant boundaries?*
- *The relevant environment and system parts?*
- *The transformation achieved by the general activity of the system (R1)?*
- *What are the inputs/outputs of the relevant parts?*
- *Who are the stakeholders?*

### A.5.2 System Purpose

Every system has a purpose – it is there for a reason. The purpose makes the system meaningful within its context and its aim should be to achieve this purpose as efficiently and effectively as possible. Often the true purpose of the system has not been recognised or clearly defined/understood, and therefore it appears to perform inadequately as the inferred purpose is different.

Also, all systems are teleological, which means that they are goal orientated (Churchman, 1979). Depending on the stakeholders influencing and controlling the system and what their perception of the system's purpose is, the pursued goal may not be in line with the actual purpose intended for the system. For this reason it is necessary to explicitly question what the intended purpose of the system is and whether this required output is being achieved. In this regard the system under consideration may be required to produce an output that is needed by a larger containing system. Typical questions include:

- *What is the real purpose of the system (R1)?*
- *What is the desired purpose?*
- *What is the inferred/perceived purpose and what purpose is being pursued?*
- *Can other purposes be inferred when observing what the system is actually doing?*
- *What is it producing/doing?*
- *How does R1 contribute to the purpose of the containing system (R0)?*
- *Who is the owner of the system?*
- *Who can stop it operating?*

### A.5.3 System Constraints

Each and every system is bound by certain real environmental, physical and physiological constraints. Because these constraints directly or indirectly limit the performance of a system they need to be considered critically. The perceived constraints are both internal and external to the system, with the external constraints usually being beyond the direct influence of the stakeholders within the system.

Typically the environment that contains the system forms the external constraints, such as geographical location or market trends. Although the system may not be able to change these constraints this does not imply that the system is powerless to affect changes that will 'shift' these constraints. A company may for example not be able to prevent a change in the market but it can anticipate this change and ensure that the adequate measures are taken to change its products according to the emerging market needs. Internally created constraints on the other hand are often due to ineffectiveness and this is a primary area for systems improvement. A useful systems view is to consider constraints as potential opportunities. Related questions are:

- *What are the constraints imposed upon the system by the environment?*
- *Are they real or perceived?*
- *How do they affect inputs and resources?*
- *Are there internal constraints?*
- *Are these constraints avoidable?*
- *Can these constraints be avoided by re-describing or re-defining the system boundaries and/or purpose?*

### A.5.4 Pertaining Worldview (*Weltanschauung*)

In every system there is an espoused theory pertaining to the way the system is structured, how it should operate, what it is there for, what it should achieve and so on. This consideration addresses the implicit worldviews that make the system meaningful. When considering a system there will always be numerous perceptions of that system that make it meaningful in the real world. In this regard Checkland (1981, p215) states that 'we attribute meaning to human activity and our attributions are meaningful in terms of a particular image of the world, or *Weltanschauung* which in general we take for granted'.

Each system has a principal or leading worldview from which the system has been derived and which justifies its existence. Within this worldview there will also exist a language that is used to

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Each system has a principal or leading worldview from which the system has been derived and which justifies its existence. Within this worldview there will also exist a language that is used to effectively communicate within the system. This is the 'meta-language' - the language used to speak about the system.

However, the worldview and meta-language may not be shared by all stakeholders within a system and in turn this will lead to poor communication and other adverse effects. It is thus important to explicitly establish the leading or principal view and to compare its compatibility with the actual system and the views held by its stakeholders. For example one of the principal worldviews of Systems Thinking is a holistic approach to problem solving as opposed to a reductionist or mechanistic approach. If the reader is not aware of the concept of holism and reductionism, this worldview is meaningless. Questions include:

- *What are the protagonist (principal or leading) worldviews that make the system meaningful and relevant within the organisation?*
- *Are their antagonist worldviews?*
- *Are these causing conflict?*
- *What language is used within these worldviews to think about the system?*
- *What are the constraints, limitations, assumptions or beliefs contained within these worldviews and the language used?*
- *What problems do these create?*
- *Can a meta-language be developed to eliminate these problems?*

### **A.5.5 System Dynamics**

System dynamics take into consideration *how* the system works, i.e. how the emergent properties of the system are produced. Every system is comprised of parts or elements (R2s) which interact and function in conjunction with each other in order to achieve the overall transformation that is required of the system. To coherently comprehend the complexity of any situation these individual parts need to be identified and their interaction and contribution to the whole understood. The parts are defined in a similar format to the input/transformation/output of the relevant system R1. System parts are systems in their own right at a lower level of recursion and thus if a more detailed analysis of any part is required the same principles are applicable.

During this stage of the inquiry it is important to be aware of the level of recursion one is working at, for each part can in some way be broken down further into smaller parts and in turn each of these will again have a purpose, input, transformation and output. However at some stage the detail becomes irrelevant and conceptually an inquirer must maintain a general overview and identify the broader contextual picture.

Of important during the analysis of the internal dynamics of system R1 is whether the interacting parts R2 are furthering the purpose to the containing whole, i.e. R1's function, or whether the parts are prioritising their own purpose. Critical to the Systems Thinking concept is the retention of a holistic perspective, and not to sub-optimize. Any potential identification of a problem in a part must not be treated in isolation. Traditionally this has been management's approach to problem solving. Problem areas are identified and treated in isolation from the entire context. Due to the dynamics of every system however, this mostly results in the partial resolution of the problem, or the manifestation of the problem in another area. As per Bullock *et al* (1988, p842):

'one of the discoveries made by the System Approach is the extent to which attempts to improve the performance of a sub-system by its own criteria (*sub-optimisation*) may act to the detriment of the total system and even to the defeat of its objectives'.

System dynamics are therefore a very important aspect of Systems Thinking. By taking into consideration the interdependence of a system's parts, the aim is to produce holistic problem solutions. The cause and effect of various actions are considered to prevent the problem re-surfacing or manifesting itself elsewhere in a different form. An intricate part of systems dynamics concerns the interaction of the actors contained within the systems – i.e. the human dynamics. Corresponding questions include:

- *How does the system (R1) work?*
- *How is the transformation achieved?*
- *What are the parts and their interaction?*
- *What are the human activity systems?*
- *What are the processes and activities?*
- *How do they interact with each other?*
- *Who are the actors that carry out the processes and activities?*
- *What are the underlying dynamics?*
- *Which part of the system produces the actual results rather than the espoused results?*

In other words, systems exhibit self-organising tendencies. These tendencies for systems to self-organise, stem from the fact that they are teleological and no system can perform effectively in an unstable state. Therefore every system either has to settle in a state of equilibrium or will eventually collapse.

However self-organising tendencies of the parts have to be monitored especially in view of the fact that in order to achieve total stability, certain parts (R2's) may pursue their own purpose, which more than likely is in conflict with the overall purpose of system R1. Also, it is essential to achieve a dynamic rather than static equilibrium, for otherwise the system will not respond effectively to change and in this manner threaten the systems viability.

It should be noted that self-organisation in systems containing humans is achieved by the actors within the system and is governed by personal initiatives, interests, perceptions and value systems as well as social and cultural backgrounds. For this reason it is easily explicable that the self-organising dynamics of a system often opposes the overall purpose of the system. For example, choosing the 'easy way out' is a manifestation of this. Although self-organisation may appear to be limiting to a system, it also provides tremendous opportunity if understood and harnessed. Ensuring that the actors within a system have a stake or interest in achieving the overall purpose of the system will for example automatically enhance the stability of the environment.

An important factor contributing to successful self-organisation is feedback, a characteristic inherent to all stable systems. This feedback may be formal or informal, and again the recognition of the feedback channels is an opportunity to use the self-organising tendencies to the advantage of the situation in consideration. Useful questions include:

- *What are the purposeful parts that the system contains (in view of actors, customers, and owners)?*
- *What self-organising tendencies do these have?*
- *What personal goals, values, aspirations do individuals effecting and being effected by the system hold?*
- *What are the cultural norms/values pertaining to the system?*
- *What are the organisational/technical imperatives inherent?*
- *How does the system interact with the environment? What are the feedback loops?*
- *What are the rewards and punishments involved and how is this power exhibited?*

Using the above questions to uncover the underlying systems properties facilitates a much better initial understanding of the system and hence the context of the problem situation. By clearly defining

the system and considering the various characteristics discussed, the analyst gains insight into potential deficiencies and areas of focus. These systems considerations provide a rigorous foundation from which further inquiry is conducted. To further enhance our initial understanding of any given organisational system, especially in as far as the human dynamics are concerned, the following sections provide a brief discussion on relevant organisational and managerial perspectives.

## A.6 Organisational Perspective

Organisational issues deal with the sustainability of the system in focus (R1). The organisation has to facilitate and encourage the development of the system to ensure its survival by retaining its viability within the environment in which it operates. It relates to the concerned business on two levels, internally and externally.

Internally the organisation has to provide the identity, philosophy, and vision that guide its employees - which is encapsulated in its policy and organisational identity. It also has to co-ordinate and control all internal activities, creating the dynamics needed to produce the desired output which will make the enterprise viable.

Externally the organisation's main function is to ensure that the internal system is in tune with the containing environment R0 and adequately equipped to cope with external threats to the system's viability. In particular this relates to an ever rapidly changing environment which in the 90's has produced radical changes in social values, organisational approaches, production methods, customer service levels, quality approaches, productivity measures and resource availability. The primary areas of concern identified from an organisational perspective are the issues of *Policy & Organisational Identity*, *Intelligence*, *Control* and *Co-ordination*. These four areas are illustrated in an organisational tetrahedron (Ryan, 1996) in Figure A.6.

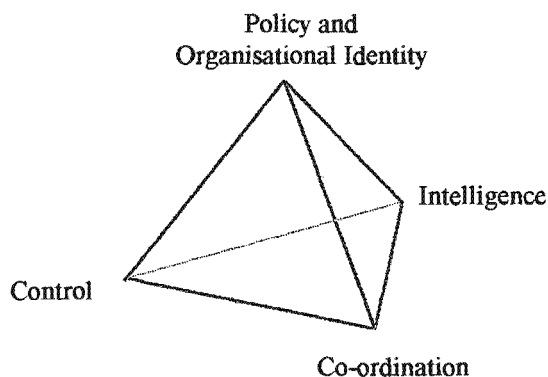


Figure A.6 The Organisational Tetrahedron

### A.6.1 Policy and Organisational Identity

The policy of the organisation relates the respective values the organisation identifies with. It determines goals and guidelines and aims to create a balance between the system and the environment. Policy essentially is what makes the organisation effective in that it determines the course or principles of action to be adopted by its members.

The ability to make relevant policies that guide decision-making, and establish and maintain an organisational identity in today's rapidly changing environment is critical to the survival of all organisations. In this respect a policy has to be lived, it has to be communicated to all concerned by top management and not simply be put into writing to become a framed statement pinned up on the MD's wall or for display in the reception area. When reflecting on these issues during an initial assessment of a problem situation the following questions are useful:

- *Does a clearly defined policy exist?*
- *Do all employees have an understanding of policy, what it is meant for and what it is?*
- *Is the policy useful in terms of setting guidelines and decision-making?*
- *How is the policy communicated/enforced?*
- *Does the organisation project an identity? Is this identity shared by all?*
- *Does the policy lead the organisation, i.e. is there a common vision that adequately addresses the future sustainability of the organisation?*

### A.6.2 Co-ordination

This concerns the ability to gather, translate and communicate information that facilitates the interaction of the system parts (R2's) with each other and with the external environment (R0). More specifically, it is concerned with providing the organisation with the ability to produce its output i.e. efficacy, as well as assuring that this be done efficiently. Co-ordination is required to help the relevant system (R1) achieve its output optimally, in other words to optimise the viability of the whole system and not its parts. Successful co-ordination requires a shared understanding of the processes to be managed among the people who manage them.

The inquirer has to consider how the co-ordination is achieved, whether it constitutes a conscious deliberate process, or whether it has fallen to the self-organising tendencies of the system due to the lack thereof. The actual mechanism should also be considered, as this will shed light on the effectiveness of the co-ordination process. Questions include:

The inquirer has to consider how the co-ordination is achieved, whether it constitutes a conscious deliberate process, or whether it has fallen to the self-organising tendencies of the system due to the lack thereof. The actual mechanism should also be considered, as this will shed light on the effectiveness of the co-ordination process. Questions include:

- *How is the co-ordination of all general activities achieved?*
- *Is there specific focus on co-ordination of vital activities?*
- *What are the co-ordination channels used? Is information communicated clearly, is there overall synergy?*
- *What is the degree of autonomy of individual system parts (R2s)?*
- *Is there a shared understanding of what the overall required output of R1 is?*
- *Is the appropriate management structure in place to effectively co-ordinate and is there a shared understanding amongst managers?*
- *What are the feedback loops, if any?*

### A.6.3 Control

Control issues at an organisational level involve the ability to set appropriate goals, detect errors and to correct them. To effectively achieve this, performance criteria have to be set for the system and its parts and in turn these then have to be monitored and compared via feedback loops. Control should ensure that the right things are being done i.e. that effective action is being taken and also that the actions themselves are performed correctly i.e. efficiently. The control must be consistent with the policy of the organisation and essentially must ensure that these policies are implemented correctly. Deviations need to be picked up and corrective action taken.

Again the inquirer should analyse the current control mechanisms and how effective they are. In this regard it is important that the correct variables are being monitored and that effective action is being undertaken in the event of deviations.

Equally important is the awareness that control mechanisms need to take time horizons into consideration and not simply react on and in view of current indicators. Further, when control action is undertaken the control mechanism should inform the affected actors why this action was necessary. Some relevant questions are:

- *Have the correct control measures been identified?*
- *What are the Measures of Performance?*

Primarily management is concerned with decision making, the accuracy of which will determine the effectiveness and efficiency of the action undertaken pertaining to the organisation. Managerial decisions can be divided into three broad areas; being normative decisions which are long-term, strategic decisions which are medium-term and operational decisions which are short-term (Espejo and Schwaninger, 1993).

However, regardless of the time framework involved, all decisions revolve around understanding the system context, enabling the system, and settling socio-technical issues as well as socio-political issues or disputes arising in the system. Graphically these are again depicted in a tetrahedral model in Figure A.7 (Ryan, 1996).

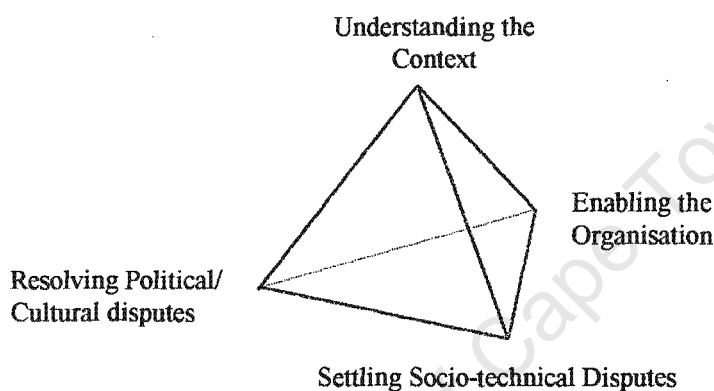


Figure A.7 The Managerial Tetrahedron

It is important to note that the author's intentions are not to cover the latest theories on these issues, but simply to create a holistic understanding of the general function and purpose of management in order that when a generic inquiry is undertaken, fundamental deficiencies will be spotted. When potential shortcomings are identified, the inquirer can then further delve into the pertaining theory in order to determine exactly what is missing.

### A.7.1 Understanding the Environment (Context)

In order to ensure that the system as a whole performs effectively, efficiently and efficaciously, it is vital that management understands the system context. In fact understanding the context is perhaps the most important issue management have to deal with, since the context forms the environment within which the manager has to make his decisions, and if s/he does not understand the environment in its entirety his/her decision cannot be accurate. Without an understanding of the relationships, influences and boundaries of the system, the manager cannot effectively co-ordinate or control. S/he

will also be inhibited to deal with socio-technical and -political issues due to a lack of complete understanding of the system and how it can be influenced and controlled. An awareness of the interrelationships, boundaries and influences is vital for synergy of the system with other systems and its environment.

An inquirer therefore needs to be aware of the perception management has of the system being dealt with. Guidelines for this are the systems questions discussed in Section A.5 above. These questions discuss fundamental characteristics of the system and based on the manager's perspective on these characteristics as well as his/her actions within the system, it can be determined to what extent the manager is aware of the context.

### A.7.2 Enabling the Organisation

Fundamentally enabling the organisation is what constitutes the manager's job. Enabling means being efficient, doing things right, and developing the capacity to do things right. To do this the manager has to provide the system with the ability to perform, give it the permission to perform and create the motivation or willingness for the system to perform. When considering whether the system has the ability to perform, the inquirer has to consider the following areas:

- resources - *Are the required inputs readily available?*
- technology - *Has the system been provided with the adequate technology to perform?*
- manpower - *Are employees adequately equipped to perform? Have the required skill levels been provided?*
- infrastructure - *Does the system have the necessary backup and support it needs i.e. are financial management, information management and human resource management adequate? Are appropriate communication and information channels available? Distribution networks? Marketing, research and development?*
- processes and procedures - *Are these optimal or do they contain inherent inefficiencies which compromise the systems performance? Do they conform with current and future world standards?*
- quality and service - *Does the system have the capacity to deliver the required quality and service levels expected?*
- working environment and social structure - *Are social considerations adequate?*

### **A.7.3 Settling Socio-technical Disputes**

The settling of socio-technical disputes requires management to resolve problems arising due to the interaction of fellow humans in a working environment. This involves dealing with issues arising from the overlap of two distinct areas, namely social and technical. Typical examples are dealing with competitiveness, performance pressure, appraisals, job descriptions, promotional issues, inter-departmental relationships, cross-functional relationship etc. Animosity between line operators on different production lines are a prime example of poorly handled socio-technical issues.

Depending on the nature of the technological status and technical context of the system, the interaction of the humans in the system with the system and with each other, will produce potential conflict areas which management has to balance. The extent to which the management has enabled the organisation will have direct consequences pertaining to socio-technical issues.

### **A.7.4 Resolving Socio-political Conflicts**

In dealing with socio-political conflict as opposed to socio-technical, management has to balance conflicting belief and value systems. Largely these will be external factors brought into the system pertaining to the personal worldviews held by individual stakeholders. These include religion, culture, race, political views, economic values, personal experiences and insecurities, disciplinary belief systems and so on.

The two areas of socio-technical and socio-political conflict are by far the most difficult to identify and resolve. In this regard, during an initial assessment of a problem situation, it is necessary only to identify that problems do exist in these areas.

# APPENDIX B

## Relevant Theory on Operations Management, Factory Physics and Work Systems

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### B.1 The Operations Management Environment

In any system the operations environment is construed to be the primary value adding function. It is this environment that is concerned with the actual processes that transform the system inputs into required outputs to satisfy customer needs and make the organisation viable. In other words the operations function is the heart of any enterprise, without it all remaining 'functions' become irrelevant. If the 'heart' is performing poorly, the whole enterprise will perform poorly and it is thus vital that management within an organisation understand the operations environment and its corresponding dynamics in its entirety. The purpose of this appendix is to provide the reader with a basic understanding of this field as it forms the contextual setting for the thesis.

Wild (1989, p4) terms the operations function the 'operating system' and identifies four basic value adding functions -

- manufacture - in which the principal common characteristic is a change in *form utility*
- transport - in which the principal common characteristic is a change in *location utility*
- supply - in which the principal common characteristic is a change in *possession utility*
- service - in which the principal common characteristic is a change in *state utility*.

The basic value adding function performed within the system defined as *C&L inc. Forlezer* is manufacture, whereby the inputs, in the form of raw material (aluminium), as well as labour and other resources are transformed into ladders which form the mainstay of the organisations products. The applicable environment is the factory floor, with a system structure that manufactures from stock in the form of raw extrusions, to stock in the form of finished goods and then to the customer.

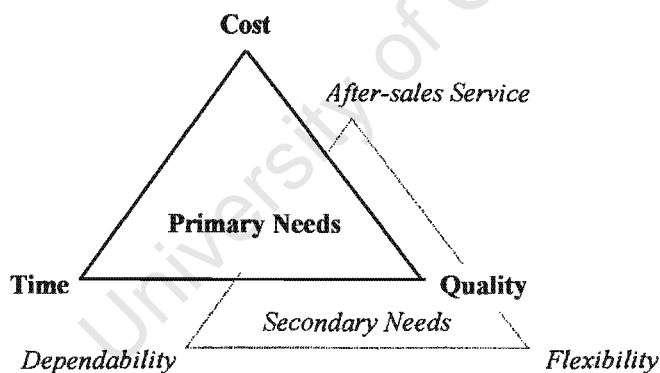
Throughout this thesis the focus will be on this manufacturing environment, and how management influences it. For this reason a broad overview of Operations Management is presented in this section, as it focuses on this environment and provides a comparative context for

*C&L inc. Forlezer.* Although the scope of the thesis addresses primarily a manufacturing environment, the principles are equally applicable to all operating systems.

### B.1.1 The Nature of Operations Management

The nature of Operations Management involves balancing the twin objectives of maximising organisational and customer needs. Traditionally this focus has been around achieving adequate levels of resource utilisation or productivity whilst satisfying the customer in terms of quality, cost and time with the overall business objective of maximising profits.

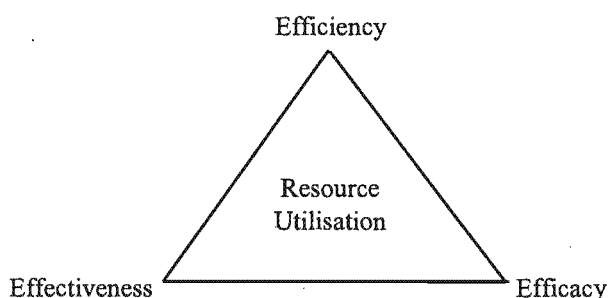
With the development of new age production methods and approaches, like for example World Class Manufacturing, Just In Time or benchmarking, the important additional attributes of manufacturer/supplier dependability, flexibility and after sales service have become as critical to customer satisfaction, as the traditional 'primary requirements' of quality, cost and time. In particular dependability is directly concerned with product and service reliability and availability. Graphically these have been expressed in figure B.1 as primary and secondary needs. The primary needs have to be fulfilled at all times, whilst the secondary needs are becoming an ever increasing competitive advantage.



**Figure B.1** The Primary and Secondary Needs Concerning Operations Management

In as far as resource utilisation is concerned, Operations Management must ensure the most effective use in the most efficient manner as well as providing the efficacy to achieve this. In other words, the function is concerned with ensuring that the right things are done in the right way, given that the environment to do the right things in the right way is provided. With the recognition of the value of the individual within organisations, an additional dimension to maximising resource utilisation has emerged. The human now plays an intricate part in the system, and the realisation has

has been made, that job satisfaction and personal development of individuals is paramount to maximising productivity. Figure B.2 illustrates the utility concerns.



**Figure B.2** The Utility Concerns Faced by Operations Management

Operations Management being in charge of the primary value adding function within an organisation has to deal with the conflicting objectives of balancing internal and external needs to ensure the sustained viability of the system. It does this by following set strategies that have been formed within the context of the operating system and its external environment.

The long-term strategy followed by Operations Management is developed by and in accordance with the corporate policy function. The policy making body of the organisation targets a market based on identified needs, and within this context and the overall business objective of the organisation it creates a vision that sets the purpose of the organisation.

Policy then embodies the *modus operandi* for achieving this purpose, i.e. it sets the means whereby the organisational objectives are to be achieved (Lockyer, 1983, p16). Operations Management will then be charged with the *manufacturing policy* – the task of designing and planning the operating system to achieve the overall business objective, and to operate and control the system.

Manufacturing policy is the term applied to those aspects of corporate policy which particularly concern the production or manufacturing departments. In this regard, Lockyer (1984, p9) states that ‘clearly this [the manufacturing policy] is an integral part of corporate policy and must act within it, and not be independent of it’. At *C&L inc. Forlezer* the manufacturing policy set by the corporate policy is to supply the sales branches on a recovery basis, a policy that severely limits the Manufacturing Division.

The specific market being targeted, the type of value adding process planned and the environmental constraints presented, will clearly influence the task faced by Operations Management. The structure of the operating system is dependent on these factors, and in turn the structure imposes *feasibility constraints* upon the system (Wild, 1989, p6).

The structure of a manufacturing function may for instance be to manufacture or supply from stock, to stock and then to the customer, or it may manufacture or supply directly from an external source to the customer.

An example of the former structure would be the manufacturing environment dealt with at *C&L inc. Forlezer*, where ladders are manufactured from raw material stock to finished goods stock, and from there distributed to the customer. An example of the latter structure would be the building of a house, where the builder only sources his raw materials from his suppliers, once the house needs to be built.

In contrast, Operations Management is also faced with *desirability constraints*, which are set by the objectives adopted or prescribed by the greater system, i.e. the corporate policy (Wild, 1989, p11). Together these constraints influence the operations strategies as depicted in figure B.3.

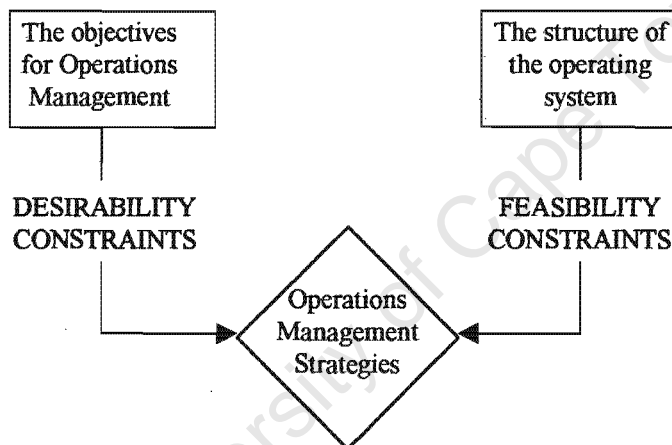


Figure B.3 Dual Constraints Affecting Operations Strategies (Wild, 1989, p12).

In the next section a closer look at the role that Operations Management plays in achieving the transformation required will be taken.

### B.1.2 The Role of Operations Management

As alluded to in the previous section, Operations Management is involved in the design, planning, operation and control of the operating system. Wild (1989, p289) primarily distinguishes between operations planning as being a *pre-operating* activity that '*is concerned with the determination, acquisition and arrangement of all facilities necessary for the future operations*'; and operations control as being a *during-operating* activity that '*is concerned with the implementation of a*

*predetermined operations plan or policy and the control of all aspects of operations according to such a plan or policy*'. The following key areas can be identified which have been adapted from Wild (1989) and elaborated upon:

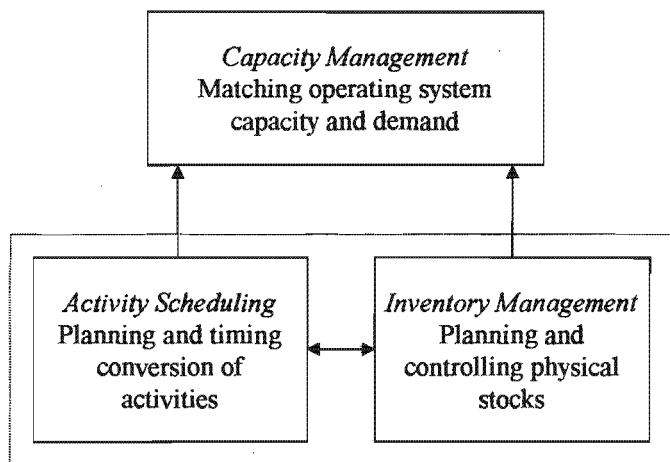
1. *Design and Planning-*

- Design and specification of product/service
- Design and specification of systems and processes to produce goods and services to satisfy primary and secondary customer needs as well as resource utilisation
- Determination of location of facilities
- Layout and logistics of facilities and resources/materials handling
- Determination of operational capability and achievable capacity
- Design of work methods and work systems
- Determination of job specifications and work measurement
- Determination of required knowledge and skill levels
- Involvement in determination of remuneration system and work standards

2. *Operation and Control-*

- Capacity management
- Planning and scheduling of activities
- Material administration, purchasing and distribution
- Inventory management
- Quality management
- Scheduling and control of maintenance
- Modification and/or replacement of facilities
- Monitoring performance measures
- Controlling undesirable variation

With the *pre*-operating tasks mostly being in place in existing systems, the focus of Operations Management shifts to the *during*-operating activities. Of all these tasks, three are of particular significance and form the essence of what Operations Management concerns itself with- they are the areas of capacity management, scheduling and inventory management as illustrated in figure B.4 (Wild 1989, p17). It is by way of these essential continuous activities that Operations Management pursues the overall business objective. Briefly the essence of each activity will be discussed.



**Figure B.4** The Three Main Activity Areas of Operations Management

*i) Capacity Management*

The determination and adjustment of the capacity of the operating system is perhaps the primary function of Operations Management. Capacity management is concerned with the matching of the capacity or capability of the operating system and the demand placed on that system. The determination of capacity is the key system planning or design problem and the adjustment of capacity is the key problem area in system control. Capacity decisions will have a direct influence on system performance in respect of both criteria of resource productivity and customer service. Excess capacity inevitable gives rise to low resource utilisation, while inadequate capacity means poor customer service (Wild, 1989, p18 – 19).

Capacity management involves the study of likely demand patterns, the determination of the capacity required to meet such demand, and the development of strategies for the deployment of resources, in particular for accommodating temporary changes in demand levels.

*ii) Activity Scheduling*

Scheduling is concerned with the timing of occurrences. In its widest sense scheduling may be considered to be concerned with the specification in advance of the timing of occurrences within the system, the arrivals to and the departures from the system - including the arrival to and departure from inventories within the system. For this reason the inventory management problem is considered as part of a wider operational scheduling problem. The nature and extent of this overall scheduling problem will be influenced by the presence and location of inventories and the relationship between the customer and the system, all of which are characteristics of system structure (Wild, 1989, p18).

*iii) Inventory Management*

The nature of inventory management involves the planning and control of physical stock, which is directly influenced by and also directly influences the system structure. The structure of an operating system will largely affect the nature and location of inventories, and the management of such inventories will influence both resource productivity and customer service. The existence of output stock may facilitate the provision of high customer service, at least in terms of availability or 'timing', however, their existence may be costly.

Inventories will normally tie up considerable amounts of capital, so there is a balance to be struck between obtaining the benefits of inventories such as flexibility, high customer service and buffering demand fluctuations on the one hand, and minimising the costs of such stock on the other (Wild, 1989, p 17 – 18).

Even though these activities are absolutely paramount to the successful operation of the transforming system, it is important that Operations Management does not lose sight of the 'overall picture' and concern itself entirely with the day to day running of the system and the problems posed by these three issues.

In the process, the alternative of actually changing the system to manipulate these activities may be overlooked. The essence of the system structure may not be critically questioned because it 'has always been this way' and modelling alternatives considered to much work. Factory layouts, processes and work methods are frequently taken for granted and assumed to be acceptable and the fact that this is one of the easiest areas to effect improvements is not recognised. The value of the worker is often neglected, although s/he forms an integral part of the system and the corrupting influences of the variability within the system ignored.

Operations Management is faced with large amounts of information concerning the skills and knowledge required to manage. Often, when analysed objectively, this information provides conflicting views on what should be done in order to succeed as a manager. Most information focuses on achieving the primary business objective of maximising profits without taking into account the conflicting sub-objectives that are created as a direct result of trying to balance the opposing twin objectives of resource utility and customer satisfaction.

Figure B.5 (Hopp and Spearman, 1996, p200) is an example of a hierarchy of sub-objectives that Operational Managers are frequently required to manage. Understanding the inter-relationships of these and the influence that these have on the purpose of Operations Management is vital for effective decision making.

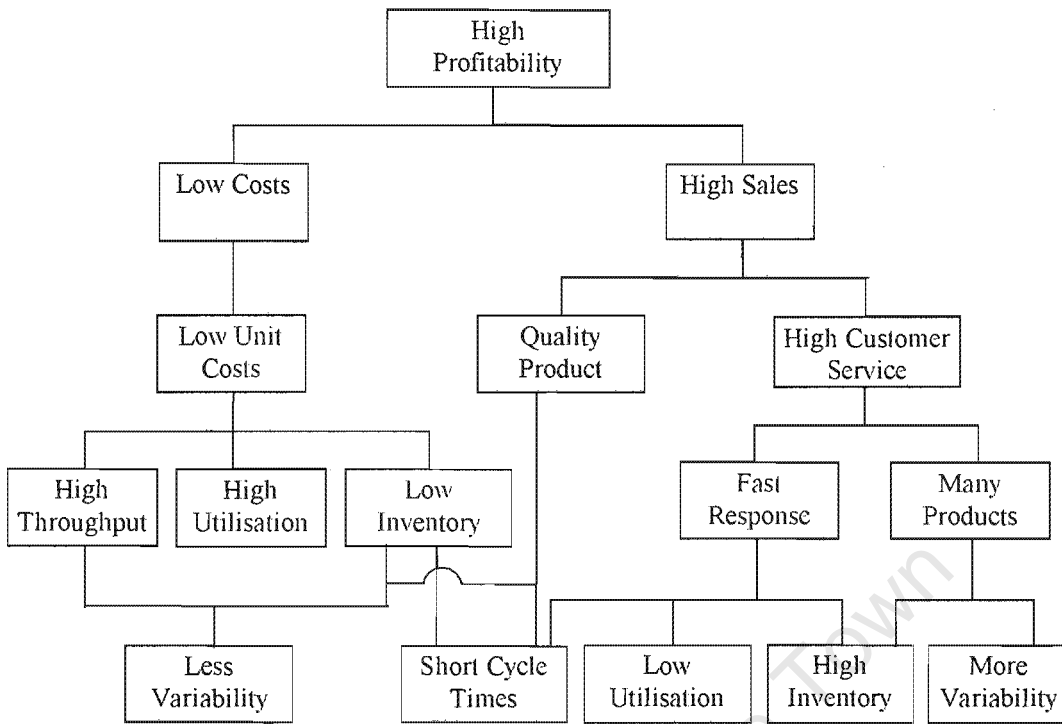


Figure B.5 Hierarchical Sub-objectives of Operations Management

As can be seen from the hierarchy, many sub-objectives are conflicting. Operations Managers are faced with the task of finding the correct mix in order to achieve their fundamental objectives. To do this Operations Managers must understand the operating system in its entirety and how various trade-offs influence the system. They must also understand how the operating system fits into the organisation and what the underlying dynamics with other organisational parts are. As the primary value adding function, the operations function can be considered to form the heart of the enterprise, without which the existence of all other functions is nullified.

Thus the view is propounded that the remaining business functions - such as research and development, marketing, sales and distribution, finance and accounting, human resources, and information technology - form a support platform to the operations function, assisting in policy implementation, auditing, co-ordination, control and intelligence procedures.

In a similar manner, Chase and Aquilano (1995, p29) suggest an *operations strategy framework* built on the support platform of financial management, human resource management and information management. At the centre of this model are the operations capabilities, which are identified as the *core enterprise*, the essence of which has been discussed above. In summary, the following model of Operations Management illustrates its role within the organisation (figure B.6).

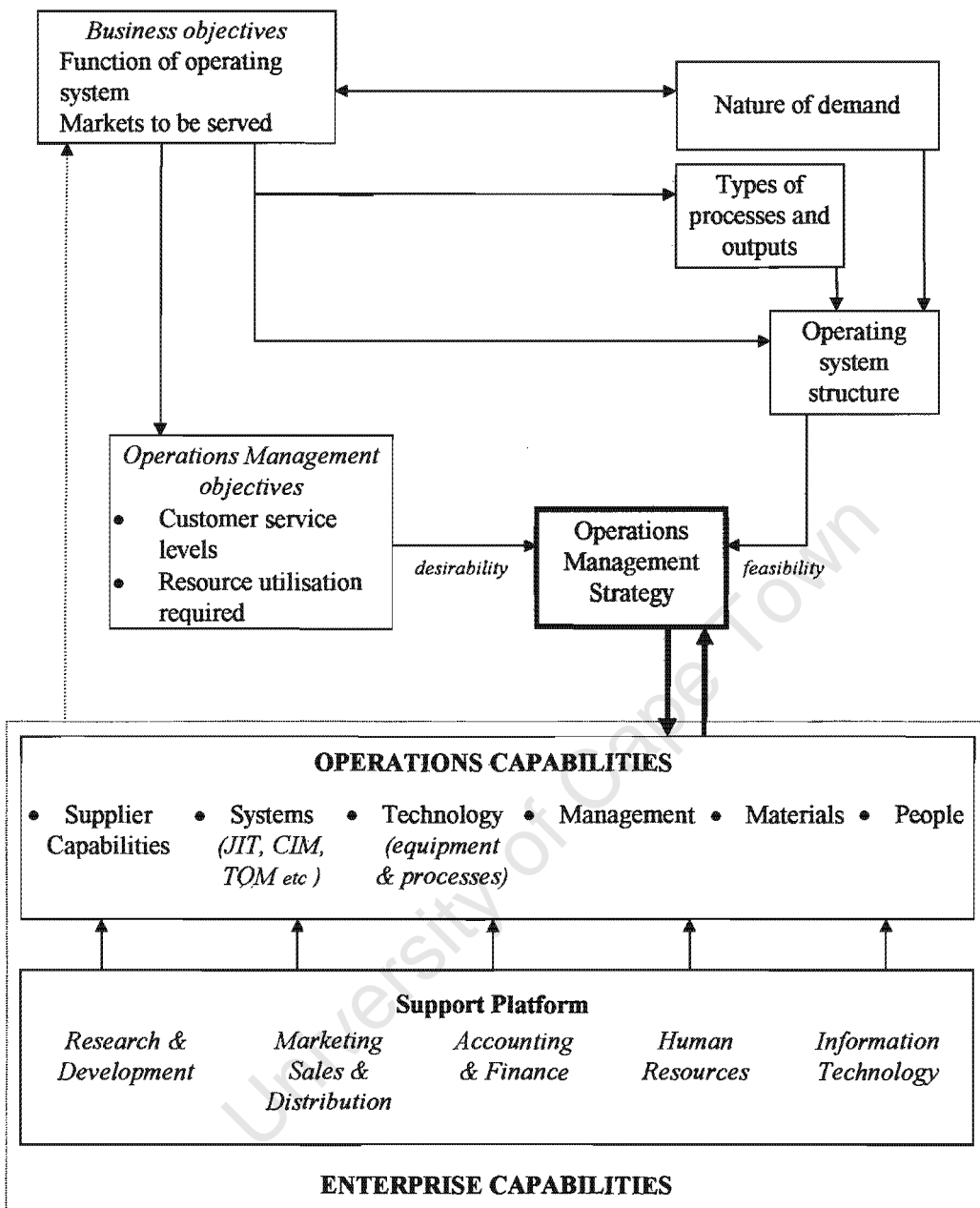


Figure B.6 The Role of Operations Management within the Organisation

### B.1.3 Operations Management and Variability

Operations Management is faced with a considerable amount of complexity created by the dynamics of the operating system and the human operating it. Not only does the function have to concern itself with the physical variances directly related to the shop floor activities - such as in materials, machines, and processes - but also with human variation.

When taking into consideration that the majority of a manufacturing organisation's work force is employed on the 'shop floor' and that often the level of education and insight is lowest at this level, the complexity of the task can be appreciated.

The more complex the environment becomes, the higher the levels of variability, making it more difficult to manage and more difficult to achieve the purpose of the operation. The Law of Requisite Variety (Clemson, 1984, p36) states that control in a system is limited by the variety perceived by the manager and the feedback system available. It is therefore important that Operations Managers know which variables to select and manage, i.e. those where the effect of variability may have the greatest impact and in turn have the greatest impact on achieving the organisations overall objectives.

Traditionally the focus has been on controlling process variability where tangible variables are measured, recorded and statistically interpreted. In this regard the 1980's and 1990's, starting with Crosby's message '*quality is free*' (Rosenthal, 1992, p263), saw a major paradigm shift with the advent of Total Quality Management (TQM) and Statistical Process Control (SPC) methods.

However whilst the statistical monitoring and controlling of actual processes has almost become standard procedure, little knowledge has been generated on the dynamics of the production line, the core element of any manufacturing operating system. For Operations Managers to effectively make decisions and optimise the operating system, it is important that they develop an intuitive understanding of variability and how it affects the line, and what the implications for the entire system are. There is a need to develop guidelines that will assist in decision-making when dealing with complex variable situations in a production environment.

These guidelines should be based on probabilistic intuition developed from the nature of variability within the context of the production line and the task Operations Management faces, i.e. operating the line to achieve a balance of resource utility and customer satisfaction. To develop such probabilistic intuition, a clear understanding of the line and of the concept of variability is essential, as this directly affects the vital tasks of capacity management, activity scheduling and inventory management.

#### **B.1.4 Understanding the Causes of Variation**

In endeavouring to identify the causes of variation it is essential to be aware of the dynamics within a system. As discussed in the Systems Approach (Section A.4, Appendix A) the system parts are interdependent and actions undertaken in one area will not only affect that particular part, but numerous other areas. The effect of variation on various dimensions of performance can be

## **B.2 Factory Physics**

Throughout the discussion in this section, it is assumed that the reader is familiar with basic manufacturing terminology; however it must be noted that the terminology used varies greatly amongst different sources and as such the meta-language of Factory Physics lacks unity. For the discussion presented in this dissertation the definitions used by Hopp and Spearman (1996) have been used.

From the discussion presented thus far it is clear that variability introduces a great deal of complexity into a system and is one of the main causes of inefficiency in operations today. Certainly it would appear that it is one of the least understood factors. Therefore the need exists to understand the relationships between basic manufacturing quantities such as work-in-process, cycle time and throughput and how these are affected by variability, and in turn how this impacts on capacity, scheduling and inventory. In this regard Factory Physics deals with these relationships in a quantitative as well as qualitative manner, enabling clearer MOPs to be derived.

Factory physics culminates in deriving laws that intuitively aid in dealing with the fundamental behaviour of manufacturing systems involving variability. These laws and concepts are useful for tracing the sources of performance problems in the transforming system. Whilst the analytical formulas derived by Factory Physics are certainly valuable in this regard, it is the intuitive understanding behind the formulas that is most critical in this process.

### **B.2.1 The Workstation**

To commence with, there is a need to define the basic building block around which to develop a body of knowledge of fundamental factory dynamics - much in the same way as Newtonian physics started with gravitational experiments. In operations this building block may be construed to be the workstation (Hopp and Spearman, 1996, p221), for this is the smallest holistic unit of consideration and fundamentally where the transformations take place and value is added. If the operations environment understands this fundamental unit and the physical entities describing its dynamics, a considerable step towards understanding variability and therefore reducing and controlling it has been taken.

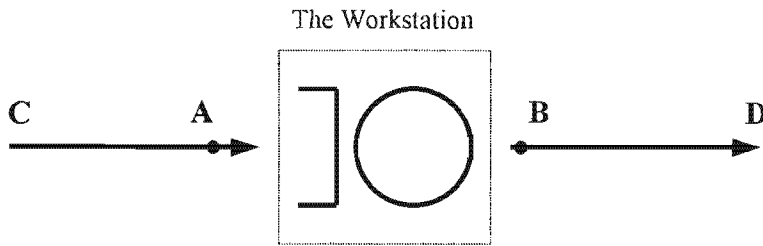
In its simplest form a line consists of one workstation with one machine or some separable value adding process. In its more complex form, there are several different workstations that interact and are linked through some defined sequence of workflow forming a routing through which a part moves.

In essence a workstation performs a value adding function by altering the state of an input that is fed into the workstation by performing some operation (the actual transformation). Each workstation, and consequently each line, factory and operating environment is governed by a set of fundamental parameters that describe the dynamics of the operating system. In order to gain a quantitative understanding and be able to physically predict the behaviour of the operating system these need to be defined. Once quantitative measures describing the operating system have been established, a better qualitative understanding will follow.

In Factory Physics both quantitative as well as qualitative relationships are dealt with, however for the scope of this thesis the detailed derivation of the various Factory Physics laws will not be discussed. Rather, the intention is to illustrate the qualitative value of understanding the fundamental descriptors and the derived laws.

The most fundamental relationship identified by Hopp and Spearman (1996, p232) relates the key measures of throughput (TH), work-in-process (WIP), and cycle time (CT). These three characteristics are the key measures of performance (MOP) characterising the operating system and leading to an in depth understanding or intuition of the operations environment. The following definitions are provided with the concepts illustrated by means of figure B.7 (Hopp and Spearman, 1996, p223):

- *Throughput (TH)*: Is the average output of a production process per unit time (throughput rate.) At the firm level it is defined as the production per unit sold. At a plant, line, or process centre it is the average quantity of good parts produced per unit time. In terms of a workstation (figure below) it can be thought of as the amount of good output leaving point B per unit time.
- *Work-in-process (WIP)*: Is the inventory between the start and end points of a product routing, i.e. all the product between, but not including, the stock points. Referring to our diagram below, WIP would include all parts between C & D (including any inventory flowing from C to A and from B to D).
- *Cycle time (CT)*: Is the average time from release of a job at the beginning of the routing until it reaches an inventory point at the end of the routing, i.e. time spent as WIP. This implies that it is the time taken for parts to get from points C to D. The time taken to get from A to B can also be considered. This would then be the cycle time of the workstation and not of an entire routing.



**Figure B.7** The Basic Building Block of Factory Physics – The Workstation

In order to quantify these characteristics, Hopp and Spearman (1996) further define key *parameters* or numerical descriptors of the manufacturing processes. These parameters form the basis for mathematical derivations that allow numerical determination of capacity, throughput, cycle time and inventory levels. The four key parameters in this regard are the bottleneck rate, raw process time, critical WIP and congestion coefficient (Hopp and Spearman, 1996, p225):

- *Bottleneck rate ( $r_b$ )*: Is the rate of the workstation having the least long-term capacity i.e. the slowest rate at which throughput is produced. Goldratt (1992) emphasises that the correct management of the bottleneck workstation as being absolutely critical to the overall success of operating the line.
- *Raw process time ( $T_o$ )*: Is the sum of the average long-term process time of each workstation in the line (i.e. the average time it takes a single job to traverse the empty line.)
- *Critical WIP ( $W_o$ )*: Is the WIP level for which a line having parameters  $r_b$  and  $T_o$  with no variability in process time achieves maximum throughput (i.e.  $r_b$ ) with minimal cycle time (i.e.  $T_o$ ).
- *Congestion coefficient ( $\alpha$ )*: Measure of the congestion in the line i.e. the tendency for the line to 'clog' up. This also reflects on the utility of the workstation.

In using these parameters, the first requirement for developing a quantitative scientific body of knowledge is achieved. The next step then is the derivation of the law that forms the equivalent of the  $F = ma$  of Newtonian physics or the  $E = mc^2$  of Quantum physics. This law is termed *Little's Law* and forms the first fundamental law of Factory Physics (Hopp and Spearman, 1996, p232). It expresses WIP, cycle time and throughput as an empirical formula and states that throughput is a ratio of WIP to cycle time:

### B.2.2 Little's Law

Little's Law relates the fundamental measures of throughput, work-in-process and cycle time (Hopp and Spearman, 1996, p231 *et al*) as follows:

$$TH = \frac{WIP}{CT}$$

This fundamental relationship forms a direct link to determining and manipulating capacity, inventory and scheduling. Throughput provides a MOP of current capacity, WIP gives an indication as to the inventory levels and thus the scheduling requirements, and cycle time directly affects scheduling and lead times. The expressed relationship also allows clarity on the effect of manipulating any of the three MOPs and thus provides a basis for understanding when the operating system needs to be manipulated.

Little's Law holds for all production lines, including lines containing variability and it is applicable to single work stations, a line, or the entire operations function/plant. As long as there is consistency in the units that the three quantities are measured in, the relationship will hold over the long term.

It is critical to note, that due to the multitude of factors affecting the operating system and the vast amount of variation it is subjected to, the application of this law is highly dependent on the assumptions made. Certain of the parameters defined form very real limitations on the operating system and thus Little's Law should never be considered in isolation. It is also critical that the Operations Manager has an understanding of the context within which this law is applicable and how the defined parameters affect the system.

For example, Little's law states that if the WIP levels are increased whilst the cycle time remains constant, the throughput will increase. However, it must be taken into consideration that every system has a bottleneck rate and raw process time that define a *critical* WIP level above which the throughput no longer increases but rather results in queues and inventory build-up. Thus at all times, the best one can do is to characterise the behaviour of system under specified assumptions.

Nevertheless, in understanding how various assumptions affect the predictions made by Little's Law, a best case, worst case and practical worst case of performance can be derived, (Hopp and Spearman, 1996, p234 – 241). In the best case performance for example, the assumption is based on minimum cycle times and maximum throughput and vice versa for the worst case performance given that the system is not affected by randomness.

Essentially these form upper and lower possible theoretical boundaries for the performance of the system and thus are useful in a practical sense in that, given that the actual performance of the system is known, it can be determined whether the systems performance is good or bad and what potentiality for improvement there is. Little's Law thus defines a simple, quantitative, and intuitive relationship with the key variables contained such that, barring any external influence, managers can adequately understand and therefore manage the transformation process.

Even more importantly Little's Law paves the way for the derivation of other laws applicable in the operations environment which can be used to better understand and manage it. The essence of these laws is presented in the ensuing section.

### B.2.3 The Remaining Factory Physics Laws

Hopp and Spearman (1996, p282) state the following about the derived laws of Factory Physics:

'...some of these "laws" are *always* true while others hold *most of the time*. On the surface this may appear unscientific. However, we point out that physics laws, such as Newton's second law,  $F = ma$ , and the law of the conservation of energy, hold only approximately. But, even though they have been replaced by deeper results of quantum mechanics, these laws are still very useful....Something similar can be said for the laws of factory physics. Such laws help to understand the relationships between basic manufacturing quantities...'

The laws are divided into flow laws, batching laws, the "pay me now or pay me later" law, the lead and cycle time laws, the push-pull laws, and basic human laws. A brief outline follows:

#### i) Flow Laws

This set of laws relates to the flow of material through an operating system, line or workstation. In particular the focus is on clarifying the factors that limit flow or cause congestion. Flow laws deal with flow conservation, steady state capacity limits, overtime vicious circles, as well as congestion caused by variability and utility (Hopp and Spearman, 1996, p282 – 287).

#### ii) Batching Laws

The laws identify the two primary reasons for batching jobs together as avoiding set-ups and facilitating material handling. These two different reasons for batching lead to two different kinds of batching conventions - namely *process batching*, which involves the number of parts processed between set-ups, and *move batching* which involves the number of parts moved between workstations.

Traditionally these have been assumed equal, however the batching laws illustrate that by lot splitting, which keeps process batches large and move batches small, cycle time can be significantly reduced provided set-ups are long and processes close together.

The laws thus discuss the effect of batching and batch sizes on waiting time, capacity and utility. Batching and set-up time reduction should be used in concert to achieve high throughput and efficient WIP/cycle time levels (Hopp and Spearman, 1996, p288 – 296).

iii) *“Pay me now pay me later” Law*

This law implies that variability reduction is a key means for improving a manufacturing system, and that if the necessary expense in reducing variability is not incurred, the system will pay by way of inefficiencies in other variables. It should however be noted that the law does not imply that reducing variability is the only and best option, merely that some form of payment will be made and that the choice should rather be made consciously (Hopp and Spearman, 1996, p296 – 302).

iv) *Lead and Cycle Time Laws*

The laws discuss the affect of variability on lead and cycle times and thus consequently on service levels. The major concern emanating from the lead and cycle time laws is cycle time reduction. This involves reducing mainly queue time, wait for batch time and wait to match time which are all strongly affected by random variability.

Adding capacity and reducing variability are interchangeable options. Both can be used to reduce cycle times for given throughput levels or vice versa (increase TH for given CT). However the ease of implementation of spare capacity by buying new machines for example must be considered in contrast to the potential learning undergone by implementing a successful variability reduction program for instance (Hopp and Spearman, 1996, p302 – 305).

v) *Push-Pull Laws*

These laws highlight the advantages of a pull system which authorises the release of work based on the operating system status, as opposed to a push system which schedules the release of work based on predetermined demand regardless of the system status.

The advantages of a pull system include reduced manufacturing costs, reduced variability especially in cycle time, improved quality, maintainable flexibility and facilitation of work ahead. The true underlying cause of the key benefits of a pull system is that there is a limit to the maximum amount of inventory in the system. Thus regardless of what happens on the factory floor, the WIP level cannot exceed a specified limit.

This WIP cap reduces manufacturing costs by reducing the average level of WIP required to achieve a certain throughput. It reduces variability by reducing buffers thereby exposing problems and forcing the system to become responsive to improvements. It forces the system to produce adequate quality levels in order to maintain reasonable throughput levels and allows flexibility by keeping orders on paper for as long as possible until it is certain that a specific product is wanted.

Consequently the pull system has a higher level of transparency, efficiency and robustness and enables better control of the operating system. Whilst push systems control throughput and observe WIP, pull systems control WIP and observe throughput. Setting the release rate in a push system is based on capacity capabilities, however estimating capacity is not simple. It is thus preferable to control a robust parameter that is easily observable and monitor the sensitive parameter (Hopp and Spearman, 1996, p316 *et al*).

#### vi) Basic Human Laws

The mentioning of human laws in the field of factory physics is essentially to draw attention to the fact that the human element is an intrinsic part of any operating system. The laws offer a factory physics perspective on the role of humans in manufacturing systems, their aim being to highlight some of the most basic aspects of human behaviour and how it affects the operations environment (Hopp and Spearman, 1996, p336 *et al*). It must be noted that these laws are not sufficient for dealing with and understanding the complexities of human behaviour, an area which is supplemented by the discussion presented in the Work Systems section that follows.

### B.3 Work Systems

In view of the variability attributable and introduced into systems by human influence it is essential to appreciate the human dynamics affecting the operating system. Variability induced by humans is one of the primary sources that are poorly understood and/or controlled. Generally these can be attributed to socio-technical and socio-political dynamics, which are related to human interaction and are often separated from the factual operating environment.

In context, when talking about the human dynamics in operations the interactions and dependencies amongst the people forming the organisation are specifically referred to. Critical to this understanding is the fact that in any organisation, or to make it clearer, in any group of people that interact to achieve a common goal (work), people perform *activities* and form a *span of relations* around which this goal is pursued (Hoebeke, 1994). People thus form their own meaningful systems, or *work systems*, and in order for managers to effectively understand the human interaction within the parts of the system they are trying to manage, they need to be aware of this.

Hoebeke (1994, p9) defines work systems as ‘ a purposeful definition of the real world in which people spend effort in more or less coherent activities for mutually influencing each other and their environment.’ Graphically the concept of work systems is illustrated below in figure B.8.

To completely understand this concept and harness its potential, managers need be aware that individuals in an organisation have their own values systems, goals and self-actualising needs, which are seldom aligned with those of the organisation. Hopp and Spearman (1996, p337) state that ‘organisations made up of people will not necessarily act according to organisational goals. The reason is that the sum of the actions that improve the well-being of the constituent individuals is by no means guaranteed to improve the well-being of the organisation.’

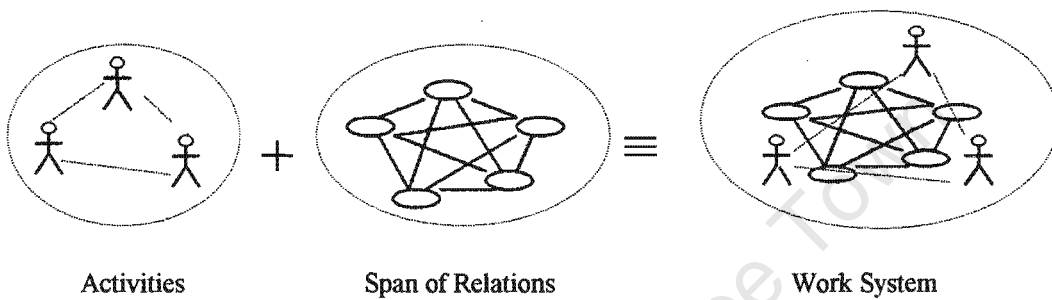


Figure B.8 The Composition of Work Systems

The tendency is thus for the individual to be self-optimising without an awareness of how s/he fits into the bigger picture and how her/his actions affect the system. An individual will have a different perspective on his role in comparison to the manager who represents the organisation, and therefore can cause considerable human variability. This will manifest itself in such factors as motivation, effort, co-operation, understanding and so on. Critical also is the understanding that managers as humans will also tend to self-actualise unless explicitly aware of the consequences of their actions in the bigger picture.

From a cybernetic viewpoint this is pertinent in that humans, as observing systems, influence their own reality. Thus the relations that humans form around their work system have far more underlying effects on an organisation than any policies or visions dictated by the organisation. When managers define the systems that they have to manage, they need to pay attention to two fundamental aspects:

- Choosing the set of variables or parameters that defines the system as a holistic unit.
- Choosing the basic premises or beliefs about the way the system operates.

The choice of variables that define the system is critical in determining what the system is, what its behaviour will be and what can or can't be done about, or to, the system. Historically the focus has been on defining variables of a measurable 'hard' nature, such as throughput, capacity limits or requirements, process boundaries and so on. Little attempt is however made to define the 'softer' underlying issues inherent in human involvement.

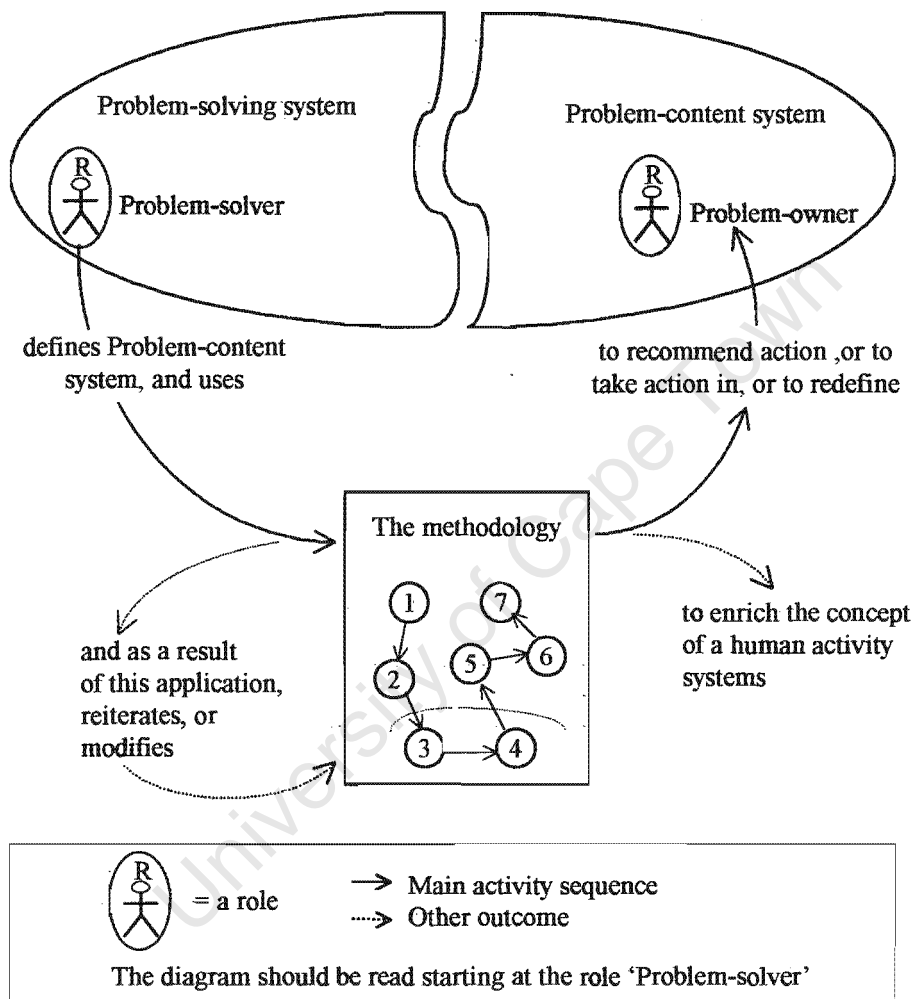
In the case of the interaction and interdependency of humans, the manager is dealing with a *social system* the choice of premises of which, in terms of how the system works, is crucial in determining how the system does actually work.

An example of this is McGregor's (1960) theory X and theory Y. According to theory X, the average human has an inherent dislike of work and little personal motivation, and therefore people must be coerced, controlled and directed towards achieving organisational objectives. If a manager has this basic belief, his style will necessarily be autocratic and dictatorial with the corresponding consequences.

The nature of reality thus depends partially upon the nature of the observing system. At this point, reference to the philosophical framework developed in Chapter 3 is made, which discusses the issue of reality as a crucial foundation to understanding. Since the observing system is part of reality, the nature of the observing system influences this reality. This aspect has a great influence on human dynamics and a good understand of this would enable Operations Management to deal far more effectively with human variability.

Managers need to develop an intuition for human variance factors via an adequate feedback system based on good communication, participation, interaction and a pro-active learning cycle. Only in this manner can the variation introduced due to 'soft' parameters be identified and controlled.

The problem owner and solver are not restricted to individuals but can be groups or various individuals affected by the situation. By using/applying the SSM the problem solver aims to clarify and better understand the problem-content system and through a process of 'learning one's way to a solution' aims to recommend action, undertake action or redefine the situation to improve it for the problem owner. Figure C.1 pictures this illustration of the use of the methodology as per Checkland (1981, p239).



**Figure C.1** The Soft Systems Methodology Approach

Patching (1990) states that the SSM is used primarily to gain an understanding of an organisation and that it suggests guidelines for examining it with a view to clarifying where improvements are possible. These high-level guidelines provide a general learning framework for problem-identification by applying systems ideas to 'soft' or unstructured situations, normally prior to the application of systems techniques.

The use of the methodology within an organisation is thus intended to assist in the process of solving poorly defined or messy problems, especially where these involve the interaction of members of the organisation. The idea is to involve all parties concerned in order to try solve, understand or improve the problem, defined not by the management or the organisation, but rather as a result of analysing the perceptions, opinions and underlying assumptions of all stakeholders involved, including the cleaning girl on the shop floor. The SSM endeavours to facilitate the communication and create debate on each of the perceptions in order to create 'solutions' that are acceptable and reflective of all stakeholders.

Due to the fact that the methodology has evolved from the deficiencies discovered during the application of hard systems analysis it has a strong link to pragmatism, in that it aims to achieve purposeful action. Like hard systems analysis, SSM values real-world applicability rather than theoretical development and thus fits in well with the espoused philosophical framework of chapter 3. To better understand the SSM the remainder of this section will deal with the most important underlying philosophies and principles and some of the features of the methodology.

### **C.1.1 The Emergence of the Soft Systems Approach**

The three main proponents from which the soft Systems Approach has evolved are systems engineering, systems analysis and classical operational research, all of which are considered to be 'hard' approaches. Systems engineering stems from the teleological way of engineering thinking, where the solution to a problem is worked backwards from the identified *purpose served* by the object or system. Checkland (1989, p274) states 'in a sentence, the essence of the approach is the selection of an appropriate means to achieve an end which is defined at the start and thereafter taken as given.'

System analysis brings together ideas from engineering and economics and seeks to help a real-world decision maker choose between alternative options that all produce the desired goal. In turn, operational research seeks to apply the scientific method to real-world operations, thereby breaking down the logic of situations to gain intuitive understanding.

These three methodologies all entail starting from a carefully defined objective which is taken as given and which is then pursued in the most efficient means. The best solution is searched for systemically by defining the objectives to be achieved and manipulating models of real-world situations or other simulations. However in most managerial or social problems the objectives or what is to be achieved, forms part of the problem.

In this regard, Checkland (1989, p276) states that all hard approaches,

‘assume a relatively well-structured problem situation in which there is virtual agreement on *what* constitutes the problem: it remains to organise *how* to deal with it. However, for most managers most of the time both what to do and how to do it are problematical, and questions such as: “What is the system? What are its objectives?” ignore the fact that there will be a multiplicity of views on both, with alternative interpretations fighting it out on the basis not only of logic but also of power, politics and personality.’

With the realisation that the hard Systems Approach failed to deal effectively with problem-situations in which human perceptions, behaviours or actions form part of the problem, and where the definition of goals, objectives as well as the interpretation of events are all problematic, the soft Systems Approach evolved.

### C.1.2 The Underlying Philosophies and Principles of the Methodology

To best understand the methodology and its capacity to deal with ‘soft’ problems it is important to make explicit the underlying assumptions on which it is based. In this regard, of principal importance is the realisation that most problems (and especially managerial and organisational problems) do not have an existence independent of the human beings involved with them. As Naughton (1984, p10) explains, ‘problems are constructs of the concerned mind, defined by the perceptions of the individuals who are troubled or intrigued by them’. Problems are thus perceived differently by each individual and precisely for this reason many real-life scenarios are difficult to resolve because people differ on what ‘the problem is’. In a similar way in which ‘problems’ are subject to individual interpretation, so too are ‘solutions’. This stems from the fact that individuals have different *appreciations* of situations because they are seen in different ways. Precisely for this reason epistemology, metaphysics and axiology are incorporated in the philosophical framework guiding the thesis inquiry in Chapter 3 in order to gain an understanding of this fact.

Reality as perceived by the individual is shaped by personal belief system, values, experiences and knowledge and is the basis on which thought processes are constructed. Naughton (1984, p11) uses the expression of a ‘personal prism’ through which each individual looks at, and interprets, the world. This prism refracts the light of experience and forms a unique picture of reality. This individual reality is what Systems Thinking has termed *Weltanschauung* or worldview. Checkland (1989, p279) describes *Weltanschauungen* as ‘the stocks of images in our heads, put there by our origins, upbringing and experience of the world, which we use to make sense of the world and which normally

go unquestioned'. The *Weltanschauungen* held by individuals are thus shaped by the beliefs they have about the world. These espoused beliefs involve perceptions of *what is* and *what ought to be*.

In developing a problem-solving methodology that deals with, and that is directly influenced by these intellectual constructs of the mind, it is paramount to make explicit the underlying assumptions that govern individual perception of a problematic situation. The underlying philosophy therefore assumes that insight into, or the understanding of, a complex problem-situation can only come from an appreciation of the perspectives generated by the different *Weltanschauungen*, especially since there are no logical or *a priori* grounds for deciding that one perception is more valid or relevant than another.

Related to these *Weltanschauungen* is Checkland's (1989) realisation that due to the autonomy and individual perceptions of people affecting a problem situation, managers will always be faced with individuals making their own assessments of the problem on which they then base their actions. Due to individual actions not necessarily being coherent with the actions required for contributing holistically to the system purpose, or with the actions of other people involved, management will always be faced with 'issues' arising out of human dynamics. These human dynamics can result in conflict and manifest themselves in socio-technical and -political disputes, as discussed in Sections A.7.3 and A.7.4 (Appendix A), generated largely by differing cultural backgrounds. The use of SSM aims to reduce this conflict by assuming that developing mutual understanding between the people of different cultures can alter the individual interpretations.

Checkland (1989, p278) further identifies 'human activity systems', which he derives from the fact that inherent to any organisation is 'a set of activities linked together in a logical structure', that in a coherent manner 'contribute to the purposeful whole'. Clearly this bears resemblance to Hoebeke's (1994) Work Systems, discussed in Section B.3 (Appendix B). Humans thus engage in purposeful activity to achieve a desired output, however accounts of 'purposeful activity' as well as 'desired output' are subject to interpretation.

Principally the SSM takes into account that within any system there will be multiple possible descriptions of any named real-world purposeful action and thus activity systems will differ and may clash. Again by recognising the *Weltanschauungen* generating the human activity system, SSM can understand how it is contributing to or affecting the problem. A further fundamental principle underlying the SSM is the recognition that problems seldom exist in isolation. Ackoff (1974), as per Naughton (1984, p12), goes as far as stating,

'that no problem ever exists in complete isolation. Every problem interacts with other problems and is, therefore, part of a set of interrelated problems...Furthermore, solutions to most problems produce other problems.'

Ackoff terms this concept a 'system of problems' and refers to it as a 'mess'. The soft systems analyst therefore is concerned with 'mess management' and in this regard, the SSM has to deal with the emergent properties of component problems which are systemically interconnected and, as noted by Naughton (1984), will not yield to a reductionist approach. For this reason SSM takes into account multiple perspectives and creates a 'bigger picture' defining the current situation in terms of all interrelated problems.

Central to the solution of these problems then, is the sharing of perceptions amongst stakeholders to induce a debate that ultimately can lead to a common view of the problem. This is an important philosophy of SSM, which assumes that improvements can only be achieved if the solution stems from a problem definition that incorporates all views concerned. In line with this philosophy is the principle that the inquirer too, forms part of the analysis as his/her perception of the situation will influence the situation itself.

### C.1.3 Features of the Soft Systems Methodology

Following the successful application of the SSM by various analysts such as Checkland and Scholes (1990) certain features that characterise the methodology have emerged. To start with a central feature of the SSM is a paradigm shift from 'hard' systems analysis to 'soft' systems analysis i.e. taking into consideration the complexity of human dynamics in a potential problem situation and clarifying both the *what* as well as the *how*.

It can also be said that the SSM is a continuous never-ending learning process, which is generated by the application of the methodology to a particular problem situation. This learning changes the nature of the problems being analysed, or rather the different perceptions of the problems and results in a new or developed situation. Checkland (1989, p278) states,

'SSM is a learning system. The learning is about a complex problematical human situation, and leads to taking purposeful action in the situation aimed at improvement action which seems sensible to those concerned. SSM articulates a process of inquiry which leads to the action, but that is not an end point unless you choose to make it one. Taking that action changes the problem situation. Hence inquiry can continue; there are new things to find out, and the learning is in principle never ending.'

Concurrently SSM is a systemic process of inquiry that constantly seeks to incorporate multiple perspectives. What is important to note here, is the acknowledgement that different people will have different perceptions of, will make different evaluations of and will take different actions in the same

situation. For this reason the inquiry is justified, as all contributions can be taken into consideration. The inquiry process is how learning is initiated, even more so because it takes place not only at the real-life level but also at a theoretical level, the two subsequently being compared.

One of the main aims of SSM is to generate learning amongst the stakeholders of a perceived problem situation by eliciting the different perceptions of the problem from the stakeholders through inquiry. In turn, debate is initiated, which by means of sharing perspectives, leads to an understanding of the social dynamics involved. In essence the SSM generates a socio-political and socio-technical synergy.

Further, Checkland (1989) describes the SSM as a process for managing. He describes managing as a 'process for achieving organised action' entailing 'deliberate, thought-out action' and not 'random thrashing about'. Management is continuously acting and reacting to an 'ever-changing flux of interacting events and ideas' and therefore forms an intricate part of this flux. The SSM provides an effective means for interacting with and affecting the changing dynamics of a manageable situation. Again the cyclic nature of the process is reiterated - management can never withdraw from this flux just like it cannot stop time.

A final feature to be mentioned is that SSM is a methodology and not a technique or philosophy. Where a technique is concerned with *how* and a philosophy with *what* and *why*, a methodology will contain all elements.

## C.2 The Inquiry Process of the Soft Systems Methodology

In this section, the inquiry process used, is presented and briefly discussed in order to give the reader some background to the application of the methodology in this thesis. Traditionally the process of SSM has been expressed in the form of figure C.2 which appears to present a sequential seven-stage process. It has to be noted however, that SSM is presented in this chronological form (from 1 to 7) in order to describe it in the most logical manner and not because the steps have to be followed rigorously in this sequence.

For the purpose of this thesis the more holistic model of the SSM in figure C.3 below, that has evolved from the experiences of Checkland and Scholes (1990, p29), will be used, which is an extension of the seven-stage 'logic-based stream of analysis' presented in figure C.2.

The essence of the inquiry process however, remains the same and involves the iterative process of using systems concepts to reflect upon and debate perceptions of the real world, taking action in the real world, and again reflecting on the results using systems concepts. The reflection and debate is structured by a number of systemic models which are conceived as holistic ideal types of certain aspects of the problem situation rather than as real-life accounts of it.

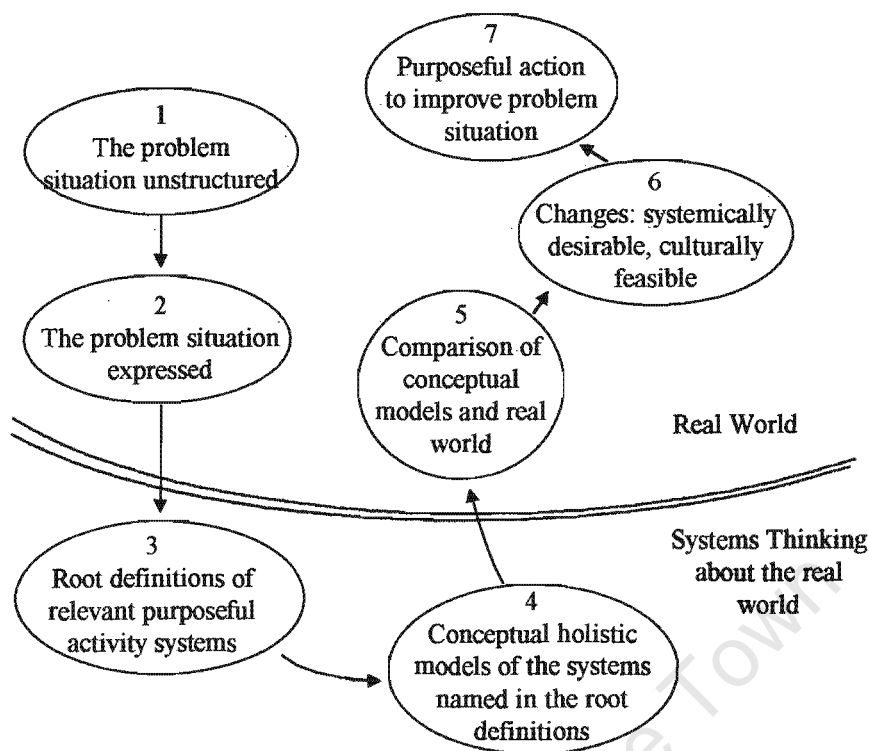


Figure C2 The Seven-Stage Logic-based Stream of Analysis

The methodology thus contains two kinds of activity - 'real-world' activities concerning the actual problem situation experienced and 'systems-thinking' activities, concerning ways of thinking about the problem situation in order to achieve purposeful action.

The seven-stage process identified in figure C.2 constitutes what Checkland and Scholes (1990) term the 'logic-based stream of analysis' which traditionally the methodology has revolved around. In addition to this logic-based stream, Checkland and Scholes, in their further developed model (1990, p29) depicted below in figure C.3, introduce an additional stream of inquiry --a the 'stream of cultural analysis'.

As illustrated by the model, the SSM inquiry process starts with a 'real-world problem situation' as perceived by a problem-owner (refer to figure C.1). The problem situation is a product of a 'history' formed by the complexity of human interaction, from which emerges a problem that to the problem-owner cannot be clearly defined and therefore also not effectively resolved.

Dealing with the problem are the problem-solvers or the 'would-be improvers of the problem situation' who, by a process of taking all *perceptions* into consideration, are concerned with arriving at relevant 'tasks' and 'issues'. These 'tasks' include the perceptions of various purposeful actions in the situation, whilst the 'issues' are the various things about which there are disagreement.

Given the situation, two streams of interactive inquiry are undertaken by the problem-solvers, which ultimately lead to changes aimed at improving the problem situation. What follows is a brief discussion of these 'streams of inquiry'.

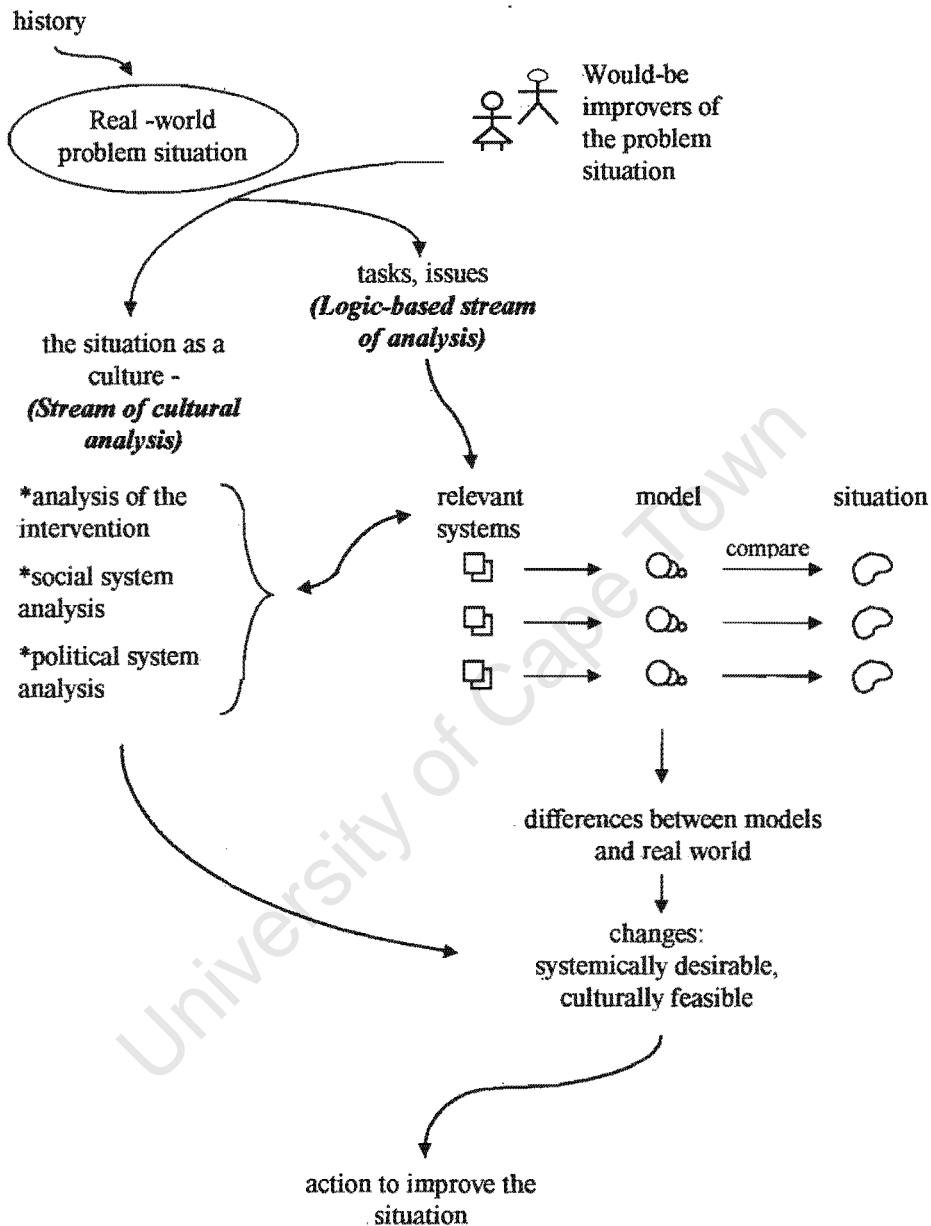


Figure C.3 The Cultural and Logic-based Streams of Inquiry of the SSM

### C.2.1 The Logic-based Stream of Inquiry

As previously mentioned, the logic-based stream of inquiry is captured in the seven-stage diagram in figure C.2. The seven stages, to be briefly discussed in this section, are:

1. The problem situation unstructured.
2. The problem situation expressed.
3. Defining root definitions of relevant purposeful activity systems.
4. Development of conceptual models of the systems named by the root definitions.
5. Comparison of the conceptual models with the real world situation.
6. Proposing potential changes to improve situation.
7. Take action to improve the situation.

*i) Finding out - (Stage 1 and 2)*

These two stage have been combined, as they involve the gathering of all information and perspectives in the unstructured situation and expressing this in an ordered structured form. Checkland (1981) suggest numerous methods of 'finding out', the most obvious being similar techniques used in the case study research methodology (Chapter 4, Section 4.2.2, *stage 4*). These include gathering information about procedures, structure and processes through observations, interviews, documentation, and archival records and importantly through informal sources such as the 'grape vine'.

The approach adopted in this thesis was to also take the stream of cultural inquiry into consideration, which runs concurrently to the logic-based stream being dealt with in this section (see figure C.3). This stream of cultural inquiry deals with the effect of the intervention itself, an analysis of the 'social system' in place as well as the 'political system' - as will be discussed in the following section.

The outcome of 'finding out' is the situation expressed in the form of a 'rich picture'. This is a graphical representation of all discovered tasks, issues and other problematic or contributing information pertaining to the situation. The rich picture is a form of synthesis of all relevant information from which hopefully a number of relevant viewpoints or 'relevant human activity systems' can be identified. In Checkland's (1981, p166) own words, 'the function of Stages 1 and 2 is to display the situation so that a range of possible and, hopefully, relevant choices can be revealed.'

Checkland and Scholes (1990) distinguish between '*primary-task*' and '*issue-based*' relevant systems. Primary-task systems are defined as 'notional human activity systems whose boundaries would coincide with the real-world manifestations. These are the simplest systems to identify and typically can be easily mapped onto real-world organisational boundaries. An example at *C&L inc. Forlezer* would be 'a system to manufacture ladders' or 'a system to provide raw material for the manufacturing of ladders'.

However, within *C&L inc. Forlezer*, ‘as in any organisation undertaking a portfolio of different tasks, there will always be debate about its core purposes and about the fraction of resources which should be devoted to each’ (Checkland and Scholes, 1990, p31). This necessitates the formulation of issue-based relevant systems that cannot be mapped directly onto real world systems i.e. organisational boundaries. An example of such a system would be: ‘a system to improve communication with management’, which one would not expect to find in an institutionalised form in the real world. Checkland and Scholes (1990, p32) express that issue-based system ‘are relevant to mental processes which are not embodied in formalised real-world arrangements’.

### ii) *Formulating Root Definitions - (Stage 3)*

Having expressed the problem situation in a structured form in which relevant human activity systems are identified, the methodology switches from the real world to systems thinking about the real world. Stage 3 is concerned with expanding the relevant human activity systems identified into concise, formal definitions which ‘draw out the essence of what is to be done, why it is to be done, who is to do it, who is to benefit or suffer from it and what environmental constraints limit the actions and activities’ (Flood and Jackson, 1991, p175).

As stated by Checkland (1981, p166-167) ‘the choice will represent a particular outlook on the problem situation and the purpose of naming the system carefully is both to make that outlook explicit and to provide a base from which the implications of taking that view can be developed.’

The root definition thus expresses the core purpose of each activity system identified, which is always expressed as a transformation process changing a given input into a required output. This is in accordance with the Systems Thinking principles discussed in Appendix A. As a root definition, the transformation on its own does however not provide a rich enough model of an activity system. In formulating a root definition, a ‘CATWOE’ is performed which is a mnemonic taking the following elements into consideration:

- |                             |   |
|-----------------------------|---|
| Customers -                 | the victims or beneficiaries of the purposeful activity identified.     |
| Actors -                    | those who perform the activity in question.                             |
| Transformation process -    | the purposeful activity changing the defined input to a defined output. |
| Weltanschauung -            | the relevant perception that makes the definition meaningful.           |
| Owners -                    | those who can stop the activity.  |
| Environmental constraints - | the constraints taken as given.   |

In formulating a root definition, Flood and Jackson (1991, p175) suggest first taking into consideration the transformation to be achieved and the underlying *Weltanschauung*. This answers the questions, “What is the core process at work in the idealised system and what is it doing?” and “Why is this being done?” Checkland and Scholes (1990, p36) suggest formulating ‘a full root definition’s core transformation as *a system to do X by Y in order to achieve Z*, where the transformation will be the means *Y*, *Z* is related to the owners’ longer term aims, and [where] there must be an arguable connection which makes *Y* an appropriate means for doing *X*’.

### iii) Modelling Relevant Systems - (Stage 4)

Whereas Stage 3 is an account of what the idealised system is, Stage 4 is an account of activities which are essential for the idealised system to fulfil the requirements of the root definition. During this stage, the aim is to develop conceptual models from each of the root definitions derived in the previous section.

These conceptual models in themselves form independent self-sustaining systems and for this reason must contain aspects of monitoring and control. Simplified, the conceptual model describes what the idealised system *does*, and therefore must be constructed from the root definition, which defines what the system *is*. The root definition describes a transformation process which must now be modelled as a system of activities needed to achieve this process. The builder of the conceptual model must be aware that s/he is still moving in the realm of Systems Thinking about the real world, and should not describe actual activity systems which s/he knows exist in the real world.

The models are constructed by extracting the minimum number of verbs necessary to describe the activities that would have to be performed in order to achieve the transformation ascribed to the identified relevant systems, whilst also taking into account the long-term viability of the system. These verbs are then expressed in dependency order based upon logical contingency to illustrate the dynamics of the system.

Flood and Jackson (1991, p176) suggest a basic model built around seven verbs; Checkland and Scholes (1990, p37) suggest seven plus/minus two. Any additional detail can in turn be expressed as a further root definition to be expanded at a next recursion level.

As mentioned above, to ensure the long-term viability of the system, elements of monitoring and control need to be added. In this regard, Checkland and Scholes (1990) convey the idea of a model consisting of a sub-system concerned with the operations of the idealised system and a sub-system concerned with the monitoring and control thereof, as depicted in figure C.4. To achieve this it is useful to include measures of performance based on efficacy, efficiency and effectiveness. Efficacy checks whether the means chosen actually works in producing the output. Efficiency then considers

the use of resources, and effectiveness reflects on whether the longer term aim is achieved (a measure which is at a different level to the other two and therefore separated).

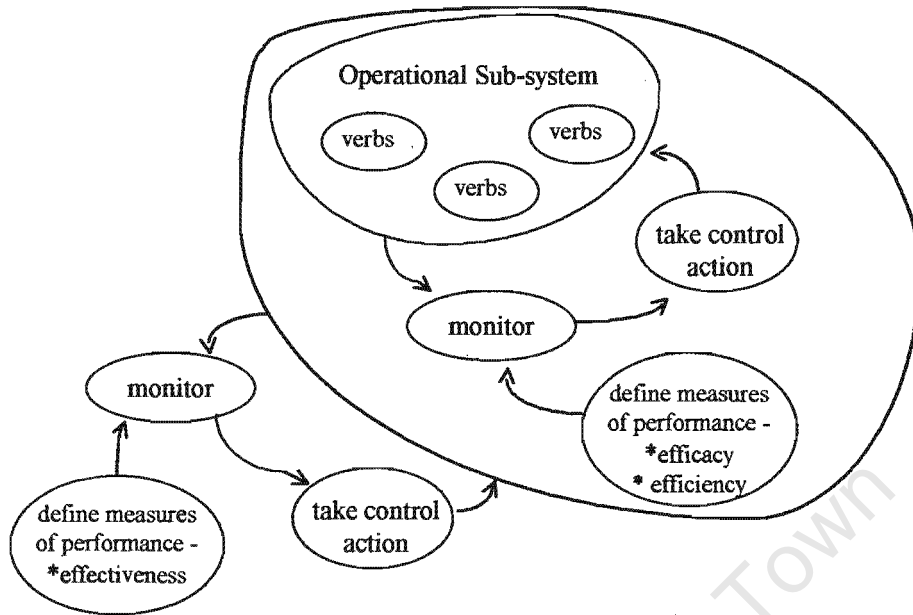


Figure C.4 Modelling the Relevant Systems

iv) *Comparing the Conceptual Models with 'Reality' - (Stage 5)*

During this stage in the SSM process, the debate about possible changes that could bring about improvements in the real-world problem situation is initiated. By comparing the idealised systems with the current perception of actual systems, Stage 5 aims to highlight differences from which potential solutions can be derived. Checkland and Scholes (1990, p42-43) state 'models are only a means to an end, which is to have a well-structured and coherent debate about a problematic situation in order to decide how to improve it. That debate is structured by using the models based on a range of worldviews to question perceptions of the situation.'

Flood and Jackson (1991, p176) argue that 'differences between the idealised models and "reality" highlight likely changes that would have to be made in order that reality better reflects the pure Systems Thinking contained in the models'. The result is that basic assumptions held by the stakeholders of the problem-situation are challenged leading to alternatives or perspectives not considered before.

The comparison aims to highlight deficiencies in purpose, structure, procedure or activity. The effectiveness and efficiency of current systems are questioned, inefficiencies identified. Valid perspectives that have in the past been ignored or not recognised are surfaced, and human dynamics and activity systems recognised.

Checkland (1989) infers that an initial comparison is useful at the root definition stage, and suggests four different ways of performing the comparison:

- By informal discussion - listing the main differences that stand out between the conceptual models and the perceived reality and initiating debate over their significance.
- Formal questioning - in a more detailed fashion, by formally listing all differences and defining specific and relevant questions regarding the activities and dynamics of the systems. These questions are then answered in the situation itself.
- Scenario writing based on 'operating' the models - through drawing up scenarios of how the idealised systems will behave under certain conditions which are then compared to events in the past.
- Modelling the real world in a similar format - by constructing a model of the relevant perception of reality in a similar fashion to the conceptual models and mapping between the two in order to highlight the differences.

v) *Defining Changes - (Stage 6)*

Following on from the debate initiated during the previous stage, are suggestions or proposed changes for achieving possible improvements. These changes must be 'systemically desirable' and 'culturally feasible'. Systemically desirable refers to how relevant the proposed changes are to the real life situation in light of the inquiry undertaken. If the relevant systems from which the root definitions were extracted during Stage 3 are purposeful, and the conceptual models built in Stage 4 (based on the outcome of the root definitions) are systemic, then the proposed changes will automatically be systemically desirable. By way of cultural feasibility, the proposed changes must be viewed in respect to organisational and individual culture. These changes will only be meaningful if the culture and relevant *Weltanschauung* pertaining to it accept them. In taking multiple perspectives and the relevant *Weltanschauungen* into consideration, as well as initiating debate about the proposed changes, the process achieves cultural feasibility.

Checkland (1981) proposes that changes can be made in the following areas - structure, procedures and attitudes. Changes in structure are relatively static and easily achieved, although the changes are affected over a longer term. Examples of structural changes are organisational groupings, reporting structures and areas of functional responsibility. Procedural changes are more dynamic and involve reporting processes, information processes or any activities performed in the structural areas. Changes in attitude are far more complex as an attitude is a matter of perception and not clearly definable. These include changes in influence or expectations.

### vi) *Implementing Changes - (Stage 7)*

Having identified changes for improving the situation, the final step of the logic-based cycle is to take action. However, this does not conclude the learning process. In fact a lot of the learning to be gained from the methodology would be lost if the cycle is not repeated at least once. For in implementing changes, the situation again changes and at best, the problem-solvers will have achieved an improvement and not a permanent solution.

In repeating the cycle, the learning process will be maximised, as the problem-solvers will discover what the effects of the proposed changes were. In this manner insight is gained into the dynamics that govern the situation. The aim is thus to continue with the cycle and thus enable problem-solvers to pre-empt potential 'dynamic problems'. This is especially feasible in that as the methodology is used more and more often, the application becomes easier and users will find that they only extract the help of certain stages, which are relevant and do not have to continuously proceed through the entire cycle.

## C.2.2 The Stream of Cultural Inquiry

From figure C.3 depicting the SSM process, it is evident that the methodology consists of two interacting streams of inquiry that run concurrently. Whilst the stream of logic-based inquiry dealt with in the previous section forms the backbone of the methodology, Checkland and Scholes (1990) have identified a need to explicitly consider the cultural aspects of a situation by means of a 'stream of cultural inquiry'. The situation as a culture is endemic to human dynamics and is possibly the most difficult 'soft' area to deal with. Whereas personal experience and *Weltanschauung* clearly shape the individuals perception of any given problem situation, the cultural aspects specifically *within* a situation, like within a company for example, form powerful underlying influences which easily escape open analysis – even within the SSM application.

For this reason Checkland and Scholes (1990) identify three major additional areas of inquiry under a 'stream of cultural inquiry' – an *analysis of the intervention*, a *social system* analysis and a *political system* analysis. Undertaking these analyses explicitly, enriches the cultural appreciation of the situation and complements the logic-based stream of inquiry helping to identify 'relevant systems' which are more relevant to the actual situation.

### i) *Analysis One - Analysis of the Intervention*

Analysis of the intervention looks at various clients, problem owners and problem-solvers of the situation. This role analysis is very productive, as multiple perspectives are easily generated

especially through the list of possible problem owners. Further, as noted by Checkland and Scholes (1990, p48) making the 'problem solver' one of the 'problem owners' leads to the consideration of 'a system to do the study' as a relevant system. A conceptual model built on these premises leads to the structured set of activities which the problem solver(s) hopes to turn into real-world action by doing the study. The analysis of the intervention was of particular relevance in this thesis, as in fact it turned out that the application of a SSM was blocked by the Management of *C&L inc. Forlezer*.

### ii) Analysis Two - 'Social System' Analysis

This analysis is based on the assumption that a 'social system' is a continually changing interaction between the three elements: roles, norms and values (Checkland and Scholes, 1990). 'Each continually defines, redefines and is itself defined by the other two' (Checkland and Scholes, 1990, p49), as illustrated in figure C.5 below.

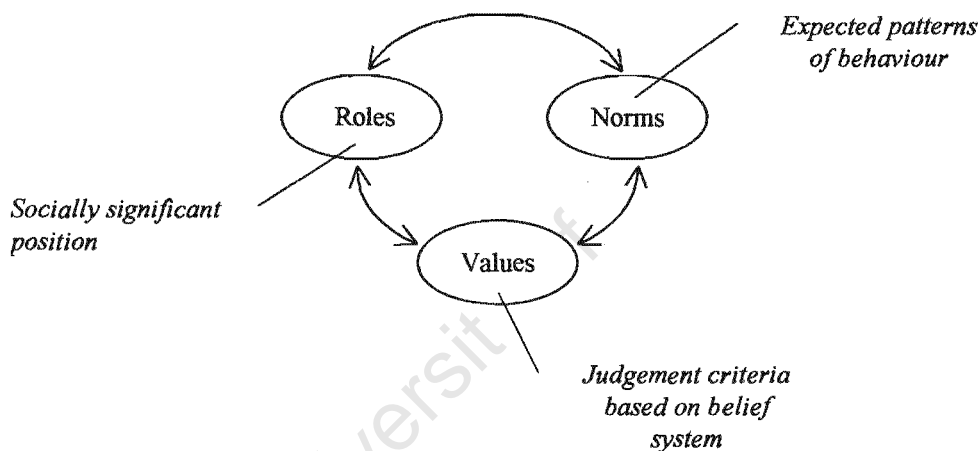


Figure C.5 The Three Elements of the Social Systems Analysis

A *role* is construed to be a position socially recognised as significant by people in the problem situation. This position may be institutionally or behaviourally defined and is characterised by certain *norms* i.e. expected patterns of behaviour. In turn, the actual performance exhibited by a person commanding a role, will be judged according to standards, or *values*. These values deal with morals and ethics and are based on beliefs about what is humanly 'good' or 'bad', 'fair' or 'unfair', 'acceptable' or 'unacceptable' etc. According to Checkland and Scholes (1990, p49) the model has been found to be widely applicable and very useful as long as it is accepted that the account of the 'social system' it leads to is never either complete or static.

In performing an analysis of the social system in a given problem situation, the analyst also needs to be aware that its nature will not easily be expressed. Uncovering the dynamics of a social system will involve a large amount of 'reading between the lines' as it is not a property simply revealed in response to direct questions. As per Checkland and Scholes (1990, p49) 'direct questions will probably receive as responses the official myths of the situation'. It is thus up to the analyst to infer from his/her observations and experiences with regards to roles, norms and values.

This may appear to be entirely dependent on the subjectivity of the analyst - however, at least in dealing with this aspect it can be discovered that there are underlying problems generated by the social system present, whether the initial prognosis of the analyst is accurate or not. For in having discover a symptom, the analyst can refine and revisit until the true or approximate cause is revealed.

### *iii) Analysis Three - 'Political System' Analysis*

The final important influence that the cultural stream of analysis deals with is power. This intrinsic human characteristic expresses itself in the form of a political dimension within any organisation. Politics concerns the process of accommodation of differing interests. Checkland and Scholes (1990, p50) state,

'the accommodations which are generated, modified or dissolved by politics will ultimately rest on dispositions of power. So politics is taken to be a power-related activity concerned with managing relations between different interests. As such it is endemic to human affairs, and there will be few purposeful acts which do not have a political dimension.'

In this regard, it is important that the analyst considers how power is expressed - what mechanisms are used, how it is dispersed and preserved, how it is used or abused. Power is an extremely sensitive subject and not easily questioned within the parameters or influence of its holders. Political issues are not usually faced overtly in human dialogue and there is a natural reluctance to openly express opinion on power related topics. This lack of openness results in political issues retreating to an implied level thus making it difficult to analyse (Checkland and Scholes, 1990, p51).

Needless to say, the analyst has to exhibit a level of tact that will prevent politics inhibiting the inquiry process. Due to the very nature of power, any potential political problem needs to be approached subtly, without 'rocking the boat'. Nevertheless, understanding the politics governing a particular situation is central to gaining cultural understanding. This also assists in successfully implementing any changes that may require power manipulation.

Taking into consideration the three analyses of the cultural stream of inquiry, contributes largely to the understanding of the human dynamics governing a situation. In conjunction with the logic-based stream of inquiry this assists in selecting, naming and modelling relevant human activity systems.

Further, consideration of both streams results in changes that are 'systemically desirable' and 'culturally feasible'. Systemic desirability is achieved through the application of systems concepts throughout the methodology, in particular through the logic-based stream of inquiry. Cultural feasibility is achieved only if the changes are perceived as meaningful within the *Weltanschauung* of the particular culture. In turn this *Weltanschauung* is only accessible through the consideration of its social and political dynamics, and how an intervention affects these.

# APPENDIX D

## The Viable Systems Model

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### D.1 Modelling the Organisation

The aim of this chapter is to provide the theoretical basis for tackling problems of organisational design and behaviour. The methodology used to do this is the Viable Systems Model (VSM) as developed by Stafford Beer (1985) as well as the application thereof, the Viable Systems Diagnosis (VSD) (Flood and Jackson, 1991). The model is derived from cybernetic principles that are critical to the understanding of its dynamic nature, and for this reason the fundamental building blocks of cybernetics will be briefly discussed. When considering a conceptual model for understanding and improving the operation of organisations, the model should fulfil the following criteria (Jackson, 1990):

- Be applicable to a wide range of organisations, large and small.
- Deal with 'multi-organisations' which have relatively independent parts.
- Understand the interdependence or dynamics of these parts.
- Provide a basis for the design of information systems.
- Represent the system in dynamic interrelationship with its environment.
- Provide explanations for organisational success or failure.
- In the event of poor performance, highlight and facilitate the action to be undertaken.

In the following sections the cybernetic VSM will be put forward as capable of meeting these demands and therefore as appropriate for use by inquirers/managers. Before commencing however, a brief look will be taken at other models in organisational theory, and their inadequacy discussed.

### D.2 Models in Organisational Theory

Jackson (1990, p2) presents four models of importance in the development of organisational theory, namely the traditional or rational model, the human relations model, the systems model and the cybernetic model. The aim however is not to present and discuss all these models, but rather to justify why the cybernetic model is more advanced in comparison to the other models. In support,

some of the shortcomings of the traditional, human relations and systems models will briefly be discussed as presented by Jackson (1990).

### **D.2.1 The Traditional/Rational Model**

This model views the organisation as a 'machine'. The machine in turn is made up of individual parts having their own identity and in dealing with problematic areas, the 'machine' can be taken apart and its parts dealt with in isolation. The model is the foundation of the mechanistic mental model discussed in Section A.2 (Appendix A). The model is inadequate because:

- As a 'machine' model it neglects the interdependence of the sub-systems of organisations, which cannot be viewed as operating independently but have to be understood in conjunction with their interaction with each other in forming a complete system.
- It only takes the perspective of the owners of the organisation as the basis for studying its behaviour and neglects the perspective of other groups in the organisation pursuing different objectives based on their rationalities. The social needs of individuals working in organisations and how these affect the goals pursued are also not considered.
- The environmental constraints imposed on the goal sought and the way in which it is sought, are neglected.
- It misrepresents the nature of human decision making by overemphasising the rational pursuit of goals and ignoring the emotional considerations that influence decision-making.
- It does not provide a suitable guide for solving organisational problems and improving its effectiveness.

### **D.2.2 The Human Relations Model**

With the realisation and liberation of the affect of human emotions and personal thought processes, human dynamics were taken to be the most important factor constituting organisations. Organisations were viewed as social systems with social and moral obligations. Again this model contains fundamental deficiencies as follows:

- The idea that human beings have fundamental social or self-actualising needs that must be satisfied at work has been questioned - perhaps human needs are variable and circumstantial and many of them can be satisfied outside work.
- Whilst the importance of meeting individual human needs cannot be denied, the organisation may face several other needs - imposed by the goal it is seeking, the technology available, the

environment it operates in etc. These needs may at times be far more important to sustaining the organisation's viability than meeting the human needs.

- The model does not allow for a satisfactory organisational analysis; the design of information and control systems and the structuring of the complex tasks that organisations must perform, as well as the interaction with the environment are insufficiently dealt with.

### **D.2.3 The Systems Model**

As pointed out by Jackson (1990, p4) the systems model undoubtedly allows many of the important characteristics of organisations to be recognised and examined. However, it is also misleading in a number of respects:

- The systems model considers survival rather than goal attainment as the justification for existence of organisations - a view which may neglect the considerable amount of purposeful, goal-oriented activity forming part of modern organisations.
- It suggests difficulty in measuring the performance of an organisation in attaining its goal.
- There is a tendency to overemphasise the interdependencies of parts and the functional relationship of the parts to the whole - practically there will be degrees of interdependence which need to be explored and some units of a system may develop relative functional autonomy.
- There is little attempt to explain change except as an adaptive mechanism, which again discounts the rational planning activities undertaken by organisations. This also implies that the true centres of command and control in organisations are poorly or incorrectly located.
- Although the model suggests that managers of failing enterprises should ensure that all the 'needs' of the enterprise are being fulfilled, at an organisational level these 'needs' are not readily identified.

### **D.2.4 The Cybernetic Model**

In view of the deficiencies highlighted in the above sections, a superior model is therefore required to guide managers in improving the efficiency and effectiveness of their organisations. The cybernetic model, the VSM as developed by Stafford Beer purports to be such a model (Jackson 1990). To commence with, the model has an inherent high level of generality. The recommendations endorsed in the model do not cast a particular structure in stone, but rather relate to the essentials of a system's organisation. As a result, the cybernetic model has been found to be applicable across a broad spectrum, ranging from the small firm to the large corporate body.

Also, the model is able to deal with organisational parts that are both horizontally and vertically interdependent. The horizontal interrelationship and dependence of the various parts on any particular level are modelled by an organisational 'meta-system', which contains and integrates all essential aspects needed in a successful organisation. This horizontal interrelationship allows the model to cope with the traditional problem of centralisation or decentralisation. The vertical link in turn is dealt with by the notion of recursion (Clemson, 1984, p112 – 116), in that the model is applicable at multiple systems levels. Because the same model - the VSM - is applicable at different systems levels it acts as a great variety reducer thereby enhancing managerial understanding.

The cybernetic model demands that attention be paid to the sources of command and control in the system. These are spread throughout the architecture of the VSM, which grants a high level of autonomy to the system parts and allows the self-organising properties of all systems to be used to their full advantage. Overall systems cohesiveness is achieved via co-ordination and control functions, which in turn also limit the before mentioned autonomy. A development function collects relevant environmental information and depending on potential opportunities or threats, suggests necessary changes to systems purpose and structure. Finally there is also a higher, policy function which takes overall responsibility for the system and balances internal and external needs.

Further the model succeeds in presenting the organisation as being in sync with its environment, both influencing and being influenced by it. It thus strikes a careful balance between emphasising goal seeking and surviving. But perhaps most importantly, the model provides a very effective diagnostic tool for organisational problem identification and for making recommendations for improving the overall performance of the organisation.

### D.3 The Cybernetics of the VSM

Norbert Wiener<sup>1</sup> defined cybernetics as 'the science of effective communication and control in man and the machine'. Stafford Beer defined it more clearly as 'the science of effective organisation'. Clemson (1984), in his introduction suggests 'it introduces a framework for thinking about organisations and management, i.e. it provides a set of natural laws, theorems, and principles which specify the limits for organisations in much the same way as physics describes the limits for bridge building.' Cybernetics thus studies the difference between effective and ineffective structures or modes of organisation in certain classes of systems. These systems have the following characteristics (Clemson, 1984, p19):

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<sup>1</sup> Norbert Wiener is generally accorded the title of the father of cybernetics, taken from *Cybernetics: Or Control and Communication in the Animal and the Machine*, (Wiley, New York, 1948)

- *Complex* - in that they contain more relevant detail than the given observer can possibly cope with.
- *Dynamic* - in that they continuously change in their behaviour or structure or both.
- *Probabilistic* - in that they contain vital elements whose behaviour is at least partially random and therefore exhibit variability.
- *Integral* - in that they act in some important sense as a unity.
- *Open* - in that they are embedded in an environment, which directly affects them and which, they affect.

Cybernetics itself is concerned with the general behaviour, patterns, principles and laws that govern the systems which have been described above. In particular, management cybernetics is the applied science that uses these laws and principles as an underlying body of knowledge for dealing with organisational studies.

### D.3.1 The Cybernetic Laws and Principles

Two fundamental insights of cybernetics are *circular causality* and *holistic properties* (Clemson, 1984). Traditionally science has viewed the notion of cause and effect as being a linear process with A causing B, B causing C etc. Circular causality identifies the circular nature of cause and effect, with A causing B, which in turn affects A again, which influences B etc. thereby resulting in a vicious circle. With this realisation of the importance of circular processes which in effect constitute feedback, came the awareness that the relationship and interaction between the elements might well be more important than the nature of the elements themselves (Clemson, 1984, p22).

The second fundamental insight that cybernetics had, is that there are many systems exhibiting 'holistic' properties (Clemson, 1984, p24)- in other words exhibiting properties of the system as a whole uniquely different to those properties exhibited by its parts (Ackoff, 1994). A more detailed discussion of this concept is undertaken in Section A.1(Appendix A). Stemming from these insights, cybernetics identifies three basic laws of nature to which all complex, dynamic, probabilistic, integral and open system are subjected. These laws are:

**Law 1: SELF-ORGANISATION SYSTEMS LAW** – *Complex systems organise themselves. The characteristic structural and behavioural patterns in a complex system are primarily a result of the interactions among the system parts (Clemson, 1984, p26).*

In other words, the system is the way it is because of the mutual adjustments the parts have made

in the process of interacting with each other. Complex systems have basins of stability separated by thresholds of instability. This means that some configurations of a system are stable and some are not. When changed some systems will return to their original state or alternatively change to another state of equilibrium, however, regardless of the change, the system will always seek a stable environment.

*Law 2: FEEDBACK – The output of a complex system is dominated by the feedback and, within wide limits, the input is irrelevant (Clemson, 1984, p28).*

For a system to function properly it requires circular causality, meaning feedback is provided to all parts of a system and cause and effect is accepted for all parts of the system. Feedback in this sense is not a one sided feedback provided by a superior to a junior. This feedback is a continuous loop that brings about change or a desired situation. Positive feedback is a reinforcing loop that will bring about exploding change, where negative feedback is a balancing loop that brings about goal orientated change. All outputs that are important to the system will have associated feedback loops. This means that any system that does not have the necessary feedback mechanism will be defective and will not achieve the desired effect.

*Law 3: THE LAW OF REQUISITE VARIETY – Given a system and some regulator of that system, the amount of regulation attainable is absolutely limited by the variety of the regulator (Clemson, 1984, p36)*

The law implies that the complexity of a system to be regulated can only be successfully managed by a regulator able to handle the complexity. A receiver capable of receiving two signals cannot be used in system where it has to receive three signals. The variety of the system is defined as the number of possible different states of that system. The law of requisite variety says that the degree to which a system can be regulated is always and absolutely limited by the variety of the regulator. Most of the regulation of very complex systems is achieved through the interaction of the parts (i.e. one part acts to regulate some other part). This law goes back to the self-organising law in that parts interact and regulate themselves via feedback loops.

### **D.3.2 The Cybernetic Building Blocks for the VSM**

In the previous section, the fundamental laws and principles of cybernetics were discussed from which the basic building blocks that construct the cybernetic model, the VSM, are derived. The starting point for the cybernetic model is the input-transformation-output layout as derived from

systems theory (see Appendix A). This layout is used to describe the basic operational activities of an organisation. Within an organisation there are a number of different operational activities, which are linked together by various material and informational flows and which exhibit varying degrees of interdependence. These are constructed and related by the cybernetic building blocks, which include the black box technique, feed back and variety engineering, as discussed by Clemson (1984) and Jackson (1990).

*i) The Black Box Concept*

The black box concept allows the user of the model to deal with the extreme complexity, dynamics and probabilistic nature of organisational systems (Jackson, 1990, p13). Exceedingly complex systems, according to Beer, are those which are so complicated that they cannot be described in any precise and detailed fashion and thus cannot be easily analysed to determine what processes are responsible for the system's behaviour. These systems are classed as black boxes as their operation is non-transparent. According to Ashby (1964) they cannot be analysed by means of a reductionist approach, as individual parts will never enable 'whole' interactions to be understood.

Instead, the 'black box technique' of input manipulation and output classification should be adopted. Managers of complex organisations cannot proceed by analysis to understand all the possible combinations of the parts of the systems under their control. Their approach should be one of manipulating the inputs and observing the outputs in order to find regularities that make the system/part more predictable (Jackson, 1990, p 14 – 15).

*ii) Feedback*

Exceedingly complex probabilistic systems have to be controlled through self-regulation. This can only be achieved through continuous feedback, or circular causality, an understanding of which is vital for two reasons (Clemson, 1984).

Firstly, the existence of mechanisms bringing about self-regulation are what provide an organisation with stability in its environment. It is useful for managers to be aware and understand how this stability comes about and how it may be threatened, especially by the actions of the organisation itself (Jackson, 1990, p17).

Secondly, in understanding the circular causality in the organisation, managers will be able to harness it and thereby induce more stability into it. This stability is necessary, as organisations face sufficient challenges from changing environments which continuously threaten to destabilise them. It is also desirable because managers lack the requisite variety to make all needed decisions (Jackson, 1990, p17).

An effective way to ensure self-regulation is by means of negative feedback. During negative feedback the output of the system is monitored by a sensor, which feeds the current state information to a comparator, which in turn compares it to a desired goal. Depending on the deviation between the actual and desired situation, an actuator then re-adjusts the system input to produce the desired output.

In designing feedback control systems, it is important that managers ensure that there is rapid and continuous comparison of the actual performance against the desired performance, as well as rapid implementation of corrective action by the actuator. Further, for effective control systems, all elements of the system must be functioning properly and there must be adequate communication channels between them to ensure their interaction. From an organisational perspective it is also necessary that the organisational structure is clear to all elements so that responsibility can be allocated (Jackson, 1990, p18 – 20).

### iii) *Variety engineering*

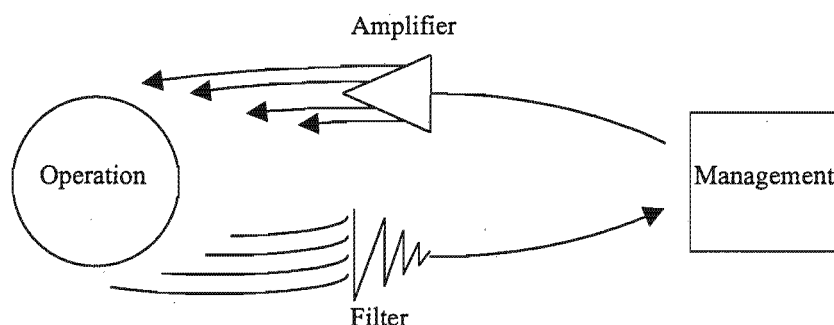
According to the law of requisite variety, the degree to which a system can be regulated is always and absolutely limited by the variety of its regulator (Clemson, 1984, p36). This implies that in order to effectively and efficiently deal with organisational situations, the manager must learn to cope with this complexity - i.e. if managers are going to control their organisations and make them responsive to environmental fluctuations, they must command as much variety as these systems themselves exhibit (Jackson, 1990, p21).

Due to the fact that organisational systems are probabilistic and complex, it is however impossible for management to consider all data, process it to information and make effective and accurate decisions. Besides the regular information flows that managers are meant to monitor and control, they are continuously faced with unexpected occurrences to which they must respond appropriately.

The way to deal with this problem is either to reduce the variety of the system or to increase the managerial variety perception. This process is known as variety engineering and is achieved by variety reducers or filters, and variety amplifiers (Clemson, 1984, p128 *et al*). Consider the interaction between management as depicted by a square in figure D.1 and the operation as presented by the circle. In a well designed information system there must be a set of explicitly designed filters to extract meaningful information from the massive variety of the operation.

Similarly, the management has a relatively small capability to send information back to the operation, so some sort of amplifier is required. A foreman is a good example of both a filter as well as an amplifier. In the event of producing a production report, he is acting as a filter (in conjunction with the setup of the report that is), as the report will contain only relevant information

required by the manager. In turn, the manager will brief the foreman on any decisions taken, and will 'amplify' this decision down to the shop floor via the foreman.



**Figure D.1** The Concept of Variety Engineering

Clearly the design of these filters and amplifiers is paramount, for if the filter is suppressing crucial information, and likewise if the amplifier is amplifying the incorrect information, the consequences can be catastrophic.

#### **D.4 The Viable Systems Model (VSM)**

Having elaborated the cybernetic building blocks from which the model is constructed, the VSM is presented. The twentieth century with its new degrees of complexity, rate of change and interdependency of social systems requires an increased amount of learning on the part of individuals and organisations. Organisations have to be able to learn and adapt rapidly in order to meet the needs of their clients on a continuous basis. In order to remain viable a system has to achieve requisite variety within the complex environment it is faced with. Beer (1984), as discussed by Jackson (1990), sets out a number of strategies that can be used by managers to achieve this.

The first set of strategies - *structural, planning and operational* - are aimed at reducing the variety of the external environment (Jackson, 1990, p30). Managers using the structural strategy utilise tactics such as divisionalisation and delegation, whereby the organisation's goals are broken down into sub-goals, which are allocated to sub-systems for achievement. The planning techniques set priorities that clearly determine which parts of the environment the organisation needs to give attention to. The operational technique is designed to ensure that only vital information filters through to top management levels, which it does by using such techniques as management by exception.

managerial expertise and knowledge is optimised through methods such as integrated team-work. Augmentation involves the recruitment of additional managers or consultants to enrich the managerial expertise that already exists, whilst informational methods aim to provide the best possible flow of useful information.

Beers purpose in prescribing the variety engineering strategies are twofold. Firstly, the organisation should have the best possible model of the environment relevant to its purposes. And secondly, the organisation's structure and information flows should reflect the nature of the specific environment so that the organisation is responsive to it. Having made these comments about the variety engineering process, the VSM is discussed.

Essentially the VSM is an interaction of subsystems that models the web of regulatory mechanisms that an organisation requires to cope with the complexity of real-world tasks. It is a conceptual model of the organisation's management information system and is a tool with which to assess the implications of alternative policies (Espejo and Harnden, eds. 1989). As per Espejo and Harnden a viable organisation must always be able to:

- Make all normal decisions simply and effectively (inner stability).
- Adapt itself to changes in the demands made by the world around it. This world consists mainly of customers, employees, suppliers, competitors and owners.
- Learn from experience.

Channels of communication should exist which allow the outside world to influence the organisation. An organisation cannot remain viable if it lacks the means to change and adapt. It becomes out-of-date, and eventually vanishes (Espejo and Harnden, eds. 1989, p282-283).

#### **D.4.1 The Five Systems of the VSM**

The complete VSM is depicted in figure D.2. Five different systems or management functions can be identified as being essential to a viable organisation, which have been integrated into the model:

1. Implementation/operation - (System 1)
2. Co-ordination - (System 2)
3. Control - (System 3)
4. Intelligence - (System 4)
5. Policy - (System 5)

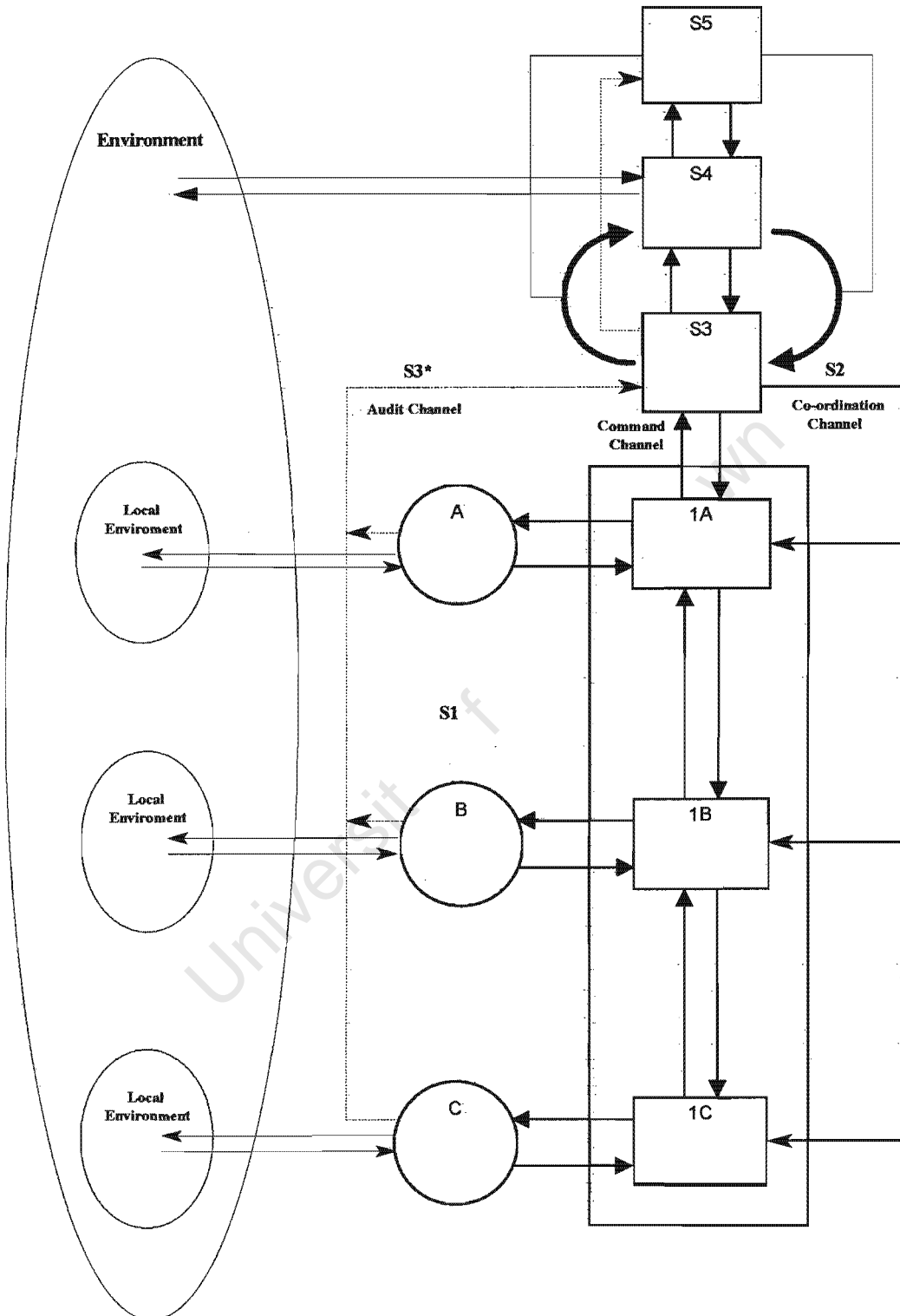


Figure D.2 The Viable Systems Model

*i) System 1 – The Operations Function (S1)*

System 1 (S1) of an organisation consists of the various parts directly concerned with implementation. It concerns itself with the management of interactions amongst the operating elements which are carrying out what the organisation is supposed to be doing. When modelling the S1 function, it is typically split into the various subsidiaries that could present divisions, or functions achieving a specific goal, as depicted in figure D.2 by A, B, and C. It should be noted that each part has its own relation to the external environment and has its own localised management (1A, 1B, 1C) embedded in the larger management system. Management within system 1 is charged with ensuring that the elements that provide the operating capacity, work well together. They also establish what can be produced, taking into consideration methods, materials, manpower, machinery and money, as well as communication aspects.

Each part of S1 is connected to the larger management system via vertical communication lines or command channels. Instructions for the parts arrive down these channels from higher system levels. The localised management, say 1C, receives a set of instructions specifying what its operational element, C, should do (effector). The actual processes in C are then monitored by a sensor and fed back to 1C. By comparison of the actual to the planned performance, 1C can adjust the behaviour of C accordingly. In this manner, feedback enables self-regulation within the subsidiary C. The localised management 1C is then able to transmit this information about C's performance to higher levels along the upward communication channel. This constitutes variety reduction and amplification between higher management and localised management.

To ensure effective variety reduction and amplification, each of the parts constituting S1 should be autonomous in their own right, so that they can absorb the massive environmental variety and complexity that would otherwise flood higher management levels. In order to make the parts of S1 autonomous, they must each be viable systems, reflecting the VSM structure. It is this concept of recursion that allows the individual systems to make adequate decisions about the external world and what information needs to be filtered through to management.

The autonomy of the parts is regulated by the higher systems. Each part of S1 must accept a degree of control and co-ordination from system 2 and 3 for the good of the organisation as a whole. In summary System 1 therefore:

- Has parts directly concerned with implementation.
- Has parts that are autonomous in their own right.
- By recursion the parts contain features of a viable system themselves.
- Absorbs much of the environmental variety.

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- By recursion the parts contain features of a viable system themselves.
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## *ii) System 2 – The Co-ordination Function (S2)*

The co-ordination of the operations subsidiaries is handled by the S2 function. Co-ordination is an important function as it guides the day to day activities of the operations function. For effective co-ordination, clear lines of communication should be set by clearly defining the operations structure and establishing lines of responsibility. The flow of information is of vital importance to the whole organisation since decision making is dependent on it as it informs management of current situations and enables management to react to arising issues.

Under normal circumstances compatible instructions from higher management result in interaction between the parts that is not destructive to the organisation as a whole. In these circumstances the S2 function ensures that the various parts of S1 act in harmony in order to optimise the overall organisational goal. Under more extreme circumstances however, the autonomous parts will act to further their own interests. The autonomous parts will have only local information to act on and their interaction with other parts may lead to dangerous and unpredictable effects for the organisation as a whole. In this capacity, S2 is the anti-oscillating mechanism of the organisation, ensuring that the action by one element (e.g. front-line staff) does not have the opposite effect to what was intended on another element (e.g. support staff). System 2 prescribes and regulates in its co-ordinating role in order to avoid oscillations, but it does not have the right to dictate what has to be done.

The S2 function consists of localised control centres forming part of the operations function linked to a corporate regulatory centre. The corporate regulatory centre receives information about the actions of the various subsidiaries and, via information supplied by the control function (S3), prevents dangerous oscillations by regulating these interactions.

Suppose the subsidiaries A, B and C in figure D.2 are directly dependent on each other to produce the overall output of S1. In the event of B experiencing a problem, this would directly influence system A and C. Due to these systems being autonomous they might continue with their regular operations regardless of the problem that system B is experiencing. In turn this could result in an overall detriment to the organisation. For example - A continues producing a subassembly even though B cannot process it - the result being an accumulation of inventory that is unnecessarily tying up organisational capital. It is S2's job to oversee these interactions and to stabilise the situation so as to obtain a balanced response from S1. It thus sends feedback to the localised management of S1 informing them of B's problem and re-establishes harmony.

management of the three operations units. The co-ordination capability of S2 is facilitated by the S2 operations management wide view that includes all the three operational units. System 2 thus:

- Co-ordinates the part that constitute the operations function in a harmonious manner.
- Provides the life-line for information flows.
- Dampens dangerous oscillations.

### *iii) System 3 – The Control Function (S3)*

System 3 has the overall responsibility of managing the day to day activities of the organisation. In this capacity it is the organisational control function which is charged with ensuring that the organisational policies and procedures, stipulated by the organisations policy makers S5, are implemented and carried out correctly. It is therefore responsible for passing a co-ordinated action plan down to S1 (via S2) and distributing/allocating organisational resources to the parts of S1 to achieve this. It has to monitor and control, over time, the performance of S1 and its parts, taking corresponding action in accordance with the information it receives via its own auditing channel S3\* and up the information channel from S2. The control steps involve collecting and interpreting data, monitoring performance, comparing it to the desired goals and taking corrective action where necessary.

Through the S3\* auditing channel, which is a control feedback channel, S3 can get immediate information rather than relying on the information supplied by the localised management functions (1A, 1B, 1C). This direct access to the situation is how the control is achieved as it monitors through these channels whether the S1 parts are doing what they are supposed to be doing.

Whilst reacting to this internal information and creating stability within the system, the control function also receives information from S4, which is an external information channel. As will be discussed in the next section, S4 are the organisation's external 'eyes' communicating to the control function what is happening in the environment and therefore, what S3 has to do to ensure that the organisation remains viable.

Only system 3, provided with information from system 4, can know how essential any division or part is to the overall system, and thus based thereon make decision affecting its viability. The control system also observes the effects of the implemented policy on the activities of the operations system. This is compared in the context of set objectives – for example market demands and resource utilisation. If objectives are not met due to policy deficiencies, the effect is feed back to S5 where the changes that need to be made are determined. The changes are then again communicated to S3 who affects implementation to bring about the required result. Thus not only is there a downward control

with regards to S1, but also an upward control with regards to S5. The control function is therefore concerned with the dynamic equilibrium of the entire organisation.

The control system (S3) carries out its function through the following channels - a) resource bargaining channels, b) reporting channels and c) policy and legal constraints:

- a) *Resource Bargaining Channels* - Sets definitive roles, responsibilities and accountabilities. It should ensure that the S1 parts have the capacity ( required skills to meet tasks and if not what training is required),ability (the proper equipment and operational environment) and are enabled (the authority and responsibility to do what is required to complete the tasks).
- b) *Report Channels* - This is the setting up of performance measurement criteria, as well as systems and feedback channels to constantly monitor inputs and outputs. It ensures effectiveness and efficiency. Doing the right thing and doing it right.
- c) *Policy and Constraint Channel*. - This is the setting of rules and procedures for doing the tasks. The procedure and constraints will be directly based upon the policies of operations so as to gain standardisation to reduce the requisite variety.

In summary, System 3:

- Is a control function trying to maintain internal stability.
- Interprets and implements policy decisions of higher management.
- Allocates resources to the system parts of S1.
- Communicates relevant filtered information to higher management.

#### iv) *System 4 – The Intelligence Function (S4)*

System 4 concerns itself with the overall health (viability) of the organisation relative to its environment. It is the intelligence gathering function of the enterprise and has as its prime purpose an external and futuristic focus, whilst ensuring that all information gathered is constantly fed back to the control function S3. Whereas S3 is concerned with the internal here and now, S4 adapts the organisation to external threats and changes. If the organisation is to remain viable and effective in the future it somehow has to match the complexity and variety of the environment in which it finds itself. To do this, it needs to model the environment so that predictions of the likely future state of the environment can be made, and allow the organisation to respond in time.

In order to achieve this response, intelligence formulates a model of the operations function, (i.e. its measures of input and output - what it does and how it does it), assesses its overall health,

explores its synergistic relationships (and impact on other parts of the organisation) and evaluates future alternatives based on the current state of, and current choices exercised by, the operations function relative to its changing environment. In this capacity it acts as a development function. Alternatives are always oriented towards growth and change, toward dealing with new threats and capitalising on new opportunities and towards being more efficient and more effective. To do this it has command of the remaining resources which are left over after the needs of the productive system have been met by S3 and in this regard is naturally in competition with S3 for the resources. Unlike S3, which represents 'operations in being' S4 represents 'operations in becoming'.

Furthermore, S4 forms the link between the 'thinking chamber' of the organisation S5 and the rest of the system, relaying information upwards and downwards. In its capacity of transmitting information upwards, it is a vital filter in the system, as this is the point where internal and external information is brought together. There could thus be a natural tendency to flood S5 with information, which S4 therefore needs to filter. Due to the fact that S4 is the source of intelligence both externally and internally, it is here that the 'operations room' as suggested by Beer (Clemson 1984, p149) should be situated. This is conceived as a meeting room for managers, task forces and so on, where, due to the available information, there are adequate support systems for effective decision making.

Typically activities such as corporate planning, market research, operational research, research & development and public relations are located in this function. System 4, thus:

- Is a development function.
- Takes an intelligence gathering and processing role that captures information about a system and its environment and maintains overall homeostatic stability.
- Models the organisation and its environment.
- Distributes environmental information upwards or downwards depending on its importance.
- Brings together internal and external information providing a proper environment for decision making.
- Rapidly conveys all important information about the internal viability to S5.

#### v) System 5 – The Policy Function (S5)

System 5 represents the identity function of the system and is concerned with defining and clarifying the basic purpose of the enterprise. It is the 'brain' of the organisation - the thinking part guiding the whole direction of the enterprise, concerned with formulating policies based on the information supplied to it by S4 that will ensure that the system as a whole will remain viable and achieve its goals. These policies are then communicated downward to S3 for implementation and monitoring.

System 5 guides the decision making processes throughout the organisation by creating boundaries, thereby reducing requisite variety and improving decision making by guiding managers to only take cognisance of the variables within the constraints of policy.

A critical task of S5 is the balancing of Systems 3 and 4, which have conflicting interests. Inherently S3 will oppose change, whilst S4 will demand it, and therefore System 5 must ensure that the organisation adapts to the external environment while maintaining a degree of internal stability. System 5 must also represent the essential qualities of the whole system to any wider system of which it forms part, acting in this capacity simply as the localised management of a particular part of a new System 1 of a wider system, in accordance with the recursion principle. In conclusion, System 5:

- Represents the organisation.
- Is responsible for formulation of policy.
- Responds to the filtered information sent up through the communication channels.
- Arbitrates between the antagonistic internal and external demands on the organisation as represented by System 3 and System 4.
- Deals with the 'wider' system.

It must be noted, that each of the systems discussed in the above section, do not constitute separate "jobs" that are allocated to any single person or department within the organisation. Rather, each system represents activities that have to be performed across the organisation, summing all jobs that are involved in the activity into a singular system. In other words, the different systems do not describe official positions or persons. The information function will for example encompass research and development, marketing and customer services, information systems etc. The control function on the other hand may comprise work activities associated with finances, personnel management, operations, planning, management information, information systems, and quality.

The VSM focuses on the organisation of vital activities rather than on how to structure the organisation or how to define jobs. Flood and Jackson (1991, p89) provide the explanation, that in applying the VSM, organisations ideally are ordered so as to achieve efficient and effective realisation of their set goals. Nevertheless these goals themselves have to be continually revised in response to the rapidly changing environment of the twentieth century through self-questioning, learning and predicting future scenarios.

Due to the importance of the sources of command and control which are spread throughout the architecture of the VSM, it 'enhances self-organisation and localised management of problems' (Flood and Jackson, 1991, p90). Important to the model are appropriate information flows and

communication links, which provide information about how the different parts of the organisation and the organisation as a whole are performing in relation to their goals. Emphasis is placed on the viable system in its environment and on the influences of it on its environment, and vice versa, in order to maximise the learning process and facilitate the organisation.

#### D.4.2 Performance Indices

Traditionally the measure of achievement in organisations has been in monetary terms - the criterion being profit maximisation and cost minimisation. This according to Beer (Jackson 1990, p40) is however no longer a sufficient measure of performance as it fails to take into consideration how well the organisation is doing in terms of future developments, like investments in research and development, or in terms of more abstract resources like employee moral. Instead, three levels of achievement are suggested, which are combined to give three performance indices used 'as comprehensive measures of performance in relation to all types of resource throughout the organisation' (Flood and Jackson 1991, p93). The three levels of achievement are:

- *Actuality* - the current actual achievement using existing resources and being limited by existing constraints.
- *Capability* - the current maximum achievement that would be possible given the existing resources and being limited by existing constraints.
- *Potentiality* - the potential achievement that could be reached by developing the resources and removing the constraints, taking into consideration what is already known to be feasible.

Which are combined to create three performance indices:

- *Productivity* - the ratio of actuality and capability.
- *Latency* - the ratio of capability and potentiality.
- *Performance* - the ratio of actuality and potentiality; the product of ;latency and productivity.

The objective in any organisation should be to maximise actuality and minimise latency, thereby increasing productivity and performance. The lower the latency the more room there is for improvement.

## **D.5 The Viable Systems Diagnosis (VSD)**

The VSM provides a framework for thinking about and analysing organisational activities, and through its application the design of an organisation (as a system) can be tested. This application of the VSM is termed viable systems diagnosis, or VSD, and will be briefly looked at. Flood and Jackson (1991, p88) state that ‘the VSM can be used for diagnosing “problems” of organisation, hence the term Viable Systems Diagnosis (VSD)’. By problems they refer to ‘particularly those arising in complex probabilistic “systems” that comprise purposeful organised parts and are open to a changing environment and yet in which there is general or easily attainable agreement about the goals or objectives to be pursued.’ Two stages of the VSD can be identified, the system identification and the system diagnosis.

If a VSD were to be performed of Forlezer, essentially the design of the company as a ‘viable’ system that is adequately equipped to cope with its internal and external environment would be tested, and if required, various structures and processes redesigned to achieve this.

### **D.5.1 System Identification**

The process commences with the identification of the purpose to be pursued or the establishment of an identity relating the purpose. Then taking the purpose as given, the relevant system for achieving the purpose is identified. This forms the ‘system in focus’ and represents the R1 system discussed in Section A.5.1 (Appendix A).

The system in focus is the value adding function and this forms System 1 of the VSM. Next the viable parts of S1 are identified, which correspond with the system parts R0 discussed in Section A.5.1 (Appendix A) as well as specifying the containing whole (R0) of which the system in focus is part.

### **D.5.2 System Diagnosis**

The system diagnosis involves questioning the information flows between parts of the organisation, especially with regards to communication and control. Each part of the system in focus has to be analysed and the relevant support functions in terms of co-ordination, control, intelligence and policy assessed. Each management function of the parts of the system in focus has to be studied and overall deficiencies identified. Flood and Jackson (1991) suggest the following broad guidelines, which suffice to illustrate the concept.

- *System 1 - Operations:*
  - For each part of S1 detail its environment, the operations and localised management.
  - Identify the constraints imposed on the parts by higher management.
  - Determine how accountability is exercised.
  - Determine the performance indices (if any are used?).
  - Model S1 internally using the VSM.
  
- *System 2 - Co-ordination:*
  - Identify possible sources of oscillation or conflict both internal to S1 and external in terms of dealing with the environment/customers.
  - Identify the various S2 elements that have a dampening or harmonising effect.
  - Determine how the co-ordination function is perceived in the organisation, whether as a threat or as facilitating.
  
- *System 3 - Control*
  - Identify the S3 components in the system in focus.
  - Determine how authority is exercised by S3.
  - Determine how resources are allocated with S1 i.e. resource bargaining.
  - Determine who is responsible for the performance of the parts of S1.
  - Identify what 'audit' enquiries are undertaken into the conduct of S1 and how.
  - Determine the autonomy allowed to S1 and its parts.
  - Determine how the control function is perceived (autocratic or democratic) and understand the relationship between S3 and S1.
  
- *System 4 - Intelligence*
  - List all intelligence activities of the system in focus.
  - Ascertain the time framework of these activities, i.e. long-term, medium-term or short-term.
  - Assess whether these activities guarantee adaptation in the future.
  - Determine if S4 is monitoring what is happening to the environment and assessing future trends.
  - Assess whether S4 is open to novelty.
  - Determine whether S4 provides an environment for decision-making by consolidating internal and external information.
  - Does S4 fulfil the function of monitoring and notifying S5 of urgent developments.

- *System 5 - Policy*
  - Determine who determines policy, i.e. who comprises the board and how does it act.
  - Assess whether S5 provides a suitable identity for the system in focus.
  - Determine how the ethos set by S5 affects the perception of S4.
  - Determine how the ethos set by S5 affects the S3 and S4 homeostasis, i.e. does one of the two receive preference.
  - Assess whether S5 shares the identity provided with S1 or whether it claims to be something different.

In addition to performing these assessments of the five system activities, all information channels, filters, amplifiers and feedback loops - currently existing or required - need to be correctly designed and placed in order to maximise the organisational efficiency and effectivity.

# APPENDIX E

## Applicable Data

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### E.1 Description and Analysis of the System Parts

This section provides a description of the various existing departments at *C&L inc. Forlezer*. The layout itself is depicted in Section E.3 (figure E.3.1).

#### *i) The Finished Extrusion (FE) Store*

The FE Store is the central raw material store in which the aluminium profiles and lengths used in the manufacturing process are stored. This raw material is used mainly to manufacture the rungs, stiles and tops of the various ladders being produced. It arrives in its extruded form as delivered by the supplier in varying lengths of different profiles and is stored vertically in designated compartments.

The store contains five isles with twelve compartments on either side which have not been laid out according to any system and the only identification the compartment slots have, are alphabetic demarcations per isle and numbering per compartment.

The storage of individual extrusion lengths and profiles is ad hoc no arrangement has been made to accommodate the fast movers so that they are the most easily accessible. There is no clear identification of the profile type as used per production line or product and as identified by the bill of material (BOM). The selection of the correct profile for any given product is based on the experience and expertise of the store-men who know from experience where the material is located.

The store also contains several horizontal compartments for the shorter sections used, which are located on the opposite side of the receiving area closest to the FC Store. Several stacks of material are seemingly randomly stored on the floor where space is available indicating that the availability of sufficient upright storage space is a problem.

The layout of the store is far from optimal and the material handling and flow are poor – the reasons being the vertical storing position, as well as the fact that the storing cubicles have not been arranged systematically to place fast moving profiles at the beginning of the isle. Consequently the incoming raw material undergoes a lot of lifting from the horizontal to the vertical position and back, which makes the general handling, especially of the longer pieces, difficult. The vertical storage of the lengths is further inhibited by the fact that the ceiling is zigzagged and crossbeams obstruct random storage of very long extrusion profiles. Also from a material flow perspective the

distance the raw material travels is not the shortest possible which is a direct indication of inefficiency.

The signs of insufficient storage space are verified during peak production periods, as large amounts of raw material are stored in the receiving area, aisle areas as well as on the production floor. According to Management this is a regular occurrence during their seasonal peak production periods in August, September and October, and is due to large orders of up to 4000 ladders of one type being placed. Ideally however Management wish to keep all raw material off the factory floor for stock control purposes.

Furthermore, the visual control on the stock levels is poor and the store-men have to walk down each aisle and inspect the individual cubicles. Taking accurate stock is difficult. Further, as can be seen on the layout, the FE Store is located off centre from the Cutting Department and the overall positioning and layout of the individual production lines in the Production Department does not allow for optimal material flow. The amount of stock kept in the store is sufficient for between four and six weeks standard production and ties up approximately R800,000.00 in capital. In summary the following main problems are clearly evident:

- The main problem in the raw material store concerns the handling and storage of the extrusion profiles. The material is stored vertically in designated compartments that are arranged along five aisles that contain 12 compartments per row.
- There has been no sorting of any sort be it according to product type, production line, length, frequency of use etc. and the profiles are arranged ad hoc.
- The vertical storage causes unnecessary material handling, poor accessibility, poor visibility and inaccurate stock control.
- Individual aisles are alphabetically marked (A, B, C etc.) with each of the 12 compartments being numbered. However this 'identification' does not coincide with the identification of individual profiles generated by the BOM, and thus is essentially useless. Manual lists are available identifying profile codes as generated by the BOM with compartment identification.
- Identification and location of specific profiles is highly dependent on the store men, who know by experience where to locate the needed profiles.
- No consideration has been given as to feeding the raw material onto the production lines with the least amount of effort in terms of storage, material handling and minimal transportation distances. Specifically fast moving profiles have not been stored closest to the stores exit or for easy accessibility.
- Unnecessary material handling is induced due to the vertical storage arrangement. Material is delivered and down loaded onto the floor of the receiving area by *Hulett Aluminium* from where it first has to be sorted, picked up and stored from a horizontal to a vertical position.

Subsequently upon issuing the raw material onto the factory floor, it again moves from a vertical to a horizontal position.

- The general location of the FE Store in respect of material handling is not optimal. Ideally the store should feed the material in one line from storage, to the cutting department onto the production lines, which is not the case.
- The inventory control is poor. Stock-takes are labour intensive and often found not to be accurate, be it because the store men try counting the stock in a vertical position, or because amounts are rather estimated than physically counted.
- Inventory levels are excessively high and a large amount of capital is tied up unnecessarily.

#### *ii) The Finished Component (FC) Store*

The FC Store is situated facing centrally to the factory floor, opposite the production floor and adjacent to the raw material receiving area on its one side, and the Hiring Department on its other. It locates all additional components and accessories that are assembled to the ladders to form the complete product, which includes items such as rubber feet, stoppers, guide brackets, spacers, locks, pulleys, base plates etc. as well as nuts, bolts and rivets used to secure the components.

The store is a fenced-off area containing four isles with components stored in bins varying in size and stacked up three levels high in shelving extending to a mezzanine level forming the ceiling, on top of which the Cape Town Sales Branch stores some of their stock. Again there is little or no order in the location of components in respect of the production line, product or frequency of use however, as the finished components are small and easy to handle, this is deemed by Management to be not so critical.

This again results in the efficiency of the store being dependent on the knowledge of the storeman. The storage of the components in this fashion also causes poor 'visibility'. Generally the bins are checked at regular intervals and as a bin becomes almost empty, new components are ordered or made. The bins are not transparent, so the procedure of monitoring stock (especially on the top shelves) involves moving a "mounty" (which is a ladder on wheels) from shelf to shelf.

The location of the store is optimal for supplying the production lines, however for the FC Store components this is not critical as the components are not bulky or difficult to handle. Also the bulk of the components are needed at the rear of the production lines where most of the assembling is performed.

The main reason for the location of the FC Store where it is, is because the Tool Room manufactures numerous of the components used in-house and thus for handling purposes the two departments are located close to each other. The main problems initially identified are:

- There is a complete lack of control of the issuing and use of components.

- Again the storage system is not optimal. Finished components are stored in bins that are located on three levels in a shelving configuration, with no identification of what specific component is located in a bin. Also the top level is only accessible by ladder.
- The components are stored in an ad hoc manner, without being sorted and allocated per production line, type component or frequency of requirement. Furthermore, the bins are not identified or marked in accordance to the code issued for the component by the BOM.
- The bins are not transparent so the stock levels cannot easily be gauged.
- The poor visibility again results in poor inventory control and a dependence on the store man's knowledge to ensure efficient supply of components.
- The store is centrally located opposite the Production Department and ideally situated to feed material directly onto the production lines. However, the finished components used are small and thus easily transportable (as opposed to the extrusion profiles) and the components are typically used at the end of the production lines where the assembly processes take place.
- The FC store man is also the union shop steward and Management claims that this inhibits the constant operation of the store. As a union representative, he is often required to attend courses and meetings, as well as disciplinary hearings etc. With the store being as 'chaotic' as it is, the absence of the store man induces inefficiency in that components (of which there are hundreds) are not easily found.
- Flow of components to where they are needed most is not efficient or controlled.

### *iii) The Cutting Department*

The department forms part of the production floor and is designated solely for the purpose of cutting the raw extrusion profiles issued from the FE Store to the required lengths needed on the production lines. The area contains two cutters that are manually operated.

Within the Cutting Department there appears to be a high percentage of wastage. Management has no clear idea of the % waste in this department, however the wastage is visible by the remaining lengths of off-cuts being produced during a production run through the department.

The reason for the high wastage is due to the use of standard lengths of raw material for various extrusion profiles commonly used. Regular lengths are ordered and kept in stock as it is impossible to store exact lengths for the entire range of products. A further reason for this action is the fact that minimum order quantities of extrusion profiles need to be taken into consideration. However there seems to be no focused effort to minimise the off-cuts or find alternative solutions. The awareness that this may not be the optimal solution is there, but little is being done to focus on minimising % waste on off-cuts. Waste is often high because workers don't care whether the raw material issued or available is the actual material designated to the product according to the BOM.

Often a shortage of say 6m lengths of any particular extrusion which are to be cut to 5.8m arises and then the next available length will be used (although the 6m length is the designated length to be cut to 5.8m). The problems identified are:

- The main concern is the apparent high percentage of waste in off-cuts. At times, the off-cuts are as long as 30 – 40 cm. There is no indication that Management is aware of the percentage waste generated.
- The location of the department is not ideal as it is situated within the Production Department, as illustrated in Figure E.3.1 (Section E.3). The department only contains two cutters that cut the profiles to the required length before moving them onto the production floor. Ideally the department should be located between the FE Store and production lines.
- There appears no reason why the department cannot be included into the FE Store.

#### *iv) The Tool Room*

The central function of the Tool Room is for in-house component manufacture and the production of non-standard products called 'specials', which often involve alterations or modifications to standard products.

A further essential function of the Tool Room involves the set-up of all machines and the changing of tool bits. The component manufacture involves mainly welding for which there are three stations, two for aluminium welding and one for regular steel welding. Some components also need machining on either a lathe or milling machine.

Further, the Tool Room is responsible for affecting the necessary repairs and maintenance to all plant machinery. For this purpose, the Tool Room has a separate maintenance section, however a preventive maintenance program is not in place. Problem areas include:

- The department spends an excessive amount of its time affecting repairs to broken down machinery. The tool room is often restricted by these continual problems, which inadvertently affect the output of the Manufacturing Division.
- This is mainly due to the outdated and old machinery being used and the fact that a preventive maintenance programme is not in place.
- Besides the dependence on the availability of extrusion profiles for the FE Store, the Production Department is most dependent on the efficiency and effectiveness of the Tool Room. If the technicians for example are busy with major repairs on any particular line, the other lines requiring their expertise for set-ups are slowed down and the overall productivity is affected.
- There appears to be some animosity between the Tool Room technicians and the remaining factory workers. This is potentially due to a difference in income.

- The Tool Room technicians are under a lot of pressure from the line operators to repair broken machinery as quickly as possible. Most mechanical problems inhibit the line operators in achieving their daily targets and potential bonus, which is the cause of much conflict amongst the two departments. This is due to the way Management has structured the factory's incentive scheme.

#### v) *The Production Department*

The Production Department manufactures the 150 odd products offered by the Manufacturing Division and employs 32 line operators in total. Despite the entire range of products offered, certain characteristic features allow the distinction and separation of the products into six typical product types distinguishable from each other that are manufactured on six distinct production lines. Products of a certain type differ mainly in terms of dimensional specifications of length and number of rungs, with very little variance in terms of special additions. The decision to split or combine plant facilities as allocated per production line is also based on such considerations as:

- Size, weight, shape, and physical characteristics of product.
- Basic Material of items.
- Processes, routing, or type of operations as well as equipment available.

The various products are therefore identified according to these six lines which in general also characterise the type of product. Further, four basic product groups can be identified:

1. Round rung ladders
2. Flat rung ladders
3. D-rung ladders
4. Scaffolding

The individual production lines and their groupings and the number of operators per line are listed in table E.1.1 below and a more detailed description of each individual line follows. A product-quantity (P-Q) analysis, plotting the volumes of individual products produced, reveals a typical Pareto split of 80/20, in other words 80% of the manufactured volume is constituted by 20% of the products. As per Muther (1973, p3-2) this implies a 'steep' P-Q chart which optimally constitutes a mass production layout.

LINE	LINE TYPE	PRODUCT GROUP	NO. OF WORKERS
1	ALFLO	3	5
2	LAS-QS	2	5
3	STECALLOY	1	9
4	FIBREGLASS	3	4
5	SPL-FM	2	2
6	UPRIGHT	4	3

**Table E.1** The Six Production Lines

Although a detailed analysis of the individual production lines was not intended as an intricate part of the research undertaken towards the content of the thesis (due to the fact that the thesis is concerned more with organisational issues), the overall layout and work flow of the lines was analysed. The main issues noted for each line follow:

#### *The ALFLO Line*

- The line is the busiest production line, and termed the ‘bread and butter’ line. The main products consist of extension ladders and household step ladders.
- The line has the crimping machine included in its layout, which essentially does not form a direct part of the ALFLO production run. The crimping machine ‘presses’ the ferrules to the ladder rungs and is a machine used for all lines and products. This machine should thus not be located in any particular line.
- The production runs on the ALFLO line require the use of a 60t and a 7t press. The 60t press is unique to the line (i.e. dedicated), however the 7t press is also used for the fibreglass line.
- Also ladders on the ALFLO line are often moved to the SPL/FM line to perform a drilling operation. This move constitutes complete waste in terms of transportation.
- Management believe the throughput on the line can be tripled based on observations made in America. No capacity or utility data is available and the current throughput is used as a MOP.
- This figure is held to be very unrealistic unless the machinery on the line is replaced.
- The assumption of tripling the throughput was based on observations made by the MD in the American *Werner* factory, who operate under totally different dynamics. For one, the production process in America has minimal operator involvement, thus minimising human variability.
- Furthermore the production methods are more advanced in that most processes are mechanised, especially the riveting and crimping. Also the work ethics are different.

*The LAS/QS line*

- The line manufactures all flat rung step ladders, both single and double sided.
- The single sided ladder is produced directly off the line, however the double sided ladder requires the assistance of the Tool Room for the welding of the top hinge connecting the two sides. This implies that the line should be situated close to the Tool Room, however at present the line is the second furthest removed.
- Interference on the line is caused by the location of a section of the Cape Town Sales Branch mezzanine, on which some of their stock is stored.

*The STECALLOY line*

- The line predominantly produces extension ladders.
- The variability on the line is high, as the assembly process involves a large range of finished components that are added to the ladders.
- The line appears to be the slowest, the ladders large and difficult to handle.
- Numerous obsolete and unused pieces of machinery are located on the production line.
- The logical sequencing on this line is particularly inefficient, with unnecessary to-and-fro movement.
- The product orders of the STECALLOY line appear to be declining, which either implies a cost problem, quality problem, obsolescence or incorrect target-market. The reason was not conveyed and thus appears unknown.
- Management are dissatisfied with the performance of some of the line operators who are letting the remaining operators do all the work.

*The FIBREGLASS line*

- The line manufactures heavy duty industrial and step extension ladders.
- The process is labour intensive due to the fact that the rungs are riveted to the fibreglass stiles and involves predominantly assembly operations. Consequently the production output of the line is poor, and thus ladders are expensive.
- The product is unique to the market, and Management should exploit this.
- The overseas trend indicates future potential and in this regard the process improvement of the line ought to be considered, perhaps investing in more machinery to increase the output (thus also reduce cost).
- The main customer at present is Eskom, who are currently increasing their operation wherefore the above point should further be considered.
- The line shares the 7t press with the ALFLO line.

*The SPL/FM line*

- Two basic types of ladders are manufactured on this line – simple single ladders and single platform ladders.
- The location of the line is poor in that it is far removed from the raw material stores and material is carried manually by the line operators to the area.
- The line includes a jig, which is no longer used due to it having ‘broken down’ and not been repaired, although it would far increase the speed of production.

*The UPRIGHT line*

- The main product produced is aluminium scaffolding and associated accessories, as well as ‘specials’.
- In this regard, the line produces the most ‘once-offs’ and thus often requires the assistance of the Tool Room. For this reason the line should be located as close possible to the Tool Room, as their machinery is required.
- The production line contains a small cutter for cutting the aluminium tubing used for the scaffolding. There is however no reason for this and the cutter could be moved into the Cutting Department. This would allow the cutter to be used for other purposes and increase its utility.

From the analysis of the layout of the individual lines it can be concluded that the material flow through the lines is poor with excessive and unnecessary transportation of material. For example, the tumbling machine is located behind the assembly area of the LAS/QS and the ALFLO lines, however is actually required at the beginning of the line.

In term of logistics, the actual manner in which the ladders are moved between workstations is inefficient, and little consideration has been given for the storage and handling of WIP. Also the lines are labour intensive, with little consideration having been given to work methods and ergonomics. This is particularly noticeable during the assembly processes. Operators store the various FC components that are assembled ad hoc and the assembly processes are consequently far from optimal. Finally, the machinery used is obsolete with some machines having been commissioned in the 1950’s. The primary causes for concern with regards to the Production Department are:

- The layout of the entire department is poor. Not only does this involve the layout of the individual production lines, but also the location of the individual lines relative to each other. The LAS/QS and SPL/FM lines in particular are poorly located. Both lines are fairly busy lines (in fact at 2<sup>nd</sup> and 3<sup>rd</sup> place in terms of throughput) however; the LAS/QS line is far away for the Finished Goods Store and the SPL/FM far away from the raw material store.

- As mentioned, the routing and sequencing of individual operations performed on each line are inefficient. The lines need to be optimised in this regard by performing material flow and process analyses.
- Furthermore, not only should the conveyance of material and equipment layout be taken into consideration, but also the actual work methods. To do this, time and motion studies should be performed.
- The conveyance of material itself between lines is poor and labour intensive. Mainly female operators man the production lines, and the physical lifting of ladders throughout the day is cause for complaint.
- It is evident that little or no MOP exist that are based on the fundamental measures of throughput, work-in-process and cycle time (see Little's Law, Section B.2.2, Appendix B). Other Factory Physics parameters such as the bottleneck rates, critical WIP or congestion coefficients are unknown. In general there is a lack of understanding of Factory Physics.
- The technology used is old, outdated and processes are labour intensive. In particular the old machinery is constantly breaking down, whilst certain machines that were once used in the past are standing idle and have not been modified, incorporated for use or sold.
- The general organisation and layout of workstations is poor. Ergonomic considerations have clearly not been included; for example operators in the assembly processes work from bins situation on the floor or behind them in shelves.
- There is a lack of control due to the poor overview. Piles of inventory are located throughout the factory floor during peak operation.
- The department is untidy and dirty.
- There appears to be a lack of communication amongst line operators themselves, as well as with the Management.
- General motivation and moral is low. There exists little job satisfaction, operators are distrusting and in general the needs of the factory floor worker appear to have been neglected. The working conditions are poor, with bad lighting and temperature extremes in summer and winter.
- There is dissatisfaction with the incentive scheme.
- As observed, it appears that the line operators have sufficiently organised themselves to methodically perform the required operations. However, in particular in the assembly areas this self-organisation is not necessarily contributing to the overall productivity of the lines.
- This is mainly due to a lack of organisation – a prime example is the lack of convenient positioning of the bins containing the finished components that are assembled to the ladder. Operators are forced to place these bins on the floor or on shelving in the near vicinity, thus not being able to perform the assembly operations with minimal effort.

- Similarly, the manufacturing processes are impaired. For instance, the stiles are mostly lifted and carried from worktable to table.

#### vi) *The Finished Goods Store*

FG Store locates the factory's finished goods inventory that is comprised of a set safety stock as well as any pending orders that are being completed prior to dispatch. The stock is considered factory stock and is held separately from any stock held by the Cape Town Sales Branch, who manage their own inventory. The store is fenced off from the Production Department and the Tool Room, with access to the dispatching area being provided through a large roller door leading into the yard where the trucks transporting the finished goods are loaded.

Completed ladders are stored in product batches, which are arranged randomly and according to space limitations. During completion of large or numerous orders, the space availability is limited which mostly results in 'chaotic' packing/stacking of the ladders. This results in poor accessibility which increases the workload for the employees as the ladders often have to be moved and/or re-stacked in order to reach desired products. The actual flow of finished goods from the store until dispatch is thus highly inefficient.

There again is no apparent storage system. Although the two employees in charge of the store seem to know where everything is, the actual visibility of how much stock of each ladder is available is lacking. The question of control is thus a concern as it is not evident which products are where and how much safety stock is left. The amount of capital tied up in safety stock is in the region of R230,000.00. To summarise the main problems that are evident are:

- The storage of finished goods is not according to any system.
- Consequently the overview of the stock in store is difficult. Although minimum stock levels are set, it is not always noticed when these are reached.
- Again the stock control is insufficient. Theoretical stock figures on the company's IMACT Management System constantly differ from the actual in-store figures. Furthermore, control of stock coming into the store is inadequate. Consequently, stock is counted on a weekly basis resulting in more work.
- The material handling is also not efficient. Fast moving stock is not stored closest to the dispatch area for example.
- The FG Store is limited by space availability.
- Access to the store is insufficiently controlled, (even though it is not easy to walk out with a ladder in your bag!)

## E.2 Organisational Structure

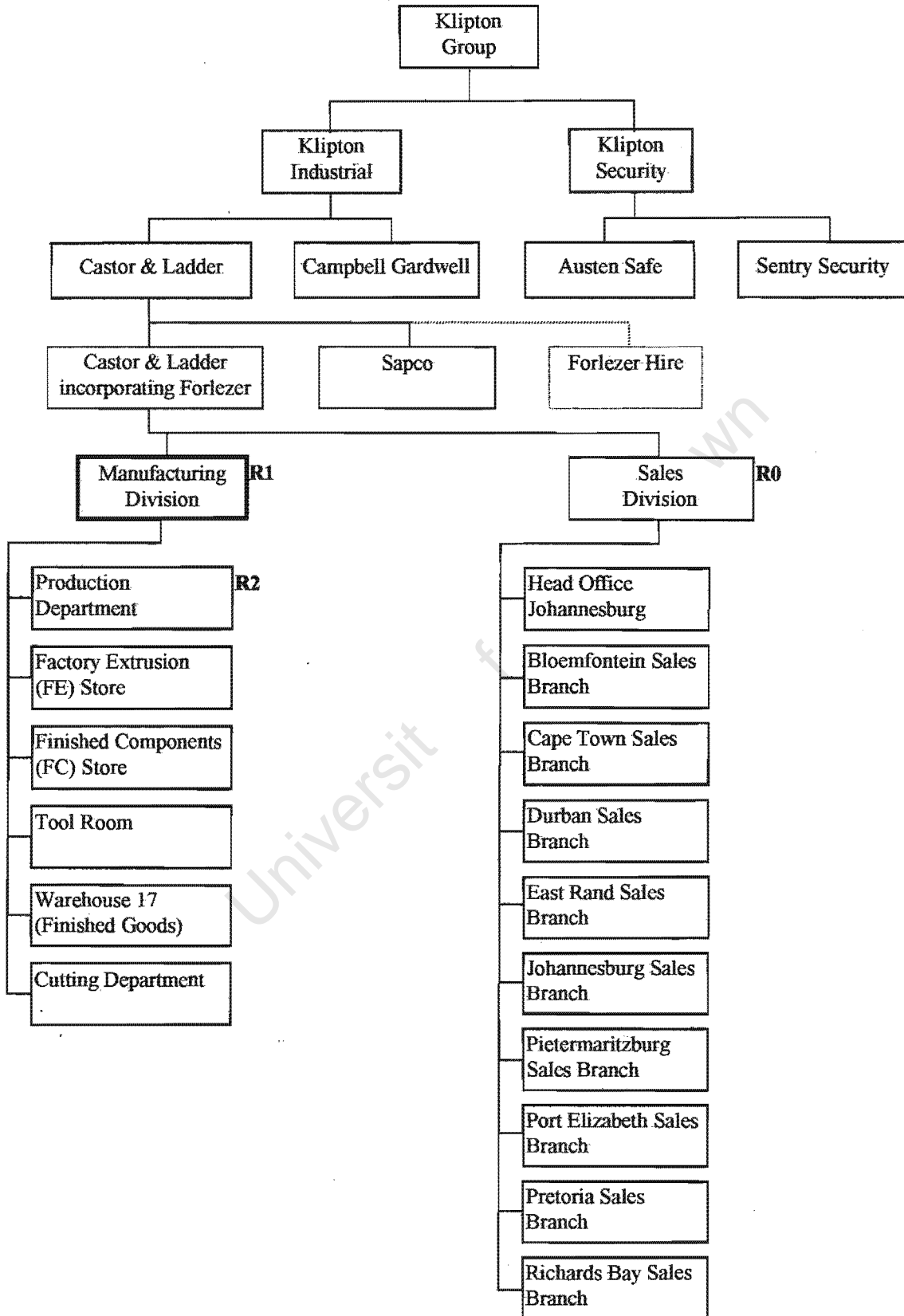
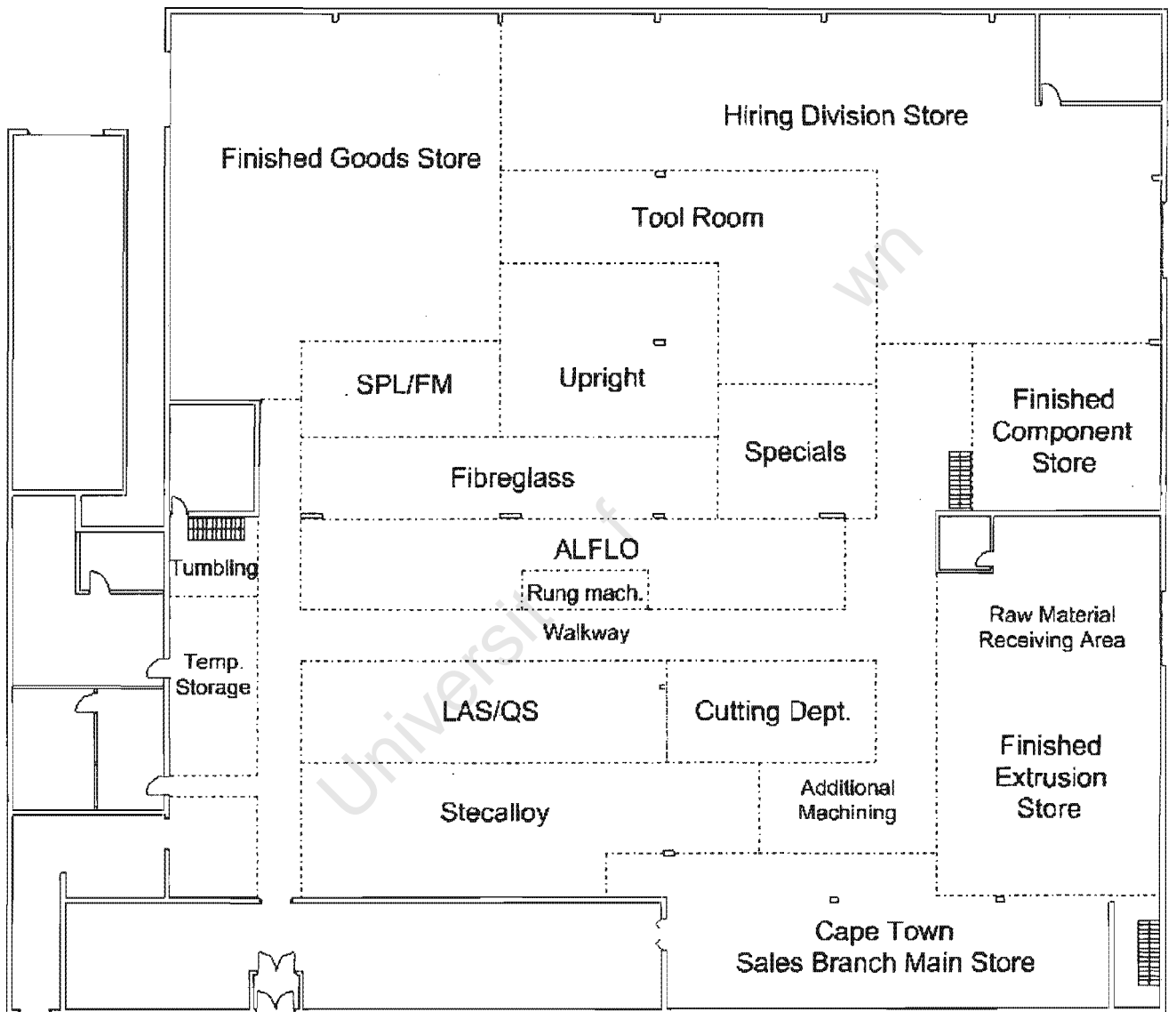


Figure E.2.1 The Organisational Structure of the Klipton Group

### E.3 The Various Factory Layouts

The section illustrates the various factory layouts referred to in the main body of the thesis.



**Figure E.3.1** The Original Location of Various Departments and the Production Lines of the Manufacturing Division

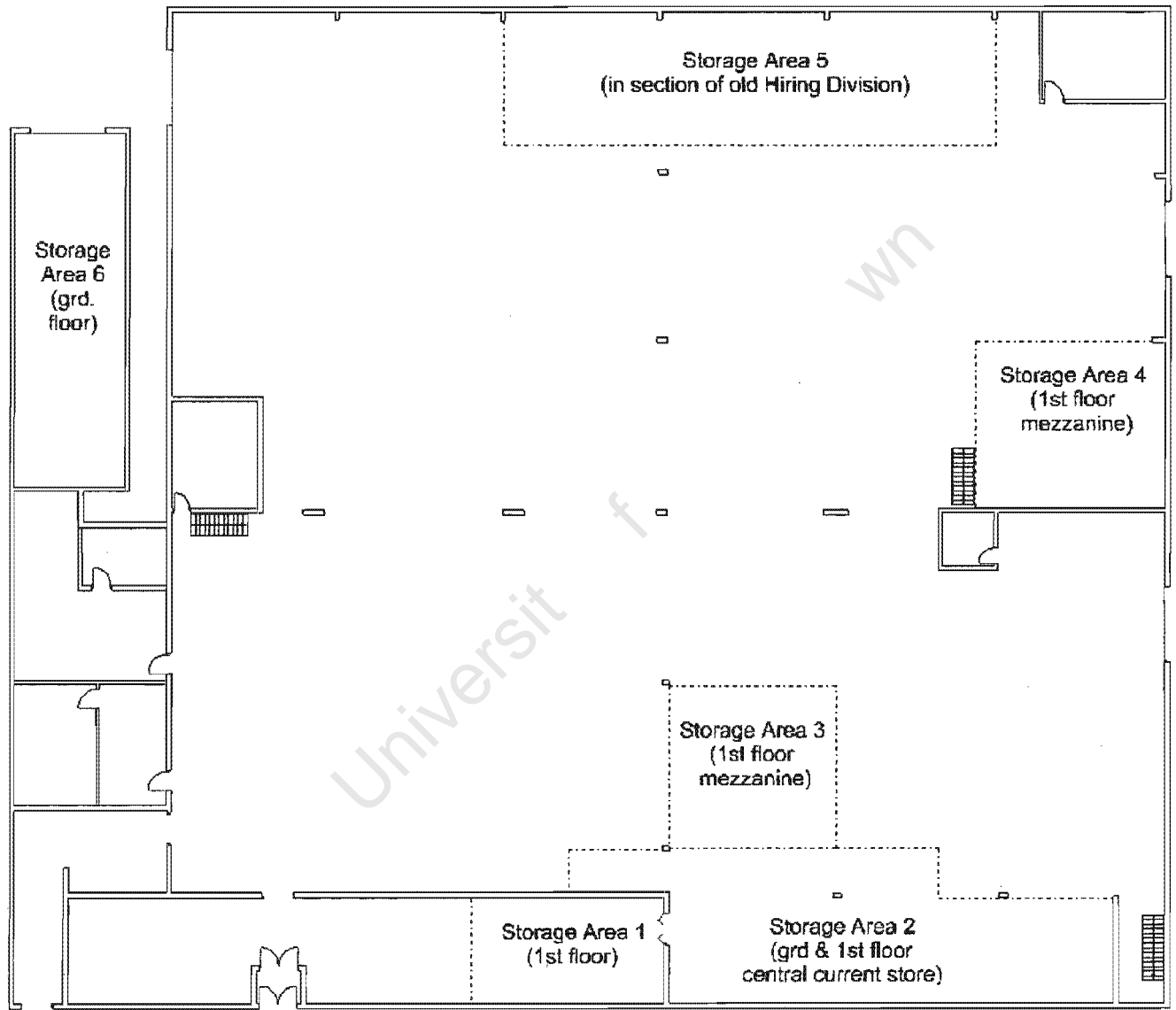


Figure E.3.2 The Storage Space Allocation of the Cape Town Sales Branch

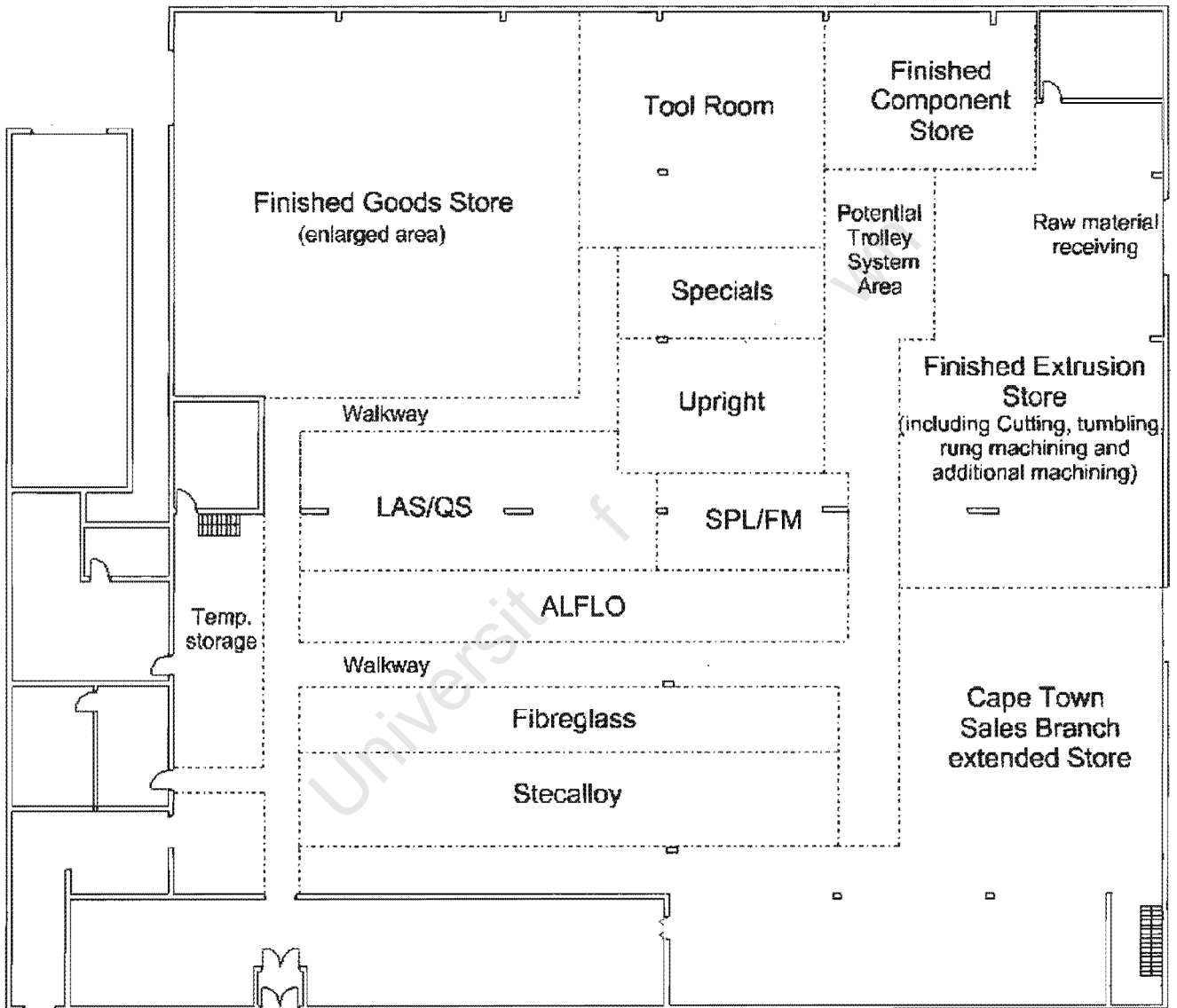


Figure E.3.3 The Proposed Conceptual Layout Based on the Systems Inquiry

## E 4 The Cape Town Sales Branch Redesign Proposal

The following motivation for the proposed layout diagrammed in figure E.4.1 below was prepared by the Sales Branch and presented to the Klipton Board as well as the Management of the Manufacturing Division. This proposal was the trigger that initiated the current research study.

### 1] PROPOSAL FOR FACTORY LAYOUT BY SALES BRANCH

“The present stores layout is a nightmare, goods are stored in various areas scattered around the building wherever there is any available space. There are 6 separate and distinct storage areas, and stock control is a joke.

The dispatch and receipt of stock takes place through one single garage door. This door is directly onto the main road, and stocks have to be loaded and unloaded on the pavement, in the open, and with a constant stream of passing pedestrians. Once the goods are received into the store, the vast majority of them have to be stored on the first floor, this means double or even quadruple handling when goods are assembled, prior to dispatch. We often have a ‘traffic jam’, because in a small area we are trying to check incoming goods, assemble goods for dispatch, load the delivery vehicles, and dispatch out the showroom for calling customers, all at the same time. All this from a Company that claims to be material handling experts!

Please investigate this proposal, and if you cannot accept it as it is, make alternative proposals whereby my stores can be at least 80% on ground level, consolidated into one unit, and at least 20% larger. At present I have nowhere to store, extra trolleys, --proposed Euroshelf systems, - or even the full range of mounties and conveyors.

There have been proposals made to “enlarge & improve” the showroom. This is very nice, but unless my stores problems are solved first, any showroom changes would be a complete waste of time.

The drawing of the existing layout shows the extra space available due to the closure of the Hire Division. Apart from the Cape Town branch problems already mentioned, there are several other problems caused by this layout.

1. The cutting machines are facing directly on to the main passage through the factory, dirt from these machines is collected on everyone’s shoes, and walked through the factory and offices.
2. The Tool Room is some distance from the cutters and lathes. The setting and testing of these machines is the work of the Tool Room personnel, and it would be logical to move the two closer together.
3. The cut material can pass straight from the cutters onto the line, there is a distinct lack of control over this process.
4. Part of the Cape Town Store mezzanine floor is in a position which makes the manufacture of Stecalloy ladders extremely difficult.
5. The finished ladders are counted on the factory floor, there is not control on the movement into, or out of the finished ladder store.
6. The dispatch of the ladders is done on the open road, with ladders being loaded in full view of passers by. The gate and back door to the factory is open for the whole of the loading process. A senior person (normally the Production Supervisor) has to be at the loading post for the whole time that the loading is taking place.

The drawing of the proposed layout shows my suggestions for overcoming my stores problems, while at the same time generally improving the factory operation. This is done as follows:

7. The section of the Tool Room containing the heavy machinery, (lathes, milling machines, etc.) stays unchanged. But the portable equipment is swung through 90 degrees, and moved into what is now the back of the Hire Store. This move can be done at any time with minimal disruption.
8. The cutting machines and production lathes are then moved into the area vacated by the Tool Room. This move can take place over two separate weekends, and production need not be disrupted if a ‘buffer’ stock is built up before each move.

9. The raw material store can then be moved into the rest of the existing Hire Store. This can be a phased operation over a few weeks, little would have to be physically moved, because new stock could be delivered to the new storage area, while old stock was drawn from the existing area. All raw material deliveries would be made via the Hire gate area.
10. The factory stores personnel could then be moved into the existing Hire offices.
11. The vacated raw material and stores area could then be given to CT Branch, including the old factory store office. New fences would be erected in both areas to make the areas more secure.
12. Once the Branch store has moved in, the smaller section of mezzanine (the part that affects Stecalloy production) can be removed.
13. The only detriment to the factory production is the longer delivery lines from the cutters and lathes to the various production lines. This is not the problem that it may appear, the delivery to the AFLO, SPL/FM and the Upright lines is the same or shorter, the delivery to the LAS/QS lines slightly longer, and the delivery to the Stecalloy lines a little longer again. These extra delivery lengths are more than offset by the greater control over the product, and by the improved efficiency due to the better working conditions on the Stecalloy line. Special trolleys could be made to ease the transportation of production materials.

**That concludes the essential parts of the move, but there are some other possible benefits.** The reorganisation of the Cape Town Branch Store will result in the existing branch ladder store becoming available. There are two possible uses for this area.

14. The branch ladder store could be taken over by the factory and used as a bond store for imported goods. This would save the payment of any import duties on goods until they are actually put into production.
15. I believe that a better use would be as a ladder dispatch area. The existing dispatch door should be bricked up and a new opening knocked through the wall, and into the branch ladder store. (As per drawing) When a load of ladders are to be dispatched, they can be moved into this store, and the door to the factory locked. The truck is then driven into the end of the building, and loading takes place behind a locked gate. The factory is secure, and so is the load.
16. You will see from the drawing that the proposed alterations divide the building into three distinct areas, all of which have their own logic.
  - a) The factory stores and dispatch areas can be fenced into one group of stores. This will give a secure, controlled area, with restricted access.
  - b) The main part of the branch is grouped together, with receiving and dispatch away from the road, again the area can have restricted access.
  - c) The factory would be a common area, with general access, especially for the canteen, toilets etc.
17. The costs have not yet been investigated, or dates set and bar charts generated etc, because I do not want to waste time if this proposal is not accepted, but if you wish I will do further costing and planning.

To me, the proposal seems logical and cost effective. The revised layout can be described as “win, win”. However, if they are not acceptable, please give alternatives.

Signed [MD Cape Town Sales Branch]”

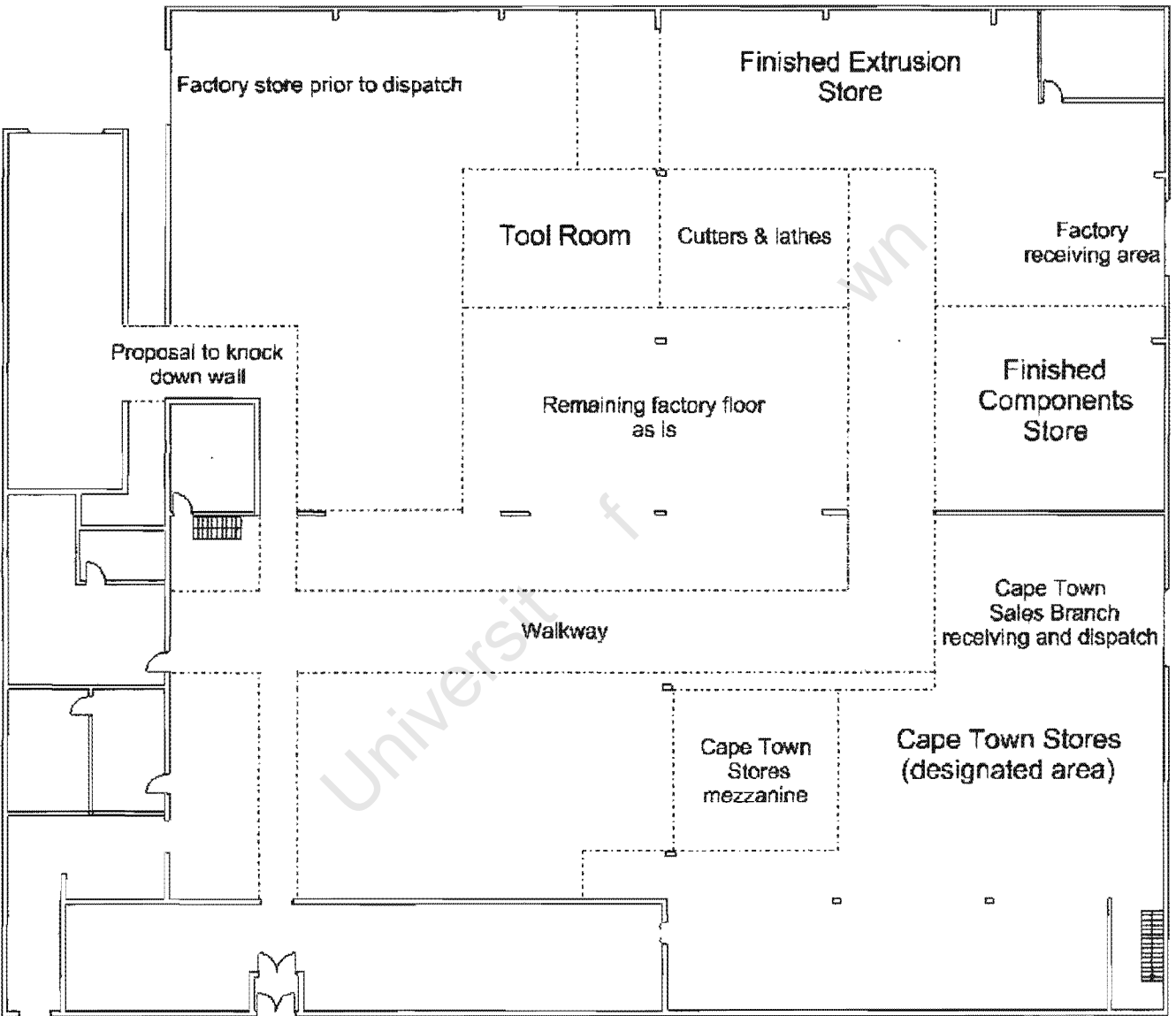


Figure E.4.1 The Proposed Layout Suggested by the Cape Town Sales Branch

## E.5 The Rich Picture

Based on the first two stages of the Soft Systems Methodology, the following 'rich picture' modelling the 'problem situation' was developed. Figure E.5.1 depicts a rich picture regarding the human dynamics, whilst figure E.5.2 presents an overall conception of the situation.

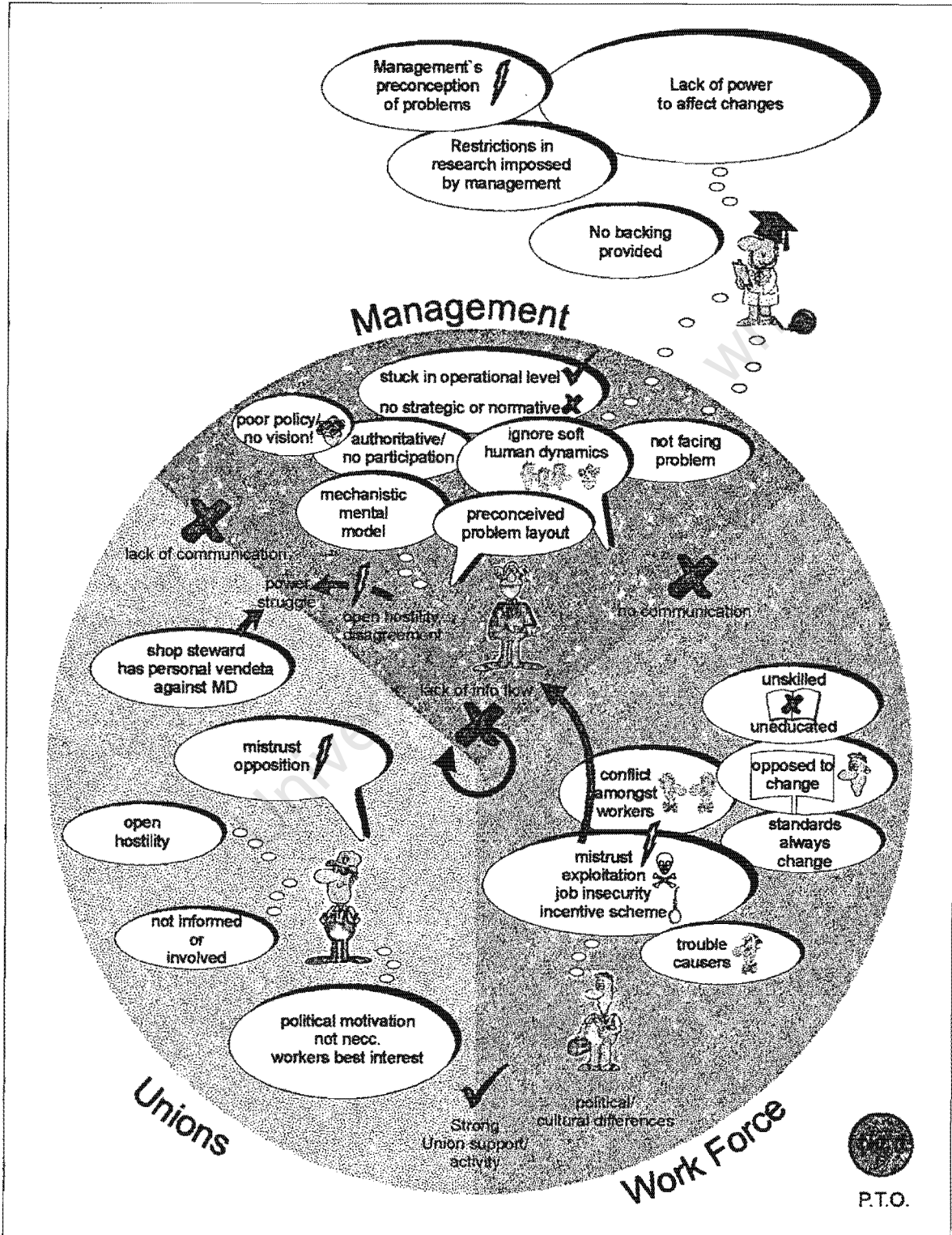


Figure E.5.1 The Rich Picture Depicting the Human Dynamics

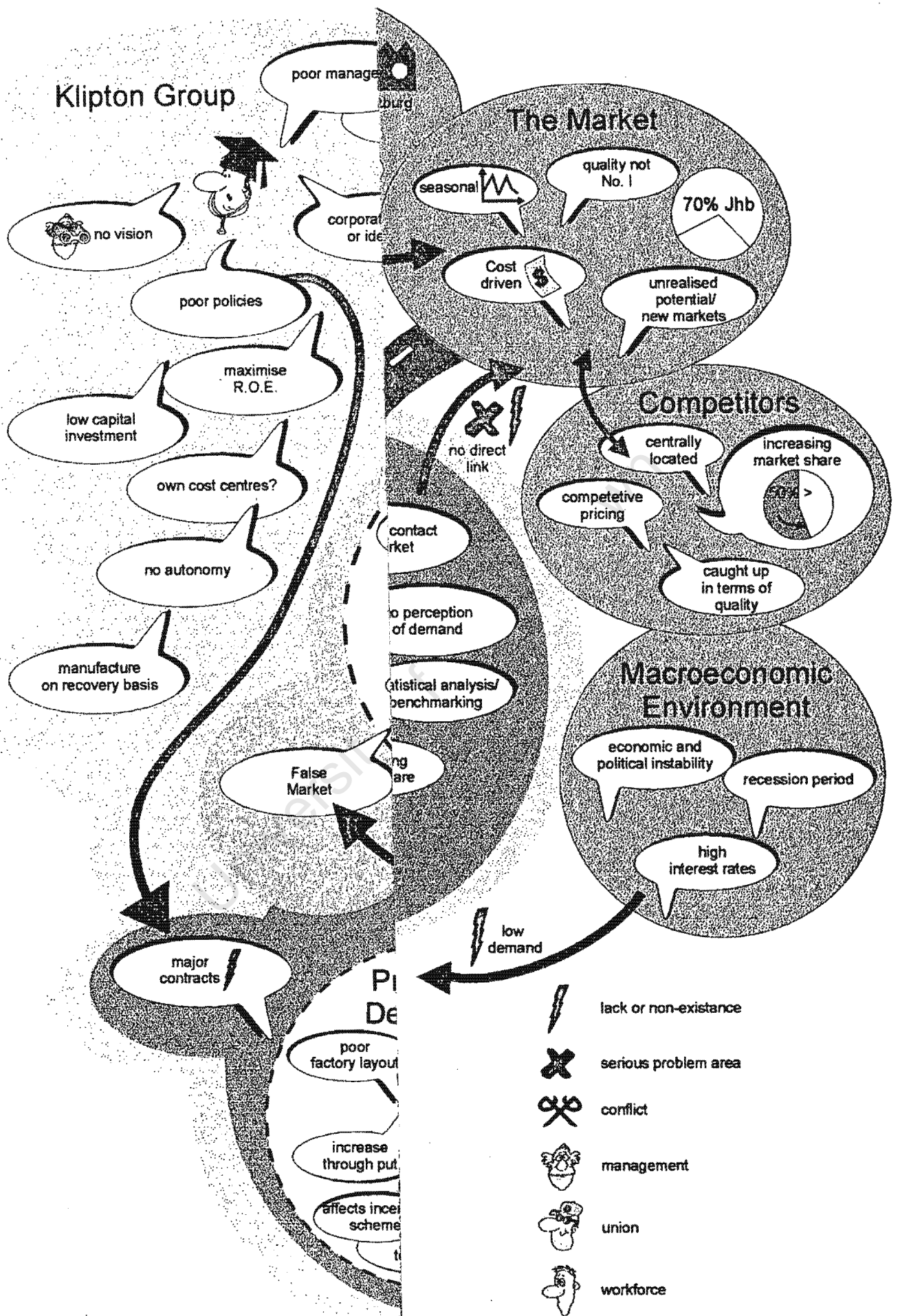


Figure E.5.2 The Overall Rich Picture Present

## E.6 Process/Flow Analysis of the ALFLO Line

Although not documented in detail, a process flow analysis of each line was performed in order to gain insight into the dynamics of the factory layout. In this section, the analysis performed on the ALFLO line is illustrated. The process descriptions listed in the *Process Analysis Flow Chart* are graphically depicted in figure E.6.1, which plots the various processes through the actual physical location of the machinery used on the ALFLO line using the same colour co-ordination.

**Figure E.6.1** The Process Analysis of the ALFLO Line - presented on pages 228 - 231  
**Figure E.6.2** The Flow Analysis of the ALFLO Line - presented on pages 232 - 233

PROCESS FLOW CHART						Date:	
Line: ALFLO							
Product: Tuffy/Alac Step Ladder							
Steps	Flow	Mach/ Tool	Dist.	People	Chart Symbol		
					○	⇒	▽
<b>a) Manufacture front part of step ladder - Consisting of stiles (sides of ladder) and rungs</b>							
1	From FE Store draw required profile for stile	▽			FE store man		
2	Onto movable table 1 or table 2	▽	5m		Oper. 1		
3	To Cutting Department # i)	⇒	5m		Oper. 1		
4	Cut to length	○	Cutters		C-oper		
5	Transportation to 60t press	⇒	5m		Oper. 1		
6	Holes punched for rungs	○	60t Press		Oper. 1		
7	Temp. storage table 4	▽	2m				
8	Transport to table 5 # ii)	⇒	5m		Oper. 2		
9	Storage on table 5	▽					
10	Transfer to table 6 # iii)	⇒	7m		Oper. 2		
11	Insert rungs (see production of rung)	○			Oper. 2		
12	Process through rung machine # iv)	○	Rung Machine	5m	Oper. 2		
13	Storage on table 7	▽	1m				
14	From table 7 move remaining stile onto table 5 and locate remaining rungs	○	1m		Oper. 2		
15	Process through rung mach.	○	Rung Mach.	5m	Oper. 2		
16	Temp. storage area G # v)	▽					
<b>Total Steps</b>			<b>Occurrence Value</b>				
<p># i) If the extrusion profile is delivered in the correct length it proceeds straight onto production line.</p> <p># ii) The stiles are manually transferred.</p> <p># iii) Several stiles are manually carried over at a time (i.e. in batches) to be processed the rung machine.</p> <p># iv) At this stage one side of the stile is pressed with rungs, with the material moving back in the opposite direction (counter flow)</p> <p># v) The completed from is temporarily stored against a rack that locates rungs. Storage is ad hoc and the front essentially moves from here into assembly where it is combined with the back part of the step ladder.</p>							

**b) Manufacture back part of step ladder - Consisting of back stiles and lower support rail**

1	From FE Store draw required profile for stile	▽			FE store man					
2	Onto movable table 1 or table 2	▽		5m	Oper. 1					
3	Transport to Cutting Dept.	⇒		5m	Oper. 1					
4	Cut to length	○	Cutters		C-oper.	<				
5	Transport to area C # i)	⇒		28m	Oper. 1					
6	Temporary storage	▽								
7	Transported to SPL/FM # ii)	⇒		5m	Oper. 3					
8	Drilling	○	SPL Drill		Oper. 3	<				
9	Transported to area D	⇒		5m	Oper. 4					
10	Temporary storage on trestle	▽								
11	Transported to assembly table 10	⇒		2m	Oper. 3&4					
12	Support rail inserted # iii)	○	Pneu. Tools		3&4	<				
13	Temporary storage area E	▽		2m						
14	Assembly of ladder top # iv)	○	Pneu. Tools		3&4	<				
15	Storage in area F against pillar ready for assembly	▽		2m						
	<b>Total Steps</b>		<b>Occurrence</b>							
			<b>Value</b>							

# i) The material is mostly carried across the ALFLO line from the walkway and temporarily stored on trestles in area C, from where the stiles are further moved across the factory to the SPL/FM line. This constitutes a complete waste in terms of transportation and is highly ineffective.

# ii) The SPL/FM line contains a drill which is used for drilling the hole locating the support rail. Ideally the drill should be located in the actual ALFLO line.

# iii) Bottom support rail (round tubing) inserted into predrilled hole (operation 8), locating rubber hammered in, hole drilled through stile, support rail and locating rubbers and rail rivitted.

# iv) For this a jig is used at table 10. The sub-assembled back section is taken from area E, placed in jig, 4 holes drilled on each side of the stiles, the top positioned and rivitted 8x

**c) Manufacture of Rungs** - includes two stage process of making rung and ferrules which are then combined.

**Stage 1: Ferrule Manufacture**

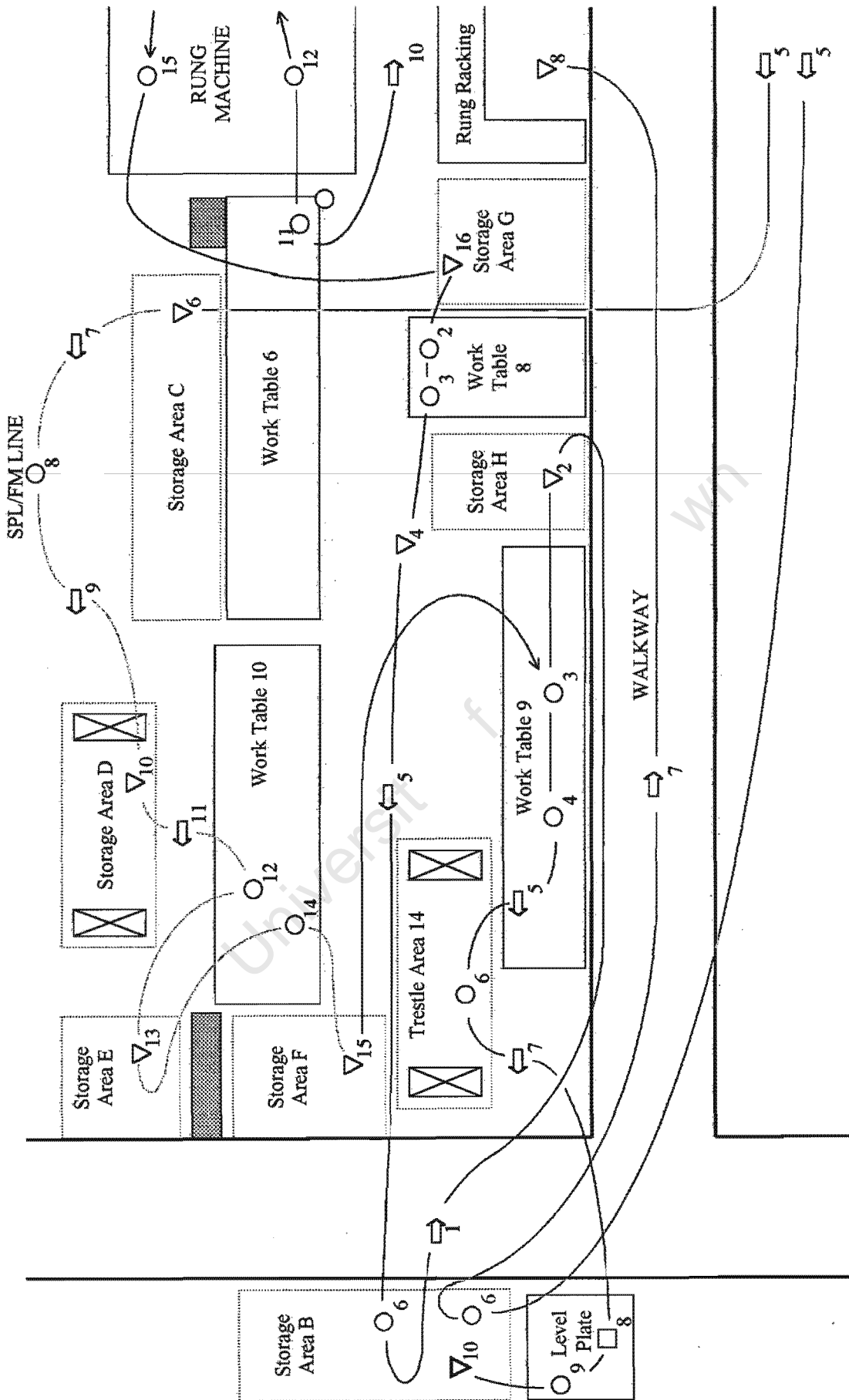
1	Extrusion profile from FE Store	▽		5m	FE store man				
2	Transportation to Cutting Department	⇒		5m	Oper. 5				
3	Cut to required size	○	Cutters		C-oper.				
4	Storage in crates	▽							
5	Carried to tumbling machine	⇒		25m	Oper. 5				
6	Tumbling	○	Tumbling Mach						
7	Carried to rung manufacture area	⇒		18m	Oper. 5				
8	Temporary storage	▽							
<b>Total Steps</b>			<b>Occurrence Value</b>						

**Stage 2: Rung Manufacture**

1	Extrusion profile from FE Store	▽		5m	FE store man				
2	Transportation to Cutting Department # i)	⇒		5m	Oper. 5				
3	Cut rung to required width	○	Cutters		C- oper				
4	Storage in wooden crates	▽							
5	Carry rung to rung manufacturing area	⇒		7m	Oper. 5 & 6				
6	Temporary storage	▽							
7	Add ferrule	○			Oper. 6				
8	Crimp ferrule to rung in crimping machine	○	Rung machine		Oper. 6				
9	Storage in racking for manufacture of front of ladder	▽		1m					
<b>Total Steps</b>			<b>Occurrence Value</b>						

d) Assembly - consisting of two stages									
Stage 1: Assembly of front									
1	From temp. storage area G after step 16 in a) to table 8	▽		1m	Any of 3,4,5,6				
2	Assembly front top # i)	○	Pneu. Tools		same				
3	Assembly foot rubbers and support gussets # ii)	○	Pneu. Tools		same				
4	Temporary storage # iii)	▽		1m					
5	Transportation to area B	⇒		13m	3 or 4				
6	Temporary storage area B	▽							
Stage 2: Final assembly of front and back of step ladder									
1	Transportation of front from area B to area H # iv)	⇒		11m	Any of 3,4,5,6				
2	Temporary storage area H	▽							
3	Leveling front and back sections taken from areas H and F on table 9	○		2m 5m	same				
4	Hinging front and back sections	○	Pneu. Tools		Oper 3 or 4				
5	Transportation to trestles 14	⇒		3m					
6	Attachment of side hinges by drilling and rivetting	○	Pneu. Tools		Any of 3,4,5,6				
7	Carry to levelling plate	⇒		4m	3 or 4				
8	Levelling of ladder	□	Saw		Any of 3,4,5,6				
9	Insert back rubbers	○			3,4,5,6				
10	Final storage in area B, awaiting store in FG Store	▽		3m					
	<b>Total Steps</b>		<b>Occurrence Value</b>						
<p># i) The front section is placed on table 8, the top rung of ladder positioned, 2 holes drilled per side and rivitted (4x)</p> <p># ii) A rubber foot is assembled per stile, as well as one support gusset connecting bottom rung with each stile. Two holes are drilled per rubber and rivited, whilst gussets are also drilled twice per attaching side and rivited.</p> <p># iii) The completed front section is stored at random, normally laid down on the floor, until sufficient have been made to warrant an operator carrying a batch to area B. The entire production run is completed in this manner, before continuing with the assembly of front and back.</p> <p># iv) Carried manually in batches that can be handled by operators.</p>									





## E 7 Interview and Observation Data

### *i) Policy and Mission Statement*

- The factory is run according to the policy set by the Klipton Board of Directors.
- The 'greater' policy is not clear in any way. In fact policy is in no manner explicit. The policy should provide guidelines for achieving the organisations goals, i.e. describe the means. As far as 'middle' Management there is no clear conception of policy.
- The Researcher was not informed as to how policy is set other than by the board.
- The MD of the factory sits on this board, however he enacts little of the policy.
- One of the major Klipton policies affecting the factory is to minimise capital outlay and maximise return on investment. Consequently the manufacturing policy set, operates on a recovery basis, supplying the various sales branches at cost, who in turn then sell the product to make the profit for the group.
- Management claims that the group's employment policies are predominantly aimed at retaining as much of the current workforce as possible. If layoffs are to take effect, this would only be for maintaining a competitive advantage in the market. Short-term layoffs are seen as a better option than relocation of factory to Johannesburg and retrenching the entire Western Cape staff.
- A further policy that is deeply rooted in the perception held by Management is that the factory has to remain in Cape Town. The view is expressed that it is too expensive to relocate the factory. Also Management argues that they want to employ people, and relocation would result in less people being employed, as the factory would become more mechanised.
- Remaining policy is unclear and poorly communicated.
- There is an underlying policy to not empower the workforce by keeping them uninformed. Mainly this is due to the fear of opposition from the unions and employees.
- Workers have the perception that it is company policy to pay them as little as possible.
- The workers have no idea why a redesign is being implemented. To them it appears as if Management wants to reduce the amount of jobs available. The policy of keeping the operators uninformed causes a lot of distrust.
- The factory floor workers do not understand any organisational or market concepts. Thus they do not see the logic in performing for the company, so that the company may perform in the market, so that its survival is ensured. At face value they understand that if the company is not making money, their wages cannot be paid. But they blame Management for this. If Management were doing their job correctly, then it would not be a problem. They feel that they are putting more than enough effort in, so clearly if there is a problem it is due to Management. They also feel that the company is making enough money.

- The companies mission statement is to be the top ladder manufacturer in the country - producing a quality product that the customer wants, at a competitive price and on time.
- This mission statement was seen displayed in A4 format in the MD's reception area to his office, which is located upstairs (on the second floor) in the administration block.
- The factory floor workers are not versed in this mission statement. They do not understand what is meant by vision.
- The vision is poorly developed. It does not specify specific values or goals. Its generality is comparable to thousands of other organisations – they all want to be the best, but do little in terms of actually achieving this. The vision has not been broken down into sub-goals that provide guidelines for achieving the vision.
- From a viability and a survival perspective, the location of the factory should be seriously reconsidered. The company could employ equally many workers in the Johannesburg area. If the company was genuinely committed to minimising retrenchment and provide employment, a move closer to their market would have long been considered. The fact remains that regardless of its claim that it aims to retain as much of its workforce as possible, if the organisation's viability is threatened the workforce will be the first to be reduced.
- There appears to be an underlying interest from the MD with regards to keeping the factory in Cape Town. The MD openly stated that he did not want the factory to be relocated to Johannesburg as he did not want to live in Johannesburg.

## ii) The Management

### Structure

- The management structure within the system considered (the Manufacturing Division of *C&L inc. Forlezer*) consists of the MD who represents the 'Top Management' function, and the Production Engineer and Production Supervisor who take on the role of 'Middle Management'. The MD is on the Board of Directors of the Klipton group, to whom he reports. In turn Middle Management reports to the MD. Directly below Middle Management are the Manufacturing Division employees consisting of the Production Department (line operators), the Finished Extrusion and Finished Component Stores as well as the Finished Goods Store, the Cutting Department and the Tool Room workers.
- Although the Production Engineer and Supervisor perform Middle Management roles, these positions are not official and more recognition and authority should be given to them to effectively perform their task. Effectively the Production Engineer performs the task of a Technical Manager, whilst the Production Supervisor performs the task of a Production Manager.

### *Responsibilities*

- The MD describes his main function as implementing the policies dictated by the Klipton Board of Directors, controlling all financial aspects, general delegation and control as well as more specific functions such as determining stock levels, setting targets and dealing with the recovery. He also claims to deal with personnel and union problems, promotions and spearheads improvement projects. A further important responsibility is the report back to the Klipton group.
- Although these were responsibilities identified by the MD, the research process revealed that the fulfilment especially in terms of human related responsibilities was not entirely being met. In particular the union aspects were being very poorly handled by the MD.
- The Production Supervisor is in charge of running the production lines, the FE, FC and FG Stores. This includes managing the orders and deliveries, setting up the production schedules and determining capacity requirements. Further this involves raw material re-ordering as well as controlling the finished goods dispatch process.
- The Production Engineer is in charge of the FC Store and the Tool Room. All technical or engineering aspects such as maintenance, any modification or repair work are his responsibility. In addition he is responsible for safety and all quality aspects, and in this regard has been informed that obtaining the ISO ratings will be his project. The Production Engineer together with the MD is also involved in settling labour disputes, holding disciplinary hearings and other union issues.
- Directly below the espoused 'Middle Management' are the Line Supervisors.
- The Line Supervisors are responsible for collecting the material required for the daily production. They are also responsible for the smooth operation of the lines and are representatives to Management in the event of a problem. They are also responsible for ensuring the quality of the ladders.
- The supervisors are not used extensively. Management has not provided them with the backing or financial status to earn them the required respect amongst fellow workers.

### *Accountability*

- The fact that the organisation has deteriorated into its current state indicates that Management is not held fully accountable for its actions or performance.
- Further there are indications of poor accountability from Middle to Top Management. This was observed during round-table meetings held with Management. For example the Production Supervisor was instructed to prepare a detailed layout for the next meeting. This was not done, however there were no consequences.
- Operators are not held accountable for the handling of issued stock.

### *Management Style and Approach*

- Traditional top-down approach with authority 'over' or power 'over', as opposed to authority or power 'to'.
- The mental model held by Management is primarily mechanistic. The organisation is structure hierarchically, power is centrally located from top down, and problems are approached with reductionism. Workers form part of the organisational machine. They are forced to perform the same tasks every day, there is little focus on job satisfaction, personal growth and development, promotion or job opportunities.
- In general the communication between Top and Middle Management is good, with the MD relying on the feedback given to him by Middle Management. Both the Production Engineer and Production Supervisor have respect for the MD, mainly because they perceive him as a 'straight down the line' person who does everything to enable middle Management and stands up for them.
- The management style of the MD towards the workers however seems predominantly autocratic and authoritarian, although fair. No input or feedback is requested, no participation is evident and the workers generally have little to say.
- In particular Top and Middle Management have a problem with the union Shop Steward to the extent that the Researcher was inhibited from dealing with union issues at any level (as discussed under the union section).
- Although there seems to be little communication between the workers and the MD, he is known to 'get his hands dirty' and thus there is some respect for him. The image perceived is that he is not disliked, but rather unapproachable (this excludes the perception from union representatives, in particular the Shop Steward who intensely dislikes the MD).
- The managerial relationship between the Production Supervisor and the workers is the most open of all relationships. Primarily this is a culturally related issue as the Production Supervisor is a Cape local and considered to be 'one of us' by the workers. The language used is also the same and thus the workers can identify more easily with him. A further contributing factor is the fact that the Production Supervisor has been with the company for 15 years and has an in-depth understanding of the factory dynamics and all processes involved. He has thus earned his respect and, although they may not completely understand, the workers are aware of his responsibilities and that he is a key factor in making the factory work. Due to their daily involvement the workers also feel more comfortable with interacting with him. In this regard the workers are also forced to address all problems they may have to him.
- The relationship between the Production Engineer and the shop floor is a little more formal. This may be because he only recently joined the company (approximately two years), but certainly there is a perceived cultural difference and an 'us – them' split. He is considered in

the same manner as the MD, although through daily interaction the workers feel he is more approachable. The Tool Room operators convey the most trust in him, due to respect for his technical abilities. Although generally liked he bears the cross of having to deal with disciplinary hearings and dismissals. The Production Engineer is the most open minded and very enthusiastic towards new concepts and ideas.

- There is a complete lack of participation at *C&L inc. Forlezer*, and discussion is only initiated through union action.
- Information flow and feedback to the operators is virtually non-existent, and Management are happy to keep the workers as uniformed as possible – ‘the less they know the less trouble they can cause’.
- Workers are motivated by an incentive scheme, which appears to be ineffective, due to the fact that the targets are reset almost on a weekly basis which workers think is unfair. The scheme is also not founded in clear terms and Management decide at will whether bonuses are paid out at the end of the week.

#### *Perception of the Workers*

- The MD does not believe the workers care about anything more than their own benefits and therefore that communication and participation is difficult. He believes that they do not understand the seriousness of the company’s situation and are not interested in the holistic goal of the company.
- Workers are seen to be lethargic and antagonistic by upper Management. The level of education is poor and therefore the opinion is held that there is little room for understanding and implementing continuous improvement and training programs. Job enrichment is thus difficult.
- The Production Supervisor feels there is definitely a communication problem, the workers seem only interested in their bonuses. When making proposals or trying to implement changes, participation is only achieved if workers are bribed. The worker moral and discipline is low, absenteeism high. Education levels are also perceived to be low.
- Both the Production Engineer and the Production Supervisor expressed frustration at not being able to ‘reach’ the workers.
- Management also feel that there is a disproportionately high level of union activity amongst the workforce, which they feel is unnecessary and unjustified.
- The cause, they believe lies in a few ‘stirring individuals’. In this regard, Management have identified the ‘rotten apples’ amongst the workers and would like to see them go.
- Some workers work hard and seem eager to learn, but with the union situation Management feels that they are subjected to peer pressure and will not take a stance against lazy workers.

### *Perception of Management*

- Workers believe that Management expectations are too high, and that the targets set by Management continually rise as they are met, and that this is to prevent them from getting their bonuses. Some workers also believe that Management purposefully loads the lines with slow moving products to reduce the daily output.
- Management is perceived as being unapproachable and workers often do not understand Management's actions.
- The workers are aware that the company is in trouble and that their future is uncertain. This is blamed on Management who must do something about the situation (other than lay off staff).
- There is also the perception that Management is making all the money and that the workers are 'getting nothing'.

### *Strategy*

- There exists a clear lack of middle and long term planning and goals. Management is active only at the operational level dealing with short-term goals, hence the development of the problem situation.
- This point is related to the data collected on the organisational policy and mission statement above, in that the lack of strategy directly affects these issues.
- The level of strategic thinking was found to be poor, especially during the undertaking of the redesign of the layout.
- Also Management had no broader strategy for the resolution of the current situation. The strategy was to simply redesign the factory layout and hope for the best.
- In the past, Management had initiated other improvement projects in co-operation with the School of Engineering Management. In particular analyses of the layout of the individual production lines were performed, investigations into a JIT manufacturing system undertaken and the company's IMPACT computer system programmed in order that individual costs per ladder were determinable in accordance with the BOM. No action was implemented from these prior studies. The information contained in the studies was not even available to assist in the current research.

### *Relationships – General Comments*

- "Line operators are lazy, unmotivated and uneducated. They are not interested in contributing to the whole of the organisation and only want to get without giving."
- "Some shop floor workers have no respect for Management."
- "Some people always complain, no matter what the conditions are like or what the situation is."

- “There are certain operators who don’t do their work, however little can be done about it. This puts pressure on those who actually do perform.”
- Supervisors mostly disregard operators not pulling their weight, they have no authority and do not want to fall out of favour with their co-workers.
- “Some operators are trouble causers”.
- Other operators do not take any nonsense from anybody. They have minds of their own, not letting anybody or anything influence them, even union pressure.
- There are certain key figures and ‘stars’ on the production lines.
- “It is difficult being a supervisor – the other operators gang up against us and often don’t listen to what we tell them. There is a lack of discipline.”
- The problem is that the supervisors are operators working. Supervisors should train operators and make sure that the line is running smoothly and at full capacity.

### iii) Organisational Culture and Learning

- For an apparent market leader, the organisational culture is poorly developed. This goes hand in hand with the lack of vision.
- There is a lack of ‘commonality’ that is essential for effective interaction amongst individuals. In this regard no common ground has been created and no common identity into which all people within the organisation can buy in to.
- To understand the organisational culture, three key areas were considered (as per Clement, 1994 on *Culture, Leadership, and Power*): basic assumptions, values and artefacts.
- ‘Basic assumptions’ are the circumstances taken for granted in an organisation as the “correct” way of doing things. There appears to be a considerable gap in this area between Management and the line operators. The underlying assumptions that appear to be governing the operators are not founded in manufacturing knowledge, or learned skills or higher education. Things are done according to how Management tells them to do things, and if in any way possible, corners are cut. These deep-rooted assumptions will only be changed by Management initiative and leadership, and will take a long period of time. However, Management shows no such initiative. Learning within the organisation is virtually non-existent.
- Similarly the values held by the major stakeholder parties differ. These are also founded in differing cultural backgrounds. Clement (1994, p34) describes these values as a sense of what “ought” to be. Again there is no explicit expression within the organisation of ‘ought to be’ conduct and what is expected of workers.
- Artefacts include amongst other things, procedures followed, technology used, and ways of communicating. Even at this most basic level the development is poor.

- Technology is outdated, although this is not a serious problem in view of the fact that operations performed are mostly simple. More importantly the communication is not explicit, open and unimpaired. The socio-political situation is strained between Management and the workers (unions) and this has a direct impact on the cultural perception.
- The impression is still one from the Apartheid era, with barriers between white Management and non-white workers.
- The network of relationship is poorly developed between Top Management and the line operators, however the relationship between Middle Management and line operators is much better. Especially the relationship between the Production Supervisor and the workers is good, whilst the Production Engineer is at least respected in his integrity and intentions amongst most workers.
- Top Management lacks the co-ordination, commitment and competencies in terms of analytical and inter-personal skills to change the organisational culture.
- The disciplines of a Learning Organisation (Senge, 1991) are missing: systems thinking, personal mastery, mental models, shared vision and team learning.
- Management falls into the trap of 'fixation on events'. The fact that a prior study revealed the poor layout of the production lines and factory is what Management is clinging to as an explanation for the existence of the problem situation.
- There are no efforts at team building, house meetings etc.
- Organisational learning is not observable at the factory floor level. Middle and Top Management were attending courses on Operations Management and Quality Management, but the line operators were not being furthered in any way.

#### *iv) Organisational Structure*

- The organisational structure of *C&L inc. Forlezer* exhibits a typical hierarchical structure and is presented exhibited in Section E.1 of this appendix.
- The details of the Klipton group are not known.

#### *v) Communication, Control and Co-ordination*

- There is a lack of these elements throughout the system.
- In particular there is a lack of communication between the Sales Division and the Manufacturing Division.
- The Manufacturing Division is however directly dependent on the Sales Division to generate the sales and thus also the orders to ensure the viability of the organisation.
- Information-flow, both from the factory floor upward to Top Management and most distinctly from the top down, are limited.

- The communication amongst line operators is good. As a whole the informal self-organisation amongst operators is the organisations strength.
- There is a lack of personal communication between employees at different hierarchical levels.
- In this regard, the lack of MOPs contributes to the poor control of the system.

*vi) Union Related Issues*

- Almost all factory floor workers belong to the union.
- The FC Store store-man is the union representative and shop steward.
- Great antagonism exists between the shop steward and the MD. So much so that it is common knowledge that the two cannot agree on anything.
- The store-man is continuously absent due to being at meetings or on union courses. This affects the efficiency of the FC Store.
- The shop steward is conscious of his position of power and is not shy to use and show it. In general he exhibits a tendency to oppose Managerial decisions out of principle.
- Most workers feel that the union is necessary to guard their interests. Without them they feel Management would exploit them even more.
- Generally there is no co-operation between union representatives and Management. In this regard, the MD originally held a meeting with the shop steward and other union representatives and explained the need for a redesign. According to the MD this approach was a 'complete waste of time' as the union refused to accept the situation.
- Consequently, the redesign project itself was not further presented or discussed with the union during the course of undertaking the project as it was felt that this would 'simply cause more hassles'. The feeling was to exclude union involvement until such time as the redesign was complete and then to convince the union to accept the developed plan.
- The union has called for involvement from the start. They feel everything needs to be discussed with them and their approval obtained.
- The shop steward has been trying to extract information from Management in order to report back the progress or happenings to the union. Due to the lack of co-operation, this information may be incorrect or skewed thereby creating more opposition to the redesign process.
- Consequently the workers and thus also the unions were highly suspicious and negatively inclined towards the plan. Some workers expressed the fear of losing their jobs.
- Largely the lack of worker participation is the cause of much fear and concern.
- The opinion was expressed, that having been excluded from the process, the union will have to very carefully scrutinise the final proposal and at least make some changes. This will further delay the time to effective implementation of any changes.

- From a managerial perspective the view is that once the design has reached a certain stage and momentum, there will be little the union can do to stop the process. The fear exists that involving the union from the start will result in the project never materialising, as they will realise that in improving the overall layout and efficiency of the factory less workers may be needed.
- An attempt should be made to explain the fact that this is critical to the survival of the company and therefore for the remaining work-force. However Management has as little trust in the union as vice versa. The consensus is that the union actually are more interested in the power struggle than having the workers interests at heart.
- This opinion is based on previous experiences with the union, i.e. there is a history of disputes within the organisation.

***vii) Human Resource Development, Job Satisfaction and Moral***

- The human resource function in general appears to be lacking within the organisation.
- The workforce is considered as uneducated and disposable, and consequently no effort is put into developing the skill levels of individuals.
- There is also no attempt to create an understanding within the workforce for the nature of the manufacturing environment.
- Little importance is attributed to job satisfaction. Because workers are uneducated this is not perceived as a priority.
- In this regard, the line operators are not even rotated from line to line to provide some form of variety. The day to day existence is therefore mundane and the only motivation created by Management and perceived by the workforce is the incentive scheme (although its exact structuring is cause for much dissatisfaction).
- Individual line operators express the interest to learn more. Certain employees are however not interested in enhancing their jobs. If the general approach was towards developing the workforce, this lack of interest would more than likely change.
- Due to the minimal capital expenditure policy, no funds are available to send operators on courses or to provide/create training opportunities/facilities.
- Consequently there is a direct lack of loyalty towards the organisation, as well as verifying the individuals perception that Management actually doesn't care about the well being of the workers.
- Due to this attitude, the organisation is also experiencing high levels of dissatisfaction and consequently union activity.
- Worker moral and ethics are in turn also low. In this regard Management mentioned that pilfering is a continuous problem.

- To improve motivation, the workers have to be more involved in the organisation. Little can be changed by way of the manufacturing process other than gradually replacing mundane operations with automated equipment. However, the individual can be made to feel more important and appreciated by asking for his/her input and involvement in improvement projects.
- Factory floor workers are not prompted to think for themselves.
- As is, there is little room for self-motivation and self-improvement even if the willingness is there.

#### *viii ) Performance Measures*

- There exists a clear lack of understanding of Factory Physics principles as briefly discussed in Appendix B (Section B.2).
- Consequently vital MOPs are either lacking or extremely poorly developed.
- Management do not know exactly what the capacities and performance capabilities of the lines are. The best case cycle times and throughput figures are not known. The capacities are derived from extrapolation of past performances and experience.
- There exists a great danger in the assumption that the new layout of the production lines will for example increase the ALFLO line throughput by up to 3x its previous capacity. This assertion has not been proven or verified in any way.
- In this regard, the lines require time and motion studies to optimise the work flow and determine critical MOPs.
- Very little statistical data is available to gain an improved understanding of the process, market trends, seasonal fluctuation and so forth.
- Although the organisation has a powerful integrated computer package, called IMPACT, the programme is not being put to its full use.

#### *ix ) Technological Status*

- The Division only requires simple machinery that essentially can perform cutting, drilling, punching and shaping of the aluminium stiles and rungs and thus the very latest technology is not a prerequisite for effectivity.
- However, the equipment available is extremely old and in constant need of repairs.
- The production process is very labour intensive and inefficient.
- Simple operations that are mechanically performed at a much faster rate are performed by hand. Particularly the riveting procedure, where the holes are first drilled, the rivet inserted manually and then 'gunned'. Standard European and American processes have automated in particular the riveting processes.

- A video of the Werner ladder manufacturer in the United States was supplied and analysed. It was evident that the production lines are as much possible automated and far fewer line operators involved in the manufacturing process than in South Africa.

*x) Quality*

- Management speaks of TQM, continuous improvement, and zero defect, however there is no evidence of any of these quality systems either in place or being pursued.
- The quality of the products is the responsibility of the foreman superintending the production line in question. The foreman is supposed to inspect the ladders for 'abnormalities' but there is no official procedure or formal checklist etc. setting guidelines on what to check.
- The factory wishes to obtain ISO 9000 ratings in the future. According to Management this is to be taken into consideration during the redesign. During the entire redesign period there was however no focus on the ISO ratings or on quality issues for that matter.
- Documentation is important, but the feeling is to not let the documentation drive the system. The recording of all control procedures is thus a secondary objective. Currently there is no documentation whatsoever available.
- The primary objective is to eliminate variability from the start and thereby build quality into the product. The Forlezer name is a synonym for quality in the ladder industry and the company wishes to retain this competitive advantage.
- There is no set quality procedure or awareness amongst the shop floor.
- A sources of quality variation is on the supplier side. The production process in itself is very simple and the aim should be to produce zero defect.

*xi) Remuneration/Incentive Schemes*

- Operators are paid a weekly wage.
- An incentive scheme is in place that pays out bonuses on a monthly basis if the operators produce in excess of predetermined target levels.
- Management sets the target levels initially on a monthly basis that are then refined to a weekly target.
- In setting these targets, Management take into consideration the overall amount of orders for the month, the types of ladders to be produced and the quantity and subsequently based on experience and what it believes to be 'fair', sets the desired threshold target limit.
- The problem is that the workers do not always feel that the target level has been set fairly. Numerous operators stated that Management are continuously increasing the target levels and making it more and more difficult to achieve the targets. A standard that is set in one week will be adjusted during the following week and operators are extremely dissatisfied.

- The dissatisfaction arises due to the fact that there are no laid down rules when bonuses are earned and when not. The workforce feels that it is at Management's mercy and that the goal posts are continuously being moved.
- In view of workers receiving a weekly wage, bonuses should be adjusted to a weekly basis as well. This will have the effect of workers receiving and experiencing the rewards for harder work in more real terms. It is easier for an undereducated worker to rationalise a bonus scheme in a more short-term time frame.
- Essentially Management has difficulties in determining accurately when bonuses are due because it has no MOPs in terms of standard throughput rates and cycle times for individual products.
- There is a need to break down the incentive scheme into clearly set criteria that are understood by all. For example an average output rate per hour per ladder type is required and once this is exceeded by line operators a bonus of X Rand should be due per ladder.
- The current incentive scheme also does not take into consideration the breakdown of the lines. As this is a frequent occurrence, it directly affects the operators' bonuses and is cause for much grievances.
- The operators should also be given the opportunity to share their views concerning this aspect, especially as this is the prime motivator to an otherwise mundane job.
- A neutrally perceived party should ideally handle the bonus scheme.

#### *xii) Capacity, Inventory, Scheduling*

- Again due to the lack of sufficient MOPs, these areas can potentially be improved.
- These functions are largely dependent on the Production Supervisor due to his 15 years of experience.
- No official systems are in place, and even the Production Supervisor's knowledge has to be questioned when it comes to scheduling variations of the 150 odd products offered.
- Inventory management is a major problem in the system.
- Large stock discrepancies exist between theoretical stock held on the IMPACT computer system and actual stock, especially in the FE Store.
- A full stock-take has to be performed every three months to control this. On a particular stock-take performed during the course of the research period, the discrepancy between theoretical and actual was R26,000.00 in the FE Store and R29,000.00 in the FC Store. Mainly this is accounted to the production of specials, an area that has not been located any component or material identity on the BOM. Thus material is used and not booked off the stock system.
- However there is also definite pilfering and Management has the suspicion that operators are selling off aluminium at scrap value.

- No capacity management – have no idea of fluctuations or requirements (upper and lower limits per month).
- The system essentially functions as a pull system, with the orders ‘pulling’ the product out of the factory.
- The factory operates on a back-order system.
- The factory works on minimum stock levels (MRP) with a one week replenishment stock.
- One of the biggest problems is the actual material handling.
- The inventory is managed and controlled by a computer system that records and calculates all inventory requirements. The system used is the IMPACT system, which amongst other functions has the BOM for each product. Orders are entered onto the system and the material requirements calculated.
- Raw material is ordered on a weekly basis based on the orders entered for that week and the previous orders and supplier lead time taken into consideration.
- The requirement is calculated based on set minimum raw material safety stock levels, as well as the finished goods stock. The raw material stock is captured onto the computer system once it has arrived and been counted.
- When the raw material passes into production, it is not taken off the system, but ‘theoretically’ still sits in the store. In other words there is no handle on WIP levels. Once it arrives in the Finished Goods Store, it is counted and only then taken off the raw material stock and entered as FG stock. Any orders dispatched are subtracted from the FG stock, a process which involves manual counting and entering onto the system.
- WIP is dealt with by consideration of what has been ordered. This is then compared to the FG stock and the required safety stock and calculates the quantity that needs to be produced.
- The factory produces on a make to order basis while holding a certain safety stock level.
- Because the factory does not run its own profit centre the inventory tied up in finished goods does not have such a big impact and it is preferred to hold finished goods stock in order to offer higher service levels (especially considering that the demand fluctuates vastly).
- It was Management’s intention to further increase the current safety stock levels to create more of a buffer.
- Essentially it is a pull system which is driven by customer orders. Raw material is ordered three weeks in advance (because of supplier lead times). The order is based on the following formula:  
$$\text{To make} = (\text{Back orders on hand} + \text{Minimum Stock}) - \text{Stock on Hand}$$
- Minimum stock levels are set from the past production figures (July 95 - Dec 96) using moving averages, where peak fluctuations have been eliminated in the calculation of the moving average. The peaks have been removed to prevent carrying excess high stock.

- A more detailed analysis of the extent of fluctuations over the last 3 or 5 years has not been undertaken to better adjust the stock levels held over the fluctuating periods.
- Customer are quoted on a four to five week delivery lead time which will be reduced now that the finished goods stock levels have been increased.
- With accurate seasonal forecasting for the coming demand the delivery lead time could further be improved. (There seems to be a lack of commitment to quote shorter lead times, and this must be looked at. The new capacity should be analysed to shorten the lead times and to use this as a market advantage.)
- The inventory control in terms of ordering new stock is dependent on the accuracy of the computer system. For each product the computer uses the BOM and the “to make” quantity and then breaks it down into material needed.
- The system thus is dependent on the accuracy of the BOMs (everything hinges on this!!!) and takes into consideration a 3mm loss due to cutting. The minimum stock levels are checked on the computer and reordered on a weekly basis and it seems that this system works reasonably well as there are seldom instances where expediting raw material takes place.
- If shorter lead times are quoted this will have to be reconsidered as the accuracy between real and theoretical stock is critical.
- Problems often arise due to discrepancies between the codes used for the material on the BOM and the actual raw material code. This arises because of the fact that material often has to be cut to length and the processed lengths are programmed onto different codes, or registered under the BOM differently.
- The minimum order quantities are also taken into consideration by the computer system.
- The Production Supervisor on a weekly basis manually compiles the production schedule, one week in advance.
- The schedule is compiled according to back orders outstanding, which are handled on a first-in first-out basis. Even though orders are entered onto the IMPACT system to determine material requirements, the system is not used to work out the outstanding orders or WIP and quote lead times accordingly. Rather, lead times are quoted on the conservative four week period.
- The Production Supervisor admits that a Master Production Schedule should rather be used.
- The IMPACT system offers such applications, including Material Requirement Planning modules, rough-cut capacity modules and order release modules which could accommodate large future orders to be produced and delivered on time far more accurately and easily than current ‘guestimation’.
- The problem is that nobody knows how to use and programme the IMPACT system.

*xiii ) The Market*

- The market is becoming more and more competitive and price orientated.
- Over the last 6 years have had constant 'base' orders with great seasonal fluctuations, often with magnitudes of up to 5 times the average order quantity.
- The majority of the ladder market is in Johannesburg and to a lesser extent in Durban (80%).
- Transport from Cape Town to Johannesburg contributes 15% to the overall cost of each ladder.
- The factory does not sell directly to anyone except the sales branches. Even large accounts like the post office or Eskom account are handled through the sales branch. However, where a major account is held and orders are large, the factory organises delivery directly to the end client.
- This means no source of profit at all for the factory.
- The factory supplies a distribution network that is owned by the Klipton Group, which is the link to the market. This network consists of sales branches located nationally that distribute various products of which ladders are one of them.
- There is thus no direct marketing undertaken by the Caster & Ladder outlets that focuses on the ladders only and the Management rightly feels that this is not the optimal set-up. Instead it is felt that the distribution network should be treated like all external customers, and that the company should have a sales representative in Johannesburg, which does the marketing solely for ladders. Management feels this would improve the way the company services the market.
- The distribution network is currently the biggest national distributor of ladders, but the market share is gradually diminishing, mainly due to competitive pricing from competitors.
- In terms of new products the ladder industry is fairly constant. But in view of the extensive range of products, little marketing is done.
- There is limited benchmarking - although the factory does occasionally test and compare competitor products to their own.
- Marketing relies mainly on the reputation the company has built for itself based on the Forlezer brand name, which is a world renown ladder manufacturer. Forlezer is the American manufacturer to whom Caster & Ladder pay a licensing fee for the use of the Forlezer brand name. The ladders are manufactured in accordance to the Forlezer specifications.
- There is little in terms of vision for new products. The view is, "a ladder is a ladder." However during a visit to America whilst the research was in progress, the MD returned with "a couple of new ideas". These were however not shared with any of the Management. It appeared as if the intention was to expand or diversify the fibreglass line, perhaps indicating an overseas trend. The local trend for fibreglass ladders was however not that positive. The reason being that the fibreglass stiles are imported and that these ladders are therefore expensive. Telkom and Eskom mainly purchase the fibreglass ladders.

- Although data is available there is no evidence of any attempts to establishing market trends. Also the seasonal fluctuations on orders and products has not been analysed.
- Will we have the customer if we triple the throughput - yes, because will become more competitive. Lost the Makro account on the basis of a few cents cost per ladder.

*xiv) The Sales Branches*

- The premises in Paarden-Eiland are shared by the factory and the Cape Town Sales Branch.
- There is insufficient space to separate the two and the sales branch uses part of the factory floor for storage purposes.
- There is little or not communication between the factory and the sales branches unless orders are placed.
- In fact there appears to be a communication breakdown between the two. On numerous occasions the factory Management was observed to have a 'fall-out' with the sales staff. Arguments were witnessed where sales reps of the Cape Town Sales Branch entered the factory and demanded why their orders were not being produced on time. According to them, these had been promised to customers on a certain delivery date that now could not be met.
- Often factory Management makes comments like, "the damn reps make promised of delivery without checking what the factory backlog or current capacity is. Thus they make empty promises because we run according to our own production schedule and cannot expedite just because they couldn't be bothered to place an order and enquire when it can be produced. Once the order is accepted, we then end with all the trouble to try keep the customer happy"
- This problem occurs particularly on large orders.
- The sales branches and the factory carry stock of all items.
- There is a definite 'us and them' split between sales and factory. This split is not only observed between Management but also shop floor workers.
- It appears that the sales reps often do not know enough of the product. The various length, width and height combinations of products are often checked by phoning factory Management. The factory floor Management continuously receive "can we do ...." calls from the reps. This often leads to annoyance, especially when Management is faced with trying to sort their own mess out.
- The Cape Town Sales Branch uses some of the factory floor space to store their stock. Most of this space is allocated on mezzanine levels above the Finished Component Store, the LAS/QS production line and in the old Hiring Division section. This results in the sales reps and other sales branch employees continuously entering the factory to get to their stock, which however annoys the factory Management as this results in distractions and meddling in of their affairs.

- The Cape Town Sales Branch also uses a section of the 1<sup>st</sup> floor of the Administration Building to store stock as well as an externally located store room (see figure E.3.2).
- The 'inconvenient' allocation of space in turn annoys the sales branch and amongst other factors this is what prompted the redesign of the factory layout.
- The sales branches want the factory to increase their stock levels so that the delivery time for orders is reduced.

*xv) The Suppliers*

- The supplier of the raw material is Huletts Aluminium who is the biggest supplier of raw processed aluminium in the Western Cape.
- The supplier lead time is 2 to 3 weeks.
- Minimum order quantities are by weight and are 60kg.
- Huletts normally deliver the stiles cut to size. However mostly the Production Department will order longer lengths of which multiples can be cut. This is to allow for flexibility and to prevent that the FE Store holds stock that does not move for several months because they were forced to order say 120 lengths of 3m and only need 40 (minimum order quantity). So they rather order lengths of 6 or 9 meters and cut it to size.
- There is no official QC of delivered materials. If the material is delivered undersize it is scrapped. There should however not be any off cuts as the lengths are ordered to size. (There are however off cuts and the reason for this should be addressed.)
- Huletts deliver the lengths 5mm - 15mm longer than ordered.
- The vendor punches up to 30 tonnes of material per day. Consideration must also be made for the fact that aluminium is soft and contorts while handling. For this reason Management says it would be difficult for the suppliers to deliver the lengths cut accurately to size.
- Should the demand increase or the throughput, the availability of raw material does not pose a problem. In the past the factory used up to 12 tonnes a week and currently is using 5 tonnes.
- There does not appear to be another supplier that could be used.

*xvi) The Competitors*

- The company's biggest competitor and main threat is a company called South African Ladders who are based in Johannesburg.
- SA Ladders are undermining the companies market share through competitive pricing. Their product used to be inferior however they have improved their products and are gradually producing ladders of equivalent quality.
- The Management recently tested some their own ladders and those of the competition to failure, and in all cases, the Forlezer product was still superior - al be it not by much.

- Although this is the main competitor, *C&L inc. Forlezer* know little about them.
- There is a definite future threat from Asian manufacturers. The first cheap products made in China have entered the market.
- The company has not yet addressed the cheap end of the market unlike its competitors.

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# APPENDIX F

## Sources of Evidence

Source of Evidence	Strengths	Weaknesses
Documentation	<ul style="list-style-type: none"> <li>• stable - can be reviewed repeatedly</li> <li>• unobtrusive - not created as a result of the case study</li> <li>• exact – contains exact names, references, and details on an event</li> <li>• broad coverage - long span of time, many events, and many settings</li> </ul>	<ul style="list-style-type: none"> <li>• retrievability -can be low</li> <li>• biased selectivity, if collection is incomplete</li> <li>• reporting bias - reflects (unknown) bias of author</li> <li>• access - may be deliberately blocked</li> <li>• unavailability - there may be insufficient documentation</li> </ul>
Archival Records	<ul style="list-style-type: none"> <li>• (identical to documentation above)</li> <li>• precise and quantitative</li> <li>• historical</li> </ul>	<ul style="list-style-type: none"> <li>• (same as for documentation above)</li> <li>• accessibility due to confidentiality reasons</li> <li>• historical</li> </ul>
Interviews	<ul style="list-style-type: none"> <li>• targeted – focuses directly on case study topic</li> <li>• insightful – provides perceived causal inferences</li> <li>• cleverly constructed questions and interview interaction give insight into philosophies and underlying beliefs</li> </ul>	<ul style="list-style-type: none"> <li>• bias due to poorly constructed questions</li> <li>• response bias</li> <li>• inaccuracies due to poor recall</li> <li>• reflexivity – interviewee gives what interviewer wants to hear</li> <li>• required information can easily be blocked</li> <li>• requires essentiality that interviewer has a solid comprehension of situation</li> </ul>

<p>Direct Observation</p>	<ul style="list-style-type: none"> <li>• reality – covers events in real time</li> <li>• contextual – covers context of event</li> <li>• allows unbiased external perspective</li> </ul>	<ul style="list-style-type: none"> <li>• time - consuming</li> <li>• selectivity - unless broad coverage</li> <li>• reflexivity - event may proceed differently because it is being observed</li> <li>• cost - hours needed by human observer</li> <li>• misconception - event may be interpreted incorrectly by observer</li> </ul>
<p>Participant - Observation</p>	<ul style="list-style-type: none"> <li>• (same as above for direct observation)</li> <li>• insight into interpersonal behaviour and motives</li> <li>• exposure to situational dynamics</li> </ul>	<ul style="list-style-type: none"> <li>• (same as above)</li> <li>• bias due to investigator's influence of events</li> <li>• personal agendas</li> </ul>
<p>Physical and Cultural Artefacts</p>	<ul style="list-style-type: none"> <li>• insightful into cultural features (socio-political)</li> <li>• insightful into technical operations (socio - technical)</li> </ul>	<ul style="list-style-type: none"> <li>• selectivity</li> <li>• availability</li> </ul>

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