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Appendix A

Analysis of the Hard Systems Approach

A1 INTRODUCTION

The 'hard' systems approach as adapted by Jackson (1991:80) from Checkland[1], presupposes that real world problems can be addressed on the basis of the following four assumptions:

- There is a desired state of the system $\mathbf{S_1}$, which is known.
- There is a present state of the system, $\mathbf{S_0}$.
- There are alternative ways of getting from $\mathbf{S_0}$ to $\mathbf{S_1}$.
- It is the role of the systems person to find the best means of getting from $\mathbf{S_0}$ to $\mathbf{S_1}$.

This is supported by Habermas[2] cited by Jackson (1991:85) who is of the opinion that hard systems is a manifestation of the technical interest in the prediction and control of natural and social systems. Furthermore, according to Habernas, hard systems methodologies seek as far as possible to follow the empirical analytical methods employed in the natural sciences.

In addition to the references cited in this thesis, Checkland 1989:72-89) acknowledges the fact that the hard systems methodology is an established concept with contributions over the years made by revered academics, amongst others: Hitch, Hall, Quade, Machol, Chestnut, Jenkins, Lee, De Neufville and Stafford, Miles, Miser, Churchman, Ackoff, Sasiene, Hoos, Lilienfeld, Chase, Daenmzer, and Wymore.

To ensure that the entities under discussion are not only appropriately placed within context of hard systems, but also within context of the overall research of

[1] Checkland P. 1989. Systems Thinking, Systems Practice. Chichester: Wiley.
[2] Habernas J. 1974. Theory and Practice. London: Heineman,

this thesis, the classification of systems falling within the ambit of the systems approach depicted in Chapter 4, Paragraph 4.1, Figure 4.3, is repeated here as Figure A1. Figure A1 is however modified to indicate the relative position of 'hard systems'.

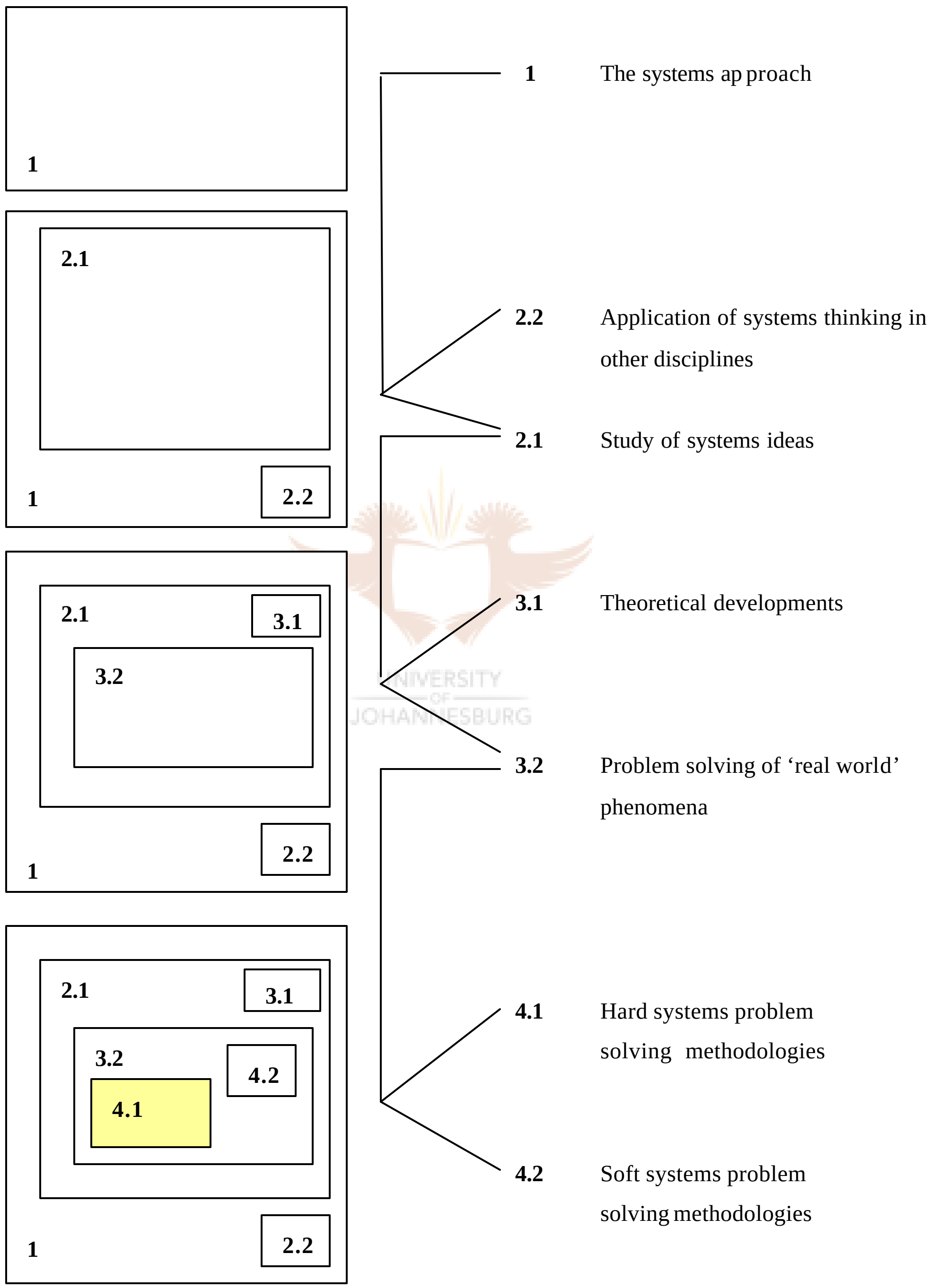

Figure A1: Classification of systems falling within the context of the systems approach

The problem solving methodologies specifically selected for their appropriateness to the research and included within the context of this Appendix are Systems Engineering and Systems Analysis as categorised by Checkland (1989:128-138) with Jackson (1991:75-78) adding Operational Research, and Management Cybernetics to the list. In addition, Systems Dynamics pioneered by J.W Forrester concludes the list.

Figure A1, (Frame 3.2) pertains to problem solving of 'real world' phenomena having two distinct components namely:

- The 'hard' systems approach, (analysed in this Appendix).
- The 'soft' systems approach, (analysed in Appendix B).

A2 SYSTEMS ENGINEERING

In his description of the nature of systems engineering, Checkland (1989:138) views the concept as:

> *"a set of activities which together lead to the creation of a complex man-made entity and/or procedures and information flows associated with its operation"*

Jackson (1991:74) cites Jenkins (1972)[3] who defines systems engineering as:

> *"The science of designing complex systems in their totality to ensure that the component subsystems making up the system are designed, fitted together, checked and operated in the most efficient way"*.

For Jenkins (1972), the purpose of systems engineering is to ensure the optimal use of resources, the main ones being men, money, machines, and materials. This can be achieved through a methodology incorporating four basic phases namely:

- Systems analysis.

[3] Jenkins GM 1972. The Systems Approach. (*In:* Beishan J & Peters G *eds.* Systems Behaviour. London:Oxford University Press).

- Systems design.
- Systems implementation.
- Systems operation.

Systems analysis: In this phase, the real world is taken to consist of systems and are examined in systems terms. The problem is formulated and the system in which it exists is defined and analysed in terms of important subsystems. Thereafter, the interactions between these subsystems are studied.

Systems design: In this phase, the future environment of the system is forecast. The system is then represented in a quantitative model that simulates its performance under different operational conditions. The particular design that optimises the performance of the system in pursuit of its objectives is then chosen. The model therefore is an aid in the prediction of the consequences that follow from adopting alternative designs. Furthermore, a control system is incorporated in the design of the optimum system.

Systems implementation / Systems operation phases: These phases involve the construction, operation and testing of the system in the 'real world'. Checkland (1989:74) sees systems engineering as part of 'organised creative technology' in which new research knowledge is translated into applications meeting human needs through a sequence of plans, projects, and 'whole programs of projects'. Hall (1991) offers the following explanation of the concept:

> *"Thus systems engineering operates in a space between research and business, and assumes the attitudes of both. For those projects which it finds most worthwhile for development, it formulates the operational, performance and economic objectives, and the broad technical plan to be followed".*

The following problem-solving sequence is suggested by Hall (1991):

- Problem definition.
- Choice of objectives.
- System synthesis.

- System analysis.
- System selection.
- System development.
- Current engineering.

From the above, the analogy can be drawn that there is a need to import the concept of '*Weltanschauung'* into systems engineering in order to cope with human activity systems. This is based on the fact that hard systems are only concerned with a single '*Weltanschauung'*, 'a need is defined or an objective is stated, and an efficient means of meeting the need or reaching the objective is needed'.

A3 SYSTEMS ANALYSIS

Jackson (1991:75) cites Quade 1963[4] , who defines systems analysis as:

> *"Analysis to suggest a course of action by systematically examining the costs, effectiveness and risks of alternative policies or strategies – and designing additional ones if those examined are found wanting".*

According to Jackson (1991:75), systems analysis developed out of wartime military operations planning during the 1940's and 1950's were applications primarily involving work on weapons systems and strategic missile systems. At that time, the approach was closely associated with the Rand Corporation, a non-profit body in the advice giving business that was set up in 1947 and came to embrace systems analysis as its favoured methodology. As a result of the Rand Corporation's association with systems analysis, the latter became to be known as Rand ('research and development') –style analysis.

Jackson (1991:76) describes the methodology of systems analysis being consisting of seven major steps, namely:

[4] Quade ES. 1963. Military systems analysis. (*In:* Optner SL. *ed.* 1995. Systems Analysis.Harmondsworth: Penguin.)

- Formulating the problem.
- Identifying, designing, and screening alternative responses.
- Building and using models for predicting the consequences of adopting particular responses.
- Comparing and ranking alternative responses.
- Evaluating the analysis.
- Decision and implementation.
- Evaluating the outcome.

From the above description, Checkland (1989:137) draws the analogy that the establishment of systems analysis is a way of tackling complex problems of resource allocation in defence, thus becoming inevitable that it should be advocated as a methodology for business managers who face problems of a similar kind. According to Ways (1967:374), 'systems analysis involves ways of arranging ends and means so that decision makers have clearer ideas of the choices open to them and better ways of measuring results against both expectations and objectives'. This description is supported by Schoderbeck *et al. 1975*[5] cited by Checkland (1989:137), who define systems analysis as:

> *"The organised step-by-step study of the detailed procedures for the collection, manipulation and evaluation of data about an organisation for the purpose of not only of determining what must be done, but also of ascertaining the best way to improve the functioning of the system".*

While the systems approach is more 'synthesis' than 'analysis', the following abbreviated rendition from Johnson (1997:48) by example demonstrates the distinctive differences between the entities 'systems analysis' and 'systems synthesis':

- **Analysis:** In terms of 'analysis', the first step to understanding a system is to take it apart. Consider a University for example. An analysis to define a

[5] Schoderbeck PP Schoderbeck CG & Kefalas AG. 1975. Managing systems: Conceptual Considerations. Dallas: Irwin-Dorsey.

University, one might first say that it consists of colleges, in turn, contain departments, and departments are made up of students, faculty, and areas of study. The University can be continued to be reduced in this way until all of its indivisible elements are identified. From this an understanding can be built up of the entire University.

- **Synthesis:** With 'synthesis' the opposite of the process followed in 'analysis' apply. To define a University using 'synthesis', one would first try to determine the larger system of which the University is a part; in this case, education. As a second step, one would try to understand the larger system as a whole. Finally, refinement of the understanding of the University should take place by identifying its role or function in the containing system of which it is a part.

Flow tracing is a dimension which Strümpher (1992:7) adds to the concept 'analysis', and makes the following comparisons between 'analysis', 'flow tracing' and 'synthesis':

- **Analysis:** Strümpher (1992:7) is of the opinion that analysis cannot explain the dynamics of a system, but it can help identify and explain static relationships, i.e. structures. As such the primary knowledge product of analysis is information and the process involves the following steps:
  - Break 'the thing' (system) to be understood into its logically constituent parts.
  - Explain the parts.
  - Assemble the explanation of the parts into an explanation of the whole.

- **Flow tracing:** This methodology is used to obtain insight i.e. knowledge about the process dimension, which is a generalised approach of that which is called 'systems analysis' in the computer world. Flow tracing involves the following steps:
  - Starting at either the input or output points of the system, trace the sequence of matter/energy or information flow through the system.

- Regard process points as points where matter/energy or information flows enter and are transformed into new matter/energy or information flows, thus describing the transformation that takes place.
- Assemble an integrated process diagram, which describes the matter/energy or information flows, their confluences and the transformations.

- **Synthesis:** Neither 'flow tracing' nor 'analysis' can form understanding. To form understanding requires explanation of the function(s) fulfilled by the system with respect to a containing whole. To form understanding one requires 'synthetic thinking', which follows the following process:
  - Place the entity (system) to be understood within a containing whole.
  - Explain the containing whole.
  - Explain the item of interest by explaining the function(s) that it fulfils with respect to the containing whole.

Capra (1996:29-30), summarises the functionality of the two entities by using the analogy that 'analysis means taking something apart in order to understand it, and synthesis[6], means putting it into the context of a larger whole'. Against the background of the theme of this thesis, the observation of Lewis (1995b:188), that 'system analysis is becoming of increasing importance as data analysis is used earlier in the systems development process, and as thinking in the field of information systems increasingly emphasises the social nature of organisations'.

A4 OPERATIONAL RESEARCH

The first textbook according to Jackson (1991:77) on 'operational research' appeared in 1957 and was written by Churchman *et al*. entitled, '*Introduction to Operations Research'*. According to Jackson (1991:77), operational research as an established concept emerged during World War II, when military management called on scientists in large numbers to assist in solving strategic and tactical

[6] The original text used by Capra (1996:29-30) refers to the concept 'systems thinking', as opposed to the word 'synthesis' as used within context of this thesis.

problems. Many of these problems fell in the category of 'executive-type problems'. Scientists from different disciplines were organised into teams, which were addressed initially to optimising the use of resources and thus becoming the first operational research teams.

One of the objectives of operational research as it emerged from the evolution of industrial organisation was to provide managers of the organisation with a scientific basis for solving problems involving the interaction of components of the organisation in the best interest of the organisation as a whole. Such decision would become known as the 'optimum decision', while the best relative to the function of one or more parts of the organisation would be known as a 'sub-optimum decision'. The problem of establishing criteria for an optimum decision would prove in itself to be very complex and technical. In summary, the objectives of operational research were to find the best decisions relative to a large portion of a total organisation as is possible. One of the earlier views on the purpose of operational research is provided by Ackoff (1960:331), who was of the opinion that operational research is concerned with increasing the effectiveness of operations of organised man-machine systems, and according to Ackoff and Rivett (1967:10), based on three essential characteristics namely:

- Systems orientation.
- The use of interdisciplinary teams.
- The adaptation of scientific method.

Jackson (1991:77) identifies six phases of an operational research project, while Ackoff and Sasieni (1968:11) identifies five stages, combined here for ease of reference as follows:

- Formulating the problem.
- Identifying, designing, and screening alternative responses.
- Building and using models for predicting the consequences of adopting particular responses.
- Comparing and ranking alternative responses.
- Evaluating the analysis.
- Decision and implementation.
- Evaluating the outcome.

Ackoff with co-author Sasieni (1968:6) provides the following as a useful basis for understanding the nature of operational research, namely:

> *"The understanding of scientific method by inter-disciplinary teams to problems involving the control of organised (man-machine) systems so as to provide solutions which best serve the purposes of the organisation as a whole".*

The Operational Research Society's official definition for operational research as cited by Jackson (1991:77) reads as follows:

> *"Operational Research is the application of the methods of science to complex problems arising in the direction and management of large systems of men, machines, materials and money in industry, business, government and defence. The distinctive approach is to develop a scientific model of the system, incorporating measurements of factors such as chance and risk, with which to predict and compare the outcomes of alternative decisions, strategies and controls. The purpose is to help management determine its policy and actions scientifically".*

Interpretation of this definition and its applicability as a viable solution in solving complex phenomena of the real world is provided by Checkland (1989:73) as follows:

- The definition of operational research applies the methods of science to parts of the real world, as opposed to artificial situations created in the laboratory. It is interesting to note that engineers apply the same solution: To carry out 'experiments', not on the real world object of study, - which is usually not available – but on a model of it, if possible a quantitative model.
- The strategy of operational research, is to build a model of the process concerned, one in which the overall performance is expressed in some explicit measure of performance (often economic), then to improve and optimise the model in terms of the chosen performance criterion. Finally, to transfer the solution derived from the model to the real world situation. This equates to an

attempt to be scientific in the real world as opposed to the laboratory. Beer (1970:246) is of the opinion that when the operational research scientist sets about the task of making a particular model rigorous, he is using the tool called 'General Systems Theory'[7].

- The strategy obviously ought not to be pressed unless the model can be shown to be valid. In the case of a well defined production process, this may not be too difficult – if the model when fed with last year's demand, can generate last year's output generating a feeling of confidence
- No single performance criterion can possibly unite within itself the myriad considerations, which actually effect decisions in social systems.

From the above interpretation, Checkland (1989:73) draws the analogy that what operational research can provide is one crucial contribution to a management decision, a rational story of the form: 'If you adopt *X* as the measure of performance, then you may optimise with respect to *X* by the following actions …, but it can hardly generate the kind of irrational decisions which, in a management situation, often turns out to be a good one'.

This criticism is echoed by Jackson (1991:78) who is of the opinion that:

> *"Operational research largely abandoned any pretence of taking a 'systems approach' or of being interdisciplinary in nature. It failed to establish itself at the strategic level in organisations and become associated with a limited range of mathematical techniques".*

It is of interest to note that Ackoff (1960:331), as early as 1960 saw that systems engineering and operational research was converging into one entity, namely 'systems research'.

[7] As described in Chapter 4, Paragraph 4.3.

A5 MANAGEMENT CYBERNETICS

The ultimate solution for addressing unstructured complex phenomena will in this thesis not be limited to a single set of problem solving methodologies. While management cybernetics falling within the ambit of the hard systems approach, (as opposed to organisational cybernetics, a soft systems approach, which will be discussed in Appendix B) do not form part of the core of the thought processes to address the research problem, the building blocks thereof however requires scrutiny for the purpose of completeness. These building blocks of management cybernetics according to Jackson (1991:94) include:

- The 'black box technique', which is used to deal with issues of extreme complexity.
- 'Negative feedback', which is used for the management of self-regulation.
- 'Variety engineering', which is used for probably yields.

A5.1 BLACK BOX TECHNIQUE

Exceedingly complex systems according to Cleland & King (1972:46-47), which are so complicated that they cannot be described in any precise manner or detail are commonly known in cybernetic terms as 'black boxes'. The complexity of such systems according to Schoderbek *et al. (1985)*[8] cited by Jackson (1991:95) is the combined outcome of the interaction of four main determinants namely:

- The number of elements comprising the system.
- The interactions among these elements.
- The attributes of the special elements of the system.
- The degree of organisation in the system.

It is interesting to note that Sterman (1988:24), consider certain computer models as being black boxes, due to the fact that these devices operate in completely mysterious ways.

[8] Schoderbeck PP Schoderbeck CG and Keflas AG 1985. Management Systems: Conceptual Considerations. Dallas: Irwin-Dorsey.

The way 'not' to proceed in approaching an exceedingly complex system – 'a black box' – according to Ashby (1956b:11), is by analysis. Instead of analysis, the black box technique of input manipulation and output classification should preferably be employed. According to Jackson (1991:96), faced with a black box a manager does not have to enter it to learn something about it. Instead, the system is investigated by the collection of a long protocol, drawn out in time showing the sequence of input and output states. The manager can then manipulate the input to try to find regularities in the output. Initially, if nothing is known about the black box, random variations of input will be as good as any. As regularities become established, a more directed program of research can be conducted.

Caution regarding the use of this technique is provided by Ashby 1956a[9] and Beer 1979[10] cited by Jackson (1991:96). According to Ashby, there are problems with the black box technique, as when a particular experiment changes a system to such an extent that it cannot be returned to its original state for further experimentation. According to Beer it is very important not to jump to conclusions about the behaviour of a system, without observing it for a sufficient length of time.

A5.2 NEGATIVE FEEDBACK

According to Jackson (1991:97), exceedingly complex probabilistic systems have to be controlled through self-regulation. To understand what such self-regulation cybernetics can provide, it is important to understand the following two concepts:

- It is the existence of mechanisms bringing about self-regulation that gives a degree of stability to the environment of organisations.
- Due to the fact that managers lack 'requisite variety' they should understand the nature of self-regulation they wish to induce in the organisation they manage.

[9] Ashby WR. 1956a. An Introduction to Cybernetics. London: Chapman and Hall.
[10] Beer S. 1979. The Heart of the Enterprise Chichester: Wiley.

The work of Wiener (1948)[11] cited by Jackson (1991:97), has established that the way to ensure self-regulation is through the negative feedback mechanism. The feedback control system is characterised by its closed-loop structure. It operates by the continuous feedback of information about the output of the system. This output is then compared with some predetermined goal, and if the system is not achieving its goal, then the margin of error (the negative feedback) becomes the basis for adjustments to the system designed to bring it closer to realising the goal. Churchman (1983:175) defines negative feedback as:

> *"A situation in which information coming to the manager arrives at the right time for him to take the appropriate course of action"*.

Four distinctive elements are required for negative feedback to function optimally, namely:

- A desired goal, which is conveyed to the comparator from outside the system.
- A sensor (a means of sensing the current state of the system).
- A comparator, which compares the current state and the desired outcome.
- An activator (a decision-making element that responds to any discrepancies discovered by the comparator in such a way as to bring the system back toward its goal).

This kind of control system is extremely effective, since any movement away from the goal automatically sets in motion changes aimed at bringing the system back onto course.

A5.3 VARIETY ENGINEERING

Executive management are faced on an ongoing basis with complex phenomena, which are invariable unstructured and unexpected, resulting in the use of probabilistic systems. In this respect, Ashby (1956b:110) provides some understanding of such difficulties and ways in which they should be dealt with

[11] Wiener N 1948 Cybernetics: OR and com munications in the animal and machine. New York: Wiley.

from a cybernetic point of view using 'variety engineering'. According to Ashby (1956b:110), variety of a system is defined as:

"The number of possible states it is capable of exhibiting".

It is therefore, a measure of complexity. The problem for management, as Ashby's 'Law of Requisite Variety' has it, is that only 'variety can destroy variety', thus in order to control a system, as much variety available is needed as the system itself exhibits. When faced with massive variety, the variety must either be reduced (variety reduction) or increased (variety amplification), a process according to Beer (1981:41) which is known as 'variety engineering'. From this follows the analogy that since the variety equation initially seems to place executive management at a disadvantage it will require all the skills available to balance varieties and (following the law of requisite variety) to achieve control.

Beer (1981:230-231) provides comprehensive tables, which highlights the techniques that executive management can employ to reduce external variety of both kinds (operational and environmental) and amplify their own variety. An abridged extract of Beer's tables to illustrate the techniques is reproduced here from Jackson (1991:102), as follows:

To reduce the external variety, managers can use:

- Structural (e.g. divisionalisation, functionalisation, massive delegation).
- Planning (e.g. setting priorities).
- Operational (e.g management by exception).

In amplifying their own variety, executive management can employ the following methods:

- Structural (e.g. integrated teamwork).
- Augmentation (e.g. recruit experts, employ consultants).
- Informational (e.g. management information systems).

The following extract from Beer (1981:41), provides and incumbent summary of the concept variety engineering:

> *"The output variety must (at least) match the input variety for the system as a whole, and for the input arrangement and the output arrangement considered separately".*

This is a vital important application of Ashby's Law of Requisite Variety, which determines that control can be obtained only if the variety of the controller, (and in this case of all the parts of the controller) is at least as great as the variety of the situation to be controlled.

A6 SYSTEMS DYNAMICS

The 'systems dynamics' approach of Forrester (1977:14) has its roots in the following four traditions:

- Advances in computer technology.
- Growing experience with computer simulation.
- Improved understanding of strategic decision making.
- Developments in the understanding of the role of 'feedback' in complex systems.

Forrester (1977:13) and Vennix *et al*. (1994:31), list near identical steps for the systems dynamics approach. These steps include:

- Problem identification.
- Factor isolation.
- Tracing of information-feedback loops.
- Formulation of decision policies.
- Construction of mathematical models.
- Generate behaviour through the model.
- Compare results against available knowledge.
- Revise model.
- Redesign, within the model, the organisational relationships and policies.
- Alter the real system.

Systems thinking in the systems dynamics tradition according to Richardson (1996:ix), is the fifth of five disciplines of the learning organisation. According to

Sahin (1979:105), the systems dynamics approach to modelling social systems, appears to be gaining rapid acceptance as a legitimate tool of management science even as it still evokes controversy. Sahin (1979:108), is of the opinion that the controversies might have been caused not so much by the methodology itself, but by the areas to which it has been applied (e.g. world dynamics), and the manner in which it has been applied (e.g. using possibly heroic assumptions or building on partly impressionistic data). The systems dynamics approach according to Richardson (1991:3), involves:

- Defining problems dynamically, in terms of graphs over time.
- Striving for an endogenous, behavioural view of the significant dynamics of a system, a focus inward on the characteristics of a system that themselves generate or exacerbate the perceived problem.
- Thinking of all concepts in the real system as continuous quantities interconnected in loops of information feedback and circular causality.
- Identifying independent stocks of accumulation (levels) in the system and their inflows and outflows (rates).
- Formulating a behavioural model capable of reproducing, by itself, the dynamic problem of concern – the model is usually a computer simulation model expressed in non-linear equations, but is occasionally left un-quantified as a diagram capturing the stock-and-flow/causal feedback structure.
- Deriving understandings and applicable policy insights from the resulting model.
- Implementing changes resulting from model-based understandings and insights.

It is important to note that, while systems dynamics is categorised in this thesis as belonging to a hard systems approach, it is acknowledged that recent interest has grown in systems dynamics as a soft modelling methodology. This soft approach to systems dynamics according to Morecroft (1988:308), is being spearheaded by Wolstenholme (1983)[12] and Wolstenholme and Coyle (1983)[13].

[12] Wolstenholme EF. 1983. Systems dynamics: A system methodology or a system modeling technique. *Dynamica 9*. [Part ii.]

[13] Wolstenholme EF & Coyle RG. 1983. The development of systems dynamics as a methodology for systems description and qualitative analysis. *Journal of the Operational Research Society,* 34(7).

A6.1 PHILOSOPY OF SYSTEMS DYNAMICS

Underpinning Jay Forrester's systems dynamics, is a theory of information feedback and control as a means of evaluating business and other organisational and social contexts. A systems dynamics view is one that places emphasis on structure and the processes within that structure, assuming that this is how dynamic behaviour in the real world can best be characterised. Systems dynamics considers behaviour as being principally caused by structure. It is a theory of the structure of systems and dynamic behaviour. Structure includes not only the physical aspects of plant and production processes, it also importantly refers to the policies and traditions, both tangible and intangible that dominate decision-making. Thus, systems dynamics assumes that analysis of a situation can be undertaken from an external objective viewpoint and that the structure and dynamic processes of the real world can be recreated in both systems diagrams and mathematical models. Morecroft (1994:15) describes systems dynamics as:

> *"a framework for thinking about how the operating policies of a company and its customers, competitors, and suppliers interact to shape the companies performance over time".*

Furthermore, systems dynamics builds on information feedback theory, which provides symbols for mapping business systems in terms of diagrams and equations, and a programming language for making computer simulations.

The tendency is to evaluate the applicability of methodologies only from a private sector perspective, while the public sector management and policy is equally fraught with many of the same problems encountered in private sector applications. The path to the implementation of insights is even more difficult. In addition, one of the major contributions made by Forrester was to reshape sophisticated modelling and analysis methods from control engineering into a flexible form suited to modelling and debate in the business/social arena (Moorcroft 1988:303).

A6.2 PRINCIPLES OF SYSTEMS DYNAMICS

The philosophy of systems dynamics emphasises model structure which supports an interest in prediction and control, culminating in the main principles of analysis. Structure is seen as having four significant characteristics, which amount to the focal concerns of any systems dynamics analysis, which are:

- Order.
- Direction of feedback.
- Non-linearity.
- Loop multiplicity.

A6.3 MODEL AND METHODOLOGY OF SYSTEMS DYNAMICS

Sahin (1979:15) is of the opinion that the most widely used approach in constructing 'initial' systems dynamics models is to identify the feedback loops and depict them as a causal loop diagram[14]. This is supported by Richardson (1991:4), who confirms that, 'conceptually, the feedback concept is at the heart of the systems dynamics approach'.

Morecroft (1984:54), provides the following description of a systems dynamics model:

> *"A systems dynamics model is descriptive of the way a company functions; it does not contain idealized decision-making processes. It shows the division of responsibilities, the goal and reward structure of the organization, as well as the inconsistencies of policy that are a part of any real organization".*

Wolstenholme (1994:193), suggests a 'stepwise approach' to model construction and analysis for use in systems dynamics. This is based on a combination of identifying information feedback loops and a modular approach. By their own admission, Flood and Jackson (2002:66) admits that there are many versions of

[14] Refer to Chapter 4, Paragraph 4.9.

how a quality model can be formulated, hence the approach to provide a model developed from their own work which consists of the following elements:

- Identification of the organisational problem, which focuses the attention of the decision-makers, and leads to their purposeful activity.
- Carry out 'task formulation' to assist in determining the appropriate way forward.
- Set modelling purposes which determine in unitary fashion the essential characteristics of the model to be formulated.
- Pragmatic review extant models.
- User assessment.
- Model construction (starting with the drawing up of a model development sub-methodology).
- Introduction of a validation sub-methodology.
- Model formulation:
  - Conceptualising.
  - Formulation
  - Simulation.

A6.4 MODEL UTILISATION OF SYSTEMS DYNAMICS

According to Meadows (1980)[15] cited by Flood and Jackson (2002:73-74), there are three stages in a decision making process to which systems dynamics must contribute:

- First, is to appreciate in a broad sense the situation of concern and to develop a non-precise understanding of the dynamics.
- Second, this broad understanding needs to be translated into ideas about how to improve problematic aspects which requires deeper investigation into the structure that underlies behaviour, although exact precision is not necessary.
- Third, is the need for detailed implementation where precision is vital.

[15] Meadows D. 1980. The unavoidable a priori. (*In:* Randers J. Elements of the System Dynamics Method. Cam bridge: MIT.

The type of 'systems thinking' which has emerged from the concepts of systems dynamics, is concerned with assisting the process of strategic debate by developing transparent models which at the qualitative phase, facilitate knowledge capture and pluralistic exploration of process, structure and strategy. At the quantitative phase, are capable of being developed into computer-based micro-worlds and archetypes by which insights can be disseminated in a hands-on framework.

Contents: Appendix B

Appendix B

Analysis of the Soft Systems Approach

B1 INTRODUCTION

The revered and industry proven academic research of Beer, Churchman, Checkland, Ackoff and Mitroff and Mason into the complexities of the soft systems approach, is in the opinion of the author of this thesis, highly representative of this concept from a holistic perspective. Furthermore, the research in this thesis will be limited to the work of these authors as they were specifically selected for their appropriateness to this research. It would however be naïve not to acknowledge the work of other influential academics in the field of soft systems methodologies, which regrettably will not be included.

The following problem solving methodologies which will be analysed in this Appendix are:

- The Viable Systems model of Beer (Organisational cybernetics).
- Churchman's Social Systems Design.
- Checkland's Soft Systems Methodology.
- Ackoff's Interactive Planning.
- Mitroff and Mason's Strategic Assumption Surfacing and Testing Methodology.

To ensure that the entities under discussion are not only appropriately placed within context of soft systems, but also within context of the overall research of this thesis, the classification of systems falling within the ambit of the systems approach depicted in Chapter 4, Paragraph 4.1, Figure 4.3, is repeated here as Figure B1. Figure B1 is however modified to indicate the relative position of 'soft systems'.

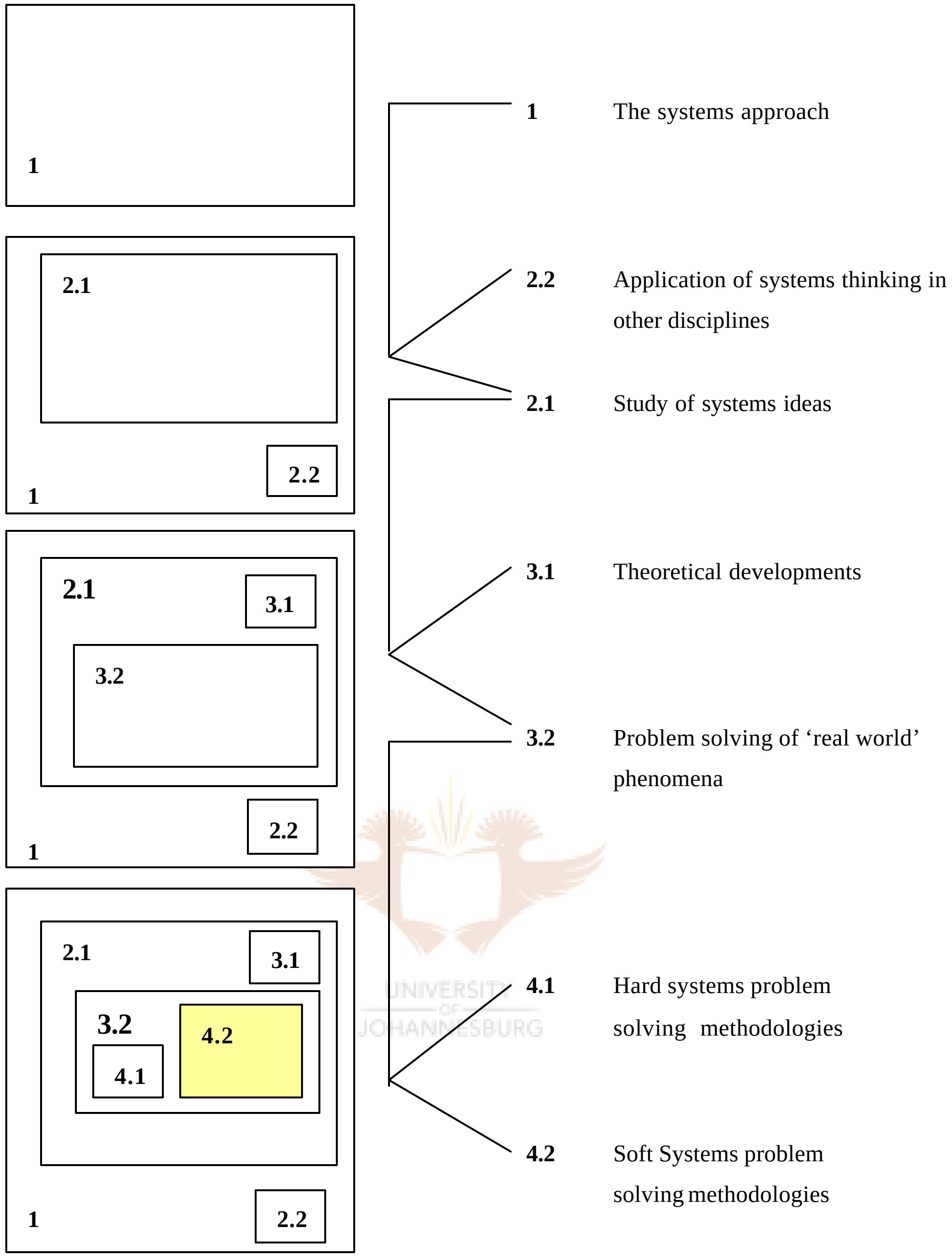

Figure B1: Classification of systems falling within the context of the systems approach.

B2 BEER’S VIABLE SYSTEMS MODEL

B2.1 BACKGROUND

The traditional company organisational chart is for Beer (1981:205) (1995:x) totally unsatisfactory as a model of a real organisation, offering his Viable System Model as a more useful and suitable alternative option. Beer’s model consists of five sub-systems – System One to System Five. According to Jackson (1991:105), the same model is derived from cybernetics and can therefore be applied to firms and organisations of all kinds[1]

According to Jackson (1991:105), Beer believes that a system is viable if it can respond to environmental changes. To remain viable, a system has to achieve requisite variety with the complex environment with which it is faced. Beer sets out a number of strategies that can be used by managers to balance the variety equations, the most important of which involves 'variety engineering', previously discussed in Appendix A, Paragraph A5.3. Having previously created some understanding of 'organisational cybernetics' *per se*, the philosophy and principles of the Viable Systems model of Stafford Beer which is intimately associated with this concept, require closer scrutiny.

B.2.2 PHILOSOPHY OF THE VIABLE SYSTEMS MODEL

The philosophy that drives Beer's view of cybernetics concerns the kind of changes to be experienced in the Twenty First Century, and that 'new ways' are required to deal with difficulties associated with changes. The main points underpinning the above, are summarised by Flood and Jackson (2002:89), as follows:

- Organisational and social problems arise because of new degrees of complexity (organisational, technological, informational and so on) and are characterised by interdependency.
- Scientifically based management taking advantage of technological advances (e.g. increased information processing capability) is vital because more traditional approaches are quite simply too trivial, and in isolation are not well worked out. Therefore, a scientific model that is based on cybernetic principles and which encompasses many ideas from management science is fundamental in the efforts to deal with modern complexities.

[1] The reader is cautioned to view this statement against the background of the analysis of cybernetics (Refer Appendix A, Paragraph A5), where a clear distinction is made between 'organisational cybernetics' and 'management cybernetics'.

- Since control is the main concern, the best approach is to replicate a well tried and tested control system. This being evident in the neuro-cybernetic processes of the human brain and nervous system as it has evolved over millennia (the same control model can, however, be derived from cybernetic first principles and is applicable to all systems.)
- Organisations ideally are ordered so as to achieve efficient and effective realisation of set goals, although the goals themselves have to be continually reconsidered in response to a rapidly changing environment through self-questioning, learning and by assessing future scenarios.

B2.3 PRINCIPLES OF THE VIABLE SYSTEMS MODEL

The principles that underpin the approach are all cybernetic in nature and outlined by Flood and Jackson (2002:89), as follows:

- Recommendations endorsed by the Viable Systems model do not prescribe a specific structure, rather they are concerned with the essentials of organisation and maintenance of identity. They are therefore, relevant to all types of enterprise, whether small, medium or large, in all types of industry. The structural outline of the Viable Systems model is completed with one of the basic concepts developed by Beer (1981:228)(1995:2), namely the concept of a 'recursion levels'. In its most elementary formulation according to Hoebeke (1993:40), the 'Recursive System Theory' reads as follows:

> *"In a recursive organizational structure, any viable system contains and is contained in a viable system"*.

Furthermore, the notion of recursion is fundamental so that vertical interdependence can be dealt with. Recursion means that the whole system is replicated in the parts so that the same viable system principles may be used to model a sub-system (a division) in an organisation, and its supra-system (that of which the system is a part or a division of).

- In any viable unit, horizontally interdependent sub-systems (divisions) are integrated and guided by the viable unit's 'meta-system', or 'higher' management levels.

- Sources of command and control are of particular concern and in the Viable Systems model these sources are spread throughout the architecture of the Viable Systems model, which enhances self-organisation and localised management of problems.
- Emphasis is placed on the relationship between the viable unit and its environment in terms of influencing and being influenced by it and particularly on using this relationship to promote learning.
- There are many other cybernetic principles that make up the viable system view, from rather simple notions of feedback to important principles such as the 'Law of Requisite Variety', that is the variety of the controller must be equal to, or greater than that which is being controlled.

B2.4 CONSTRUCTION OF THE VIABLE SYSTEMS MODEL

This highly complex model consists of basic building blocks forming the core of its structure and is comprehensively discussed by Beer in his work *'Brain of the Firm': 'The Managerial Cybernetics of Organization'*. Using the abbreviated analysis of Clemson (1984:84-144), as opposed to the comprehensive study of Beer, the interactive components, which forms an operational unit are shown in Figure B2.

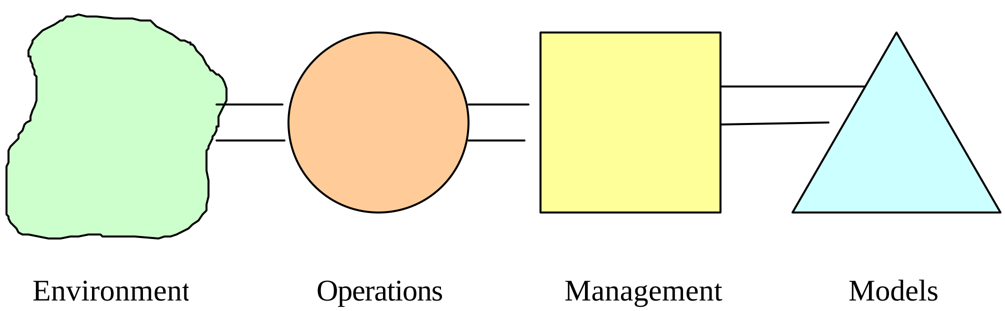

Figure B2: An operational unit dissected to show the major interactions

Figure B2 can be analysed as follows:

- **Environment:** The amoeboid shape is represented as an operational unit within an organisation.
- **Operation:** Imbedded within the environment with a flux of interaction between the 'environment' and the 'operation'.

- **Management:** There is a clear distinction between the 'operation' and 'management' thereof.
- **Models:** As in the case between management and operation, a clear distinction exists between the 'management' and the 'models' of the organisation or unit that the management holds. These models may be partially explicit (e.g. a computer simulation), but they are always at least partially (and often almost entirely) implicit, buried in people's heads in the form of biases, prejudices or guesses etc. In whatever form these models exist, they constitute the management's view of the unit that is being managed.

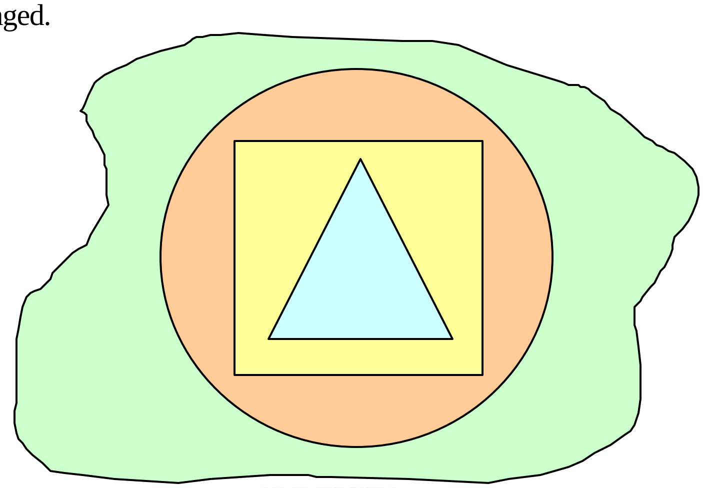

Figure B3: An operational unit showing the parts embedded

Figure B3 depicts an operational unit showing the parts environment, operations, management, and models embedded within one another. To represent a whole organisation, Figure B3 can be expanded to reflect a set of related operational elements as depicted in Figure B4.

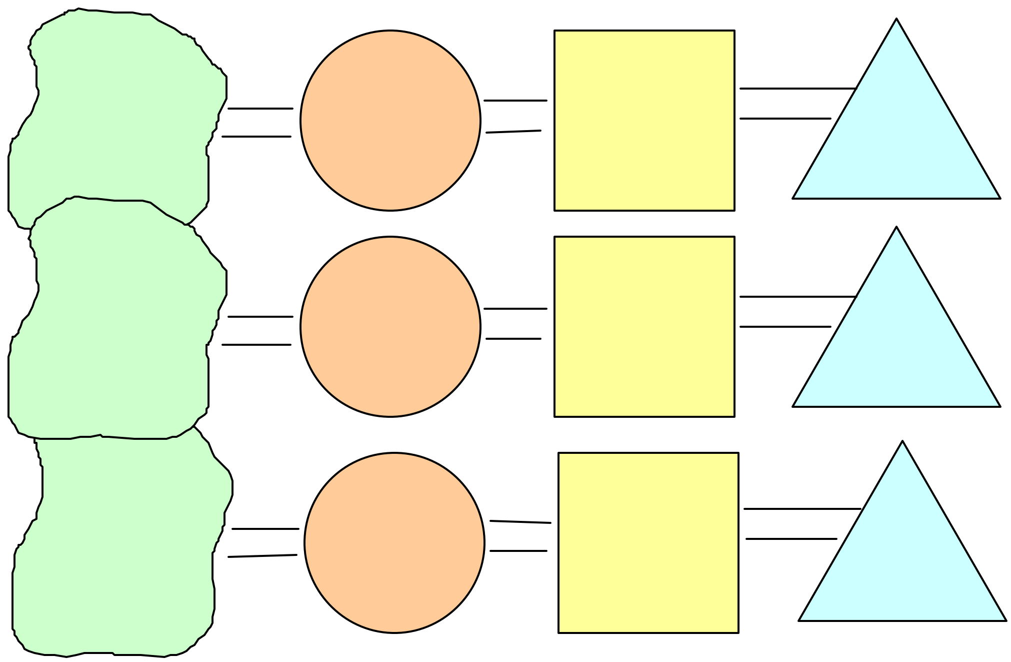

Figure B4: A set of related operational elements

The five components making up the Viable Systems model (System One to System Five) can be analysed as follows:

- **System One:** By linking the interaction of views of each manager in charge of each unit and the direct interaction which flows from one operation to the other, the set of related operational elements depicted in Figure B4 can be redrawn to collectively make up an organisational entity, termed 'System One' by Beer (1995:19) and depicted in Figure B5.

In summary, the following key aspects concerning 'System One' are applicable:

- System One parts are directly concerned with implementation.
- Each part is autonomous in its own right.
- Each part exhibits all the features of a viable system itself.
- Each part connects to its local environment and so absorbs much of the overall variety.

- **System Two:** This system, 'the co-ordination channel' prevents the various operational units from affecting each other adversely through inadequate co-ordination to operate effectively. The function of System Two must operate as a real-time co-ordinated mechanism for the operational elements.

In summary according to Flood and Jackson (2002:92), the following key aspects concerning System Two are applicable:

- Co-ordinates the parts that make up System One in a harmonious manner.
- Dampens uncontrolled oscillations between the parts.

- **System Three:** This system is charged with maintaining 'internal' homeostasis (audit), which include the following tasks:
  - Ensure that its organisation as an entity, produces the outputs that the larger organisation requires of it.
  - Ensure that its internal operational elements each produce the outputs that it is assigned to produce.
  - Ensure that its internal operational elements are able to secure resources that they need to function.
  - Ensure that the workings of its internal operational elements are co-ordinated and do not generate vicious cycle effects.
  - Be concerned about the possibility of synergistic relationships among its operational units.

  In summary, according to Flood and Jackson (2002:92), the following key aspects concerning System Three are applicable:
  - A control function that ultimately maintains internal stability.
  - Interprets policy decisions of higher management.
  - Allocates resources to the parts of System One.
  - Ensures effective implementation of policy.
  - Carries out 'audits' using the System Three auditing channel.

- **System Four:** This system is charged with the 'external' and the 'future', as contrasted with System Three, which deals with the 'internal' and the 'now'. These include the following tasks:
  - Create an explicit model of the organisation – 'what' does the organisation do and 'how' does it do it?
  - Model the organisation's environment.

- Given that the organisation has a model of itself and a model of its problematic environment, it now is tasked to build its 'desired' future.

In summary, according to Flood and Jackson (2002:92) the following key aspects concerning System Four are applicable:

- An intelligence gathering/reporting function that captures all relevant information about a system's total environment.
- Provides a model of the organisation's environment.
- Distributes environmental information upwards or downwards according to its degree of importance.
- Brings together internal and external information in an 'operations room' - an environment for decision.
- Rapidly transmits urgent information from Systems One, Two and Three to System Five.

- **System Five:** This system has as its primary function, the maintenance of 'creative tensions' between Systems Three and Four. This implies that System Five has to maintain a balance between 'stability' entrenched within the context of System Three, and 'change' entrenched within the context of System Four. Furthermore, System Five is typically a function of the organisation's executive management. Thus, System Five which provides 'identity', would also be able to maintain the proper balance between System Three and System Four.

In summary, according to Flood and Jackson (2002:92), the following key aspects concerning System Five are applicable:

- Is responsible for policy.
- Responds to significant signals that pass through the various 'filters' of Systems One, Two, Three and Four.
- Arbitrates between the sometimes-antagonistic internal and external demands on the organisation as represented respectively by Systems Three and Four.
- Represents the essential qualities of the 'whole system' to any 'wider system' of which it is a part.

The completed structure of the Viable Systems model can now be graphically summarised by expanding Figure B4 to become Figure B5.

- **System One:** The collection of operational elements.
- **System Two:** The co-ordinating function.
- **System Three:** The 'internal' and 'now' management function.
- **System Four:** The 'external' and 'future' management function.
- **System Five:** The closure and identity management function.
- **Recursion:** Level '*N*' of recursion – one level in a hierarchy of autonomous entities, each of which has a System One, a System Two, a System Three, a System Four, and a System Five.

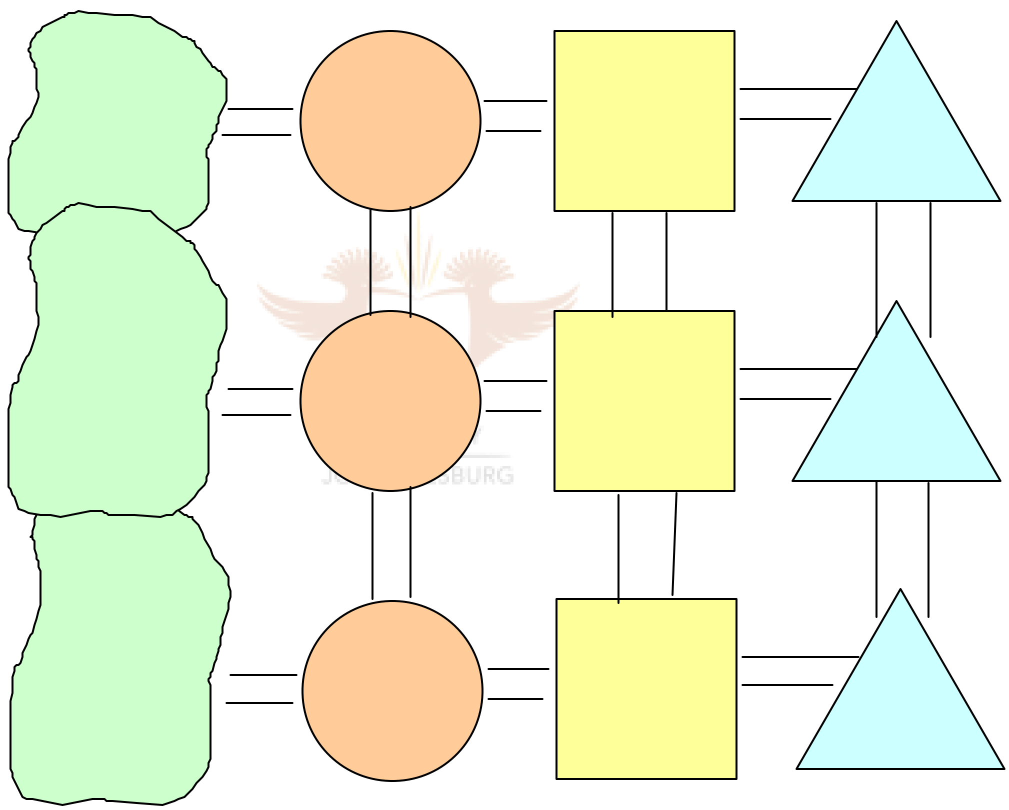

Figure B5: 'System One': A set of operational elements which collectively make up an organisational entity

Analysing the Viable Systems model holistically, Flood and Jackson (2002:90) proposes that the concept is made up of an arrangement of five (Systems One to Five) functional elements that are interconnected through a complex of information and control loops (communication links). Emphasis on recursion allows the utilisation of the 'same' basic model to represent for example, a company and its divisions together with the wider organisations of which it may also be a functional part.

B3 CHURCHMAN'S SOCIAL SYSTEMS DESIGN

B3.1 INTRODUCTION

In the preface of Churchman's Social Systems Design, it is interesting to note that Churchman (1983:i), is of the opinion that:

> *"The systems approach consists of a continuing debate between various attitudes of mind with respect to society".*

Churchman's perspective on systems thinking is the result of careful and profound philosophical exploration. The works of Churchman, while rewarding, is difficult to interpret even by the standards of revered academics in the likes of Checkland, Jackson and Flood and Jackson (by their own submissions).

B3.2 SOCIAL SYSTEMS DESIGN EXPLAINED

In his book *'The Design of Inquiring Systems'*, Churchman (1971:viii) considers that the most important intellectual activity is 'the formulation of social systems'. The book's method is to examine the work of five historical figures – Leibniz, Locke, Kant, Hegel and Singer, taking them to be designers of systems to produce sure knowledge. In an attempt to analyse Churchman's social systems design, Jackson (1991:137-138) take the four aphorisms proposed by Churchman and expand upon them. The four aphorisms (my italics) are:

- *"The systems approach begins when first you see the world through the eyes of another".*
- *"The systems approach goes on to discovering that every world-view is terribly restricted".*
- *"There are no experts in the systems approach".*
- *"The systems approach is not a bad idea"*

B3.2.1 THE FIRST APHORISM ANALYSED

The first aphorism: *'The systems approach begins when first you see the world through the eyes of another,* contains lessons from philosophers Kant and Hegel.

- According to these authors, everyone tell a particular 'story of the world' ('*Weltanschauung'*), based on their own taken for granted, *a priori*, assumptions. However, it is as well to recognise that there are other equally legitimate stories based upon alternative sets of *a priori* assumptions. Once this is recognised, it becomes clear that 'subjectivity' must be embraced in systems thinking, Different evaluations of what needs to be derived from systems, and of their current state of performance, are possible. The only way of grasping the 'whole system' is to sweep in as many different perspectives as possible.
- According to Hegel, it is wise for systems designers to recognise that there are many possible world-views ('*Weltanschauungen'*), constructed upon alternative sets of taken-for-granted assumptions. Once accepted, it becomes clear that subjectivity should be embraced by the systems approach. Systems designers must accept that completely different evaluations of social systems, their purpose, and their performance can and do exist. Churchman's view is that the only way one can get near to a view of the whole system, is to look at it from as many perspectives as possible.

B3.2.2 THE SECOND APHORISM ANALYSED

The second aphorism: *"The systems approach goes on to discovering that every world-view is terribly restricted"*, opens the way for Churchman to a different understanding of 'objectivity'. Subjectivity is no longer to be rigorously excluded, but must be included in any definition of objectivity – so that the restrictive nature of any one world-view can be overcome. Furthermore, although every world-view is terribly restricted, it is also likely to be highly resistant to change. Certainly, worldviews cannot be seriously challenged by presenting them with new facts which they will simply interpret according to their fixed presuppositions. All this adds up to the need for a dialectical approach to objectivity which can be based upon the work of Hegel, the nineteenth-century German philosopher who introduced the notion of 'synthesis of opposites'.

Hegel's central idea according to Pascale (1991:143), and shown schematically in Figure B6, is that one entity (which he called 'thesis'), when juxtaposed with its opposite ('anti-thesis'), can generate a new configuration that both include and transcends the fundamental elements. This phenomenon is known as Hegel's dialectic.

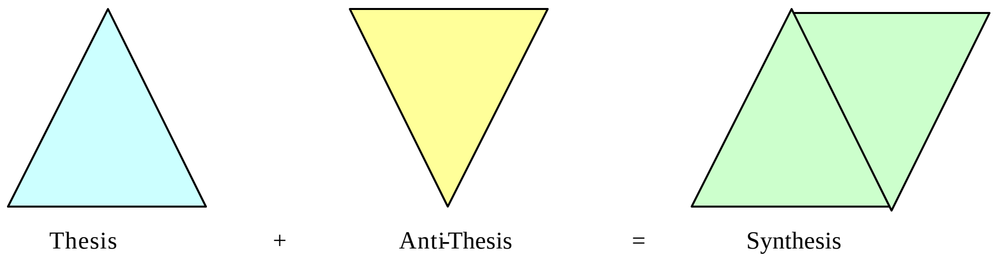

Figure B6: Hegel's Dialectic (Pascale 1991:143)

From this the analogy can be drawn that a 'prevailing worldview' (thesis) should be confronted by 'another worldview' based on entirely different assumptions (anti-thesis), in order to bring about a richer (more 'objective') appreciation of the situation. Furthermore, expressing elements of both positions while going beyond them as well (synthesis). The dialectical process advocated by Churchman can be represented as consisting of the following steps:

- **Thesis:**
  - Understand decision-maker's proposals.
  - Understand the '*Weltanschauung*' that makes these proposals meaningful.
- **Antithesis:**
  - Develop an alternative '*Weltanschauung*'.
  - Make proposals on the basis of this '*Weltanschauung*'.
- **Synthesis:**
  - Evaluate data on the basis of both '*Weltanschauungen*'.
  - Arrive at a richer appreciation of the situation.

B3.2.3 THE THIRD APHORISM ANALYSED

The third aphorism:- *"There are no experts in the systems approach"*, should be taken to heart most strongly by systems designers. When it comes to matters of aims and objectives which inevitably involve ethical considerations and moral judgements, there can be no experts. Systems designers because they seek to take on the whole system, may become arrogant in the face of opposition from apparently sectional interests. It is incumbent on them to listen to all 'enemies' of the systems approach (such as religion, politics, ethics, and aesthetics), since these enemies according to Churchman, reflect the very failure of the systems approach to be comprehensive.

B3.2.4 THE FOURTH APHORISM ANALYSED

With the fourth aphorism: *"The systems approach is not a bad idea"*, Churchman tries to capture the spirit of his mentor the pragmatist philosopher, EA Singer, who advocates the attempt to take on the 'whole system'. Increasing purposefulness and participation in system design, through the process of dialectically developing world-views, is a never-ending process. It was for this reason that Churchman writes:

> *"The Singerian inquirer pushes teleology to the ultimate, by a theory of increasing or developing purpose in human society; man becomes more and more deeply involved in seeking goals"*.

Furthermore, Churchman is of the opinion that there is a need to help bring about a (Lockean) consensus around a particular world-view so that decisions can be taken and action occur. Before this world-view can congeal into a *status quo*, however it should itself be subject to attack from forceful alternative perspectives.

B4 CHECKLAND'S SOFT SYSTEMS METHODOLOGY

B4.1 INTRODUCTION

Inspired by Churchman's Social Systems Design discussed in Paragraph B3, Checkland (1989:18) developed his Soft Systems Methodology for use in 'ill-structured' or 'messy problem contexts'. Within these contexts, there are no clear views on what constitutes a problem, or what action should be taken to overcome the difficulties being experienced. In terms of the complex phenomena executive management are faced with, Checkland's Soft Systems Methodology has the potential to prevent them from rushing into poorly thought-out solutions based on preconceived ideas about an assumed problem.

It is of importance to note that since systems models are always used in the methodological scheme, Checkland's Soft Systems Methodology, clearly assumes that pluralistic issues are tied in with complex issues of organisational structure and process. From this, the analogy can thus be drawn that Checkland's Soft Systems Methodology, has clear tangent planes with Beer's Viable System model discussed in Paragraph B2.

B4.2 PHILOSOPY OF THE SOFT SYSTEMS METHODOLOGY

According to Flood and Jackson (2002:169), the philosophy of the Soft Systems Methodology breaks away from the traditional, hard view of the nature of problems. The Soft Systems Methodology, by contrast, believes the problem situations arise when people have contrasting views on the 'same situation'. The notion of a plurality of possible viewpoints, and consequently acceptance of many 'relevant problems' emerges. 'What should be done?' -becomes the main focus of the Soft Systems Methodology. To answer this question, the Soft Systems Methodology attempts to draw in and explore a diversity of viewpoints as part of the decision making and intervention process.

Two distinct paradigms present in systems thinking are identified by Checkland (1989:141-148), namely:

- **Paradigm 1, the hard paradigm:** The real world is assumed to be systemic and the methodologies used to investigate such reality are systematic.
- **Paradigm 2, the soft paradigm:** Turns things around stating that the real world is problematic, but the process of enquiring into it, the methodologies, may be systemic. This transfers the notion of systemicity from the world to the process of enquiry into the world.

B4.3 PRINCIPLES OF THE SOFT SYSTEMS METHODOLOGY

The four main principles of the Soft Systems Methodology according to Checkland, are summarised by Flood and Jackson (2002:171), and concerns the elements of learning, culture, participation and two modes of thought.

- **Learning:** Checkland (1989:146), talks of the Soft Systems Methodology in terms of 'management', seeking to achieve organised action, coping with an ever-changing flux of interacting events and ideas. Learning is about perceiving and evaluating parts of the flux with new perceptions, evaluations and actions emerging.
- **Culture:** The idea of culture powerfully states that there are organisational and/or social constraints in the real world, which potential changes recommended by intervention must meet. This reinforces the idea of the cohesiveness of social rules and practices.
- **Participation:** The element of participation is such an important factor in the Soft Systems Methodology, that it would be invalid in its own terms.
- **Two modes of thought:** The process of the Soft Systems Methodology, can be distinguished in two modes of thought, namely:
  - Abstract and ideal systems thinking.
  - Specific context-related, real world thinking.

B4.4 SOFT SYSTEMS METHODOLOGY

According to Checkland (1989:154), the Soft Systems Methodology contains two sets of activities namely:

- The first being Stages 1, 2, 5, 6 and 7, which represents real world activities necessarily involving people faced with complex phenomena.

- The second being Stages 3 and 4, which are systems thinking activities, which may or may not involve those in the problem situation.

Figure B7 depicting the Soft Systems Methodology, represents a chronological sequence of the methodology and should be read from Stage 1 to Stage 7[2].

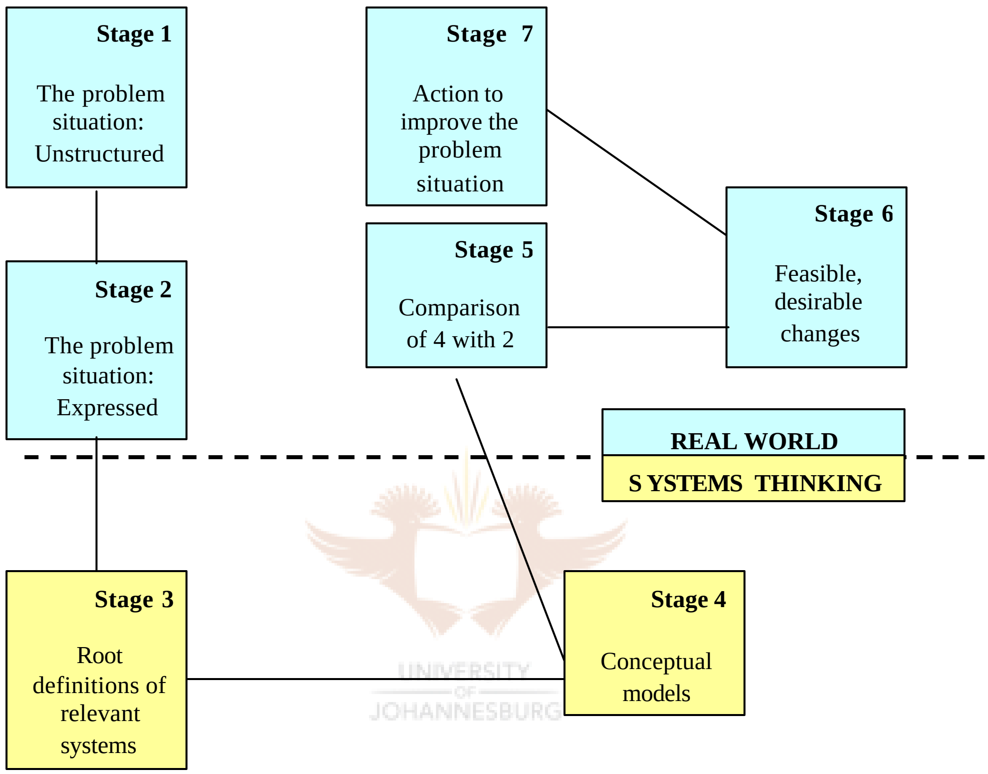

Figure B7: The Soft Systems Methodology in summary

The seven stages making up the Soft Systems Methodology, can be analysed according to Checkland (1989:165-183) and Flood and Jackson (2002:172-177) as follows:

- **Stage 1:** The problem situation: 'Unstructured' (refer Figure B7, Stage 1).

- **Stage 2:** The problem situation: 'Expressed' (refer Figure B7, Stage 2).

[2] While Figure B7 represents a chronological sequence of events for the Soft Systems Methodology and a logical sequence, which is most suitable for describing it, but which does not have to be followed when using the methodology.

These two phases are termed 'expression' by Checkland (1989:165), during which an attempt is made to formulate the richest possible picture, 'not of the problem', but 'of the situation' in which there is perceived to be a problem. Flood and Jackson (2002:172), uses the term 'finding out' for these two phases as it refers to the gathering of information about structure and process by observation, collecting secondary data, and importantly through informal interviews. An alternative approach is to move on to Stages 3 and 4 of the methodology (in this regard, see Footnote 2 of this Appendix B), as a way of promoting Stages 1 and 2. This is done by developing 'primary tasks' root definitions and conceptual models, which must be relevant to the situation, and then comparing these to the real world using the comparison to guide the 'finding out'.

➢ **Stage 3: Root definitions of relevant systems** (refer Figure B7, Stage 3). While Stages 1 and 2 help in the creation of diverse relevant systems, which are pure views of purposeful activity that may promote action for improvement in the problem situation, Stage 3 is concerned with expanding each of these into concise well formulated verbal statements (root definitions). The aim is to 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'. This is achieved by formulating the statement around the following six elements:

- **Customers:** The victims/beneficiaries of the purposeful activity.
- **Actors:** Those who do the activities.
- **Transformation process:** The purposeful activity, which transforms an input into an output.
- **'*Weltanschauung*':** The view of the world that makes the definition meaningful. Checkland (1995:8) provides the following description of the concept '*Weltanschauung*': 'Since any purposeful or identical action in real life can be perceived in many different ways – one observes terrorists being another's freedom fighter – every model of a notional purposeful whole, if it is to be coherent, will have to be built according to a declared world view or '*Weltanschauung*'.
- **Owners:** Who can stop the activity.

- **Environmental constraints:** Those constraints in its environment that the system takes as given.

- **Stage 4: Making and testing conceptual models** (refer Figure B7, Stage 4).

In this stage, a model is formulated of the activity system needed to achieve the transformation described in the definition. The model can now be built to accomplish what is defined in the root definition[3]. Furthermore, the resulting model, when complete, is not a state description of any actual activity system. It is in no sense a description of any part of the real world, it is simply the structured set of activities which logic requires in a notional system, which is to be that defined in the root definition. The whole purpose of this approach is to generate radical thought by selecting some views of a problem situations possibly relevant to improving it, working out the implications of those views in conceptual models and comparing those models with what exists in the real world situation. A conceptual model is constructed by drawing out the minimum number of verbs that are necessary to describe the activities that would have to be present to carry out the task named in the root definition. These are then logically ordered according to how they depend on each other and how they would work together in the real system. According to Checkland (1989:173), the final model should represent a compilation of 'management' components which arguably have to be present if a set of activities is to comprise a system capable of purposeful activity. Furthermore, the final model should follow Churchman's (1971:43) nine conditions that determine a system (refer Chapter 4, Paragraph 4.2).

- **Stage 5:- Comparing conceptual models with reality models** (refer Figure B7, Stage 5).

According to Checkland (1989:177), the comparison is the point at which intuitive perceptions of the problem are brought together with the systems constructs, which the systems thinker asserts to provide an epistemologically deeper and more general account of the reality beneath surface appearances. Furthermore, it is the comparison stage which embodies the basic systems hypothesis that system concepts provide a means of teasing out the complexities

[3] The root definition from Stage 3, is an account of what the idealised system is, while the conceptual model built directly from the root definition in Stage 4, is an account of the activities which the system must do in order to fulfil the requirements of the root definition.

of 'reality'. Flood and Jackson (2002:176) summarises this step and describes the aim behind the comparison stage as being essentially to generate debate about possible changes that could be made to bring improvements in the problem situation. Flood and Jackson (2002:176-177), continue and expand on the following steps suggested by Checkland (1989:177-180), to make full use of the potential of the comparison:

- From a number of models, identify the main differences that stand out against current perceptions.
- Compile a formal listing of formal differences for each conceptual model and annotate with questions for which answers need to be sought in the situation itself.
- Compile a scenario – describing how the system captured in the conceptual model is expected to behave into the future.
- Construct a model of the part of reality similar to the model, with a view to mapping between the two, which may highlight significant differences worthy of discussion.

- **Stage 6:- Feasible, desirable changes** (refer Figure B7, Stage 6). Changes of three kinds are possible, namely changes in structure, changes in procedures and changes in attitudes. According to Checkland (2002:180-181), the purpose of Stage 6 is to use the comparison between conceptual models and 'what is' to generate discussion of changes of any or all of the three kinds of changes listed above.
  - **Changes in structure:** Structural changes are changes made to those parts of reality which in the short term, in the on-going run of things, do not change. Furthermore, structural changes may be made to organisational groupings, reporting structures, or structures of functional responsibility.
  - **Procedural changes:** Procedural changes are changes to the dynamic elements namely the processes of reporting and informing all of the activities, which go on within the static structures.
  - **Changes in attitude:** This term is extended to include such things as changes in influence, and changes in the expectations which people have of the behaviour appropriate to various roles, as well as changes in the readiness to rate certain kinds of behaviour 'good' or 'bad' relative to

others – changes, in fact, in what Vickers (1965:67), terms an 'appreciative system'[4].

- **Stage 7: Action to improve the problem situation** (refer Figure B7, Stage 7). This final stage according to Checkland (1995:181), involves the implementation of the defined changes which should meet two criteria:
  - That the changes are arguable systemically, 'desirable' as a result of the insight gained from selection of the root definitions and conceptual model building.
  - That the changes are culturally feasible given the characteristics of the situation, the people in it, their shared experiences and their prejudices.

B5 ACKOFF'S INTERACTIVE PLANNING

Ackoff, as in the case of Churchman, has been much influenced by the pragmatist philosophy of EA Singer. Churchman's interpretation of this philosophy created a new understanding of 'objectivity' in the systems approach, which Ackoff endorsed, thus contributing to this new understanding of the concept.

B5.1 PHILOSOPY OF INTERACTIVE PLANNING

For Ackoff (1974c:361)[5], cited by Jackson (1991:145), the conventional view that objectivity results from constructing 'value-free' models is a myth, as purposeful behaviour cannot be 'value-free', but rather 'value-full'. Ackoff describes 'objectivity' as:

> *"the social product of the open interaction of a wide variety of individual subjectivities".*

From this, according to Flood and Jackson (2002:1435), a number of significant Ackovian conclusions can be drawn namely:

- Planning and design requires wide participation and involvement.

[4] For an analysis of 'appreciative systems', refer to Chapter 4, Paragraph 4.8.
[5] Ackoff RL. 1974c. The social responsibility of OR. *ORQ* 25.

- ‘Rationality’, should be seen interactively.
- The idea that one of the major banes of the professional planner’s life, how to quantify quality of life so that it is possible to plan well for others, can be side-stepped once it is recognised that people should plan for themselves.
- All that is needed is a planning methodology, which can be used with the aid of professional planners, and which makes the ideals and values of the users paramount.
- It is a changing world in which planners have to operate and Ackoff believes that in order properly to appreciate these changes, we need a changed conception of the world and a changed conception of the nature of corporations. It is then only that we will be able to recognise what kind of planning approach is required by the new circumstances.

Ackoff’s general philosophical orientation takes on a precise form when it is related to the profound changes, he believes, advanced industrial societies are undergoing. About the time of World War II according to Ackoff (1974b:8) and Jackson (1991:145), the ‘machine age’ (associated with the industrial revolution), began to give way to the ‘system age’. The latter characterised by increasingly rapid change, interdependence, and complex purposeful systems, which require greater emphasis be put on learning and adaptation if any kind of stability is to be achieved. This in turn requires a radical reorientation of the various ‘*Weltanschauungen*’.

To react to a changing ‘*Weltanschauung*’, and complex phenomena pertaining thereto demand, according to Ackoff cited by Jackson (1991:147), ‘interactive planning’, (which according to Ackoff (1983:63), includes the concept of ‘contingency planning’), all of which has the aim to confront ‘messes’[6]. Against the background of Ackoff’s philosophy that planning should be participative and should be about enabling others to plan effectively for themselves. Flood and Jackson (2002:146-147), sets the scene by analysing the attitudes management

[6] ‘Messes’ according to Flood & Jackson (2002:147), can be defined as: “Sets of highly interdependent ‘problems’, where ‘problem’ formulation and structuring assume greater importance than ‘problem solving’ using conventional techniques”. Mitroff and Linstone (1993:46-47), cite Ackoff who defines a ‘mess’ as: “Every human problem associated and inextricable involved with every other human problem”.

have in respect of planning. Classification of these attitudes culminate in them to be either 'inactive', 'reactive', 'preactive', or 'interactive', which can be summarised as follows:

- **Inactivism:** Inactivists are satisfied with the way things are and the way things are going. Hence, they believe that any intervention in the course of events run a great risk of making things worse. Their management philosophy is conservative. They take a 'do-nothing' posture, trying to 'ride with the tide' without 'rocking the boat'. Furthermore, their management philosophy is conservative and needless to say, they do not believe in planning.

- **Reactivism:** Reactivists prefer a previous state to the one they are in. They are generally dissatisfied with the way things are going and hence they resist to most changes. Reactive managers feel more comfortable with the old and familiar than with the new and unfamiliar. Important is that reactivists endeavour to solve problems by unmaking change – by returning to a previous state in which the problem did not exist. Furthermore, unlike inactivists who try to 'ride with the tide', the reactivist 'tries to swim back against it'. They do not plan ahead, they react back.

- **Preactivism:** Preactivists believe the world is changing in significant ways and that these changes present significant opportunities as well as serious threats. In general, they are satisfied with the way things are going, but not with the way things are. Hence, they are preoccupied with predicting and preparing for the future. Preactive planning and problem solving is based more on logic, science and experimentation than on common sense, intuition, and judgement. Preactive decision-makers tend to define the system to be treated in terms of the resources over which they have direct control. The uncontrollable is treated as environment. The management philosophy of the preactivist is liberal, seeking change 'within' the system, but not 'of' the system.

- **Interactivism:** Interactivists are dissatisfied with both the current state of affairs and the way they are going. They have a 'make-it-happen' attitude toward the future. They believe we are capable of influencing, if not controlling many future changes in such a way as to significantly improve or detract from the quality of life. They try to change the nature of systems so they can 'prevent' not merely 'prepare' for problems. Furthermore to 'create', not merely exploit, opportunities. Interactivists are as willing to manipulate a system's structure, functioning, organisation, and personnel as they are to manipulate its resources. To deal effectively with complex phenomena, interactivists maintain, one must be able to determine both what it has in common with previously experienced phenomena, and how it differs from them. Furthermore, preactive planners prepare for the future by attempting to control its effects on the system planned for.

B5.2 PRINCIPLES OF INTERACTIVE PLANNING

The principles of Interactive Planning are based on four operating principles, namely the 'participative' principle, the principle of 'continuity', the principle of 'co-ordination', and the principle of 'integration'. The principle of co-ordination and the principle of integration are combined in some cases into one principle, namely the 'holistic' principle due to the fact that the act of planning is viewed as a simultaneous and interdependent action affecting many parts and levels of the system. Flood and Jackson (2002:149), provides the following detail on the principles governing the principles of interactive planning:

- **The participative principle:** The principle that planning should be participative rests upon two connected ideas. The first is that the process of planning is more important than the actual plan produced. It is by being involved in the planning process that members of the organisation come to understand the organisation and the role they can play in it. The second idea is that all those who are affected by planning should be involved in it, which stems directly from Ackoff's philosophical argument that 'objectivity' in social systems is 'value full'.

- **The principle of continuity:** The values of the organisation's stakeholders will change over time, which will necessitate corresponding changes in plans. Furthermore, unexpected events will occur. The plan may not work as expected or environmental changes may occur. No plan can predict everything in advance, so plans, under the principle of continuity, should be constantly revised. Furthermore, actual performance of plans should be continually compared with expected performance, and where these deviate significantly, the producers of the deviation should be identified and appropriate corrective action should be taken.

- **A principle of co-ordination:** According to this principle, all functions of a system should be planned for interdependently which states that units at the same level should plan together and at the same time – because it is the interactions between units rather than their independent actions, which give rise to most difficulties.

- **A principle of integration:** According to this principle, units at different levels should plan simultaneously and together, because decisions taken at one level will usually have an effects at other levels as well.

B5.3 INTERACTIVE PLANNING METHODOLOGY

According to Ackoff (1974a:7), there are five phases to Interactive Planning. These however, must be regarded as constituting a systemic process, so the phases may be started in any order, and none of the phases let alone the whole process should ever be regarded as complete. The five phases are:

- Formulating the 'mess'[7].
- Ends planning.
- Means planning.
- Resource planning.
- Design of implementation and control.

[7] Refer to Footnote 6 of this chapter for a definition of the concept 'mess'

Each of these entities will be analysed, first in terms of Ackoff's (1974a:7) views, and then expanded upon in terms of Flood and Jackson's (2002:150-153), interpretation thereof.

- **Formulating the 'mess':** This action determines the design of a desired future. This requires specifying goals, objectives, and ideals – short-run, intermediate, and ultimate *desiderata*. Three types of study are required in formulating the 'mess' namely:
  - Systems analysis.
  - An obstruction analysis.
  - Preparation of reference projections.

- **Ends planning:** This action determines how to get there (an idealised design) – the invention of new, or selection of available ways of getting there. This requires specifying the courses of action, practices, programs, and policies to be used, by going through the following three steps:
  - Selecting a mission.
  - Specifying desired properties of the design.
  - Designing the system.

  Idealised design is meant to generate maximum creativity among all the stakeholders involved, and to ensure this, only two types of constraint upon the design are admissible namely:
  - It must be 'technologically' feasible.
  - It must be 'operationally' viable.

  The following outline for a responsive decision system is provided by Ackoff, and contains the following five essential functions:
  - Identification and formulation of problems.
  - Decision-making.
  - Implementation.
  - Control.
  - Acquisition or generation, and distribution of the information necessary to carry out the other functions.

- **Means planning:** This action determines what types of resource and how much of each is required to use the specific means. This involves specifying what is required, when, and where, and how it is to be required or generated. Four types of resource are usually involved:
  - Men.
  - Money.
  - Equipment and facilities.
  - Materials and energy.

- **Resource planning:** This action determines the organisational requirements and design of organisational arrangements that make it possible to go down the prescribed paths effectively.

- **Design of implementation and control:** This action determines the design, implementation and control of planning decisions. Furthermore, it includes maintenance or improvement under changing conditions and with the acquisition of new information and knowledge that experience with the plan can bring.

B6 MITROFF AND MASON'S STRATEGIC ASSUMPTION SURFACING AND TESTING

The inspiration for Mason and Mitroff's Strategic Assumption Surfacing and Testing methodology as described by Jackson (1991:141-145) and Flood and Jackson (2002:119-127), can be mapped back to Churchman's four aphorisms analysed in Paragraph B3 of this Appendix. Furthermore, it serves as the underlying thinking of their approach to systems analysis.

B6.1 PHILOSOPHY OF STRATEGIC ASSUMPTION SURFACING AND TESTING

The specific philosophy of Strategic Assumption Surfacing and Testing according to Flood and Jackson (2002:122-123), is based on four arguments about the 'nature of problems' and their alleviation.

- First, it is argued that most strategic problems in organisations are 'wicked problems' of organised complexity, which exhibit the following characteristics:
  - Interconnectedness.
  - Complicatedness.
  - Uncertainty.
  - Ambiguity.
  - Conflict.
  - Societal constraints.

  Furthermore, these characteristics spell difficulty for the policymaker who seeks to serve a social system by changing it for the better due to the fact that most management science methods are only suitable for simple, 'well structured problems'.
- Second, most organisations fail to deal properly with 'messes' because they find it difficult to challenge seriously accepted ways of doing things.
- Third, and stemming directly from Churchman, challenging currently preferred policies necessitates the generation of radical different policies or theories, since data alone, which after all can be interpreted in terms of existing theory, will not lead an organisation to change its preferred way of doing things.
- Finally, it is recognised that tensions may well ensue from this process, since its success depends upon the different groups being strongly committed to particular policy options.

B6.2 PRINCIPLES OF STRATEGIC ASSUMPTION SURFACING AND TESTING

From the philosophy of Strategic Assumption Surfacing and Testing according to Mitroff & Mason (1981:37), there are derived four clearly articulated principles, which are incorporated into the methodology, namely:

- **Adversarial:** This is based on the premise that the best judgement on the assumptions necessary to deal with a complex problem is rendered in the context of opposition.

- **Participative:** This is based on the premise that the relevant knowledge necessary to solve a complex problem is distributed among a group of individuals and that the relevant resources necessary to implement the solution are also distributed among a group.
- **Integrative:** This is based on the premise that a unified assumption set and action plan are needed to guide decision making and that a differentiation process of participation and adversarialness can be synthesised into a unified whole.
- **Managerial Mind Supporting:** This is based on the premise that exposure to assumption deepens the manager's insight into an organisation and its policy, planning, and strategic problems.

These principles are employed throughout the following five phases of Strategic Assumption Surfacing and Testing.

B6.3 METHODOLOGY OF STRATEGIC ASSUMPTION SURFACING AND TESTING

The methodology underpinning Strategic Assumption Surfacing and Testing has five phases:

- **Phase 1 - Group formation:** The aim of this stage according to Mitroff and Mason (1981:39) is to structure groups so that the productive operation of the later stages of the methodology are facilitated. The principles for group formation are:
  - To minimise the interpersonal conflict within a group by forming a group that has maximum interpersonal similarity and affinity. The point is that the members of the group need to get along well with one another.
  - To maximise the differences in knowledge and problem perspective between groups. The point is that each group as a whole will bring different information, habits and thought, and basic assumptions to bear on the problem.

- **Phase 2 - Assumption surfacing:** According to Mitroff and Mason (1981:37), each group should develop a preferred strategy/solution. The aim of the assumption surfacing is then to help each group uncover and analyse the key assumptions upon which its preferred strategy/solution rests. Three techniques assume particular importance in assisting this process, namely:
  - **Stakeholder analysis:** There is a strong theoretical reason derived from the concept of teleological systems for surfacing assumptions by means of a stakeholder analysis. A business firm may be conceived of as the embodiment of a series of transactions among all of its constituent purposeful entities, that is, its stakeholders. Furthermore, the final outcome of an organisation's plan will be the collective result of the effects of the individual actions taken by its stakeholders, and thus a strategy may always be thought of as a set of assumptions about the current and future behaviour of an organisation's stakeholders.
  - **Assumption specification.**
  - **Assumption rating.**

- **Phase 3 – Within group dialectical debate:** According to Mitroff and Mason (1981:44), the first step is to eliminate the bias of irrelevancy and this is done whereby each group takes each assumption in turn and negates it. Groups then simply ask themselves, if the opposite (i.e. the counter-assumption) of any particular assumption were true, does it have any significant bearing on the strategy chosen? A 'no' answer indicates that the assumption is not very relevant for the problem. The thus windowed assumption set is now ready for the stiffest test within each group, with any assumption accepted as a strategic premise meeting two criteria:
  - It should have a significant bearing on the outcome of the strategy chosen and implemented.
  - It should be as 'self-evident' and 'certain to be true' as possible.

- **Phase 4 – Between group dialectical debates:** According to Mitroff and Mason (1981:50), a dialectical debate occurs when a situation is examined systematically and logically from two or more points of view. The objective of a dialectical debate between groups is to improve the final judgement on assumptions by subjecting them to the strongest possible critical evaluation.

- **Phase 5 - Synthesis:** According to Mitroff and Mason (1981:52), the aim of synthesis stage is to achieve a compromise on assumptions from which a new higher level of strategy/solution can be derived.

B.7 OTHER INFLUENTIAL SOFT SYSTEMS THINKERS

As indicated in the introductory section of this Appendix, it would be naïve not to acknowledge the work of other revered and influential academics in the field of the 'soft' systems approach. The work of the following academics fall in this category:

- The Total Systems Intervention of Flood and Jackson.
- Critical Systems Heuristics of Ulrich.
- Unbounded Systems Thinking of Mitroff and Lintstone

The primary sources for the ensuing high level analysis of the above systems methodologies are Flood and Jackson (2002:224-238) and Jackson (1991:271-275). The entities pertaining to each of the above, can be described as follows:

- **Total System Intervention:**
  - **Philosophy:** The philosophy underpinning the Total Systems Intervention is 'critical systems thinking', and the brainchild of Flood and Jackson. Critical systems thinking makes its stand on three positions namely:
    - Complementarism.
    - Sociological awareness.
    - Human well being and emancipation.
  - **Principles:** There are seven principles embedded in the three phases of the Total Systems Intervention. These are:
    - Organisations are too complicated to understand using 'one management model' and their problems too complex to tackle with a 'quick fix'.

- Organisations, their strategies and the difficulties they face should be investigated using a range of systems metaphors.
- Systems metaphors, which seem appropriate for highlighting organisational strategies and problems, can be linked to appropriate systems methodologies to guide intervention.
- Different systems metaphors and methodologies can be used in a complementary way to address different aspects of organisations and difficulties they confront.
- It is possible to appreciate the strengths and weaknesses of different systems methodologies and to relate each to organisational and business concerns.
- Total Systems Intervention sets out a systemic cycle of inquiry with iteration back and forth between the three phases.
- Facilitators, clients and others are engaged at all stages of the Total Systems Intervention process.

- **Phases:** The three phases of Total Systems Intervention are labelled:
  - Creativity.
  - Choice.
  - Implementation.

- **Critical Systems Heuristics:**

According to Flood and Jackson (2002:197-213) and Jackson (1991:187), there has been a gap in the systems tradition, in that there has been no systems approach which has provided a means for critically reflecting, either upon the goals attained and means used by hard systems thinking, or upon the nature of the consensus achieved and the changes brought about through soft systems thinking. This gap according to the authors can be filled by the critical systems heuristics of Ulrich. The aim of the approach is nothing less than to set out an appropriate philosophy for an emancipatory systems approach, and to develop a method which can be used by planners to reveal the 'normative content' of actual and proposed systems designs. Ulrich distances himself from the currently dominant use of the systems idea in what he calls 'Systems Science'. As in the case of Mitroff and Mason, Ulrich also follows Churchman in sharing the opinion that it is the 'human problems' which make management science difficult.

- **Philosophy:** For Ulrich, the purpose of systems thinking is scientific to influence planning and design so as to secure an improvement in the human condition. The 'systems approach' is therefore an exercise in practical reason, not theoretical reason. Its aim is to help us decide what 'ought' to be done, not to produce knowledge of 'what is'. The main issue is, for Ulrich, that he finds the two classical epistemological positions relating to practical reason namely the 'systems approach' and the 'dialectical approach' to be untenable. For this reason, Ulrich advocates to extend science and rationality to the matter of 'ends', but to do so in a way which is eminently practicable in the 'here and now' of everyday circumstances.
- **Principles:** Critical Systems Heuristics is about the design and assessment of purposeful systems, and the principles which guide the practice thereof are:
  - The concept of 'purposefulness'.
  - The systems idea.
  - The moral idea.
  - The guarantor idea.

  The latter three are 'quasi-transcendental', taken from Kant's notions of 'world', 'man' and 'God'.
- **Methodology:** The methodology of Critical Systems Heuristics falls in two parts namely:
  - The first part is concerned to help planners to make transparent to themselves and others the presuppositions that inevitably enter into social system designs. To assist with this, 12 'critically heuristic categories' are established which can be used to interrogate systems designs and potential designs.
  - The second part offers a practical tool which ordinary citizens can use to engage planners in rational discourse about the partiality of their plans, and is called the 'polemical employment of boundary judgements'.

- **Unbounded Systems Thinking:**

Key elements pertaining to Mitroff and Lintstone's '*Unbounded Systems thinking*' are contained in Chapter 8, Paragraph 8.2.

B8 EMPOWERING THE USER WITH THE SOFT SYSTEMS APPROACH (CLIENT-LED DESIGN)

In an attempt to avoid failures during systems development lifecycles and to discover design methods that can exploit advances in technology, the soft systems approach is increasingly used in information systems development (Stowell 1985:48-50)(1991:173-189), (Stowell and West 1992:99-106), (Lewis 1993:168-179). One such development which is of significant importance in this thesis, is referred to as 'client-led design (Stowell 1995b:118).

Client led-design is intended to empower clients and enable them to exercise full control over the provision of technology to support their information systems. Furthermore, the notion of client-led design is based on the interpretative paradigm and uses a variety of systems based ideas as a means of facilitating problem appreciation as a precursor to the specification of technology that might be used to aid the effectiveness of the client's information system.

B8.1 PHASES OF CLIENT-LED DESIGN

Stowell (1995b:129-133), describes the five phases of client-led design as follows:

- **Phase 1:** Clients and information systems analysts gain an *appreciation* (my italics), of the problem situation and of each other's perception of the problem (refer also to 'appreciative systems' described in Chapter 4, Paragraph 4.8).

- **Phase 2:** Involves the change of emphasis from describing the problem towards a description of the information system(s) that seem to underpin the 'systems' involvement in the problem itself. This can be achieved through the use of a model, which should be used:
  - As a means of representing the information system(s).
  - As a means of communication among all those involved.
  - As a means of validating that the information system(s) identified is suited to the needs of the clients.

- **Phase 3:** The outcome of phase three is the production of a technical specification, that will support part or all of the information system(s) defined in part two. The active involvement of the client at this phase will help to assure them that their requirements are not being modified without their full knowledge and approval by any technological necessity.

- **Phase 4:** The implementation stage, which should be dominated by the client. The programme for the installation and operation of the information technology supported information systems should be determined by the client, as should the training activities for staff.

- **Phase 5:** Refers to the evaluation by clients of the operation of the information technology supported information system.

In view of this author, client-led design is directly extrapolated from the soft systems methodology. Stowell (1995a:136), however points out that:

- While the soft systems methodology is a methodology, the client-led design is a statement of intent.
- The practice of client-led design owes its roots to experience of the use of the soft systems methodology, first as a method of problem definition, and then in the exploration of the soft systems methodology as a potentially useful method of information systems definition (Stowell 1985:48-50) (Stowell *et al*. 1990:63-69).

Contents: Appendix C

Appendix C

'Hard' and 'Soft' System Methodologies Compared

C1 COMPARATIVE ANALYSIS

To this particular point in the research where the reader has been exposed to not only the 'systems approach', but also to an analysis of both the 'hard' and 'soft' system approaches, it is most appropriate to compare the primary differences between the two concepts, details of which is contained in Table C1.

HARD SYSTEMS METHODOLOGIES	SOFT SYSTEMS METHODOLOGIES
Concerned with the system dimension of the system of systems methodologies.	Concerned with the dimension dealing with people and their perceptions, values and interests (the participants dimension).
The hard approach (such as Systems Dynamics) are a better fit once codification takes place.	The soft systems approach (such as conceptual modelling) come into its own in the process of articulating uncodified knowledge.
Ignores issues of subjectivity.	Admits there are multiple perceptions of reality.
Hard systems are goal-directed, in the sense that a particular study begins with the definition of the desirable goal to be achieved.	Soft systems work within real world manifestations of human activity systems in which something was perceived to be a problem.
Hard systems are suitable to address issues pertaining to 'structured problems' - problems which can be explicitly stated in a language which implies that a theory concerning their solution is available.	Soft systems are suitable to address issues pertaining to 'unstructured problems' – problems, which manifest in a feeling of unease, but which cannot be explicitly stated without this appearing to oversimplify the situation.
Hard systems methodology is concerned only with a single '*Weltanschauung*'.	In soft systems methodology, we are forced to work at the level at which '*Weltanschauungen*' are questioned and debated. Soft systems being concerned with different perceptions derived from different '*Weltanschauungen*'
The hard approach can stand by asking: What system has to be engineered to evolve this	The soft approach has to allow completely unexpected answers to emerge at later stages

problem, or what system will meet this need, and can take the problem?	
The hard methodology is seen to be 'special cases'	The soft methodology is seen to be the 'general cases'

Table C1: 'Hard' systems and 'Soft' systems compared.

The most important difference, according to Checkland (1989:190) between the two concepts is the fact that in hard systems thinking, the end result would be to 'implement the designed system', while in soft systems thinking, one would 'implement the agreed changes'.

The main criteria, which distinguishes hard and soft problems according to Harry (1997:253-254), are in terms of:

- **Definition:** Knowing and agreeing what the problem is.
- **Boundary:** Does the definition of the problem enable the clarification of what the problem is, and what it is not?
- **Separation:** Can issues be dismissed as being not part of the problem as a result of drawing the boundary?
- **Responsibility:** Does the definition and separation of the problem make it clear who should be involved in its solution and who not?
- **Information:** If there is clarity on what the problem is and whose responsibility it is, do we know what information is required for its solution?
- **Description:** Is it known what a solution would, and would not, look like if all the previous criteria have been satisfied?

If the answer to questions based on all the above criteria is '*yes*', then the problem can be classified as a '*hard*' problem. If any of the answers are '*no*', then we a situation of '*hard uncertainty*' or a '*soft problem*' or a '*mess*' prevails. For further clarity, the following figure is adapted from Harry (1997:253), which shows hard problems and soft messes. This with the *caveat* that these should not be seen as mutually exclusive opposites, but rather as extremes of a spectrum that includes most real problems.

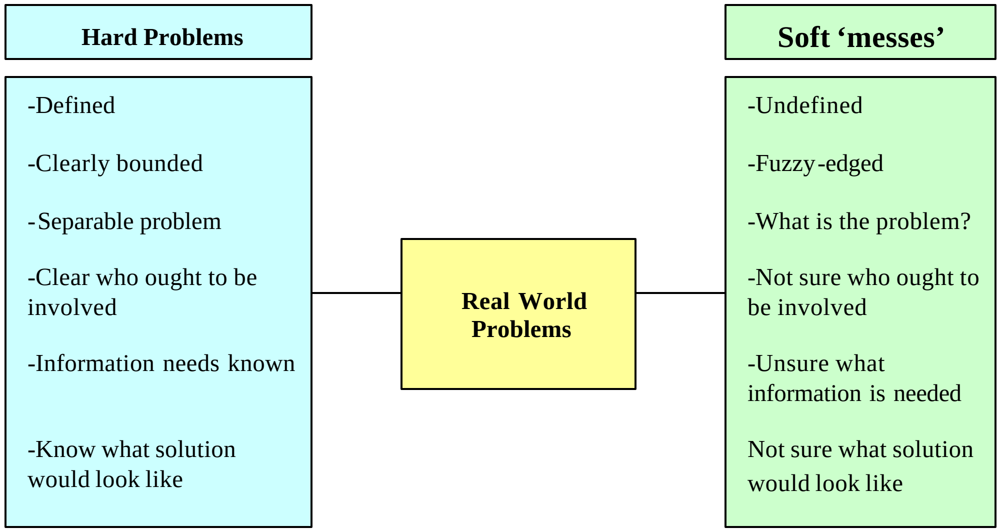

Figure C1:- 'Hard' problems and 'soft' messes.

At this particular point, is appropriate to encompass the dichotomy between 'hard' and 'soft' systems thinking. For this purpose, the summary of Gasson and Holland (1995:216) returns the following:

- Hard systems thinking, typified by systems engineering or structured systems analysis sees the system development problem as relatively well defined: the methodological objective is to satisfy the given requirements through the technical implementation of a closed system. In contrast, the soft systems thinking sees the problem situation as ill-defined: the target object system is perceived as a wider, social and political system, and the task of the analyst is to determine desirable and feasible change by exploring and expressing the problem situation.
- In hard systems thinking, the concern is with the properties of a physical (technical) system and it is believed that human behaviour can be modelled using rule-based systems, so that the problem is analysed, by defining system objectives and requirements. In soft systems thinking, the concern is with a system of human activity, so the problem is expressed, by examining elements of structure and process and their mutual relationship.

In summary, it is of importance to note that the systems approach *per se*, which forms the basis of this research, demands that the solving of the research problem will not be based on the premise of 'taking the problem apart', but by viewing it as 'part of a larger problem'. (Ackoff 1974a:74).

Contents: Appendix D

Appendix D

Validation Survey

D1 INTRODUCTION

The aim of this appendix and the limited industry validation survey contained therein, will be to provide the reader with insight into project failure dynamics as perceived by experts in the field of information systems development in the financial services industry. The concepts of practicality, validity and reliability defined by Emory and Cooper (1995:156) quoting Thorndike and Hagen, were adversely impacted upon during the research by various internal factors commonly associated with the financial services industry *per se*. These factors resulted in the application of the set of mitigating factors to facilitate the management of key factors contributing to the failure of management information system development in a live environment, virtually impossible. The most significant elements attributing to this situation were precipitated by the following:

- That the set of mitigating factors formulated from a structured sequence of events as proposed in this thesis, is aimed at introducing a paradigm shift to existing project management processes pertaining to business requirement functional specifications. To implement the set of mitigating factors on an experimental basis to prove the concept, would be unacceptable to any executive as a matter of principle operating at such a level in an organisation, as it would invariable deviate from proven project management disciplines in force and incur additional cost to execute.
- Should permission be granted to implement the set of mitigating factors in an organisation on an experimental basis, it would be most likely that the new project management discipline would be considered as confidential and part and partial of the organisations Intellectual Property Rights. Making such results public, would constitute breach of these rights.
- Programme managers at the top echelon of an organisation normally follow a very specific project management methodology, which stems from either

tradition or from organisation culture or from proven innovation management processes. This, by implication, is a private and confidential matter to the exclusion of third parties. Furthermore, introducing a new approach on an experimental basis into established structures would most likely require information technology board approval, and impact executive strategies and decision making[1], and in addition would require the management of change on a broad front in the organisation, which by implication would not be easily accepted. This statement against the background of the significant cost associated with process and technology changes in an organisation.

- An aspect, which Pascale (1991:11) terms 'conservatism', has furthermore a significant impact on the validation potential of the set of mitigating factors. Due to the fact that management in the words of Pascale (1991:11), like to 'stick to their knitting' irrespective of the fact that such a great strength, would inevitable culminate as the root of weakness, are unwilling to change.
- The South African financial services industry has in the last five years undergone phenomenal change through the deployment of technology and process cultures to gain competitive advantage and market share. Furthermore with mergers and acquisitions in the order of the day, the industry is controlled by a number of large conglomerates, with competitiveness and market share the ruling commodities of importance. Due to the extent of these factors, individual strategic project initiatives within these conglomerates are considered confidential and part of corporate strategy. An attempt to introduce a new radical concept within such an environment, as proposed in this thesis, would in view of the author of this thesis culminate in an exercise in futility. Of note the fact that similar 'competitive constraints' was reported by Kähköne and Huovila (2002:2) during their research.

[1] With this statement, the author of this thesis does not suggest that organisations are totally inflexible to their management approaches which they follow. As organisations evolve, management and new management approaches are introduced. This statement refers specifically to *ad hoc* experimentation with a new management approach, which in view of the author, would not be permitted at executive level in corporate environments.

D2 DATA COLLECTION

The data collection method used fall within the ambit of both the definitions attributed to the concepts 'survey' and 'field study'. 'Survey', according to Gay and Diebl (1992:238) is an attempt to collect data from members of a population in order to determine the current status of that population with respect to one or more variables. Kerlinger (1986:372), define 'field study' as non-experimental scientific inquiries aimed at discovering the relations and interactions among … variables in real … structures. As in the case of most academic research, the collection of data forms an important part of the overall thesis content. The choice of data collection method as well as the attendant issues therefore require clarification. For the purpose of this thesis, the required information with regards to the choice of survey methodology and in this case survey design, has been obtained primarily from the authoritative work of Emory and Cooper (1995).

According to Emory and Cooper (1995:270-286), three primary types of data collection (survey) methods can be distinguished namely:

- Personal interviewing.
- Telephone interviewing.
- Self-administered questionnaires/surveys.

The data collection method used in this survey is the latter in conjunction with the personal interview. The reasons for the selection of the survey as a data collection instrument are varied, but the following elements are of importance:

- The ease with which the survey lends itself to data collection.
- The issue of time constraints within the target environment.
- The ease with which input from diversified sources (particularly geographically) can be obtained using modern information technology.

The use of personal interviews as an additional element to the data collection process is in the opinion of the author important, since this allows for the identification of issues within the target environment, which may not be readily identifiable using a pure survey questionnaire.

D3 THE TARGET POPULATION

With any survey it is necessary to clearly define the target population, which can be defined as 'that group which constitutes the defined population from a statistical viewpoint'. For this survey, the author of this thesis has identified the target population as experts in the field of information systems development in general with the added requirement of having extensive exposure to systems development for the financial services industry. The qualifying requirement for respondents to participate was to have a minimum of fifteen years exposure to the information systems development environment, and at least five years extensive exposure to information systems development in the financial servic es industry.

The target population was specifically chosen in order to validate the practicality of the concepts as presented here. The risk of bias which cannot be statistically eliminated, is recognised by the author based on the very definition of the target population as well as the limited number of respondents selected. To ensure that respondents came from a spectrum of varied financial services industries, executives from South Africa, the European Union, Canada, and the United States were selected for the survey.

D4 THE CHOICE OF SAMPLING METHOD

Emory and Cooper define two methods of survey sampling namely:

- The conventional sample, whereby a limited number of elements smaller than the chosen population are chosen (typically randomly) in such a manner as to accurately represent (without bias) the total population (Emory and Cooper 1995:228).
- The census approach, where an attempt is made to survey every element within the population. (Emory and Cooper 1995:200).

The census approach was chosen for this survey, as this approach works best when the total number of population elements are sufficiently small and there is a strong measure of diversity amongst the population elements.

D5 MEASUREMENT SCALES

The survey used in the research validation pr ocess of the key factors contributing to the failure of information technology system development projects undertaken in the financial services industry, are based on the well-known Lickert scale, whereby respondents were asked to respond to each of the statements by choosing one of five agreement choices (Emory and Cooper 1995:179) (Parasuraman 1991:410).

The five agreement choices are shown in Table D1:

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

Table D1: Agreement choices**.**

The advantages in using the popular Lickert scale according to Emory and Cooper (Emory and Cooper 1995:180-181) are:

- Easy and quick to construct.
- Each item meets an empirical test for discriminating ability.
- The Lickert scale is probably more reliable than the Thurston scale, and it provides a greater volume of data than the Thurston differential scale.
- The Lickert scale is also treated as an interval scale.

Interval scales *per se*, have the benefit that the scale data can be analysed by virtually the full range of statistical procedures. According to Remenyi, Money and Twite (1995:224), interval scales facilitate meaningful statistics when calculating means, standard deviation and Pearson correlation coefficients.

The most important reason however for choosing the Lickert scale in this research which is supported by Emory and Cooper (Emory and Cooper 1995:180-181), is the fact that the scale can be used in both ‘respondent-centred’ (how responses differ between people) and ‘stimulus-centred’ (how responses differ between various stimuli) studies, most appropriate to glean data in support of the research problem in question.

D6 SURVEY DESIGN

The survey design to be used in this instance, is that of the descriptive survey as opposed to the analytical survey. The descriptive survey has as its purpose the counting of a representative sample, which allows inferences to be made about the population as a whole. Furthermore, descriptive surveys indicate how many members of a population have a certain characteristic.

Within the process of survey design, the author has identified the following variables as being pertinent to the investigation:

- Dependent variables.
- Controlled variables.
- Uncontrolled variables.

The statements within the survey have been designed with the following principles in mind:

- Avoidance of double-barrelled statements.
- Avoidance of double-negative statements.
- Avoidance of prestige bias.
- Avoidance of leading statements.
- Avoidance of the assumption of prior knowledge.

Statements were so formulated as to allow respondents coming from the financial services industry and respondents providing technology services to the industry, to respond on equal terms.

D7 THE VALIDATION SURVEY

The author of this thesis has developed four survey statements designed to determine the opinions of survey respondents to various concepts as introduced throughout this thesis. Individual statement content is contained within the ambit of Table D2.

Statement 1	The quality of business requirement specifications as a project failure factor, has a direct impact on information technology development project timelines and budgets.
Statement 2	Changes to business requirement specifications after finalisation thereof or during development, a common occurrences in a typical information technology project development lifecycle.
Statement 3	Specific or customised methodologies are commonly in use to mitigate and manage the quality aspect of business requirement functional specifications and subsequent changes to these requirements during development.
Statement 4	The main reasons attributed to the failure or partially failure of information technology development projects can be mapped to the quality of business requirement specifications, or changes to these specifications while the latter was already under development.

Table D2: Validation statements

Prior to conducting the interviews with the respondents, the author provided each respondent with detailed information pertaining to 'technology development cycles' and 'the systems approach' in general, irrespective if the respondents were *au fait* with the concepts or not. In addition, an overview of the thesis objectives and identified key factors pertaining to the dynamics of project failure was provided. This exercise was undertaken to ensure that a common understanding of the issues raised in the survey prevailed.

D8 VALIDATION SURVEY RESULTS

A simple analysis of the survey results returned by the 54 respondents, all of whom met the minimum qualifying requirements as set out in Paragraph D3. The responses of the respondents to each of the statements posed in terms of the industry survey are reflected below in table format for ease of reference:

Statement 1: The quality of business requirement specifications as a project failure factor has a direct impact on information technology development project timelines and budgets.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
42/54 77.8%	12/54 22.2%	0/54 0%	0/54 0%	0/54 0%

Statement 2:- Changes to business requirement specifications after finalisation thereof or during development, are common occurrences in a typical information technology project development lifecycle.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
47/54 87%	7/54 13%	0/54 0%	0/54 0%	0/54 0%

Statement 3:- Specific or customised methodologies are commonly in use to mitigate and manage the quality aspect of business requirement functional specifications and subsequent changes to these requirements during development.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
0/54 0%	4/54 7.4%	0/54 0%	19/54 35.2%	31/54 57.4%

Statement 4:- The main reasons attributed to the failure or partially failure of information technology development projects can be mapped to the quality of business requirement specifications, or changes to these specifications while the latter was already under development.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
24/54 44.5%	22/54 40.7%	0/54 0%	8/54 14.8%	0/54 0%

A detailed analysis of the above statistical analysis are contained within the ambit of Chapter 2, Paragraph 2.8.

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Appendix E

Key factors contributing to project failure

E1 LITERATURE RE.VIEW

The thesis research problem points to two aspects within the context of failure of management information development projects undertaken in the financial services industry. These pertain to:

- The quality of business requirement functional specifications.
- Change to business requirement functional specifications, while the latter is still in the process of being developed.

The literature search cited in this thesis and academic readings commonly associated with work of this nature, also did not return a single reference where these two entities were singled out or juxtaposed as being the most prevalent contributing factors associated with the failure of management information systems development projects. Neither for that matter, and more specific, for information system development projects undertaken in the financial services industry. On a broader perspective, clear tangent planes do exist where elements of these two entities are clearly identifiable, which are supported by a number of academics in different forms and approaches, which are contained within the ambit of Table E1. In scrutinising all of the listed factors contributing to project failure, the words of Zahran (1998:xix) echoes in each of the factor statements, namely, that 'developing reliable software on time and within budget, represents a difficult endeavour', if viewed against the overwhelming facts reported in this thesis on delays, escalating cost and multi-billion dollar systems that do not perform as envisioned.

Key factors contributing to project failure	Research Reference
The system specifications kept changing.	Cash & Fox (1992:12)
Developers focus on building a technical solution, as opposed to defining and solving business problems.	Kliem & Ludin (1995:25)
Insufficient client influence, poor client co-ordination, inability to freeze design early and inadequate change procedures.	Cleland & King (1983:670) Lewis (1998:46)
Termed 'corresponding failure', the main premise is that the system failed due to the fact that the design objectives stated in advance, were not met.	Oz (1994:31)
Requirements, design and the technology for which the software system is built will change. There will be social changes. What is acceptable to build at one time will not necessarily be acceptable at another time. People change, new crops of engineers are smarter, and they have been taught new ways to develop software systems. The bottom line then is not to eliminate change, but to control it.	Thayer (1988:26) Robbins (1997:5 12) Flood & Jackson (2002:49)
If misunderstood requirements are detected during the requirements analysis phase, they can be corrected at little expense. If not chances are very high that they will not be detected before testing starts or, at least, befor e major portions of the new system have already been developed.	Mittermeir *et al.* (1987: 153-154)
A key reason for failure often relates to the lack of user acceptance.	Yeates (1994:219)
Poorly defined requirements refers to those dangerous activities or factors, which, if they occur, will increase the probability that the project's goals of time, cost and performance will not be met.	Kerzner (2001:756)
Unclear definitions. Customer's requirements not understood. Poor understanding or misinterpretation of requirements. Difficulty of defining work in sufficient detail.	Klein (1994:21) Kerzner (2001:841) Cooper 2001:24 Ramamoorthy *et al.* (1984:194) Thamhain & Wilemon (1986:76)
Stable requirements. (Implying a low risk of expensive design and code breakage due to requirements changes during development).	Boehm (1988:138)
Scope changes. Cost and schedule overruns are the normal result of scope changes that are permitted without formal incorporation in the project plan or increase in the resources authorised for the project.	Kerzner (2001:861)

Approvals must be obtained for all changes to the original plan.	Miller (1987:185)
If the project team is far removed from the end-user (geographically, politically, spiritually, etc.) and if it does not understand the 'bottom line' business objectives that led to the request for a new system in the first place, the system is set to fail.	Yourden (1988:215)
Many large projects have failed in spite of using modern requirements engineering techniques.	Hsia *et al.* (1994:8-9)
Failure to fulfil original user expectations.	De Marco (1982:4)
Connecting errors in the requirements stage of systems development attracts a relatively low cost, as compared to the substantially increased cost involved in doing so in the later stage s.	Boehm (1976:1226-1241) Boehm (1980:321-326)
The successful implementation of a management information system is the proper identification of their information requirements in the first instance	De Marco (1982:5)
The logical information inputs and outputs to new information systems to be developed are adequately identified in only a third of methodologies presented	Glasson & Hodgson (1983:29-32).
Near the end of the design stage, freeze the design specification that no more changes can be made to the design.	Stair (1992:442) Abel-Hamid & Madnick (1989:1436)

Table E1:- Failure factors within the ambit of business requirement functional specifications.

In summary of the above, the observations of Humphrey 2001b:2, which is most appropriate to the research problem, and reads as follows:

> *"The software industry has a remarkably tolerant set of customers. Now, however, more users deal directly with the software. They don't like what they find. They don't understand our problems and they don't want to understand them. When a software defect damages or inconveniences them, they will be even less tolerant. If the damage is severe enough, you won't get calls on the hot line, your lawyers will hear from their lawyers".*

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Appendix F

Analysis and Construction Elements

F1 INTRODUCTION

The construction process approach followed in the formulation of the set of mitigating factors from a structured sequence of events within the context of the multimethodology approach had two important objectives in line with the thesis structure (refer Chapter 1, Paragraph 1.8), and the key research objectives of this thesis as defined in Chapter 1, Paragraph 1.10, namely:

- That the set of mitigating factors be of such a nature that it not only solves the research problem, but also facilitates the implementation thereof from a practical perspective by the average systems analyst.
- That the research makes a significant contribution (add value) to the existing body of knowledge.

To achieve these objectives, the formulation of the set of mitigating factors was approached from two distinct perspectives, namely:

- **From the perspective of the 'systems analyst'[1]:-**
  - A practical process flow model reflecting the structured sequence of events serving as mitigating factors as applied within the context of a typical systems development life cycle will be analysed in detail (refer Chapter 8, Paragraph 8.5, Figure 8.3 A-G). For ease of reference, each element of the structured sequence of events will be shown as 'numbered frames' within the context of the workflow analysis of the systems development life cycle. Furthermore, each 'numbered frame' is categorised into six logical phases with supporting guidelines annotated per individual frame to enable the systems analyst to apply the solution practically within the financial services industry.

[1] Due to the plethora of naming conventions used by the financial services industry to denote the role of the 'systems analyst', this term will be used in context and will include the roles of project manager, systems engineer, information systems analyst, business analyst, project integrator, process integrator, programme integrator, systems integrator and product integrator. This means, the day to day 'practical users of the set of mitigating factors within the financial services industry.

- **From the perspective of the academic reader:-**
  - To not only provide scientific credibility to the research solution, but also to provide the academic reader with a comprehensive analytical view of the compilation of the set of mitigating factors, each element of the structured sequence of events will be cross referenced to each of the individual methodologies from which it was originally formulated. Furthermore, each element of the structured sequence of events will be supported by appropriate theoretical references gleaned from the literature reviews cited in this thesis. This analysis will be contained within the ambit this Appendix.

The attention of the reader is yet again drawn to the specific structure of this thesis, whereby significant supporting research materials are contained within the ambit of the various appendixes of the thesis. These appendixes are considered an integral part of the main body of the thesis and should not be viewed as 'supplementary' information to the thesis, which is of particular importance in the instance of this appendix.

Further attention is drawn to the format of the analysis in this appendix from a chapter content perspective, which is mapped to the numbered frames represented in the structured sequence of events as presented by the process flow model in Chapter 8, Paragraph 8.5, Figure 8.3 A-G. For greater clarity, whenever a reference is made to a 'frame' in the analysis paragraphs below, the reference pertains to a frame within the ambit of the process flow model depicted in Figure 8.3 A-G of Chapter 8, Paragraph 8.5.

F2 CHAPTER 4: ANALYSIS FROM A SYSTEMS APPROACH PERSPECTIVE

As the systems approach (analysed in Chapter 4), forms the basis of the set of mitigating factors, it is appropriate that the formulation and construction elements are initially analysed from this perspective. Methodologies and other relevant information contained within the ambit of this thesis, will thereafter be dealt with per chapter to facilitate a consistent analysis thread.

From a holistic perspective, each element of the structured sequence of events shown as process frames in Figure 8.3 A-G, can be viewed as the 'result' of the 'interrelationship of core entities' graphically depicted in Chapter 8, Paragraph 8.3, Figure 8.2 A-G. Collectively, the 'interrelationship of core entities' makes up 'a system', which falls within the ambit of the definition for this entity as provided by Kauffman (1980:1) and Sisk (1969:12), which reads:

> *"a system is a collection of parts, which interact with each other to function as a whole"*

The interrelationship of core entities in addition map to the definition of 'a system' as defined by Strümpher (1992:2) citing Vickers, which reads:

> *"a system is a regulated set of relationships, and the key to its understanding is the way in which it is regulated"*

From the perspective of the individual frames forming a specific sequence of events and for that matter 'a system', the definition of Lannon-Kim (1994:4) and Kim (1992:2) is the most appropriate in this instance, when they define the concept as:

> *"a group of interacting, interrelated, or interdependent elements forming a complex and unified whole that has a specific purpose"*

The ultimate test in view of the author of this thesis that proves that the process frame represents 'a system', is to validate them against the nine conditions that determine a system (Churchman 1971:43). A mapping of the process frames to the nine conditions of Churchman (Refer Chapter 4, Paragraph 4.2), proved that the process frames without reservation constitutes 'a system'.

Should the 'systems approach' be applied to the development of a management information system solution as indeed presented by the process frames, a 'systems development life cycle' emerges, (Smit & Cronjé 1992:166). In addition, the systems development lifecycle represent a process-orientated approach, which views software development as a structured sequence of events (Floyd & Keil 1987:167). The sequence of events represented by the individual process frames, in addition map to the nine characteristics as definitive of 'open systems' (Katz & Kahn 1966:92-100) (also refer to Chapter 4, Paragraph 4.6). Coming the full circle with the 'systems approach' being applied to the process frames depicted in Figure 8.3 A-G of Chapter 8, Paragraph 8.5, it is interesting to note that they fall within the ambit of the definition attributed to the concept by Checkland (1989:5), which reads:

> *"An approach to a problem, which takes a broad view, which tries to take all aspects into account, which concentrates on interactions between the different parts of the problem"*

Ossenbruggen (1994:2-3), which drives to the core of the systems approach as applied in context for the formulation of the set of mitigating factors with the following steps in problem analysis and resolution thereof, which involves the following stages:

- Problem definition.
- Generation of alternatives.
- Model formulation.
- Analysis and alternative selection.

The systems approach was specifically chosen to form the basis of this research based on two significant factors namely:

- It forms the basis of systemic reason, is perfectly rational, and remains verbal, analytic, as well as synthetic, holistic and dynamic. Furthermore, the systems approach accepts non measurable elements, in its very nature deals with dynamic behaviours and its focus is not on the individual parts, but on the interrelationship between these parts (Ballé 1994:36).
- The powerful exhortation of Collins & Porras (1997:xiv) reads: 'While the world changes – and continues to change at an accelerated pace – it does not mean that we should abandon the quest for fundamental concepts, '*such as the systems approach*' (my italics), that stood the test of time'.

Chapter 4 and supporting 'hard and soft systems approach' directives analysed within the ambit of Appendix A and Appendix B, contain a plethora of conceptual directives which have direct bearing upon and, which have been taken up in the formulation of the set of mitigating factors, namely:

The concept 'model': The concept 'model' as defined in Chapter 4, Paragraph 4.7, features strongly in the structured sequence of events specifically as it pertains to the Frame 11 (preliminary program design – pilot model), Frame 5 (process mapping and Frame 8 (detailed business requirement functional specification formulation). It is of importance to note that this early program design (pilot model) represents the entire process being done in miniature, to a time scale that is relatively small with respect to the overall effort, and encompasses the entities:

- Preliminary design.
- Analysis.
- Program design.
- Coding.
- Testing.
- Usage.

Furthermore, this early program design (pilot model), must be reiteratively evaluated against all further steps in the process, (analysis, program design, coding, testing and operations). The purpose of this being to quickly identify trouble spots in the design, model them, model their alternatives and ultimately arrive at an error free program delivery. In addition, the preliminary program design facilitates experimental tests of some key hypotheses, or business drivers (Hall 2002:51) which the client could have made early in the development process. The formulation of Frame 11 (preliminary program design – pilot model), maps to the specifications for designing a model as prescribed by Blake & Mouton (1973:165) and Cook & Russell (1993:11), who views a model as 'a representation of a real world phenomenon'. While Figure 8.3 A-G in Chapter 8, Paragraph 8.5 represents a decision making model made up from 'hard' and 'soft' systems variables (Sterman 1988:217), the real key is not simply having a model, but using it in a structured dialogue with executives (Morecroft (1984:215). This statement holds true throughout the process flow model as represented in Figure 8.3 A-G.

Systems approach to problem solving: The mitigating factors formulated from a structured sequence of events, are formulated in terms of the general directives of the systems approach to problem solving as envisaged by McLeod (1979:83). These general directives and the various frames of Figure 8.3 A-G to which they map, are listed below:

- Formulate the problem, (maps to Frame 1).
- Gather and evaluate information, (map to Frames 2, 3, 4, 5, 7, and 8).
- Develop potential solutions, (map to Frames 5 and 11).
- Decide on the best solution, (map to Frames 1 and 2).
- Communicate the system solution, (maps to Frame 12).
- Implement the solution, (maps to Frame 19).
- Establish permanent standards, (maps to Frame 20).

Organisational cybernetics: While control (the process forming the structured sequence of events) is evident throughout the frames of the process flow model in Figures 8.3 A-G, it is nowhere as evident as in Frame A, where changes to business requirement functional specifications are executed. This is of particular significance, due to the fact that change (in any form), would only be allowed under the most stringent qualifying conditions. Ackoff (1992)[2], cited by Mingers (1995:19) in context of 'total quality management', argued that users only come to discover what they want through their participation in the process of design, hence the requirement for 'controlled change'. In this respect, refer to Chapter 2, Paragraph 2.7.1. Control as proposed by Beer (Refer Chapter 4, Paragraph 4.5 and Appendix B, Paragraph B2.2) of the processes within the set of mitigating factors, will be imbedded in the structured sequence of events.

Open Systems: The set of mitigating factors as an 'open system', have been formulated to the extent that they map the nine characteristics as definitive of all open systems (refer Chapter 4, Paragraph 4.6).

[2] Ackoff RL. 1992. Beyond Total Quality Management. University of Hull. [Centre for Systems Studies Publication.]

Hard and Soft systems methodologies: To map all of the frames in the process flow model in Figure 8.3 A-G to their individual tangent planes within the context of the hard systems approach (refer Appendix A), and the soft systems approach (refer Appendix B), would culminate in a piece of research of unprecedented volume, without returning implementable benefit or add to the existing body of knowledge. This statement against the background of the mapping already done in respect of the systems approach *per se* and the extensive analysis of the hard and soft systems methodologies contained in Appendix A and Appendix B. In view of the author of this thesis, a more appropriate method which would add value and be of benefit to the academic reader, is to map the frames in the process flow model in Figure 8.3 A-G to the primary differences as identified between the hard and soft systems approaches depicted in Table C1 of Appendix C. A mapping between the frames of the process flow model in Figures 8.3 A-G and the 'hard' and 'soft' systems approaches, return the following tangent planes or differences:

- The 'hard systems approach' is concerned with the systems dimension of the system and reflected in the following frames: Pilot – Frame11, Analysis – Frame 13, System build – Frame 16, Testing – Frame 18 and Implementation – Frame 19. The soft systems approach is concerned with the participants dimension and reflected in the following frames: Customer problem statement – Frame 1, Customer needs statement – Frame 2, Customer features list – Frame 3, Interface requirements – Frame 4, Detailed business requirement specifications – Frame 8, Planning: Communication requirements – Frame 10.2, Planning: Change management requirements – Frame 10.3, Final sign-off of customer and sanction of sponsor – Frame 15, Formal customer progress review process – Frame B, and Customer review process – Frame C.
- The soft systems approach being the 'dominant' approach in the formulation of the set of mitigating factors, comes into its own in the process of explaining and articulating uncodified knowledge with the Preliminary program design (Pilot model) – Frame 11.
- Allowing change to business requirement functional specifications while the latter is still in the process of being developed, confirms that in terms of the soft systems approach, there are multiple perceptions of reality throughout the

process flows depicted in Figure 8.3 A-G, especially as it pertains to Frame A.

- The process flow model in Figure 8.3 A-G, reflect goal-directed objectives (solving the customer problem statement – Frame 1), in terms of the hard systems approach, but also reflect real world manifestations of human activity systems in which something is being perceived to be a need (Frame 2). On a broader perspective, the research question in this thesis demonstrates how the soft systems approach work within real world manifestations of human activity systems in which 'something was being perceived to be a problem'.
- In view of the author of this thesis, systems problems could fall within the ambit of a) 'structured problems' (5 new management information reports are required), which can be explicitly stated and to which the hard systems approach can be applied, or b) 'unstructured problems', the latter, which culminates in a feeling of unease and to which the soft systems approach must be applied. An example of the latter being change introduced into an organisation by a system culminating in paradigm shifts being caused resulting in incumbent staff being made redundant or being retrenched, calling for extensive change management (Frame 10.3).
- The dynamics of the process flow model as depicted in Figure 8.3 A-G, are concerned with single, and multiple worldviews[3]. The application of new system functionality to improve client profitability maps to a single worldview, within the context of the hard systems approach, 'as a need is defined or an objective is stated' (Checkland 1989:218). The impact of a number of changes within the ambit of the same development effecting not only the impacted area which initially mooted the change, but impact the whole organisation at different levels, map to multiple worldviews which falls within the context of the soft systems approach, 'as questions are asked, (about the impact) and debated'.
- Chapter 2, Paragraph 2.7.1 provides critical clarity on change dynamics. The process flows of Figure 8.3 A-G deals in a structured manner, in terms of the hard systems approach, with customer problems by asking – 'what system has to be engineered to evolve this problem, or what system will meet the need

[3] 'Worldviews', refer to the concept '*Weltanschauungen*' as described in Chapter 4, Paragraph 4.8.

and can take the problem? At the same time, the soft systems approach allows for completely unexpected answers to emerge at later stages in the project development life cycle. To facilitate this requirement, a platform was created for the purpose of mooting change during the project life cycle (refer Frame A).

The tangent planes, which the process flows within Figure 8.3 A-G has with the hard and soft systems methodologies, is best summarised by Checkland (1989:100), which are adapted to read as follows: 'In terms of the hard systems approach, the end result *(of the process flows depicted in Figures 8.3 A-G)* (my italics), culminates in the implementation of the designed system *(Frame 19)* (my italics)'. In terms of the soft systems approach, the implementation would be in terms of the agreed changes *(Frame A)* (my italics)'. This analogy also supports the strong motivation made in this thesis for allowing changes to business requirement functional specifications, while the latter is still in the process of being developed. Furthermore, Mingers (1995:19) cite the following reasons of why the soft systems methodology is an imperative in the design of information systems:

- Information systems are part of social systems and their use cannot be specified wholly in technical terms.
- The technical orientation of analysts often leads to a gap between 'what users want' and 'what the analysts thinks the users want'. In this respect, refer to the first aphorism described by Churchman in Appendix B, Paragraph B3.2.1.
- Users are not concerned with the system itself, but with business tasks objectives and the formulation of requirements.

Causal loop diagrams and reinforcing and balancing processes: Due to the extensive analysis devoted to these concepts within the ambit of Chapter 4, Paragraph 4.9, it is considered sufficient to state that these concepts are evident in the processes and can be mapped back to the process flows in Figure 8.3 A-G

F3 CHAPTER 1: ANALYSIS FROM A 'SYSTEMS THINKING' PERSPECTIVE

In Chapter 1, Paragraph 1.11 of this thesis, the statement was made that the tailored sequence of events serving as mitigating factors will be based on 'systems thinking', which implies 'thinking about the world outside ourselves and doing so by means of the concept system'. The thinking of the author of this thesis is aimed at breaking the chains of traditional business thinking through the deployment of a multimethodology approach which on a personal level is underpinned by the 'ways of knowing' as proposed by Mitroff and Lintstone (1993:19-110) (refer Chapter 8, Paragraph 8.2).

F4 CHAPTER 2: ANALYSIS FROM AN INTERVENTION AND PROJECT FAILURE DYNAMICS PERSPECTIVE

Chapter 2 contains a plethora of conceptual directives which have direct bearing upon, and which have been taken up in the formulation of the set of mitigating factors, namely:

- **Forced and planned interventions:** Technology change requirements within the context of the set of mitigation factors can fall into either the category of a planned intervention (refer Chapter 2, Paragraph 2.2.1.1), or a forced intervention (refer Chapter 2, Paragraph 2.2.1.2. In selecting the appropriate intervention would, according to Porras & Robertson (1987:24) call for the diagnosing of the organisation to determine what gaps exist between 'actual' and 'desired' organisational functioning (refer Chapter 2, Paragraph 2.2.1). This requirement maps to the directives contained within the ambit of Frame 5 and Frame 8.

- **Project failure dynamics:** The following failure factors are specifically addressed in the various frames in the construction of the set of mitigating factors using a multimethodology approach:
  - **Quality of business requirement functional specifications:** The quality aspect of business requirement functional specifications is repeatedly

addressed during every 'formal customer progress review process' (refer Frame B), and during every 'customer review process' (refer Frame C). The purpose of this sustained 'quality checks' during the project life cycle is to ensure that the final deliverable of the development meets with the legitimate expectations of the end-user (Lyytinen 1988:61), thus attaining functional completeness as proposed by Sneed 1989:74 (refer Chapter 2, Paragraph 2.5). Furthermore, quality and business requirement functional specifications are synonymous, which is borne out by the statement of Huff (1992:50), that 'quality first and foremost means conformance to specifications'.

➢ **Impact of quality on project financials:-** Of particular importance the impact of quality on project financials (refer Chapter 2, Paragraph 2.5.1), hence the approach in Frame 7 to conduct a comprehensive financial and risk analysis as part of the process. Furthermore, budgets are reviewed during each formal customer progress review process (refer Frame B). This requirement according to Cronjé & du Toit (2000:299) 'is necessary to monitor the general financial position of a business *or a project* (my italics), and in the process, limit the risk of financial failure as far as possible'. While risk management is considered an important part of project management (Ward 1999:1), risk management *per se* is perceived to be a facet of quality hence the requirement to manage risk properly to avoid a state of perpetual crisis (Turner 2000:1). This could be achieved if a development project is not allowed to go from one stage into the next until a formal risk assessment has been performed against the deliverables (Tusler 1996:1).

➢ **The importance of user focus when defining business requirement specifications:** User involvement has a high focus in the whole construction process of the set of mitigating factors as depicted in Figure 8.3 A-G. Short of listing each frame in which user involvement is evident, Frame 8 and Frame A is of particular importance in this respect. In these two frames, the business requirement functional specifications are executed in *'collaboration'* (my italics) with the user, a concept that is supported by Grupe (1994:30), Moser and Ramires (1995:45), and Allen (1996:14). The ongoing involvement of the user during the life cycle of the development as proposed in Chapter 2, Paragraph 2.6, is highlighted by Cronjé and du Toit (2000:386), when quality is defined as:

> *"…continuous conformance to customer/clients expectations"*

A further aspect which is emphasised is the fact that not only the development itself, but also changes thereto must map to the business plans of the organisation and require user involvement. This aspect, yet again, is particular evident in Frame 8 and Frame A of Figure 8.3 A-G. Furthermore, this view is supported by Premkumar & King (1992:101) and by Jaafari (2000:20) in Chapter 2, Paragraph 2.6.

- **Project management:** This aspect was dealt with within the ambit of Chapter 2, Paragraph 2.7 focussing in the first instance on financial and risk management as depicted in Frame 7 and on the planning aspect of the overall development. In this respect, refer to Frame 10. The second project failure dynamic namely 'changes to business requirement functional specifications while the latter is still in the process of being developed' was identified as a key dynamic in:
- General project development (refer Chapter 2, Paragraph 2.3.1).
- Major projects (refer Chapter 2, Paragraph 2.3.2).
- Information technology projects (refer Chapter 2, Paragraph 2.3.3).
- The validation survey results (refer Chapter 2, Paragraph 2.8).

F5 CHAPTER 3: ANALYSIS FROM A MULTIMETHODOLOGY PERSPECTIVE

The multimethodology concept was mooted by 'the second way of knowing' as described in Chapter 3, Paragraph 3.4, which reads:

> *"If we have to have precise definitions of complex problems before we can proceed, and if in order to obtain such precise definitions we need to base them on the adoption of a single scientific discipline or profession, then precision and clarity may lead us deeper into deception and not rescue us from it. By selecting a single scientific discipline or profession, we cut off innumerable other pathways that we could have chosen to explore the nature of our problem".*

Support for the need for a multimethodology approach is contained in Chapter 3, Paragraph 3.6, with the ultimate conclusion that: 'there was not likely to be a single silver bullet solution to the essential difficulties of developing software'. Motivation for the use of a multimethodology approach in the formulation of a structured sequence of events serving as mitigating factors, is established in view of the author of this thesis, beyond question in the extensive analysis conducted within the ambit of Chapter 3, Paragraph 3.4.

For the purpose of absolute clarity of the reader, it is important to note that two distinct and opposing points of view are being advocated. The first view, vehemently opposed to change of business requirement functional specifications taking place during the life cycle of the project, which is supported by a plethora of academics and statistics provided in the analysis pertaining to project failure dynamics cited in Chapter 2. This was further supported by the findings of the validation survey contained in Paragraph 2.8 of Chapter 2. The second view, supported by a powerful plea for allowing change to take place during the life cycle of the project, as put forward in Chapter 2, Paragraph 2.7.1 however with the clear caveat that such change should only take place under the most stringent qualifying conditions. This author supports the second view which have been taken forward in the formulation of the set of mitigating factors.

The formulation of the structured sequence of events as depicted in Figure 8.3 A-G, represents a finely tuned balance between 'over control' and 'chaos', which can be compared with the 'Scylla' and 'Charybdis' in Greek mythology and the 'Yin' and 'Yang' from Chinese ontology. This would imply that this balance would be extrapolated from the 'hard' systems approach (refer Appendix A), and the 'soft' systems approach (refer Appendix B), as the 'systems approach' forms the basis of the multimethodology approach in this thesis. An interesting perspective is provided by Sterman on the application of the 'hard' and 'soft' approaches. As Figure 8.3 A-G represents a 'decision-making' model and such models, according to Sterman (1988:217), are usually compiled from 'hard variables' which can be measured directly and can be expressed as numerical data. Sterman is of the opinion that, 'there are no limitations on the inclusion of 'soft' variables in models, thus supporting the thinking of the author of this thesis on not only the 'hard' and 'soft' systems approaches, but also on the concept of a multimethodology approach.

F6 CHAPTER 5: ANALYSIS FROM A SIX SIGMA PERSPECTIVE

The following tangent planes are returned if the principles of Six Sigma as defined by Pande *et al.* (2000:15-18), (refer Chapter 5, Paragraph 5.4), are mapped to the process flow as in Figure 8.3 A-G:

- **Genuine focus on the customer:** Maps to Frames 1, 2, 3, 6, 8, 9, 10, 12, 14, 15, 16, 20, A, B, and C.
- **Data and fact driven management:** Map to Frames 5, 7, 11, 18, 20, A, B, and C.
- **Process focus, management and improvement:** Map to the entire process as depicted in Figure 8.3 A-G, however with specific focus on the content of Frames 1, 2, and 3, with Frame 8 representative of the extent to which Six Sigma positions 'process' as the key vehicle to success.
- **Proactive management:** Maps to Frame A, which acts as a mechanism to instil creativity and effective change into the process as opposed to bouncing from crisis to crisis to accommodate change requests.
- **Boundaryless collaboration:** Maps to Frame 8, which is representative of the teamwork effort as displayed within the ambit of the Six Sigma approach.
- **Drive for perfection, tolerance for failure:** Map to every change request introduced into the processes as depicted in Figure 8.3 A-G representing an ever increasing push to be ever more perfect.

Should the above analysis be drilled down one level further, and the Six Sigma methodology applied specifically to defining business requirement functional specifications (refer Chapter 5, Paragraph 5.6) and thereafter mapped to the process flows in Figure 8.3 A-G, the following would be returned:

- **Output identification:** Relates to the finding out, 'what' the customer requires. These elements are contained within the ambit of Frames 2 and 3.

- **Interface requirements:** Determines exactly 'who' is going to be the recipient of the product or service. These elements are contained within the ambit of Frame 4.
- **Use of objective, quantified data:** Frame 8, is representative of the use of only 'objective, quantified data' in defining business requirement functional specifications.
- **Validation of data:** Validation of data is done through the preliminary program design (pilot model). The pilot model ensures that the business requirement functional specifications accurately reflect customer needs and expectations. Furthermore, in addition the model would determine the gap between what the customer 'wants', and what can be 'delivered', thus facilitating the management of customer expectations.

The key focus areas of Six Sigma are in addition also reflected in the process frames of Figure 8.3 A-G, namely:

- Customer requirements are based on careful assessment (refer Frames 7, 8, and 10).
- Processes are designed and run to fulfil customer requirements (refer Frame 8).
- The approach embedded in the process flows of Figure 8.3 A-G, flowing from Six Sigma is signified by a multi-faceted, ongoing 'voice of the customer' effort. In this regard refer to the multiple customer and change reviews, of which Frames A, B and C serve as examples.
- Customer focussed data key to the managing of the business is in particular addressed in Frame 8, including the mapping of the business requirement functional specifications to the strategic objectives and intent of the organisation.

F7 CHAPTER 6: ANALYSIS FROM A CAPABILITY MATURITY MODEL PERSPECTIVE

The Capability Maturity Model falls within the ambit of two very appropriate definitions pertaining to the concept intervention as discussed in Chapter 2, Paragraph 2.2. In this respect, Cummings & Worley (1997:141), defines 'intervention' as:

> *"a mechanism, which purposely disrupt the status quo to deliberately attempt to change an organisation to a different and more effective state"*

This definition is echoed by Porras & Silvers (1991:54), who defines 'intervention' as:

"Creating a better fit between the organisation's capabilities and its current environmental demands"

Bringing the focus to the Capability Maturity Model itself, it is of interest to note that the definition which Paulk (1999:8) formulated for the Capability Maturity Model, maps to one of the key components (process flows) of Figure 8.3 A-G, namely 'the change request process' as depicted in Frame A. This definition reads:

> *"Focussed on process-centred change, whether the change is incremental or revolutionery, internal or external"*

The definition of Paulk *et al.* (1994:4) of the Capability Maturity Model also maps to the whole process as depicted in Figure 8.3 A-G. This definition reads:

> *"a framework that describes the key elements of an effective software process"*

The core values of the quality paradigm pertaining to the Capability Maturity Model, is 'continuous improvement' and 'customer focus'. The continuous improvement of processes is reflected in Frame A, whenever there is a call for change requests from the user, during the process as depicted in Figure 8.3 A-G. Of importance the fact that Frame 20 dictates that processes should be continuously reviewed, specifically recent implemented processes!

Issues pertaining to customer focus in this thesis cannot be over emphasised. For this particular reason, the importance of user focus as reflected in Paragraph F4 of this Appendix is repeated here for ease of reference and to highlight the tangent planes the concept has with the Capability Maturity Model:

- **The importance of user focus when defining business requirement specifications:** User involvement has a high focus in the whole construction process of the set of mitigating factors as depicted in Figure 8.3 A-G. Short of listing each frame in which user involvement is evident, Frame 8 and Frame A is of particular importance in this respect. In these two frames, the business requirement functional specifications are executed in *'collaboration'* (my italics) with the user, a concept that is supported by Grupe (1994:30), Moser and Ramires (1995:45), and Allen (1996:14). The ongoing involvement of the user during the life cycle of the development as proposed in Chapter 2, Paragraph 2.6, is highlighted by Cronjé & du Toit (2000:386), when he defines quality as:

  "continuous conformance to customer/clients expectations"

  A further aspect which is emphasised is the fact that not only the development itself, but also changes thereto must map to the business plans of the organisation and require user involvement. This aspect, yet again, is particular evident in Frame 8 and Frame A of Figure 8.3 A-G. Furthermore, this view is supported by Premkumar & King (1992:101) and by Jaafari (2000:20) in Chapter 2, Paragraph 2.6.

Should the Capability Maturity Model requirements management process as described in Chapter 6, Paragraph 6.9 be mapped to the process flows in Figure 8.3 A-G, the following tangent planes are returned:

- **Requirement conception:** Frames 2, 3 and 4 map to this requirement of the Capability Maturity Model requirement management process.
- **Requirement generation:** Frame 8 satisfies all of the requirements as set by the Capability Maturity Model requirement management process.

- **Requirement analysis:** All of the frames associated with planning (Frames 10.1 – 10.3) map to this requirement of the Capability Maturity Model requirements management process.
- **Requirement inspection:** Maps specifically to Frame 9, where a formal customer review of the business requirement functional specifications are conducted. Furthermore, issues, errors and associated changes are dealt with in Frame 9, with the deployment within the process by means of Frames A and B.
- **Requirement approval:** Risks and benefits are analysed within the ambit of Frame 7, while resource requirements are addressed within the ambit of Frame 10.3.

The 'default mitigation process', (refer Chapter 6, Paragraph 6.9), prescribed in terms of the Capability Maturity Model requirements management process, involves the following:

- Determining the cause effect and correcting it.
- Identification and correcting the process cause of the default.
- Connecting defect-detecting activities for the defects passed.
- Checking for similar defects elsewhere in the product.

These requirements are addressed at two levels. The first within the ambit of Frames A and B, and the second through an action listed in Frame 20, which calls for the continuous reviewing and mapping of recent implemented processes.

> Of importance the fact that while Figure 8.3 A-G does not in any way represent the full implementation of the Capability Maturity Model, the features of the approach guides the processes to the attainment of mature and disciplined software.

F8 CHAPTER 7: ANALYSIS FROM A BALANCED SCORECARD PERSPECTIVE

Of all of the methodologies applied to the structured sequence of events, the Balanced Scorecard proves the most tasking to apply, due to the fact that the concept according to Graeser *et al.* facilitates the translation of a company's strategic objectives into a set of performance measures'. This means that the Balanced Scorecard is a broad concept, 'implying a set of measures that spans significant processes and focuses of an organisation'. Within the context of the process flows of Figure 8.3 A-G, the Balanced Scorecard facilitates the capability to ascertain whether improvement in one area may have been achieved at the expense of another, an aspect, which is mitigated in Frame 20.

The four perspectives of the Balanced Scorecard as described in Chapter 7, Paragraph 7.4, can be mapped to the process flows of Figure 8.3 A-G and return the following tangent planes:

- **Customer perspective:** The Balanced Scorecard demands that the general mission statement of the organisation on customer service be translated into specific measures that reflect the factors that really matter to customers. This culminates in the customer perspective enabling the articulation of the customer and market-based strategy that will deliver superior future financial returns for the customer (Kaplan and Norton 1996a:26). Furthermore, this can be achieved through the deployment of Frame 19 which includes:
  - Customer satisfaction.
  - Customer retention.
  - New customer acquisition.
  - Customer profitability.

- **Internal perspective:** Translates into measures of what must be done to meet customer expectations. This, as in the case of the previous perspective can be achieved through the deployment of Frame 19, which demands that 'a value proposition' be delivered that will attract and retain customers and by satisfying shareholder expectations of excellent financial returns. Value from the Balanced Scorecard in terms of the internal perspective comes from the fact that the Balanced Scorecard identifies entirely new processes at which an organisation must excel as to meet customer and financial objectives, which are reflected in Frame 20 (Benefits harvesting). Furthermore, the Balanced Scorecard is focussed on a 'long wave' value creation, which demands the process of continuously reviewing and improving of recent implemented processes (refer Frame 20).

- **Innovation and learning perspective:** The crux of this perspective lies embedded within the capability of a company to continuously improve existing products with expanded capability, even *'to the extent that this takes place during the building of a solution'* (my italics). This requirement is clearly facilitated through the deployment of Frame A, and the multiple customer reviews as prescribed for in Frames B and C.

- **Financial perspective:** This perspective mitigates the possible failure to convert improved operational performance into improved financial performance. The importance of the financial and risk analysis as depicted in Frame 7, and the subsequent benefits harvesting of the results (refer Frame 20) is representative of these financial factors. Further to the financial perspective of the Balanced Scorecard in terms of which long-term strategy objectives are linked with short-term actions, two aspects is of significant importance. The first aspect relates to the 'translating of the organisations vision', which facilitates the building of a consensus around the organisation's vision and strategy, hence Frame 8, Task 8.2, which focuses on the mapping of the business requirement functional specifications to strategic business objectives and intent of the organisation. This aspect is further emphasised when taken forward into Frame A. The second aspect the fact that the Balanced Scorecard focuses on change efforts which will drive the desired long-term strategic outcomes of the organisation. Yet again, Frame A serves to illustrate the application of this aspect in the formulation of the structured sequence of events. The impact, which the Balanced Scorecard has on information technology development as proposed by Greaser *et al.* (1998:185), are inherently imbedded in the process flows of Figure 8.3 A-G, and repeated here from Chapter 7, Paragraph 7.6.1 for ease of reference, namely:
- **The financial quadrant:** The ability to associate financial measures with strategically based goals.
- **The customer quadrant:** Focus on specific customer needs, in particular if the technology scorecard is derived from corporate level scorecards.
- **The internal processes quadrant:** Supports information technology's ability to focus on customer facing measures.

- **The learning and growth quadrant:** Provides information technology units with the ability to assimilate measurement results and experiences to attain process improvement and fine-tuned management of the organisation.

The Balanced Scorecard, essentially represents a mechanism for the translation of a company's strategic objectives into a set of performance measures. Furthermore, the Balanced Scorecard, would, under normal circumstances be implemented as a management system that can motivate breakthrough improvements in such critical areas as product, process, customer and market place development. The Balanced Scorecard, in view of the author of this thesis is not designed to cater for specific and customised interventions as proposed in this thesis, but designed to provide executives with a comprehensive framework that translated a company's strategic objectives into a coherent set of performance measures. In addition, the Balanced Scorecard allows managers to look at business from four important perspectives, namely:

- Customer perspective.
- Internal perspective.
- Innovation and learning perspective.
- Financial perspective.

Notwithstanding the above observations, in view of the author of this thesis the Balanced Scorecard remains one of the most advanced mechanisms for measuring and driving performance in an organisation. Irrespective of the *caveats* listed above, elements of the Balanced Scorecard as demonstrated above, was taken up in the process flows of Figure 8.3 A-G. The objective being to take full advantage of the benefits, which the Balanced Scorecard provides within the context of the four quadrant focus areas.