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A Structured Systems Approach to Model Conceptualisation: An Executive Management Perspective

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ABSTRACT

Title: A Structured Systems Approach to Model Conceptualisation: An Executive Management Perspective.

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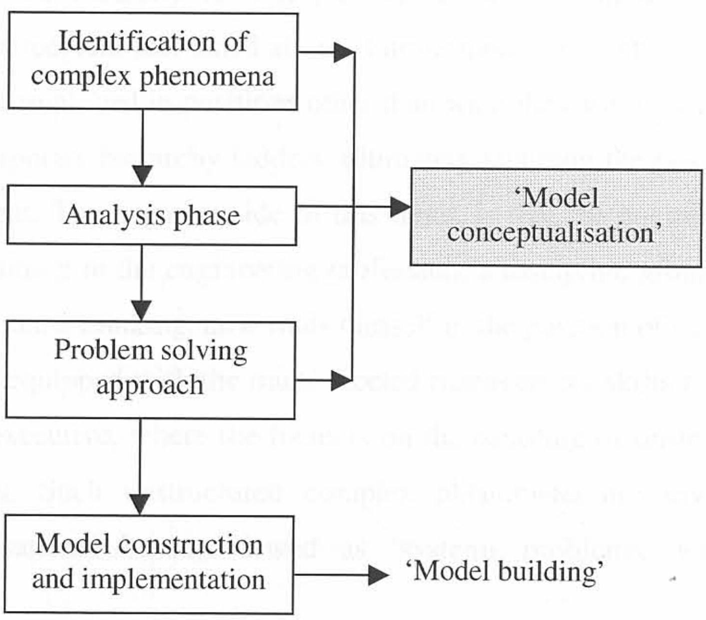
Degree: Philosophiae Doctor.

This thesis is about a specific *structured systems approach to model conceptualisation*, a way of 'thinking', about unstructured complex phenomena within the ambit and context of executive management. This way of 'thinking', according to Checkland **[29]**, although broadly part of the science movement, uses some concepts, which are complementary to those of classical natural science. Model conceptualisation within the context of this thesis and graphically depicted below, refers to a specific sequence of events, which precedes 'model construction' and 'model implementation'. These events include:

- The identification of unstructured complex phenomena.
- The analysis of the identified unstructured phenomena.
- The problem solving approach, which is to be followed to solve the identified complex phenomena.



This *structured systems approach to model conceptualisation*, this way of 'thinking', implies thinking about the world outside ourselves, and doing so by means of a concept 'system', very much in the same way as envisaged by Einstein, in an extract cited by Schilpp **[145]**:

> *"What, precisely, is 'thinking' ?" "When at the reception of sense impressions, memory pictures emerge, this is not yet 'thinking' ".*
> *"And when such pictures form series, each member of which calls forth another, this is too not yet thinking". "When, however, a certain picture turns up in many such series, then – precisely through such return – it becomes an ordering element for such series..." "Such an element becomes an instrument, a concept". "I think that the transition from free association or 'dreaming' to thinking is characterised by the more or less dominating role which the 'concept' plays in it".*

For a number of valid business reasons, including the perceptual fact that 'engineers are structured problem solvers', engineers world-wide are drawn into professions other than engineering. This trend, which was evident from this research and contained in the research findings, is most prevalent in banks, the information technology industry, processing companies, financial institutions and consulting fields where engineers often form the core of the workforce at every level of the organisation hierarchy. A variety of reasons, can be attributed to this trend including the perceptual fact listed above. Furthermore, research shows that invariably, engineers employed in positions other than what they were trained for, rapidly climb the corporate hierarchy ladders, ultimately attaining the position of executive management. The negative side of this trend, is that the engineer who primarily has had training in the engineering profession, a discipline grounded in analytical and reductionist thinking, now finds himself in the position of executive management, hardly equipped with the multi-faceted management skills typically demanded from an executive, where the focus is on the handling of unstructured complex phenomena. Such unstructured complex phenomena are invariably societal and organisational based, viewed as 'systems problems' within a particular worldview or *'weltanschauung'* and require systems-integrated solutions to solve.

While this thesis has at its core the objective to introduce the concept of a *structured systems approach to model conceptualisation* into the realm of executive management within a broader context, it is in the view of the author the most suitable structured mechanism specifically aimed at the engineer in the emergent role of executive management dealing with unstructured complex phenomena.

A further consequence of this thesis, is that the author succeeds to bridge the gap between 'hard' and 'soft' systems methodologies, by combining the two disciplines to form a 'midway approach' in solving unstructured complex phenomena. In addition, the research findings show that such an approach manifests as an essential mechanism for modern executives to facilitate the resolution of unstructured complex phenomena within their respective organisations in a structured way. Furthermore, the research findings show that management philosophies formulated by revered academics during the Twentieth Century can be applied with success to Twenty First Century unstructured complex phenomena, thus becoming an accepted alternative management mechanism for this purpose.

This thesis then, is about both a *'structured systems approach to model conceptualisation'* and 'systems practice' and the relationship between the two entities, aimed at dealing with unstructured complex phenomena within the ambit of executive management. From this the conclusion can be drawn that the systems dynamics of the formulated *structured systems approach to model conceptualisation* specifically applied to the art of executive management, can be used to structure the outcomes of paradigm shifts introduced into organisations as a result of unstructured complex phenomena. Furthermore, the outcome of the research is not as much *'an approach'*, as it is a *'set of principles to an approach'*, which in any particular situation have to be reduced to a method uniquely suitable to the particular situation, hence the applicability of the *structured systems approach to model conceptualisation* over a spectrum of disciplines.

SAMEVATTING

Title: A Structured Systems Approach to Model Conceptualisation: An Executive Management Perspective.

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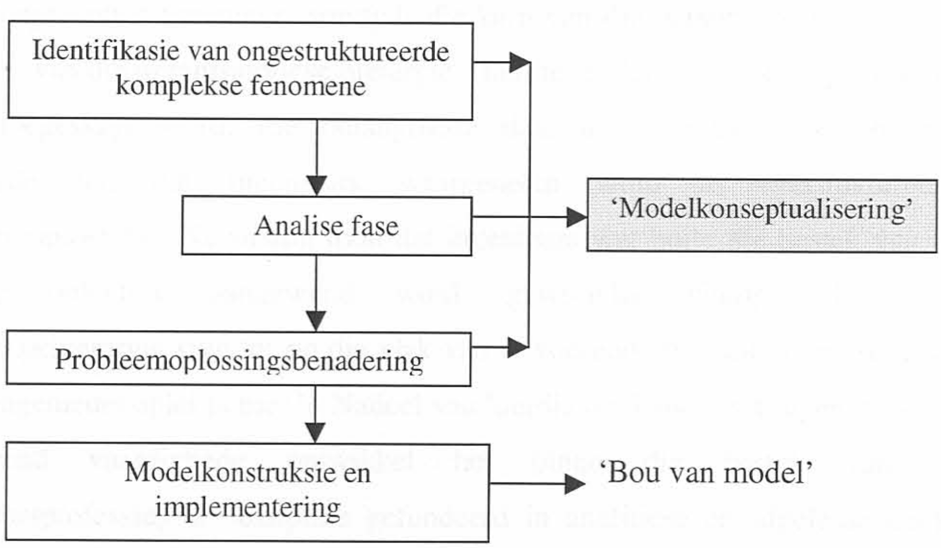
Graad: Philosophiae Doctor

Hierdie proefskrif adresseer spesifiek 'n gestruktureerde stelselsbenadering met betrekking tot modelkonseptualisering, 'n 'wyse van denke' tot die oplossing van ongestruktureerde komplekse fenomene soos dit voorkom binne die konteks van uitvoerende bestuur. Hierdie 'wyse van denke' volgens Checkland [29], verwys na denke wat oorhoofs deel uitmaak van die wetenskaplike beweging en wat gebruikmaak van konsepte wat komplementêr is tot die klassieke natuurwetenskappe. Modelkonseptualisering binne die konteks van hierdie proefskrif en grafies voorgestel hieronder, verwys na 'n spesifieke volgorde van gebeurtenisse wat 'modelkonstruksie' en 'modelimplementering' voorafgaan. Hierdie volgorde van gebeurtenisse sluit die volgende in:

- Die identifikasie van ongestruktureerde komplekse fenomene.
- Die analise van sodanige ongestruktureerde komplekse fenomene.
- Die probleemoplossingsbenadering wat gevolg sal word vir die oplossing van die geidentifiseerde ongestruktureerde komplekse fenomene.



Hierdie gestruktureerde stelselsbenadering met betrekking tot model konseptualisering, hierdie 'wyse van denke', verwys na denke buite die perseptuele raamwerk van die mens by wyse van die konsep 'stelsel', soos waargeneem deur Einstein en aangehaal deur Schilpp **[145]**, (hier aangehaal in die oorspronklike teks):

> *"What, precisely, is 'thinking' ?" "When at the reception of sense impressions, memory pictures emerge, this is not yet 'thinking' ". "And when such pictures form series, each member of which calls forth another, this is too not yet 'thinking' ". "When, however, a certain picture turns up in many such series, then – precisely through such return – it becomes an ordering element for such series..." "Such an element becomes an instrument, a concept". "I think that the transition from free association or 'dreaming' to thinking is characterised by the more or less dominating role which the 'concept' plays in it".*

As gevolg van geldige besigheidsredes, die vernaamste daarvan die aanvaarde feit dat ingenieurs wêreld-wyd waargeneem word as 'gestruktureerde probleemoplossers', word ingenieurs gereeld in posisies binne organisasies aangestel vir doeleindes wat buite die bestek van hulle formele opleiding as profesionele ingenieurs val. Hierdie praktyk, wat ook duidelik blyk uit die navorsingsresultate, is veral waarneembaar by banke, inligtingstegnologie maatskappye, prosesmaatskappye, finansiële instellings en konsultasie maatskappye waar ingenieurs somtyds die kern van die personeelkorps vorm op elke vlak van die organisatoriese hiërargie. Hierdie tendens kan aan 'n legio aantal redes toegeskryf word, die belangrikste daarvan moontlik, die genoemde aanvaarde feit dat ingenieurs waargeneem word as 'gestruktureerde probleemoplossers'. Navorsing toon dat ingenieurs wat buite die bestek van hul formele opleiding aangewend word, gewoonlik vinniger binne 'n organisasiehiërargie styg tot op die vlak van uitvoerende bestuur, as persone wat nie as ingenieurs oplei is nie. 'n Nadeel van hierdie tendens is dat ingenieurs, wat oorwegend vaardighede ontwikkel het binne die bestek van die ingenieursprofessie, 'n disipline gefundeerd in analitiese en afgeleide denke, hulself nou in 'n uitvoerende bestuursposisie bevind sonder die spektrum van bestuursvaardighede soos vereis van die pos van die uitvoerende bestuurder met betrekking tot modelkonseptualisering, waar die aksent by uitstek gefokus word op die hantering van komplekse fenomene. Hierdie ongestruktureerde komplekse fenomene het normaalweg 'n gemeenskaps- en organisatoriese basis, word waargeneem as 'stelselsprobleme' binne die bestek van 'n spesifieke waarneming van die wêreld of *'weltanschauung'*, en vereis stelsels-geïntegreerde oplossings.

Terwyl die doel van hierdie proefskrif die toepassing van 'n gestruktureerde stelselbenadering met betrekking tot modelkonseptualisering binne die breë bestek van uitvoerende bestuur is, is die outeur van mening dat sodanige gestruktureerde benadering 'n hoë toepaslikheidsgraad het op die ingenieur in die rol van uitvoerende bestuur, veral met betrekking tot die oplossing van ongestruktureerde komplekse fenomene.

'n Verdere gevolg van hierdie proefskrif is dat die outeur met sukses die gaping tussen 'harde' en 'sagte' stelselsmetodologieë oorbrug, deur die twee uiteenlopende begrippe te kombineer in 'n 'middeweg' benadering vir die oplossing van ongestruktureerde komplekse fenomene. Die navorsingsresultate van hierdie proefskrif toon verder dat sodanige 'middeweg' benadering manifesteer as 'n noodsaaklike meganisme vir uitvoerende bestuur in die gebruik daarvan vir die oplossing van ongestruktureerde komplekse fenomene op 'n gestruktureerde basis binne hul onderskeie organisasies. Verder toon die navorsingsresultate van hierdie proefskrif dat bestuursfilosofieë wat ge-formuleer is gedurende die Twintigste Eeu, met sukses toegepas kan word vir die oplossing van ongestruktureerde komplekse fenomene van die Een-en-Twintigste Eeu, en ook aanvaar word as 'n alternatiewe bestuursmeganisme vir hierdie doel.

Hierdie proefskrif, het dus ten doel die formulering van 'n gestruktureerde stelselsbenadering met betrekking tot model konseptualisering, en gepaardgaande 'stelselstoepassing', en die verhouding tussen die twee konsepte, gemik op die oplossing van ongestruktureerde komplekse fenomene binne die bestek van uitvoerende bestuur. Vanuit hierdie samevatting, kan die afleiding gemaak word dat die stelselsdinamika van 'n die 'n gestruktureerde stelselsbenadering met betrekking tot model konseptualisering wat spesifiek geformuleer is vir die gebruik deur uitvoerende bestuur, gebruik kan word om die uitkomste van paradigmaverskuiwings te rig wat in organisasies plaasvind as gevolg van ongestruktureerde komplekse fenomene. Die resultaat van hierdie navorsing dui meer op 'n *'stel riglyne tot 'n benadering'*, as op 'n *'spesifieke benadering'* wat in enige situasie gereduseer moet word tot 'n unieke metode, geformuleer vir 'n spesiale toepassingsveld. Hierdie feit maak die gestruktureerde stelselsbenadering met betrekking tot model konseptualisering, hoogs toepaslik vir die doeleindes van model konseptualisering oor 'n spektrum van dissiplines.

ACKNOWLEDGEMENTS

This, my second doctoral thesis, has been undertaken with the true belief that my years of 'thinking' and 'practising' a unique structured approach to management, can facilitate the task of every managing executive to the extent of solving unstructured complex phenomena. Furthermore, it is my conviction that this 'set of principles to an approach', which is based on the philosophies formulated by revered academics during the Twentieth Century and, which includes the author's own contribution, can add value to the existing body of knowledge and the art of executive management. This with particular reference to the systems dynamics of the formulated *structured systems approach to model conceptualisation* when applied by executive management of the Twenty First Century, to structure the outcomes of paradigm shifts introduced into organisations as a result of unstructured complex phenomena.

In submitting this thesis, I wish to take this opportunity to express my sincerest appreciation and gratitude towards the following persons, for their specific and valued contributions:

- My wife Hannetjie, my friend and soul mate for believing in me (yet again) and providing sustained encouragement, love and support.

- My promoter Prof Dr P S Kruger, for the personal interest taken and making a special effort to direct and guide me to bring this work to finality.

- My friend Mike Hare, who planted the first seeds of the 'systems approach'.

THANK YOU

"You cannot discover new oceans unless you have the courage to lose sight of the shore"[1]

[1] Anonymous

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"The one real object of education is to leave a man in the condition of continually asking questions" [1]

Bishop Creighton

[1] Quoted in C.A. Alington: *Things Ancient and Modern*

Chapter 1

THE SCOPE OF THE RESEARCH

"This is not the end". "It is not even the beginning of the end". "But it is, perhaps, the end of the beginning".

Winston S. Churchill

1.1 INTRODUCTION AND BACKGROUND

The general systems theory was first mooted by Ludwig von Bertalanffy in his book *'General Systems Theory'* **[81]**. Various permutations of the 'systems approach'[1] is currently embedded in academic literature in various authoritative publications in a multitude of forms and applications and will be analysed as part of the literature reviews contained within the ambit of this thesis. For selected background information on the history and emergence of the systems approach, refer to Chapter 2 and Appendix C of this thesis.

Our world, for a significant part, has changed to one where we have to deal with self-created reality, 'the real world', and its consequences, 'complex phenomena'[2], as opposed to early beings who had to deal primarily with natural phenomena **[165]**. Furthermore, according to Checkland **[29]**, by 'the real world' is meant the interacting human activity, which makes up the business of living, as opposed to the 'artificial' world of the laboratory experiment, in which the researcher is free to decide what to vary and what to keep constant[3]. Adapted from Checkland **[29]**, the following analogies can be made:

[1] The multiplicity of the systems approach is well illustrated by the various names associated thereto such as: General Systems Theory, Systems Science, Systems Thinking, Systems Analysis, Systems Synthesis, Systems Engineering, Operational Research, Cybernetics, etc. These terms refer to various fields of knowledge that either overlap or are completely different. Within the context of this thesis, the author will develop a set of coherent concepts and notions pertaining to the concept 'systems approach', in particular as it pertains to model conceptualisation.

[2] Complex phenomena can be defined as 'unstructured problems'. See the extended definition of this concept within the ambit of Paragraph 1.1 of this chapter.

[3] According to Jackson **[80]** citing from Checkland (1983), systems viewed as the mental constructs of observers as opposed to entities with an objective existence in the world; where systemicity is transferred from the world to the process of enquiry into the world, is typical of the 'soft' systems methodology, described in detail in Chapter 4.

- That 'the real world' is in the arena in which a systems approach must prove itself as will emerge from the arguments contained within the ambit of this thesis.
- By 'complex phenomena' is meant not the puzzle, paradox or conundrum, which exercises the philosopher, but simply any situation in which there is perceived to be a mismatch between 'what is', and 'what might or could or should' be within the context and ambit of the function of executive management[4]. Such phenomena are usually 'unstructured problems', which are novel, non-repetitive challenges that must be solved with creativity, initiative and originality **[103]**. Furthermore, adding to their complexity, the fact that these problems are societal and organisational based, viewed as 'systems problems' within a particular worldview, or '*Weltanschauung*'[5] and, which require systems-integrated solutions to solve **[68]**.

In this respect, an interesting observation is made by Skyrme **[157]** citing Davidson **[undated reference]**, who includes the possibility that, "management policy decisions may actually contribute to creating the dynamic problems they are intended to solve". Under the heading of 'management decisions', Kircher and Mason **[91]**, raises the opinion that management makes decisions, which:

- Establishes the purposes.
- React to environmental opportunities and constraints.
- Acquire the resources.
- Allocate the resources to elements of the organisation.
- Accept obligations.
- Plan and control and review the organisation structure and operations.

[4] Within the context of this thesis, the term 'executive management' will only pertain to senior executives operating at the top *echelon* of their organisations, typically fulfilling the following roles: Principal, President, Vice-president, Chairman of the Board, Executive Board Member, Operating Executive, Executive Director, Executive General Manager, General Manager, Senior Executive Officer etc. Functions of these executives would typically include: Organisational communication, Executive Decision-making, Strategy formulation, Corporate budgeting, Company vision and mission, Corporate structures, Mergers, Stock Exchange listings, Company results, Organisational/Societal issues, Model conceptualisation, and Complex phenomena, as opposed to senior and middle management who deals with Operational management issues, and lower management who deals with management of daily Functional process issues within the organisation.

[5] As defined in Chapter 2, Paragraph 2.8.

Furthermore, the unstructured complex phenomena associated with 'the real world', could mean phenomena of decisions regarding social systems **[102]**, or the scientist's problem in the laboratory, which can be defined and limited. Ultimately, complexity is the single most important factor determining the outcome of complex phenomena, which is confirmed by Richardson **[131]**, citing Brewer and deLeon (1983), as follows: "Decision making, in complex systems are difficult because of uncertainty, disagreement and complexity".

1.1.1 REALITIES OF REAL WORLD PHENOMENA

Unstructured complex phenomena as defined, very often translates into the harsh realities of 'the real world', which in the extreme, can have far reaching effects on those being impacted. Meadows **[104]**, terms these type of problems, some of which are considered humankind's most persistent problems, the 'systems paradigm'. The following serve as examples:

- Poverty stricken countries where the prime objective is to obtain food for daily survival, as opposed to affluent countries where the main aim is focussed upon wealth creation.
- Wealth and associated lifestyles, which are pursued creating within itself controversial social behaviour in the form of alcoholism, drug abuse and excessive spending patterns, to name but a select few, most probably as a result of sheer peer pressure and the quest for instant gratification.
- War torn countries where the fleeing populace gives up the total of their existence in exchange for the safety of their families.
- Unemployment leading to alternative avenues of generating income, most often culminating in new job opportunities being created in the process.
- The sudden explosion of networked electronic systems, its associated challenges and dichotomies **[11]**, which started in the 1970's with ever increasing momentum in the Year 2000 and beyond.
- Over saturation of the job markets resulting in trained personnel not being placed in the job seat most appropriate to their tertiary education. On the negative side, this situation may be precipitated by mergers, alliances, economic recession, sanctions, world economics, the gold price, price of crude oil, governments in transition and war. On the positive side, the situation may

be precipitated by the requirement for certain specific skills as demanded by global markets or even a perception of the potential skills and ability associated with a specific profession. The classic example which can be cited, being internet web page programming skills becoming the most sought after skills in the technology industry as companies jostle to enter global markets via the internet. Another example is the engineering profession, both locally and abroad, where engineers, irrespective of their expertise and tertiary background, are headhunted by industries totally divorced from the core of the engineering profession, thus crossing academic disciplines and professional boundaries. This trend is most prevalent in the banking, information technology, processing, financial engineering and consulting fields where engineers often form the core of the workforce at every level of the organisation hierarchy. A variety of reasons, can be attributed to this trend, however, one common reason given is the fact that 'engineers are structured problem solvers'[6]. Invariably, these engineers, now employed in positions other than what they were trained for, rapidly climb the corporate hierarchy ladders, ultimately attaining the position of executive management[7], hardly equipped with the multi-faceted management skills required for such a position[8] with respect to model conceptualisation, in particular when dealing with unstructured complex phenomena, specifically when such phenomena are societal and organisational based, viewed as 'systems problems' and require systems-integrated solutions to solve **[68]**[9].

The significance of the engineer is emphasised by Checkland **[29]**, when he cites from Sporn (1964) as follows:

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6 This fact was confirmed by 12 of the Executive respondents during the survey interview with the author described in detail in Appendix C.
7 This fact is in line with the findings of the limited survey contained in Appendix C.
8 It is acknowledged by the author that it would be certainly naïve to assume as *prima facie* evidence that executive management are the only decision-makers in an organisation. It would also include according to Churchman **[34]**, "those decision makers who produce change in the organisation".
9 This statement is of particular importance in this thesis. According to Mitroff and Linstone **[108a]**, the professional mind easily becomes the prisoner of a particular way of viewing the world. For this reason, crossing academic disciplines or professional boundaries is a harrowing experience and constitutes a culture shock of the highest order. See also Chapter 5, Paragraph 5.3.

> *"The engineer is the key figure in the material progress of the world". "It is his engineering that makes a reality of the potential value of science by translating scientific knowledge into tools, resources, energy and labour to bring them into the service of man . . . the engineer requires the imagination to visualise the needs of society and to appreciate what is possible as well as the technological and hard social understanding to bring his vision to reality".*

While this thesis has at its core the objective to introduce the concept of a *structured systems approach to model conceptualisation*[10] into the realm of executive management within a broader context, it is in the view of the author the most suitable structured mechanism specifically aimed at the engineer in the emergent role as the executive decision maker dealing with unstructured complex phenomena in the Twenty First Century. Adding to the roles of executive management, Churchman **[35]** includes the concept of decision-maker, which he perceives as one who controls the resources and hence creates the future of the organisation, while Beer **[22]** conceptualises the executive as, *"the brain of the firm"*.

The art of executive management requires special skills, which includes according to Senge **[153]**, the following:

- Seeing interrelationships.
- Moving beyond blame.
- Distinguishing detail complexity from dynamic complexity.
- Focusing on areas of high leverage.
- Avoiding symptomatic solutions

[10] 'Model conceptualisation' within the context of this thesis, refers to a specific sequence of events, which precedes 'model construction' and 'model implementation". These events, which are described in detail in Chapter 5, Paragraph 5.1 include: a) The identification of unstructured complex phenomena. b) The analysis of the identified unstructured complex phenomena. c) The problem solving approach, which is to be followed to solve the identified unstructured complex phenomena.

1.1.2 SOURCES OF POWER

Unstructured complex phenomena pertaining to executive management, are in fact problems associated with the practice of executive management, broadly defined. These problems (unstructured complex phenomena) have as their source, the concept of 'power', which Morgan **[114]** defines as:

> *"The medium through which conflicts of interest are ultimately resolved". "Power influences who gets what, when and how".*

Morgan **[114]** lists the following as the most important sources of power[11]:

- Formal authority.
- Control of scarce resources.
- Use of organisational structure, rules, and regulations.
- Control of decision processes.
- Control of knowledge and information.
- Control of boundaries.
- Ability to cope with uncertainty.
- Control of technology.
- Interpersonal alliances, networks, and control of 'informal organisation'.
- Control of counter-organisations.
- Symbolism and the management of meaning.
- Gender and the management of gender relations.
- Structural factors that define the stage of action.
- The power one already has.

For a more detailed analysis of the 'sources of power' listed above, refer to Appendix A.

The art of executive management employing the listed sources of power in their quest in dealing with unstructured complex phenomena, is aptly encapsulated in the following words of Capra **[27]** when he makes the observation that:

[11] These sources of power provide executive management with a variety of means for enhancing their interests and resolving or perpetuating organisational conflict.

> *"Power, in the sense of domination over others, is excessive self assertion".*

In support of the above, an even more forceful analogy pertaining to the concept 'power' is drawn by Blake and Mouton **[23a]**, who are of the opinion that, "revolutionary changes are more likely to be effected through the exercise of power and authority, which can compel compliance". Consequently, power struggles, regardless of source or location, may enhance or detract from a firm's ability to deal with the environmental or organic threats to its future **[180]**.

1.2 THE RESEARCH PROBLEM

Field research by the author[12] into unstructured complex phenomena associated with executive management, show that such entities are not commonly dealt with in terms of the systems approach **[59a]**, **[90]**, **[152]**, **[105]**, **[126]**. Furthermore, 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 the systems approach *per se*, specifically addressed model conceptualisation to solve unstructured complex phenomena pertaining to executive management over a spectrum of disciplines in a structured way. This problem is underpinned by the observation of Forrester **[59a]** who is of the opinion that:

> *"During the last half century a management science has begun to develop but is not yet an efficient basis for dealing with top management problems".*

While it would be naïve to generalise, this opinion is also supported by Druker cited by Forrester **[59a]**, who acknowledges that:

> *"Management science still has not penetrated the inner circle of top management".*

[12] Results of which are contained in Appendix B.

It is of importance to note that the stated research problem fall within the ambit of Checkland's **[29]** definition of a 'problem', which he defines as:

> *"A problem relating to real-world manifestations of human activity systems is a condition characterised by a sense of mismatch, which eludes precise definition, between what is perceived to be actuality and what is perceived might become actuality".*

Academics, which led the way in the further development and application of the systems approach, are amongst others:

- Beer **[22]**.
- Churchman **[34]**.
- Ackoff **[8]**.
- Checkland **[29]**.
- Mitroff and Mason **[108]**.
- Jackson **[80]**.
- Vickers **[174]**.
- Gharajedaghi **[64]**.
- Kauffman **[84]**.
- Senge **[152]**.

Application of the systems approach, can be found in a diverse number of disciplines as confirmed by Gray **[67]**, who is of the opinion that, "the systems approach has been used in a wide variety of organisations for many decades". This application plethora of the systems approach concept is shown in Table 1.1. While the field of application of the systems approach is multi-diciplinary, as demonstrated in Table 1.1, each of these disciplines ultimately culminate in the process of executive management thereof. Selective examples in support of this statement, are the following:

- The medical practitioner appointed to the post of hospital administrator.
- The systems programmer being promoted to project manager.
- The university professor becoming dean of his faculty.
- The physicist becoming team leader of a space program.
- The engineer becoming head of an engineering consultancy firm.

- The housewife becoming chairperson of the Consumer Council.
- The student becoming head student at the university hostel.
- The public administrator becoming a foreign representative.
- The teacher being promoted to head of a school.
- The technologist becoming head of systems and technology development.
- The pattern maker becoming head of design.
- The economist becoming head of the central reserve.
- The corporate banker becoming the senior executive officer of his bank.

From the above examples, it is clear that whatever the discipline, the requirement for executive management for each of the entities, forms an integral part thereof. The logical approach to follow this assumption, is to determine, which methodology is to be followed when faced with executive management issues in respect of an inquiry relating to unstructured complex phenomena pertaining to each of the disciplines. Furthermore, an aspect, which intensifies the inquiry, and the object of the research question of this thesis, is to determine whether the systems approach can be applied to model conceptualisation to solve unstructured complex phenomena from an executive management perspective without reverting to the concept of a 'Grand Theory' **[33]**[13]. The concept of a 'Grand Theory' requires closer scrutiny, which is provided by Checkland **[29]** citing Mills (1959), the latter who references known theorists in the likes of Talcott Parsons (1951) and Black (1963) in the explanation of the concept, as follows:

> *"The basic cause of grand theory is the initial choice of a level of thinking so general that its practitioners cannot logically get down to observation". "They never, as grand theorists, get down from the higher generalities to problems in their historical and structural context". "This absence of a firm sense of genuine problems, in turn, makes for the unreality so noticeable in their pages".*

[13] At this point it is appropriate to acknowledge the work of Chester Barnard entitled: *'The functions of the Executive'*, published in 1938 **[80]**. The aim of Barnard with his book, was to discover features common to executive functions in all organisations. Barnard's analysis identified three functions the executive must undertake namely:

- Organisational communication.
- Securing essential services.
- Organisational objective formulation.

Application	Authoritative Reference
Organisational behaviour	Scott and Cummings [149]
Psychology	Palazzoli *et al* [122], Simon [155]
Education and Organisational learning	Stata [160], English [51]
Economics	Aoki [14], Hirschman and Lindblom [74]
Nursing	Frey and Sieloff [61]
Mathematics	Rosen [140]
Digital systems/ Systems problems	Motil [115], Athey [18]
Ecology	Odum [118]
Physics	Garrido and Mendes [63]
Geography	Wilson [183]
Social sciences	Mattessich [101]
Anthropology	Sztompha [166]
Technology	Garrido and Mendes [63]
Psychotherapy	Cavalieri [28]
Public policy	Hoos [79]
Planning and design	Dickerson and Robertshaw [45]
International relations	Wettman [182]
Engineering	Unbehauen [171]
Pure and applied mathematics	Feintuch [54]
Management/Management process	Richardson [131][132], Sisk [156]
Research/ Operational research	Ackoff [2], Churchman *et al* [33]
Behavioural science/Goal-seeking behaviour	Argyris [15], Schützenberger [147]
Decision and control	Beer [21]
Project management	Kerzner [86]
Financial product development	Nagel [117]
Problem management	Sanderson [144]
Modeling managerial behaviour	Sterman [163]
Quantitative portfolio simulation	Merten *et al* [106]
Prelaunch forecasting of new automobiles	Urban *et al* [172]
Material requirements planning	Morecroft [110]
Naval ship production	Cooper [41]
Worker burnout	Homer [76]
Software development	Abel-Hamid and Madnick [1]
Multi-echelon inventory system management	Clark *et al* [37]

TABLE 1.1: Application scope of the 'Systems Theory'

To ensure that the *systems approach to model conceptualisation* has a scientific base and fulfil an operational need, the concept should be applied against the background of a systems engineering approach, which Blanchard **[24]** define as:

> *"the effective application of scientific and engineering efforts to transform an operational need".*

The problem statement will be addressed in terms of the Research Process described in Paragraph 1.4.

1.3 THE RESEARCH QUESTION

The research question, which will form the crux of this thesis, is:

Can the 'systems approach', which is currently embedded in academic literature in various authoritative publications in various forms and permutations, be applied to model conceptualisation to solve unstructured complex phenomena from an executive management perspective?

The research question will not be researched in terms of a 'Grand Theory' as it would be in danger of losing contact with reality, would be highly abstract, and it will be difficult to translate into testable propositions **[29]**. Furthermore, the researcher will steer a course between the highly abstract and the unduly specific in very much the same way as Boulding cited by Checkland **[29]** in the following extract:

> *"[General Systems Theory] does not seek, of course, to establish a single, self-contained 'general theory' of practically everything, which will replace all the special theories of particular disciplines". "Such a theory would be almost without content, and all we can say about practically everything is almost nothing". "Somewhere however between the specific that has no meaning and the general that has no content there must be, for each purpose and at each level of abstraction, an optimum degree of generality". "It is the contention of*

the General Systems Theorists that this optimum degree of generality is not always reached by the particular science".

The ultimate objective is to provide the engineer as emergent executive with a structured mechanism to address model conceptualisation in the quest to solve unstructured complex phenomena.

1.4 THE RESEARCH PROCESS

The problem statement and associated research question is approached in this thesis, using the Question Hierarchy of Emory and Cooper **[50]**, modified by Piquito **[124]** and further adapted to address the issues in this thesis.

This approach depicted in Figure 1.1 assumes the research problem to be composed of a hierarchy of questions with a descending level of specificity.

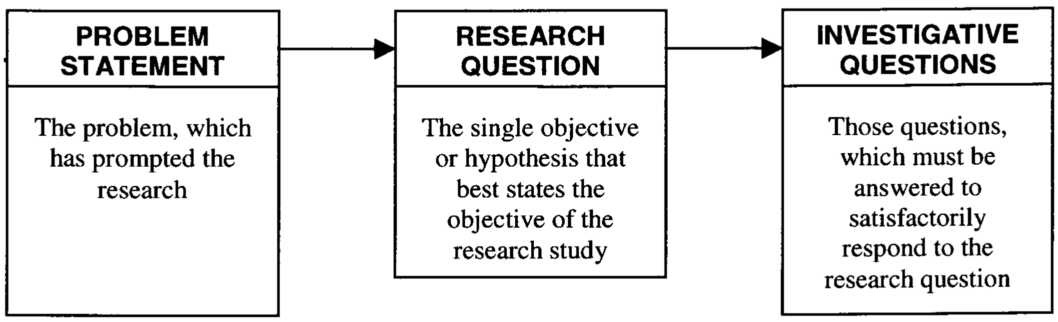

FIGURE 1.1: The Question Hierarchy

The aim of the adapted and modified Question Hierarchy, is to achieve a focus on the research problem as a result of increasingly descriptive questions. In line with the Research Problem presented in Paragraph 1.2 above and the Research Question presented in Paragraph 1.3, the following Problem Statement, Research Question and Investigative Questions are defined in terms of the Question Hierarchy:

- **Problem Statement:**
  - The systems approach *per se* does not address model conceptualisation from an executive management perspective to address unstructured complex phenomena in a structured way.

- **Research Question:**
  - Can the systems approach, which is currently embedded in academic literature in various authoritative publications in various forms and permutations, be applied to model conceptualisation to solve unstructured complex phenomena from an executive management perspective?
- **Investigative Questions:**
  - Can the most pertinent elements and dominant traits of the systems approach as described by revered academics be extracted therefrom to culminate in a new formulated *structured systems approach to model conceptualisation*, from an executive management perspective?
  - Can management philosophies formulated during the Twentieth Century, in any way apply to the technology driven, dynamic and constantly changing management environments of the Twenty First Century?
  - Can the systems dynamics of the formulated *structured systems approach to model conceptualisation* specifically applied to the art of executive management, be used to structure the outcomes of paradigm shifts introduced into organisations as a result of unstructured complex phenomena.

1.5 THE RESEARCH DESIGN AND METHODOLOGY

Galliers and Land **[62]** draw the attention to two tendencies in information systems research. The first relates to the primacy of traditional, empirical research, which is more suited to the natural sciences, while the second relates to the tendency to advocate a particular mode of information systems research, irrespective of the particular mode of information systems research topic being studied. Citing the results of a study of Vogel and Wetherby, where it was found that 85 percent of published information systems research undertaken by leading US institutions are of the traditional kind, Galliers and Land **[62]** are of the opinion, that while such research may be deemed to be academically acceptable and internally consistent, it all too often leads to inconclusive or inapplicable results.

Due to the fact that information systems research has often been viewed as residing within the province of technology according to Galliers and Land **[62]**, the analogy can be drawn that the same norms would be applicable to systems related research as presented in this thesis. The crux of the matter however, lies embedded within the context of an observation made by the authors **[62]**, which reads as follows:

> *"Increasingly, however, both information systems academics and practitioners have begun to realize it is more appropriate to extend the focus of study to include behavioural and organizational considerations".*

This is supported by the wish to place information systems, and for the purpose of this thesis, also systems related research, in a broader category according to Davenport and Stoddard **[42]**, since both entities are according to Galliers and Land **[62]**, impacted upon. The authors **[62]**, substantiate this claim when referring to information systems being impacted by:

"the organization and the people they serve".

Although a plethora of approaches are available for research, there are only a few published accounts of the successful application of newer approaches to information technology related research. One well-documented exception to this rule relates to 'action research' briefly described by Checkland **[29]** quoting from Checkland and Jenkins. Galliers and Land **[62]** suggest a taxonomy of research approaches, when dealing with society, organisation groups, individuals, technology and methodology, and for the purpose of this thesis, to also include methodologies pertaining to the concept systems approach. The taxonomy has the objective to ensure that the 'object' on which the research effort is focused and the 'mode' by which the research is carried out is differentiated. The authors **[62]**, further suggest subjective / argumentative and descriptive / interpretative approaches to be applied to the identified entities as part of a broader focus to the concept of information technology related research as opposed to the traditional empirical research.

Subjective / argumentative and descriptive / interpretative approaches require further explanation:

- **Subjective / argumentative approach:-** Quoting the research of Vogel, and Wetherbe, this approach is defined by Galliers and Land **[62]** as, "creating management information systems research based more on opinion and speculation than observation".
- **Descriptive / interpretative approach:-** Quoting Boland, this approach is defined by Galliers and Land **[62]** as, "being in the tradition of phenomenology" i.e., concerned with description. Emory and Cooper **[50]**, in describing the essence and importance of descriptive research, point out that:

> *"The very essence of description is to name the properties of things: you may do more, but you cannot do less and still have description". "The more adequate the description, the greater is the likelihood that the units derived from the description will be useful in subsequent theory building".*

The above argument in favour of a taxonomy for information technology related research, illustrates the point that the scientific paradigm is not always the most appropriate basis for research in this field and that a wider interpretation is required to include behavioural and organisational considerations.

1.6 THE DEMAND FOR A QUALITATIVE RESEARCH STRATEGY

While the researcher acknowledges that a number of strategies can be applied in similar research projects, the well-known concepts of practicality, validity, and reliability, inherited from the empirical analytical paradigm have been utilised within the ambit of this research in more or less the traditional way as proposed by Yin **[185]**. This, according to Maso **[99]**, includes new concepts, norms and rules. Quoting Thorndike and Hagen, these concepts are defined by Emory and Cooper **[50]** as follows:

- **Practicality:** - Practicality is concerned with a wide range of factors of economy, convenience, and interpretability.

- **Validity:** - Validity refers to the extent to which a test measures what we actually wish to measure.
- **Reliability:** - Reliability has to do with the accuracy and precision of a measurement procedure.

The concepts of practicality, validity and reliability defined by Emory and Cooper **[50]** quoting Thorndike and Hagen, were impacted adversely by various internal factors associated with organisations *per se*, making the validation of the *structured systems approach to model conceptualisation* in a live environment virtually impractical. The most significant elements attributing to this situation, were precipitated by the following:

- That the *structured systems approach to model conceptualisation* as formulated in this thesis, is aimed at the top echelon of management namely executive management. To implement the formulated *structured systems approach to model conceptualisation* 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 company/organisational policy.
- Should permission be granted to implement the *structured systems approach to model conceptualisation* in an organisation, it would be most likely that the new management approach 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.
- Executives at the top echelon of an organisation normally follow a management approach, which stems from either tradition or from organisation culture, which is by implication a private and confidential matter to the exclusion of third parties. Furthermore, introducing a new approach on an experimental basis into established structures would require board approval and impact executive strategies and decision making[14] and in addition would require the management of change on a broad front.

[14] With this statement, the author 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.

- An aspect, which Pascale **[123]** terms 'conservatism', has furthermore a significant impact on the validation potential of the *structured systems approach to model conceptualisation.* Due to the fact that management in the words of Pascale **[123]** 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.

It was therefore, a requirement for the researcher to become aware of all these critical issues identified above, and prepare and equip himself to handle these issues with skill and sensitivity. Furthermore, to guarantee the anonymity of all parties concerned in the quest to establish the validity of the *structured systems approach to model conceptualisation.*

A qualitative investigation of a particularly sensitive nature conducted by Oskowitz and Meulenberg-Buskens **[120]**, qualified the importance of handling mission critical issues as identified above when the authors stated:

> *"Thus any type of qualitative investigation could benefit from the researchers being skilled and prepared, and the sensitive nature of an investigation into a stigmatizing condition made the need for such an undertaking even more imperative in the current study".*

Furthermore, the sensitivity of certain issues and issues identified as impacting the research negatively in the environments being evaluated, not only demanded intimate personal involvement, but also demanded the 'personal and practical experience' of the author[15], a view upheld by Meulenberg-Buskens **[107]**, as being imperative to assure quality in qualitative research being undertaken. Checkland **[29]** supports this view, however extends the concept and is of the opinion that, "the researcher becomes a participant in the action, and the process of change itself becomes the subject of research".

[15] See also the importance of the requirement for the 'personal and practical experience' of the author referred to in Chapter 5, Paragraph 5.3.

To bridge the listed factors whilst still proactively validating the formulated *structured systems approach to model conceptualisation* as a viable alternative management methodology, a limited survey will be conducted, the results of which is contained within the ambit of Appendix B. The purpose of this limited survey will be to ascertain the opinions of executives with regard to the validity of the *structured systems approach to model conceptualisation* as an alternative management mechanism. It is not the intention of the author to conduct a full-scale survey with extensive supporting statistical analysis as used in similar research projects. The objectives of the limited survey undertaken in this thesis is to provide the reader with an appreciation of the applicability of the systems approach as perceived by experienced executives within a spectrum of disciplines and in so doing, reinforce both the uniqueness of this approach as well as the management potential inherent therein. This is further supported by a case study, which depicts the *structured systems approach to model conceptualisation* as an alternative management mechanism.

1.7 AN OVERVIEW OF THE THESIS STRUCTURE

This thesis has been structured in such a way as to ensure adherence to the following concepts:

- The concepts presented within the document must flow logically from one part to the next in order to maximise reader comprehension of the various topics presented.
- Given the diverse nature of the respective literature review interpretations, the order of presentation must be such that the reader is equipped with a deeper understanding of each review interpretation presented. This is to ensure that the new formulated *structured systems approach to model conceptualisation* is understood, particular the sub-entities thereof as it relates to the various philosophies imbedded therein.

For the reasons listed above, the individual chapters of this thesis have been grouped together in four separate parts namely:

- **Part 1:-** Consists of the abstract, the scope of the research and a detailed analysis of the complexities which pertain to the concept 'systems approach'.
- **Part 2:-** Consists of literature reviews pertaining to hard and soft systems methodologies.
- **Part 3:-** Consists of a detailed analysis of the key elements of the *structured systems approach to model conceptualisation* and the approach functioning as an alternative management mechanism.
- **Part 4:-** Consists of the conclusions of the research, identified areas for further research, appendices pertaining to the thesis and the bibliography.

1.7.1 CHAPTER AND CONTENT ANALYSIS

The chapter and content analysis shown in Figure 1.2, which is in line with the research design and methodology (refer Paragraph 1.5) requires closer scrutiny and the following analysis in respect thereof is provided:

- **Abstract:-** Provides the reader with a short synopsis of the extent of the research pertaining to the *structured systems approach to model conceptualisation* from an executive management perspective and associated complex phenomena in 'real world' situations.
- **Chapter 1 – The scope of the research:-** Sets the scene for the research contained within the ambit of the thesis, starting with a brief introduction and background to the concept systems approach, the history thereof expanded upon in Appendix C. This is followed by an insight into 'real world' phenomena and the mechanisms available to deal with such phenomena, primarily contained in the 'Sources of Power'. The latter concept which is expanded upon in Appendix A. The remainder of the chapter focuses on the Research Problem, the Research Question, the Research Process, the Research Design and Methodology and concluded with an item dealing with the Demand for a Qualitative Research Strategy.
- **Chapter 2 – The complexity of the systems approach:-** This chapter contains the key issues, which contribute to the complexities of the systems approach. Furthermore, these issues are considered to be pre-requisites to the

understanding of the reader to ensure that the interrelationships, which these entities have with the systems approach, are understood and viewed in context of the overall research. The concepts, which will be discussed are:

- The concept 'system'.
- General Systems Theory.
- The concept 'systems approach'.
- The concept 'cybernetics'.
- Closed and open systems.
- The role of models.
- The notions *'Weltanschauung'* and 'appreciative systems'.
- 'Causal loop diagrams' and 'reinforcing and balancing processes'.
- Science and Technology impact.

- **Chapter 3 – A high level analysis of the hard 'systems approach':-** In this chapter, the major 'hard' systems methodologies, selected especially for their particular applicability to the research in this thesis will be contextually analysed at a high level in terms of literature reviews. The analysis will cover the following 'hard' systems methodologies:
  - Systems engineering.
  - Systems analysis.
  - Operational research.
  - Management cybernetics.
  - Systems Dynamics.

  Included in this chapter and in lieu of Chapter 4, which will deal with the 'soft' systems approach, 'hard' and 'soft' systems methodologies are compared to add to the conceptual understanding of the reader of the two concepts. Furthermore, to provide a balanced analysis, the hard systems approach is analysed to highlight its major criticisms, positive aspects and features.
- **Chapter 4 – A high level analysis of the soft systems approach:-** In this chapter, the major 'soft' systems methodologies, selected especially for their particular applicability to the research in this thesis will be contextually analysed at a high level in terms of literature reviews. The analysis will cover the following 'soft' systems methodologies:

- 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.

As in the case of Chapter 3 to provide a balanced analysis, the soft systems approach is analysed to highlight its major criticisms, positive aspects and features.

- **Chapter 5 – In depth analysis of the construction elements for the structured systems approach to model conceptualisation:-** Chapter 5, in the opinion of the author, is one of the key chapters in this thesis, as the chapter contents is focused on a detailed analysis of all of the construction elements, which culminates in the formulated *structured systems approach to model conceptualisation*. This chapter also provides impetus to the author's objective with this thesis whereby the approach, which is based on the philosophies formulated by revered academics during the Twentieth Century and, which includes the authors own contribution, can add value to the existing body of knowledge. This with particular reference to the application of a *structured systems approach to model conceptualisation* by executive management of the Twenty First Century, when dealing with unstructured complex phenomena in a formalised and structured way.
- **Chapter 6 – Model conceptualisation as an alternative management mechanism:-** In this chapter the full potential of the *structured systems approach to model conceptualisation* is demonstrated using a case study. The derived benefits are compared to the requirements set in an analysis pertaining to an industry perception of the *structured systems approach to model conceptualisation*, which is contained in Appendix B. Furthermore, the Research Problem and associated Research Questions are compared with the deliverables of the *structured systems approach to model conceptualisation* as an alternative management mechanism.
- **Chapter 7 – Conclusion:-** In this concluding chapter, the research is summarised and evaluated in terms of 'real world' phenomena and the mechanisms available to deal with such phenomena, with particular reference

to the formulated *structured systems approach to model conceptualisation.* The remainder of the chapter focuses on concluding observations pertaining to the research and possible avenues of further research.

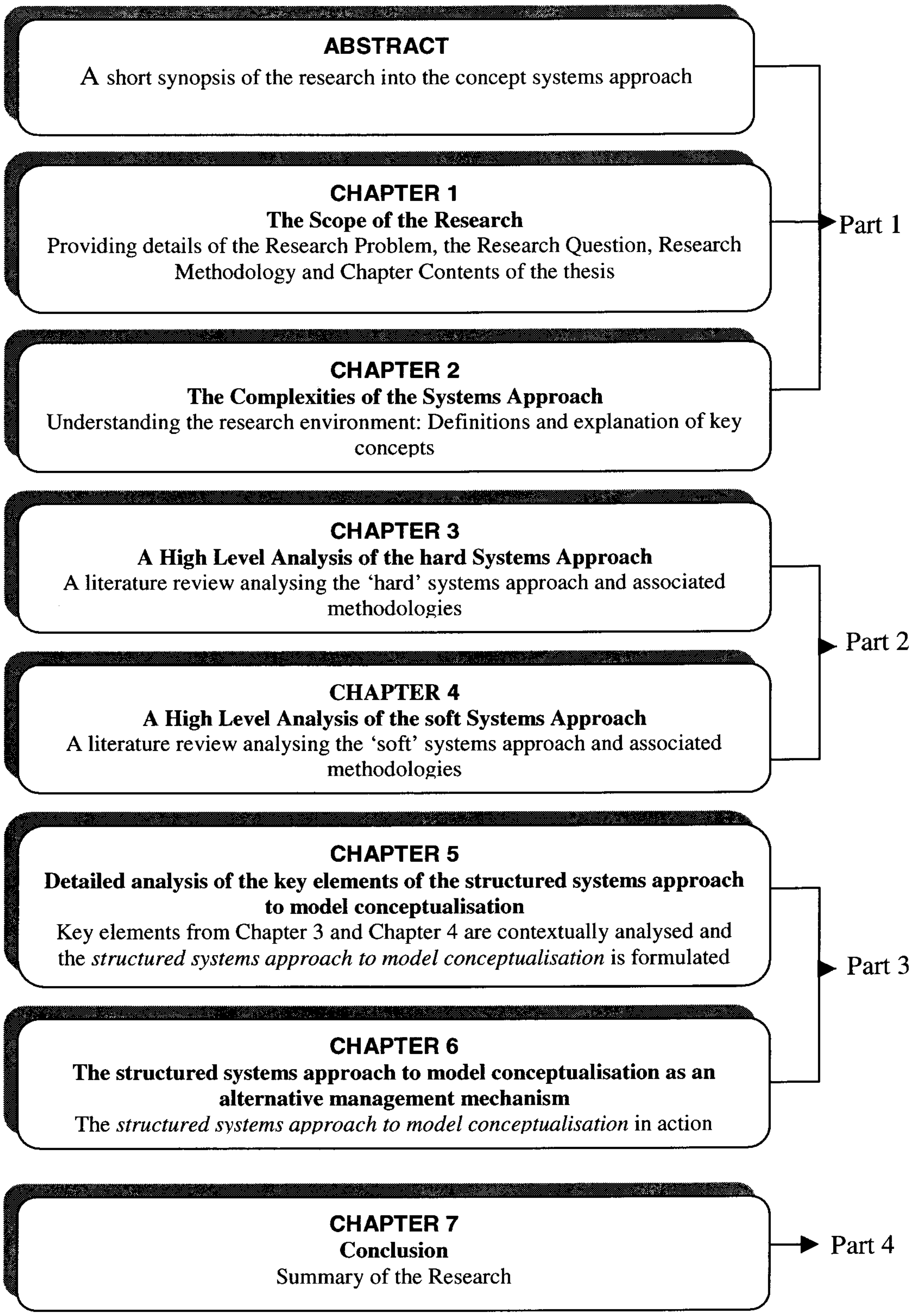

FIGURE 1.2: Schematic depiction of thesis structure

1.8 CONCLUSION

The key objectives of the author with this thesis and by implication forming the basis of any research undertaken at doctoral level according to Easterby-Smith, Thorpe and Lowe **[47]** and Kennedy **[85]**, are:

- That the results of the proposed research make a significant contribution (add value) to the existing body of knowledge.
- That the results should be of such a nature that it can be applied immediately and effectively in any corporate or commercial business environment to enhance the art of executive management.

This thesis is then about a formulated *structured systems approach to model conceptualisation*, the use of a particular derived set of systems norms to facilitate the art of executive management. Furthermore, the *structured systems approach to model conceptualisation*, makes conscious use of a particular concept of wholeness captured in the word 'system' to order a set of executive management norms.

In this first chapter, the Scope of the Research has been outlined starting with an introduction and background to the systems approach followed by clear definitions of the Research Problem and associated Research Question. The Research Process has been outlined whereby the Research Problem Statement, Research Question, and subsequent Investigative Questions are defined in terms of a formulated Question Hierarchy. This is followed by the Research Design and Methodology, which is complemented with a topic on the Demand for Qualitative Research Strategy. The chapter is concluded with an Overview of the Thesis Structure, which includes a Chapter and Content Analysis.

In Chapter 2, the complexities of the systems approach are introduced to provide the reader with the required insight into the complex issues governing the systems approach and associated problem solving methodologies which will be discussed in Chapter 3 and Chapter 4. More specific, it is the interrelationships which these entities have with 'hard' and 'soft' systems methodologies, which emphasises their importance to virtually become pre-requisites to the understanding the internal functionality of hard and soft systems approaches. Furthermore, the concepts making up the complexities of the systems approach, cover a range of diverse (and often unrelated) topics, which will only become clear as the research progresses, and the entities surface as integral components of the approach, to address complex phenomena and viewed in context of the overall research.

In final conclusion, this thesis is about both *a structured 'systems approach' to model conceptualisation* and 'systems practice' and the relationship between the two entities, aimed at dealing with unstructured complex phenomena within the ambit of executive management.

Chapter 2

THE COMPLEXITY OF THE SYSTEMS APPROACH

"The world that we have made as a result of the level of thinking we have done thus far creates problems that we cannot solve at the same level as they were created".

Albert Einstein

2.1 INTRODUCTION

In this chapter, the complexities of the systems approach are introduced to provide the reader with the required insight into the complex issues governing the systems approach and associated problem solving methodologies which will be discussed in Chapter 3 and Chapter 4. More specific, it is the interrelationships which these entities have with hard and soft systems methodologies, which emphasises their importance to virtually become pre-requisites to the understanding the internal functionality of hard and soft systems approaches. Furthermore, the concepts making up the complexities of the systems approach cover a range of diverse (and often unrelated) topics. This will only become clear as the research progresses into Chapter 5 and Chapter 6, where the entities surface as integral components of the approach to model conceptualisation to address unstructured complex phenomena and viewed in context of the overall research.

The following concepts are investigated and where appropriate, defined:

- The concept system.
- General Systems Theory.
- The concept systems approach.
- The concept cybernetics.
- Closed and open systems.
- The role of models.
- The notions '*Weltanschauung*' and Appreciative systems.
- Causal loop diagrams and Reinforcing and balancing processes.

➤ Science and Technology impact

The analytical process followed thus far, is graphically depicted in Figure 2.1, which places the chapters in context with the overall thesis objectives, and furthermore indicates the relative positioning of this chapter.

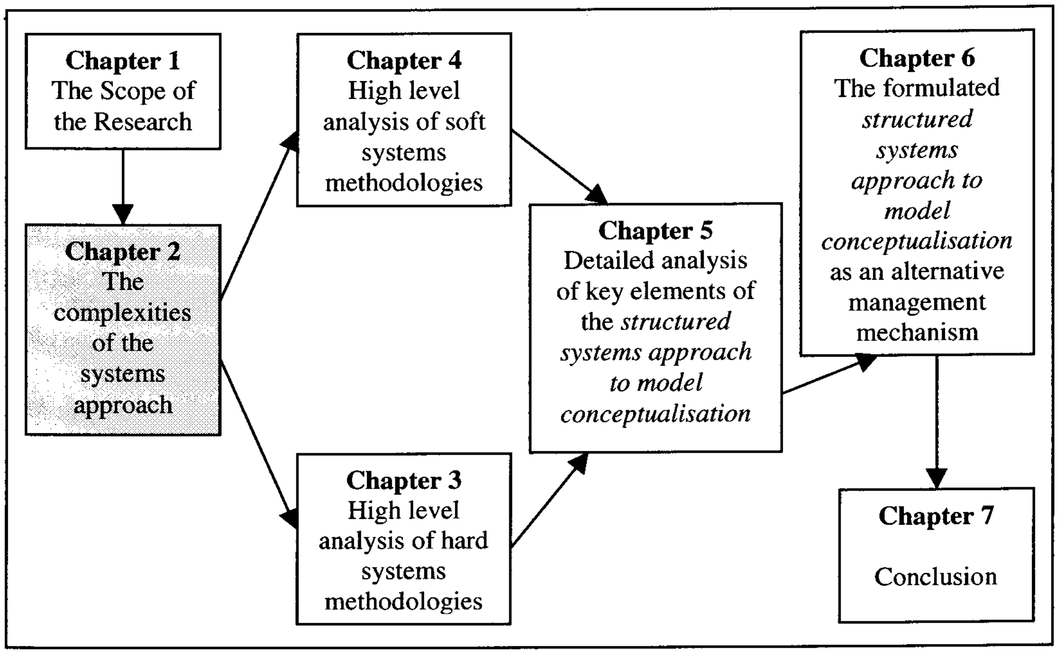

Figure 2.1: Chapters in context of the overall research

An analysis of Figure 2.1[1], shows Chapter 1 as the overall research approach to the thesis. Within the ambit of this chapter, a number of key elements (complexities), are explained in lieu of the high level analysis of 'hard' systems (contained in Chapter 3), and the high level analysis of 'soft' systems, (contained in Chapter 4). Key elements from the high level analysis of hard systems and soft systems methodologies, will serve as preliminary input mechanisms to Chapter 5, where the elements will be further analysed in detail to ultimately culminate in a formulated *structured systems approach to model conceptualisation*. Chapter 6 will depict the *structured systems approach to model conceptualisation* as an alternative management mechanism in practice, while Chapter 7 will contain a summary of the thesis content.

In addition, to provide the reader with a navigational roadmap to understanding

[1] Arrows in Figure 2.1 represents 'information flows' (inputs) from one chapter to the other.

the complexity of the systems approach, the components of which is reflected in Figure 2.2, being adapted from Checkland [29] for this purpose.

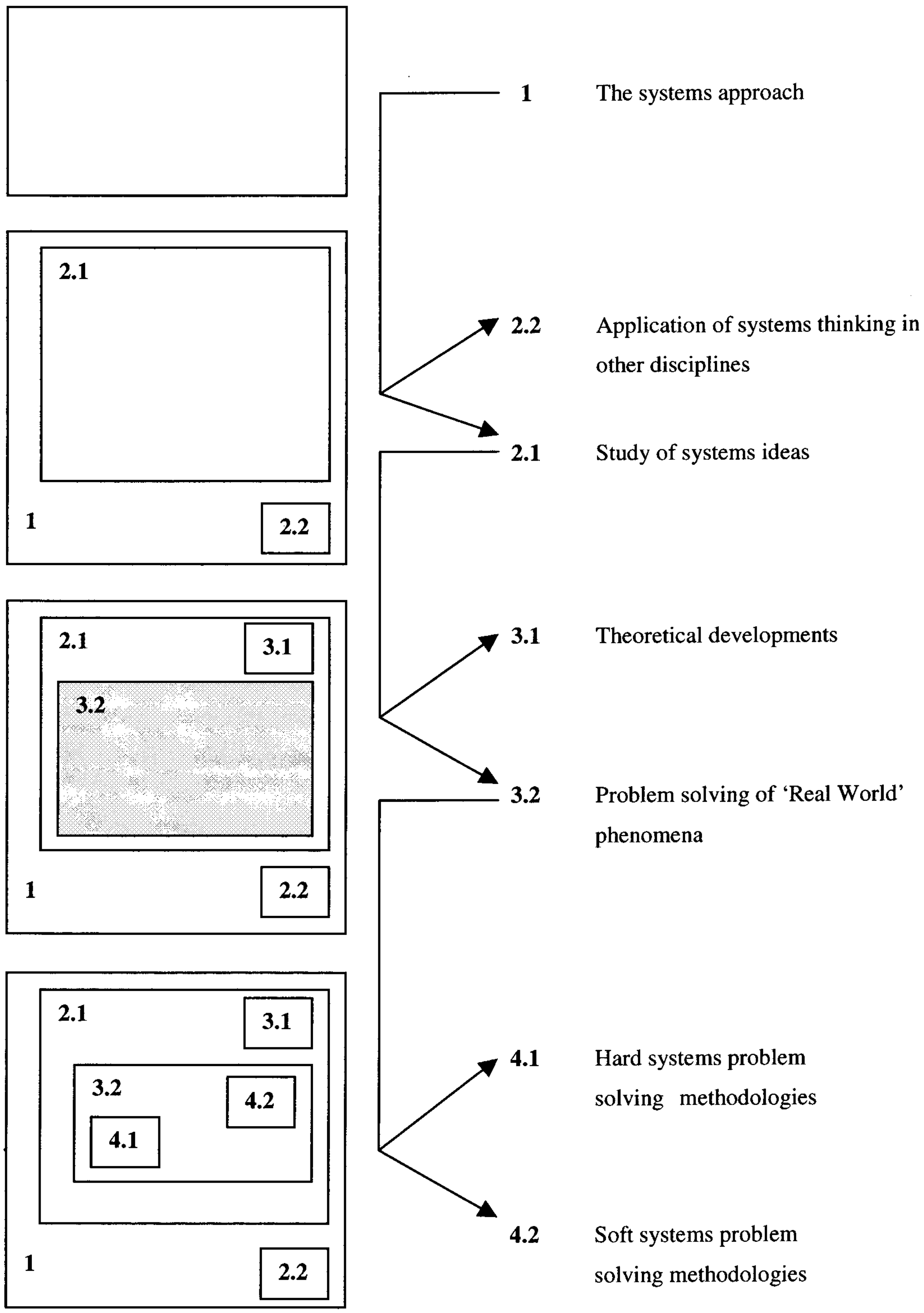

Figure 2.2: Classification of systems falling within the context of the systems approach [29]

It is acknowledged by the author that the classification of systems within the context of the systems approach as depicted in Figure 2.2, is merely 'one of many' such classifications in existence today. A more popular classification is provided by Jackson **[80]**, whereby system approaches are classified according to the assumptions they make where the terms, unitary, pluralist and coercive are used for describing the relationship between the various stakeholders with an interest in organisations. The classification as depicted in Figure 2.2, was selected specifically as the contents thereof map, to the general approach to the research problem set in this thesis.

Analysing Figure 2.2, the systems approach (shown as Frame 1), is presented as an all incumbent 'overall' problem solving methodology consisting of a multitude of different approaches to address complex phenomena. These different approaches led in the first instance to the 'application of systems thinking in other disciplines', (shown as Frame 2.2), of which the 1970's system revolution in geography serves as an example, and in the second instance, the 'study of systems ideas' (shown as Frame 2.1), which are split into two distinct fields namely:

- Theoretical developments (shown as Frame 3.1), of which the 'General Systems Theory' further discussed in Paragraph 2.3 serves as an example.
- Problem solving of real world phenomena (shown as Frame 3.2).

The hard systems approach (shown as Frame 4.1) and contained within the ambit of Chapter 3 is made up of the following problem solving methodologies:

- Systems engineering.
- Systems analysis.
- Operational research.
- Management cybernetics
- Systems Dynamics

The soft systems approach (shown as Frame 4.2) and contained within the ambit of Chapter 4 is made up of the following problem solving methodologies:

- The Viable Systems model of Beer (organisational cybernetics).
- Churchman's Social Systems Design.

- Mitroff and Mason's Strategic Assumption Surfacing and Testing Methodology.
- Ackoff's Social Systems Sciences.
- Checkland's Soft Systems Methodology.

It is this 'problem solving of real world phenomena', which gave rise to the very essence of the research contained within the ambit of this thesis

2.2 THE CONCEPT SYSTEM DEFINED

A philosopher once said he knew no two objects that were not related in some way, if only by the distance between them. This philosopher has broadly defined the concept of a 'system' **[141]**. This statement leads to the analogy that, "everything is related to everything else", which according to Beer **[21]**, is in line with the philosopher Hegel's enunciation of the proposition called 'The Axiom of Internal Relations'. In terms of this concept, the relations by which terms are related are an integral part of the terms they relate to. So the notion we have of anything is enriched by the general connotation of the term, which names it, and this connotation describes the relationship of the thing to other things. In fact, Hegel's Axiom entails that things would not be the things they are, if they were not related to everything else in the way that they are.

The term 'system' can be associated with a plethora of interpretations depending on the field one wishes to apply the concept to. The term is used in almost all sciences and in everyday language resulting in the term being associated with amongst others, system science, systems thinking, systems design, systems analysis, systems engineering and the systems approach.

According to Ackoff **[2]**, the term system is used to cover a wide range of phenomena, some of which are conceptual constructs, and others are physical entities. The following can be listed, namely:

- Philosophical systems.
- Number systems.
- Communication systems.

- Control systems.
- Educational systems.
- Weapon systems.

Against this background, Ackoff **[2]**, defines the concept as:

> *"Any entity, conceptual or physical, which consists of interdependent parts".*

Kauffman **[84]** and Sisk **[156]**, provide 'near' identical definitions of 'system' which are consolidated here to read as follows:

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

Strümpher **[165]** citing Vickers (1984) defines a system as:

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

Strümpher **[165]** makes two important observations regarding the systems definition of Vickers of which the true impact will become clear only in Chapter 5 of this thesis where the *structured systems approach to model conceptualisation* will be formulated. These, rather lengthy comments, which are quoted *verbatim* as not to lose the true meaning of the author, reads as follows:

- *"The first aspect that Vickers' definition captures is that anything that we care to group together and label as an entity proves upon further investigation to be constituted from more relationships". "In fact why we care to label an entity as such is because the constituent relationships show resilience or stability through time, i.e., 'it' persists". "It is precisely because the relationships hang together through time that we observe them (it) in the first place". "One perspective on relationships then is this stability, which I* *will call the structure". "By structure I therefore mean those relationships that remain relatively unchanged through the period of interest to the inquiry".*

- *"A second aspect touched by Vickers' system definition is that there is a dynamic dimension to the relationships". "This perspective on systems relationships, which I will call the process dimension, refers to the altering or changing of relationships over the time frame of the enquiry". "Process refers to the matter/energy and/or information flow, and their transformations, which place within the entity, as well as between the entity and its environment, during the timeframe of interest in the inquiry". "Process describes the logical thinking of inputs to output(s)". "It should be borne in mind that definitions of input and output depend on how the systems boundary is drawn, which is by no means determined absolutely". "Whereas structure describe 'static' or (relatively) unchanged relationships, the process perspective describes the changes in relationships within the time frame of interest".*

The same author **[165]** also quotes the definition of Ackoff (1981) of a system. This definition portrays a system:

> *"as a set of elements where the behaviour of any part depends on the interaction with other parts. i.e., behaviour depends on interrelationships".*

Churchman **[35]** does not define a system *per se*, but provides nine conditions that determine a system. Briefly, the necessary conditions that something ***S*** be conceived as a system are as follows:

- ***S*** is teleological[2]. (i.e., a view that developments are due to the purpose of

[2] According to Churchman **[35]** design belongs to the category of behaviour called 'teleological', i.e. 'goal seeking' behaviour. More specifically, design is thinking behaviour, which conceptually selects among a set of alternatives in order to figure out which alternative leads to a designed goal or set of goals.

design, that is served by them.)

- ***S*** has a measure of performance.
- There exists a client whose interests are served by ***S*** in such a manner that the higher the measure of performance, the better the interests are served, and more generally, the client is the standard of the measure of performance.
- ***S*** has teleological components, which co-produce the measure of performance of ***S***.
- ***S*** has an environment, which also co-produces the measure of performance of ***S***.
- There exists a decision-maker who – via his resources - can produce changes in the measures of performance of ***S's*** components and hence changes in the measure of performance of ***S***.
- There exists a designer, who conceptualises the nature of ***S*** in such a manner that the designer's concepts potentially produce actions in the decision maker and hence changes in the measures of ***S's*** components and hence changes in the measure of performance of ***S***.
- The designer's intention is to change ***S*** so as to maximise ***S's*** value to the client.
- ***S*** is stable with respect to the designer, in the sense that there is a built-in guarantee that the designer's intention is ultimately realisable.

Churchman **[34]**, underwrites the above nine conditions that determines a system with the following definition:

"a system is a set of parts co-ordinated to accomplish a set of goals"

Very closely mapping this definition, is the description of a system as perceived by Thierauf **[170]** who describes the concept as, "an ordered set of methods, procedures, and resources designed to facilitate the achievement of an objective or objectives". Returning to the root meaning of the word, The Oxford English Dictionary **[169]** defines system as:

> *"An organized scheme or plan of action, esp. one of a complex or comprehensive kind; an orderly or regular method of procedure".*

According to Senge *et al* **[151]**, the word system, descends from the Greek verb '*sunistánai*', which originally meant 'to place together', hence the view that a system is a perceived whole whose elements 'hang together', because they continually affect each other over time and operate toward a common purpose. This interpretation can be expanded upon if viewed against the definitions provided by Lannon-Kim **[95]** and the definition by Kramer and de Smit **[93]**.

- Lannon-Kim **[95]** and Kim **[89]** defines system as:

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

- Kramer and de Smit **[93]** define a system as:

> *"a set of interrelated entities, of which no subset is unrelated to another subset".*

The definitions provided by Lannon-Kim **[95]** and Kramer and de Smit **[93]**, map in certain instances to the definition, which Kast and Rosenzweig **[82]** attach to the concept system namely:

> *"an organized, unitary whole composed of two or more interdependent parts, components, or subsystems and delineated by identifiable boundaries from its environmental suprasystem".*

Within this context, the term system covers a broad spectrum of our physical, biological and social world. This suggests the requirement for a 'General Systems Theory', which provides a broad macro view from which we may look at all types of systems given effect to the following words of Ashby (1964) cited by Kast and Rosenzweig **[82]**:

> *"So has arisen systems theory – the attempt to develop scientific principles to aid us in our struggles with dynamic systems with highly interactive parts".*

While the simplistic view of the concept system for Pascale **[123]**, 'only refers to how information moves around within the organisation', Churchman *et al* **[33]**, see system as, "an interconnected complex of functionally related components". The concept system is expanded by Achoff and Rivett **[5]**, to "a system's orientation", which they define as:

> *"deliberately expands and complicates the statements of problems until all the significantly interacting components are contained within it".*

This leads into the rather lengthy explanation by Johnson **[81]** of a system, provided in terms of the following fundamental characteristics:

> *"First, a system is a whole that consists of a set of two or more parts". "Each part affects the behaviour of the whole, depending on the part's interaction with other parts of the system". "In addition, the essential properties that define any system are properties of the whole, and none of the parts have those properties".*

The fact that a system is a whole that consists of a set of two or more parts' requires closer scrutiny. This implies that systems are composed of parts, which are themselves systems, according to Cleland and King **[38]** who cites the following example: "The human body is a system composed of various 'subsystems' (nervous, cardio-vascular, etc.)". "In turn, these sub-systems are composed of cells, each of which is itself a system". "Thus, systems typically exhibit a structure in which these are parts (sub-subsystems) imbedded within other parts (subsystems) within overall systems". This issue is deliberated further by Ackoff and Emery **[4]**, who look at, "human behaviour as systems of purposeful (teleological) events". Ashby **[16]**, is of the opinion that when a set of subsystems are richly joined, each variable is as much affected by variables in other subsystems as by those in its own. Furthermore, the imbedding of one system in another can go on through many stages and indeed go on endlessly.

In summary, Capra's **[27]** conceptualisation of system, in view of the author, draws together all the components of the concept. For Capra **[27]**, system means, "an integrated whole whose essential properties arise from the relationship between the parts which can be traced back to the root meaning of the word 'system' which derives from the Greek *'sunistánai'*, (to place together)".

In final conclusion, the controversial view of Weinberg **[181]**, who, when answering the question: What is a system? – retorts with:

> *"As any poet knows, a system is a way of looking at the world". "The system is a point of view – natural for a poet, yet terrifying for a scientist".*

2.3 GENERAL SYSTEMS THEORY

According to Kramer and de Smit **[93]**, Köhler a German physicist, was the first to give impulse towards the 'General Systems Theory' in 1924 with his book: *'Die physischen Gestalten in Ruhe und im stationären Zustard'*

Focussing on management, the earliest system models used in management according to Jackson **[80]**, studied organisations as mechanical systems in equilibrium. The idea of studying social systems in this way according to Jackson **[80]**, originally derived from Pareto (1919) and thereafter promoted in the United States by Henderson, a powerful figure at Harvard University in the 1930's.

According to Jackson **[80]**, citing Kast and Rozenweig (1981), three different models of management emerged from the 1930's onward namely, the Traditional Approach, the Human Relations Theory and the Systems Theory. The Traditional Approach was based on Taylor's Scientific Management, Fayol's Administrative Theory, and Weber's Bureaucracy Theory. Another theory, the Human Relations

Theory grew out of the critique of the Traditional Approach with theorists in the likes of Mayo, Maslow, Hertzberg and Mc Gregor avid supporters thereof.

Ludwig von Bertalanffy, in 1940 published in German his first discussion on open systems **[27]**, which was followed with an essay in 1950, entitled *'The Theory of Open Systems in Physics and Biology'* **[80]**. This according to Jackson **[80]** citing Emery (1969) and Lilienfeld (1978):

"establishes systems theory as a scientific movement".

This furthermore establishes von Bertalanffy rightfully as the founding father of the systems theory[3] **[80]**, who gave institutional embodiment to the concept by setting up the society for General Systems Research in 1954 with co-founders Boulding, Rapoport and Gerard **[93]**.

Capra **[27]**, citing from the work of von Bertalanffy (1968), provides the following definition of the 'General Systems Theory' from a holistic point of view:

> *"General system theory is a general science of 'wholeness' which up till now was considered a vague, hazy, and semi-metaphysical concept". "In elaborate from it would be a mathematical discipline, in itself purely formal but applicable to the various empirical sciences". "For sciences concerned with 'organized wholes', it would be of similar significance to that which probability theory has for sciences concerned with 'chance events'".*

Furthermore, according to Capra again citing von Bertalanffy (1968), the latter believed that a 'General Systems Theory' would offer an ideal conceptual framework for unifying scientific disciplines that had become fragmented:

[3] According to von Bertalanffy cited by Kast and Rosenzweig **[82]**: "The various fields of modern science have had a continual evolution toward a parallelism of ideas". "This parallelism provides an opportunity to formulate and develop principles which hold for systems in general".

> *"General systems theory should be . . . an important means of controlling and instigating the transfer of principles from one field to another, and it will no longer be necessary to duplicate or triplicate the discovery of the same principle in different fields isolated from each other". "At the same time, by formulating exact criteria, general systems theory will guard against superficial analogies which are useless in science".*

Caution in the use of the 'General Systems Theory' comes from Checkland **[29]** who is of the opinion that:

> *"The problem with General Systems Theory is that it pays for its generality with lack of content". "Progress in the systems movement seems more likely to come from the use of systems ideas within a specific problem area than from the development of overarching theory".*

It is of importance to note that while von Bertalanffy is commonly credited with the first formulation of a comprehensive theoretical framework describing the principles of organisation of living systems, the first papers on the general systems theory were formulated, not by von Bertalanffy, but by the Russian Alexander Bogdanov **[27]** twenty to thirty years earlier. According to Capra **[27]**, Bogdanov called his theory 'Tektology' from the Greek *'tekton'* (builder), which can be translated as 'the science of structures'. Bogdanov's pioneering book *'Tektology'*, was published in Russian in three volumes between 1912 and 1917, while the German edition was published and widely revised in 1928 **[27]**. Furthermore, according to Capra **[27]**, tektology anticipated the conceptual framework of Ludwig von Bertalanffy's General Systems Theory, and it also included several important ideas that were formulated decades later as key principles of cybernetics by Robert Wiener and Ross Ashby.

Kramer and de Smit **[93]**, acknowledge these parallel developments to the systems theory, namely contributions before 1950 pertaining to cybernetics citing Sziland, being in the forefront thereof with his book: *'Über die Entropieverminderung in* *einem thermodynamischen System bei Eingriffen intelligenter Wesen'*, and the work of Norbert Wiener in this respect, which led to the publication of his book *'Cybernetics'* in 1948, claiming that this was the most important impulse to the development of the General Systems Theory.

It was only during the 1960's, that the systems approach came to dominate management theory, due to the fact that the Traditional Approach concentrated on task and structure, the Human Relations Approach on people, and the systems approach was said to be 'holistic', because it focussed on organisations as a whole[4] **[93]**. This 'holistic' approach became a requirement according to Von Bertalanffy cited by Kramer and de Smit **[93]** due to the fact that in various academic principles, problems were becoming increasingly complex owing to progress in the respective sciences.

Vickers (1972) cited by Haines **[68]**, provides the following, rather lengthy, explanation of the General Systems Theory, in layman's terms, repeated here *verbatim* as to not lose the original meaning of the author:

> *"The words general systems theory imply that some things can usefully be said about systems in general, despite the immense diversity of their specific forms". "One of these things should be a scheme of classification".*
>
> *"Every science begins by classifying its subject matter, if only descriptively, and learns a lot about it in the process. . . ." "Systems especially need this attention, because an adequate classification cuts across familiar boundaries and at the same time draws valid and important distinctions which have previously been sensed but not defined".*

[4] The essence of the General Systems Theory can be expressed according to Kramer and de Smit **[93]** as: "the whole is more than the sum of its parts".

> *"In short, the task of General Systems Theory is to find the most general conceptual framework in which a scientific theory or a technological problem can be placed without losing the essential features of the theory or the problem".*

According to Haines **[68]**, this theory, then, is a marvellous vehicle for framing and describing universal relationships. Its basic precept is that, in our work in any problem, the whole should be our primary consideration, with the parts secondary.

2.4 THE CONCEPT SYSTEMS APPROACH DEFINED

It is the 'approach' to the concept 'system', which is encapsulated in the following definition from *The Oxford English Dictionary* **[168]**, which defines 'an approach' as:

> *"A way of considering or handling something, esp. a problem"*

This definition is identical to the definition provided by Checkland **[29]** who defines 'approach' as:

> *"a way of going about tackling a problem".*

Checkland expands this definition into a definition for the systems approach, which reads as follows:

> *"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".*

Lannon-Kim **[95]** defines the systems approach as:

> *"a school of thoughts which focuses on reorganizing the interconnections between the parts of a system and synthesizing them into a unified view of the whole".*

This definition maps to the systemic view of Palazzoli *et al* **[122]** where the authors make the observation that, "no phenomenon can be grasped unless the field of observation includes the whole context in which the phenomenon occurs". This definition leads into the requirement to understand the difference between systems analysis and systems synthesis, as Johnson **[81]** is of the opinion that, "the systems approach is more synthesis than analysis"[5].

Checkland **[29]** defines the process of management as being:

> *"concerned with deciding to do or not to do something, with planning, with considering alternatives, with monitoring performance, with collaborating with other people or achieving ends through others; it is the process of taking decisions in social systems in the face of problems, which may not be self-generated".*

The systems approach, since inception have been expanded upon and changed over the years and specifically applied to a world where complex phenomena are of the order of the day. The systems approach, as a regulated mechanism, specifically provides structure and order to any mode of inquiry within the context of such complex phenomena.

The complex phenomena associated with the art of management, and for the purpose of this thesis, executive management is encapsulated by the following extract from Goodman **[66]**:

> *"English, like most other Western languages, is linear – its basic sentence construction, noun – verb – noun, translates into a worldview of X causes Y". "This linearity predisposes us to focus on one way relationships rather than circular or mutually causative ones, where X influences Y, and Y in turn influences X". "Unfortunately, many of the most vexing problems, confronting managers and corporations today are caused by a web of tightly interconnected circular relationships". "To enhance our understanding and*

[5] See also Chapter 3, Paragraph 3.3 dealing with 'systems analysis'.

communication of such problems, we need a language more naturally suited to the task".

Goodman **[66]** suggests the systems approach as being the most suited language for communicating such complexities and interdependencies. This is supported by Dearden **[44]**, a Harvard professor, who referred to the systems approach as, "nothing more than good management". The systems approach is today the most popular problem solving technique **[103]**, which is to be expanded in this thesis to address specific phenomena pertaining to executive management over a spectrum of disciplines. The statement of Churchman **[34]** that: "the systems approach is not a bad idea", encapsulates all of the issues above.

While system analysis is useful for revealing *'how'* a system works – its structure **[159]**, system synthesis reveals *'why'* a system works the way it does, the latter the very essence of the systems approach, which is supported by Kramer and de Smit **[93]** who is of the opinion that, "The systems approach is a means of tackling problems, a methodology", which maps to the theme of this thesis, namely a *structured systems approach to model conceptualisation.* This is conceptually supported by Goodman *et al* **[65]** when discussing the power of systems thinking. The authors **[65]** upheld the opinion that, "the systems approach is especially useful for defining problems, formulating and testing potential solutions and implementing effective solutions that endure".

Oversimplified in its most basic format, and bordering on layman's terms, the systems approach to problem solving involves the following steps **[146]**, **[18]**, **[103]**, **[20]**:

- Define the problem.
- Gather data describing the problem.
- Identify alternative solutions.
- Evaluate these alternatives.
- Select the best alternative.
- Follow up to determine if the solution is working.

On the broadest level according to Churchman **[32]** and Senge *et al* **[151]**, the systems approach belongs to a whole class of approaches to managing and planning our human affairs with the intent that we as a living species conduct ourselves properly in this world. More in line with the theme of this thesis, Churchman **[34]** evaluates the systems approach from the point of view of the management scientist. In this respect, the systems approach entails:

> *"The construction of 'management information systems' that will record the relevant information for decision-making purposes and specifically will tell the richest story about the use of resources, including lost opportunities".*

Churchman **[34]** continues and draws the analogy that, "systems are made up of sets of components that work together as a whole, and that the systems approach is simply a way of thinking about these total systems and their components", which is in line with the view of Senge **[152]**, who is of the opinion that the discipline of the systems approach lies in a shift of mind:

- Seeing interrelationships rather than linear cause-effect chains.
- Seeing processes of change rather than snapshots.

An all incumbent analogy provided by Capra **[27]** is most appropriate when the author views a system as meaning an integrated whole whose essential properties arise from the relationship between its parts, and 'systems thinking'[6], the understanding of a phenomenon within the context of a 'larger whole'[7].

The concepts 'systems thinking' and 'larger whole' requires closer scrutiny. 'Systems thinking' according to Duhl **[46]**, as an internal mode of 'seeing' ordered patterns of relationships, processes and interconnectedness in and between objects, phenomena, and people, has perhaps existed forever in the minds of various disparate individuals. As a particular way of looking at the world that when extended, becomes a shared total world-view of a dynamically interacting model of the universe. According to Haines **[68]**, systems thinking, represents a

[6] See also Appendix C, Paragraph C2.8
[7] See also Appendix C, Paragraphs C2.8, C2.9 and C2.10.

new way to view and mentally frame what we see in the world; a worldview and way of thinking whereby we see the entity or unit first as a whole, with its fit and relationship to its environment as primary concerns; the parts secondary. This 'whole' view of the systems approach is supported by Senge **[152]** in the following philosophical approach to the concept, which is retained in the original text to ensure that the full impact of the wisdom can be appreciated:

> *"The words 'whole' and 'health' comes from the same root (the Old English 'hal', as in 'hale and hearty')". "So it should come as no surprise that the unhealthiness of our world today is in direct proportion to our inability to see it as a whole". "Systems thinking is a discipline for seeing wholes". "It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots". "It is a set of general principles-distilled over the course of the twentieth century, spanning fields as diverse as the physical and the social sciences, engineering and management".*

The most generally known thesis with regard to 'wholes' is the following:

"The whole is more than the sum of its parts".

According to Angyal **[13]**, this is not a very felicitous formulation since – contrary to the concept of Gestalt psychologists – it may suggest that a summation of parts takes place and that, besides the summation, a new additional factor enters into the constitution of wholes. Feiblemen and Friend **[53]**, underpins the understanding of the concept of 'wholes' with this following powerful analogy of the concept namely:

> *"Wholes are not a level of analysis, but that from which analysis starts".*

This statement becomes more relevant if viewed against the background of the study at hand, in particular with respect to the analysis of complex phenomena.

Senge **[152]** concludes that the systems approach is a sensibility – for the subtle interconnectedness that gives living systems their unique character. According to Singer cited by Mitroff and Linstone **[108a]**, the fundamental notion of interconnectedness, or non-reparability forms the basis of the systems approach.

In final conclusion the views of Chestnut, cited by Silvern **[154]**, who stated that the systems approach is dedicated to emphasising the ideas, which are common to the successful operation of somewhat independent parts in an integrated 'whole'. A comprehensive analysis of the history and emergence of the systems approach is contained in Appendix C.

2.5 CYBERNETICS DEFINED

According to Checkland **[29]**, a part of 'systems theory' known as cybernetics, the word coming from the Greek word *'kybernetes'* meaning 'steersman', forms the link between control mechanisms studied in natural systems as opposed to those engineered in man made systems. According to Kramer and de Smit **[93]**, the Greek philosopher Plato used it in his discussions about the analogy between navigating a ship and governing a country or group of people, and was rediscovered in 1840 by Ampere in his classification of the sciences. The first application of the concept however can be traced back to Arabic and Greek manuscripts around 200 BC where it was according to Kramer and de Smit **[93]**, citing Verveen, used where control systems are mentioned.

It is Lerner **[96]** who draws the attention to the fact that cybernetics is generally associated with the date of publication (1948) by Norbert Wiener of his book '*Cybernetics, or Control and Communication in the Animal and the Machine*', however in addition acknowledging valuable earlier contributions from Maxwell, Vyshnegradskiy, Shestakov, Gavrilov, Nakashimo, Pascal, Leibniz and Babbage. Checkland **[29]** and Kramer and de Smit **[93]** cites the studies of Wiener (1948), who defined cybernetics as:

> *"the entire field of control and communication theory, whether in the machine or in the animal".*

Checkland **[29]** further cites Ashby (1956), the latter considered the leading theoretician in the 1950's and 1960's, and who describes cybernetics somewhat different from Wiener, Ashby (1956) defines cybernetics as follows:

> *"Cybernetics is similar in its relation to the actual machine". "It takes as its subject matter the domain of 'all possible machines'..." "What cybernetics offer is the framework on which all individual machines may be ordered, related and understood".*

Another definition of Wiener, this time cited by Clemson **[39]**, defined the concept as:

> *"The science of effective communication and control in men and machine".*

Flood and Jackson **[56]** expand on this and describe cybernetics as:

"the science of organisation".

Wiener furthermore, according to Kramer and de Smit **[93]**, is of the opinion that cybernetics is not a science, which studies systems, but a science, which studies the behaviour of systems. From this the analogy can be drawn that the origins of modern cybernetics are diverse, but are to be found most concretely in the research of Wiener during the Second World War, particularly in the attempt to develop and refine devices for the control of gunfire **[114]**. This leads onto the notion that cybernetics has tangent planes to the control of processes, an analogy that is confirmed by Churchman **[34]**, when he defines cybernetics as:

> *"a mathematical method of evaluating and controlling a process on the basis of its experience".*

Churchman **[30]**, expands on this definition when he views cybernetics as the discipline concerned with the way in which individuals pursue – or ought to pursue – their goals. According to the author **[30]**, it emphasises the importance of equilibrium, of an internal state that is capable of responding to environmental change without the system's getting off its chosen course. Beer **[22]**, is of the opinion that, "the study of control is a science in its own right, known as cybernetics", while Beer **[23]** furthermore defined the concept as:

"the science of effective organization".

Quoting from an article by Beer entitled *'Towards the Cybernetic Factory'* in Heinz von Foerster and George Zoph (Eds) *'Principles of Self-organization'* (1962), Clemson **[39]** gives the following rendition of Beer's thoughts in respect of the above definition when, the latter thinks of systems with the following characteristics:

- **Complex:-** They have more relevant detail than the given observer can possibly cope with.
- **Dynamic:-** They are changing in their behaviours or structure or both.
- **Probabilistic:-** There are important elements whose behaviours are at least partly random.
- **Integral:-** They act in some important sense as a unity.
- **Open:-** They are embedded in an environment which affects them and which they affect.

From the above, according to Clemson **[39]**, the analogy can be drawn that:

> *"Cybernetics studies the difference between effective and ineffective modes/structures/methods of organization in certain classes of systems".*

It is of importance to draw a clear distinction between 'management cybernetics' falling within the ambit of hard systems methodologies discussed in detail in Chapter 3, and 'organisational cybernetics' falling within the ambit of soft systems methodologies discussed in detail in Chapter 4. The following descriptions according to Jackson **[80]** can be attributed to these two entities:

- **Management Cybernetics:-** This kind of cybernetics treats organisations as if they were actually like machines or organisms. The starting point for a management cybernetic model of the organisation is the input-transformation-output schema. This is used to describe the basic operational activities of the enterprise. The goal or purpose of the enterprise is in management cybernetics, invariable determined outside the system. Then, if the operations are to succeed in bringing about the goal, they must, because of inevitable disturbance, be regulated in some way. This regulation is effected by management. Management cybernetics attempts to equip managers with a number of tools that should enable them to regulate operations. Simplifying considerably (since in fact the cybernetic tools represent an interrelated response to the characteristics of cybernetic systems), extreme complexity can be dealt with using the black box technique, self-regulation can be appropriately managed using negative feedback, and probabilism yields to the method of variety engineering. These three entities will be discussed in greater detail in Chapter 3, Paragraph 3.5 (management cybernetics). Furthermore, whether based on machine analogy or on a biological analogy, management cybernetics can be criticised for exactly the same reasons as hard systems thinking. In this respect, see Chapter 3, Paragraph 3.6.

- **Organisational Cybernetics:**-This concept which is primarily the brainchild of the revered Professor Stafford Beer **[21, 22, 23]**, further supported by Clemson **[39]** and Espejo, the latter cited by Jackson **[80]**. Organisational cybernetics is a strand of cybernetic work concerned with management and organisations that breaks somewhat with the mechanistic and organismic thinking that typifies management cybernetics, and is able to make full use of the concept of variety. Stafford Beer's version of organisational cybernetics seems to have emerged from management cybernetics as a result of two breakthroughs. First, in his book, *"The Heart of the Enterprise"*, Beer (1979) succeeds in building his 'Viable Systems Model' in relation to the organisation from cybernetic first principles. This enables cybernetic laws to be fully understood without reference to the mechanical and biological manifestations in which they were first recognised. Second, more attention is given in organisational cybernetics to the role of the observer. Clemson **[39]**, makes a distinction between a first order cybernetics appropriate to organised complexity because it studies matter, energy, and information and a second order cybernetics (organisational cybernetics) capable of tackling relativistic organised complexity because it studies, as well, the observing system.

Organisational cybernetics, will be discussed in greater detail in Chapter 4, as part of the analysis of the soft systems approach.

2.6 CLOSED AND OPEN SYSTEMS DEFINED

It was von Bertalanffy **[175]**, **[49]**, who first made a clear distinction between two types of systems -'closed' and 'open' in contrasting biological and physical phenomena. Furthermore, he was important for establishing the notion of open systems on a scientific basis **[84]**.

Davis **[43]**, defines a closed system as a system which is self-contained, does not exchange material, information or energy with its environment and as an example of a closed system, cites a chemical reaction in a sealed, insulated container. It is for this reason then that Kremyanskiy **[94]** argues that the entropy of a closed system as a rule only grows, whereas the system as a whole, being subservient to the environment and incapable of renewing itself, is inevitable destroyed, without, moreover, leaving a successor.

Davis **[43]**, cites a biological system (such as man) as an example of an open system, as the elements exchange information, material, or energy with the environment. This exchange according to Kremyanskiy **[94]** serves as the basis for the perpetuation of this form of existence and as the basis for the decrease of relative constancy of entropy only when the system possesses certain features of internal organisation and interaction with the environment.

According to von Bertalanffy **[175]**, the following criteria distinguishes between closed and open systems:

Closed Systems:

- A system is closed if no material enters or leaves it.
- A closed system must, according to the second law of thermodynamics, and according to Koehler **[92]**, eventually attain a time-independent equilibrium state, with maximum entropy and minimum free energy, where the ratio between its phases remains constant.

- A closed system in equilibrium does not need energy for its preservation, nor can energy be attained from it.
- Closed systems cannot exhibit equifinality (The ability to reach the same final state from different initial conditions and in different ways).

Open Systems:

- From a physical point of view, the characteristic state of a living organism is that of an open system.
- A system is open if there is import and export, therefore, change of the components.
- An open system may attain a time-dependent state where the system remains constant as a whole and in its phases, though there is a continuous flow of the component materials.
- The character of an open system is the necessary condition for the continuous working capacity of the organism.
- The basic characteristics of self-regulation are general properties of open systems adapting to circumstances by changing the structure of processes of their internal components.
- Open systems which are exchanging materials with the environment, in so far as they attain a steady state, the latter is independent of initial conditions, is equifinal.
- Open systems can evolve toward states of greater complexity and differentiation, reversing the law of entropy.

Katz and Kahn **[83]**, identifies the following nine characteristics as definitive of all open systems:

- **Importation of energy:-** Open systems import some form of energy from the external environment.
- **The through-put:-** Open systems transform the energy available to them.
- **The output:-** Open systems export some product into the environment.
- **Systems as cycles of events:-** The pattern of activities of the energy exchange has a cyclic character.
- **Negative entropy:-** To survive, open systems must move to arrest the entropy process – they must acquire negative entropy.

- **Information input, negative feedback, and the coding process:-** Inputs are informative in character, and furnish signals to the structure about the environment and about its own functioning in relation to the environment. The simplest type of information input found in all systems is negative feedback. The general term for the selective mechanisms of a system by which incoming materials are rejected or accepted and translated for the structure is coding.
- **The steady state and dynamic homeostasis:-** The importation of energy to arrest entropy operates to maintain some constancy in energy exchange, so that open systems, which survive, are characterised by a steady state.
- **Differentiation:-** Open systems move in the direction of differentiation and elaboration.
- **Equifinality:-** Open systems are characterised by the principle of equifinality, meaning that a system can reach the same final state from differing initial conditions and by a variety of paths.

The view of von Bertalanffy **[175]** is that:

> *"The formal correspondence of general principles, irrespective of the kind of relations or forces between the components, lead to the conception of a 'General Systems Theory' as a new scientific doctrine, concerned with the principles which apply to systems in general".*

This statement by von Bertalanffy emphasises the importance of the concept open systems, in particular with reference to the research contained within the ambit of this thesis.

2.7 THE ROLE OF MODELS

This thesis is based on the system dynamics of a formulated *structured systems approach to model conceptualisation* specifically applied to the art of executive management, to structure the outcomes of paradigm shifts introduced into organisations as a result of unstructured complex phenomena. This high level role of the *structured systems approach to model conceptualisation* can be generalised to provide insight into the application of models in organisations as a tool to manage complex phenomena.

To create a deeper understanding of the importance of the concept 'model' within the ambit of this thesis, the following humoristic explanation thereof is offered by Cleland and King **[38]**: "The layman's idea of the meaning of the word 'model' probably concentrates on that sort which are commonly found in *Playboy magazine* and in fashion shows, however, if pressed to consider other varieties, most of us would react to the idea by describing a model airplane". "In doing so we would have brought to light the most important characteristic of models as they are used in management and in decision analysis namely that":

"A model is a representation of something else".

In the analysis of the definition of the concept model, Cleland and King **[38]** point to the fact that the 'something else' in the definition usually denotes some observable system or phenomenon existing in the real world, which is to be represented for purposes of display and analysis. They cite the examples of a child's model airplane being a representation of a real-world airplane and a schematic diagram, which represents the configuration of a large-scale electrical system. A basic, general descriptive definition of a model is provided by Takahashi and Takahara **[167]** as follows:

> *"Let A and B be two objects". "If B is considered to copy the features of A, B is called a model of A". "Then A is a prototype of B".*

There are many different kinds of models and there are many kinds of classification schemes, which have been applied to models. One of the taxonomies, which is most useful in understanding the structural differences in models is that given by Churchman *et al* **[33]**, when the authors categorise models as either 'iconic', 'analog', or 'symbolic'.

- **Iconic models:-** An iconic model is a simple scale transformation of the real-world system thus, the model airplane is an iconic model.

- **Analog models:**- An abstract variety of models as the properties thereof are transformed – i.e., one property is used to represent another. A graph is the simplest illustration of an analog model.
- **Symbolic models:**- The most abstract variety of model is the symbolic model. In such a model, symbols are substituted for properties. For example the equation $x = \frac{1}{2} gt^2$ is a simple physical model if x is interpreted to be the distance travelled by a body falling from rest, g is a constant describing the acceleration caused by the force resulting from gravity, and t is the duration of time which the body is allowed to fall. In management, symbolic models have long been used to describe simple phenomena. For instance, the model $P = R-C$ or, '*Profit* equals *Revenue* minus *Cost*', has long been recognised and used by managers. Only recently, however, have managers begun to use symbolic models for more complex phenomena.

According to Sterman **[161]**, one of the most useful classifications of models, divides models into those that 'optimise' versus those that 'simulate'. Clemson **[39]** provides an appropriate description of the requirement for models in organisation, which reads as follows:

> *"The manager is always faced with some 'thing' which he/she is trying to 'manage' into behaving in one sort of way rather than some other sort of way".*

This rather abstract description of the manager applies equally well to a cowboy herding steers, a teenager nursing along a jalopy, a teacher coaxing a class into learning, a doctor running a hospital, or the president of the United States trying to manage foreign and domestic policy. In all cases, the 'manager' acts on the basis of some framework that includes at least four elements:

- Some image of a preferred state, perhaps a goal or perhaps merely a way of behaving by the system (e.g. a low rate of crime is desired).
- Some image of the current state of the system (e.g. society suffers from a high rate of crime).

- Some image of the 'way the system works'. (e.g. the reducible system view of crime noted above).
- A belief based on the previous three images, that the situation might be improved by a given sort of 'managing'. (e.g. increase the penalties for criminal behaviour and criminals should be deterred).

The above maps to the description of 'mental models' as provided by Sterman **[161]**, who describes the concept as flexible, taking into account a wider range of information than just numerical data, and can be adapted to new situations and be modified as new information becomes available. Furthermore, mental models can be described as the 'filters' through which we interpret our experiences, evaluate plans, and choose among possible courses of action. Richmond **[137]**, is of the opinion that mental models are the dominant 'thinking paradigm' in most of the western world today.

Given that the situation to be managed is always more complex than the manager, the problem of choosing reasonable actions is quite difficult. To be precise, it is quite common for gross errors to occur in all four of the elements noted above. This means:

- The image of the preferred state may be in error. It is quite common that once achieved, the desired state turns out to be less valuable than was expected. In particular, the desired state may have unanticipated negative consequences that outweigh the beneficial results. Typically, desired states are seen as means to some other end and the assumed relationship to the higher end may be wrong so that achievement of the desired state does not, in fact, assist in reaching the higher goal.
- The image of the current state of the system is often seriously in error. The most common way in which this happens in large systems is that the manager is simply unable to remain informed about the relevant system aspects. Another common problem is that the manager may seriously misjudge critical aspects of the system. For instance, managers are frequently grossly wrong in their beliefs about subordinate's values, attitudes, desires and the need for communication.

- Our image of 'the way the system works' is almost always inadequate and is frequently wrong for social systems. Errors in the image of 'the way the system works', frequently lead us to undertake actions, which end up having an effect opposite to that which is desired.
- Our beliefs about the relationship between action and outcome constitute a model of 'the way the system works'.

Blake and Mouton **[23a]** provide the following specifications for designing a model based on systematic development[8], 'of what should be', which is repeated here *verbatim* to retain the original thoughts of the authors and to enforce the concept of formulating an 'approach'[9] as opposed to formulating a 'model':

> *"Clear-cut objectives are a prerequisite to the kind of development that takes place under the systematic approach". "An ideal model specifies what the result should be at a designated time". "To be systematic, the model must be based on theory, fact, and logic, uncontaminated in the status quo or by extrapolations from the past". "The model must be understood to represent the ideal, not the idealistic". "Ideal thinking can identify what is possible according to theory, logic and fact". "Ideal thinking can be tested against objective criteria to assess its practicality". "Idealistic thinking, on the other hand would have an unreal quality, probably rooted in self deception and expressing what is desired or what is wanted without having been tested against theory, logic or fact". "Ideal thinking is subjective and is based on criteria having little or nothing to do with the facts of the situation". "Ideal thinking has sometimes been suspect and rejected as idealistic". "Yet through history, some of what might qualify as among the world's greatest change projects – The Magna Charta, the Constitution of the United States – have probably come about through ideal-type formulations".*

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[8] A more detailed presentation of the theory, techniques, and results of systematic development is contained in a book by the authors entitled: *Corporate Excellence Through Grid Organization Development: A Systems Approach.* Houston: Gulf publishing Company, 1968.

[9] For further discussion, see Chapter 5, Paragraph 5.1.

The above can be appropriately summarised by the view of Cook and Russell **[40]**, who in general terms, 'view a model as a representation or an abstraction of an object or a particular real world phenomenon'.

Although this thesis deals primarily with the formulation of a *structured systems approach to model conceptualisation*, an entity which will serve as input mechanism to the building of systems models[10], a discussion brief on models would not be complete without bringing to the attention of the reader, the works of Hall **[70]** and Morecroft *et al* **[109]**, to single out two of the most prominent academics, especially in describing the processes involved in systems model building.

2.8 IMPACT OF THE NOTIONS *WELTANSCHAUUNG* AND APPRECIATIVE SYSTEMS

According to Jackson **[80]**, the social world is seen as being the creative construction of human beings. It is necessary therefore, to proceed by trying to understand subjectively, the point of view and the intentions of the human beings who construct social systems. Hence the importance in 'soft' systems thinking (discussed in more detail in Chapter 4) of probing briefly the worldview or '*Weltanschauung*' of Churchman **[34]**, and the concept of 'appreciative systems' of Vickers **[174]**, that individuals employ in understanding and constructing the social world. In this thesis the above notions will only be discussed briefly as they relate to soft systems to create an understanding of the concepts.

➢ **The notion of *'Weltanschauung'***

This notion according to Jackson **[80]**, carries the implication that an individual's interpretations will be far from random, they will be consistent in terms of a number of underlying assumptions that constitute the core of that individual's world view or '*Weltanschauung*'. Flood **[55]**, is of the opinion that world-viewism has several theoretically orientated scenarios, each one neglecting to recognise that no single position has or is ever likely to explain everything. The

[10] The reader's attention is drawn to the fact that 'the pilot', represented as Phase 8 in the process of model conceptualisation and described in Chapter 5, Paragraph 5.6.1, is considered to be a 'conceptual model'

'Weltanschauung' idea has been used by Churchman **[34]** and Checkland **[29]** in the development of methodologies to solve problems in systems.

Checkland **[29]** has suggested that this methodology can be applied to reveal any recurrent *'Weltanschauungen'* and that it therefore opens up the prospect of discovering 'the universal structures of subjective orientation in the world' (Luckmann, quoted in Checkland **[29]**). The notion of *'Weltanschauung'* is brought into context with the systems approach by Checkland **[29]** as follows: "A systems approach tries explicitly to avoid reductionism by viewing the world in systems terms". "It uses systems concepts in order to see the raw data of the outer world in a particular way, namely a set of systems". "It converts the raw data into a particular kind of information, and this is the process occurring in virtually all human thinking". Whether we realise it or not, we view raw data via a particular mental framework, or worldview (*'Weltanschauung'*). The hard systems methodology according to Checkland **[29]**, is concerned only 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. In soft systems methodology, we are forced to work at a level at which worldviews or *'Weltanschauungen'* are questioned and debated. Soft problems are concerned with different perceptions deriving from different[11] *'Weltanschauungen'*.

➢ **The notion of Appreciative Systems**

According to Vickers **[174]**, "the only way to understand decision making in human systems is to understand the different appreciative systems that the decision-makers bring to bear on the problem". Jackson **[80]**, explains the concept as follows: "An individual's appreciative system will determine the way he or she sees and values various situations and hence how he or she makes 'instrumental judgements' and takes 'executive action' – in short, how he or she contributes to the construction of the social world". It follows, according to Vickers (1973) cited by Jackson **[80]**, that if human systems are to achieve stability and effectiveness, then the appreciative systems of their participants need to be sufficiently shared to allow mutual expectations to be met.

[11] This particular principle of debating multiple worldviews forms a key component of Phase 4 in the process of model conceptualisation as described in Chapter 5, Paragraph 5.6.1.

2.9 CAUSAL LOOP DIAGRAMS AND REINFORCING AND BALANCING PROCESSES

Two of the most powerful systems approach tools are causal loop diagrams, and reinforcing and balancing processes. These two entities can be analysed as follows:

- **Causal Loop Diagrams:-** According to Kim **[87]**, 'feedback' is the 'transmission and return' of information, with 'return', the very characteristic that makes the feedback perspective different from the more common linear cause-and-effect way of viewing the world. The linear view depicted below as Figure 2.3, sees the world as a series of un-directional cause-and-effect relationships: A causes B causes C causes D, etc.

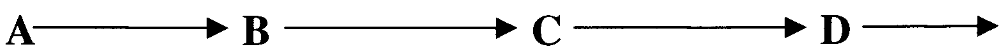

Figure 2.3: The linear view perspective (Single Loop) **[87]**

The linear view perceives the world as a series of events that flows one after the other **[19]**. For example, if sales should go down (event A), action can be taken by launching a promotions campaign (event B), sales rises (event D), and backlogs increase (event D). Should sales go down again, action can be taken by launching yet another promotional campaign . . . and so on. Through the lens of the linear perspective, the world is perceived as a series of events that trigger other events. The feedback loop perspective depicted below as Figure 2.4, on the other hand, sees the world as an interconnected set of circular relationships, where something affects something else and in turn is affected by it: A causes C causes A, etc.

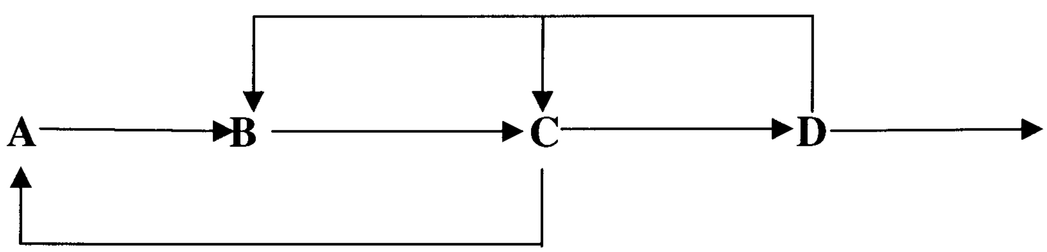

Figure 2.4: The feedback loop perspective (Double Loop) **[87]**

Using the same example as in the linear view perspective, the feedback loop perspective would demand that when sales go down (event A), action can be taken by launching a promotions campaign (event B). As orders increase (event C), and sales rise (change in event A), backlogs increase (event D), (another eventual effect of event B), which affects orders and sales (change in events C and A), which leads to a requirement to repeat the original action (event B). Mathematically, according to Capra **[27]**, a feedback loop corresponds to a special kind of non-linear process known as iteration (Latin for 'repetition'), in which a function operates repeatedly on itself. For example, if the function consists of multiplying the variable x by 3, i.e. $f(x) = 3x$, the iteration consists in repeated multiplication. In mathematical shorthand, this is written as $x \rightarrow 3x$, $3x \rightarrow 9x$, $9x \rightarrow 27x$ etc. Each of these steps is called a 'mapping'. If we visualise the variable x as a line of numbers, the operation $x \rightarrow 3x$ maps each number to another number on the line. More generally, a mapping that consists in multiplying x by a constant number k, is written $x \rightarrow kx$. An iteration found very often in non-linear systems, is the mapping $x \rightarrow kx(1-x)$, where the variable x is restricted to values between 0 and 1. This mapping is known as 'logistic mapping' and has many important applications of which the description of growth of a population under opposing tendencies serves as an example and also known as the 'growth equation'.

According to Kauffman **[84]**, feedback provides stability in a system that would otherwise be unstable. The importance of 'feedback' is emphasised by Skyrme **[157]**, when citing Davidson as follows:

> *"We are particular poor at appreciating the role of feedback structure in dynamics we experience in the systems we strive to manage . . ." "The possibility exists that management policy and decisions actually contribute to creating the dynamic problems they are intended to solve".*

The impact of feedback can perhaps best be described in terms of single loop and double loop learning using the same principle as explained above. The processes of single and double loop learning as advocated by Argyris (1992) and cited by Watkins **[177]**, are depicted in Figure 2.5.

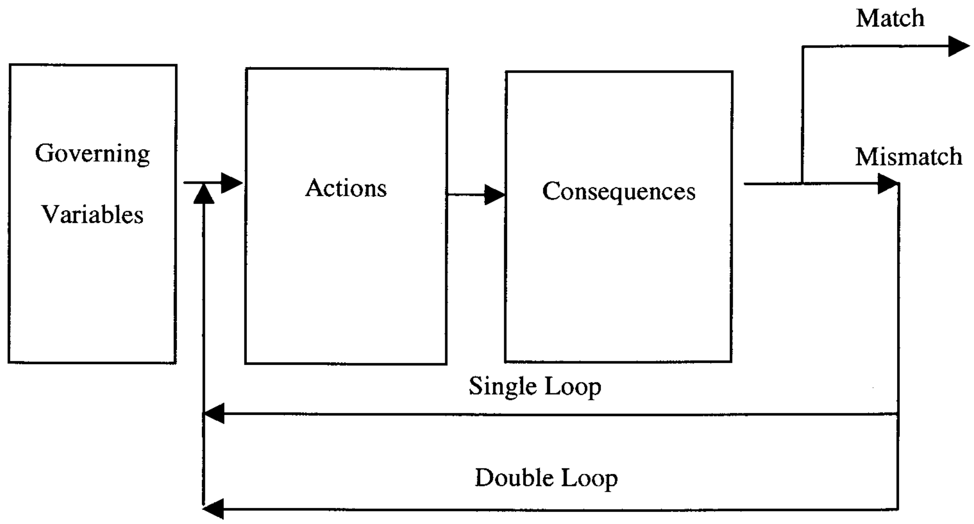

Figure 2.5:-Single-Loop and Double-Loop Learning **[177]**

The following rather extensive explanation of the above concept by Argyris (1992) cited by Watkins **[177]**, could not be improved upon, and based on the practicality of the example, is repeated here *verbatim* as follows:

> *"Single loop learning can be compared with a thermostat that learns when it is too hot or too cold and then turns the heat on or off". "The thermostat is able to perform this task because it can receive information (the temperature of the room) and therefore take corrective action". "If the thermostat could question itself about whether it should be set at 68 degrees, it would be capable not only of detecting error but of questioning the underlying policies and goals as well as its own program". "That is a second and more comprehensive inquiry; hence it might be called double loop learning". "When the plant managers and marketing people were detecting and attempting to correct the error in order to manufacture Product X, that was single loop learning". "When they began to confront the question whether Product X should be manufactured, that was double loop learning, because they were now questioning underlying organisation policies and objectives".*

Specifically pertaining to solving unstructured complex phenomena, Richardson **[133]**, makes the observation that, "management rarely have the luxury of being able to make a decision in which causality goes only outward and does not generate repercussions that feedback to influence or affect management". Richardson **[133]**, continues his observation with the view that, "management plans and decisions alter the playing field, and consequently always have a hand in shaping the subsequent conditions to which management must respond".

- **Reinforcing Processes:-** According to Senge **[152]**, reinforcing feedback processes are the engines of growth. Whenever the situation occurs where things are growing, one can be certain that reinforcing feedback is at work. Furthermore, reinforcing feedback can also generate accelerating decline – a pattern of decline where small drops amplify themselves into larger and larger drops, such as the decline in bank assets when there is a financial crisis on the financial markets. Figure 2.6 represents reinforcing processes using a savings account as an example. Kim **[87]**, provides the following explanation of the two diagrams in Figure 2.6 to illustrate the mechanisms pertaining to reinforcing processes: If there is a positive balance each time there is an interest payment calculation, the amount will be slightly bigger than the preceding payment period. This is due to the fact that the balance has increased since the previous calculation. The time period after that, the interest amount will be bigger still, due to the fact that the balance has increased a little more since the time before.
- **Balancing Processes:-** According to Senge **[152]**, balancing feedback processes operates whenever there is a goal-orientated behaviour. If the goal is to be not moving, then balancing feedback will act the way the brakes in a car do. If the goal is to be moving at sixty miles per hour, then balancing feedback will cause the car to accelerate to sixty, but not faster. The goal can be an explicit target, as when a firm seeks a desired market share, or it can be implicit, such as a bad habit, which despite disavowing, we stick to nevertheless. Figure 2.7 represents balancing processes using a thermostat in a house as an example.

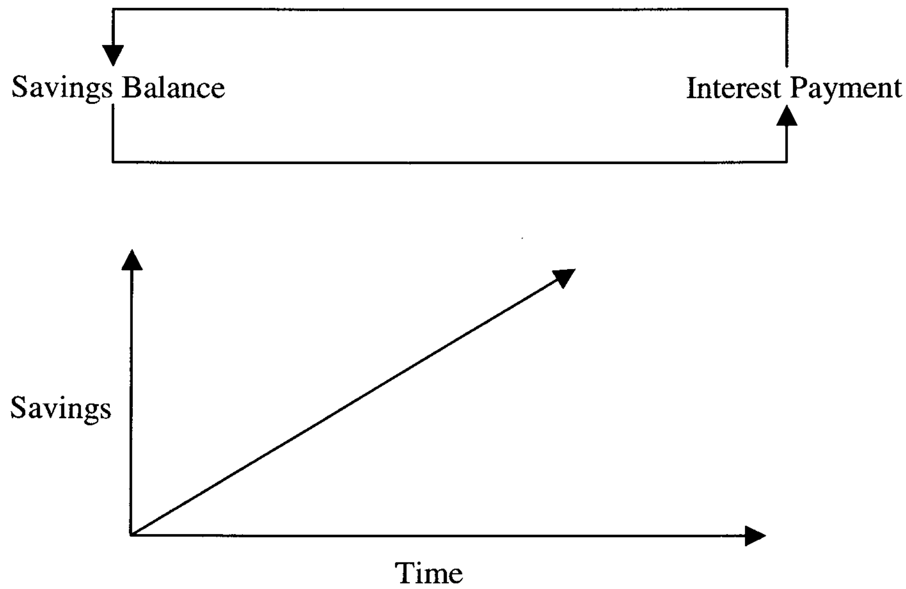

Figure 2.6: Reinforcing Processes **[87]**

Kim **[87]**, provides the following explanation of the two diagrams in Figure 2.7 to illustrate the mechanisms pertaining to balancing processes: When a home thermostat detects that the room temperature is higher than the thermostat setting, it shuts down the heat.

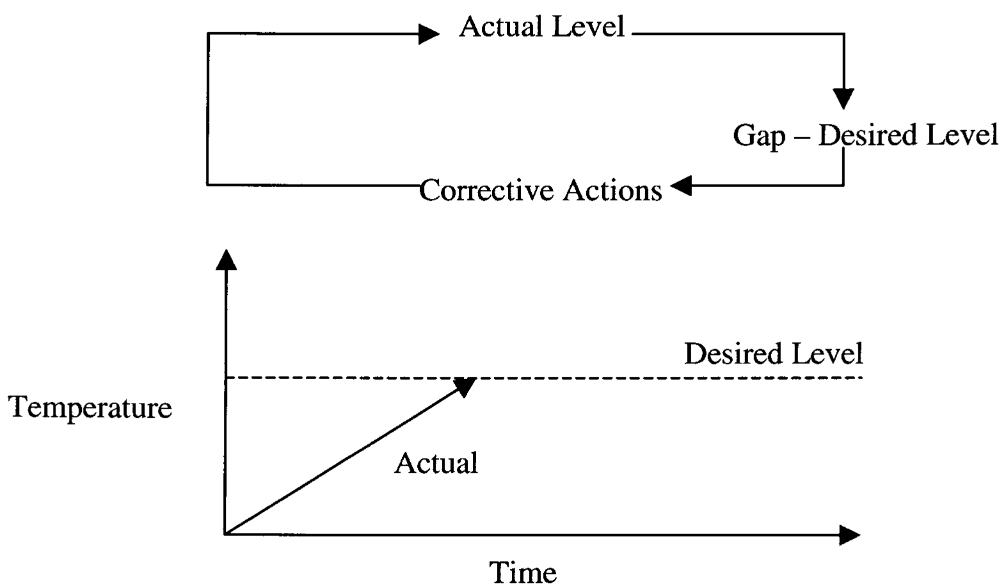

Figure 2.7: Balancing Processes **[87]**

There is always an inherent goal in a balancing process, and what 'drives' a balancing loop is the gap between the goal (the desired level) and the actual level. As the discrepancy between the two levels widen, the system takes corrective actions to adjust the actual level until the discrepancy decreases. In the thermostat example, gaps between the actual room temperature and the temperature setting of the thermostat (the goal) prompt the thermostat to adjust the heating and cooling mechanisms in the house to bring the actual temperature closer to the desired temperature. In this sense, balancing the processes always try to bring conditions into some state of equilibrium.

Although not falling within the research scope of this thesis, Kim **[88]**, in addition identifies other 'systems thinking' tools which are regularly employed as systems approach mechanisms, namely:

- Double-Q diagrams.
- Behaviour over time diagrams.
- System Archtypes.
- Graphical function diagrams.
- Structural behaviour pairs.
- Policy structure diagrams.
- Computer models.
- Management flight simulator.
- Learning laboratories.

2.10 SCIENCE AND TECHNOLOGY IMPACT

Science and technology, while not a direct consequence of the complexities of the systems approach, are considered very much part of unstructured complex phenomena, specifically if viewed against the following powerful statement by Halal *et al* **[69]**:

> *"Just as the medieval castle, the monarchy, and the institutions of an Agrarian era were transformed by the relentless advance of industrial technology into our present world, now the relentless advance of information technology is transforming society again".*

In essence, what is desired are the good, or positive benefits of technology and the elimination, or minimising of the negative aspects. To this purpose, according to

Roman **[139]** and Bond **[25]**, technological impact must be understood and technological change must be managed, which according to Feeny and Willcocks **[52]**, make them typical candidates for systems thinking. This implies in the words of Handy **[71]**, "that it is the things outside the organisation, the things that are beyond the manager's control that now become priorities".

The view of Schwartz **[148]**, encapsulates the importance of science and technology for executive management with the following extract:

> *"This force (for science and technology really comprise a single force) is one of the most important drivers of future events". "It literally shapes the future". "Politics can change, but a scientific innovation, once released into the world, cannot be taken back". "Nor can its impact be legislated away or forbidden by the chairman of the board". "Thus, keeping track of new developments in physics, biotechnology, computer science, ecology, microbiology, engineering, and other key areas is a special duty".*

Of all the authors cited in this section, it is perhaps only Beer **[22]**, who understands best the full impact of technology on management with the following powerful statement:

> *"Change – technological change – is happening all around us". "It could leave us managerially unadapted, and, in the end, extinct".*

The sudden explosion of networked electronic systems, their associated challenges and dichotomies **[11]**, which started in the 1970's with ever increasing momentum in the Year 2000 and beyond, will continue to add to the complexity of unstructured complex phenomena and thus to the complexity of the systems approach in dealing with such phenomena.

2.11 PUTTING THE SYSTEMS APPROACH INTO PRACTICE

In the following chapters, various methodologies of the systems approach and their application will be discussed in detail to ultimately culminate as the *structured systems approach to model conceptualisation.* The questions, which invariably arises, is why the concept is not commonly applied in practice and why has a *structured systems approach to model conceptualisation* specifically for executive management not previously been formulated?

These questions are echoed by Kim and Senge **[90]**, when they make the observation that, "diverse methodologies of systems thinking have been developed over the past decades, yet despite widespread recognition of the growing importance of interdependency and change, there has been relatively little penetration of these methods into the mainstream of management practice". Senge **[152]**, denotes that what is especially problematic in this respect, "is the inability to deal with dynamic complexity, when cause and effect are not closely related in time and space, and obvious changes do more harm than good". Senge **[152]**, continues his observation by viewing dynamic complexity as being more challenging due to the fact that it requires us to think in terms of complex causal interdependencies involving multiple sources of delay and non-linearity, and evolving patterns of change over time.

Kim and Senge **[90]**, provides a solution to the questions by suggesting that, "systems thinking can get into practice, through practice". This approach is based on the concept of 'managerial practice fields', which relate to settings where 'teams who need to take action together, can learn together'. This approach is deliberated further by Meadows **[105]**, who suggests that one way to remedy unsystematic, badly structured, difficult-to manage large scale social systems with persistent problems, is to bring more clear, accurate and inclusive systems concepts into public discourse, – the very objective of the author with the *structured systems approach to model conceptualisation.*

What is true about the concept systems approach in practice, can also be extrapolated to the *structured systems approach to model conceptualisation.* In spite of the existence of innumerable social system models, there is not much available literature, and probably not much existing knowledge about the process (approach) by which such models are constructed **[126]**, **[90]**, **[152]**, **[100]**, **[59a]**. Randers **[126]**, expands on the above with the view that the lack of information about the modelling process, particularly its 'first stages'[12], is probably due to the 'pre-scientific' state of modelling. The author **[126]**, maintains that model conceptualisation is especially difficult in the modelling of social phenomena because social systems are more complex and less well understood than physical systems, and because the modeller must represent aspects of the real world that are not easily observed or measured. Furthermore, the view is upheld that, "because there is no educational text on model conceptualisation, the sequence of presentation are commonly mistaken for the actual steps in the creation of these models". In addition, these findings of Randers **[126]** maps to the findings contained within the ambit of the limited survey contained in Appendix B. In the understanding of why the systems approach have not exploited to its full potential, the 'wisdom' of Churchman cited by Jackson **[80]**, underpins all of the above arguments with the aphorism, "there are no experts in the systems approach", hence the failure of the systems approach considered to be comprehensive **[32]**.

It is however Randers **[126]** himself who suggests some guidelines on model conceptualisation, and in the process provide a more balanced view of the situation described above. The guidelines on model conceptualisation as provided by Randers **[126]**, are contained in Appendix D.

2.12 CONCLUSION

Complex phenomena associated with the art of management is encapsulated by the following extract from Hesselbein **[73]**:

> *"Five hundred years ago, Renaissance man discovered that the world was round". "Three hundred fifty years later, organisation man*

[12] It is these 'first stages' or 'inputs' to the modelling process, which forms the core of the *structured systems approach to model conceptualisation*, proposed for executive management in this thesis.

developed the practice of management". "But, as this practice evolved he forgot that the world was round, and he built a management world of boxes and pyramids"

Hesselbein **[73]**, continues that this new created world worked well for a long time, until a period of massive historic change began, of global competition and blurred boundaries, of old answers that did not fit the new realities culminating in complex phenomena associated with modern management. This is supported by Strümpher **[165]**, who is of the opinion that 'systems thinking' has emerged as the dominant basis for modern managerial thinking in the last few decades, and furthermore rapidly gaining acceptance as a basis for the management of complex phenomena. These statements are evaluated against the *caveats* of limited penetration of the systems approach into mainstream practice **[90]**, **[152]**, **[105]**, and the limited literature and expertise available on the subject of model conceptualisation **[126]**.

In this chapter, the complexities of the systems approach were introduced to provide the reader with the required insight into the complex issues governing the systems approach and associated problem solving methodologies which will be discussed in Chapter 3 and Chapter 4. More specific, it is the interrelationships which these entities have with hard and soft systems methodologies, which emphasises their importance to virtually become required pre-requisites to the understanding the internal functionality of hard and soft systems approaches. In addition, the complexities of putting the systems approach into practice was explored and expanded to include the concept of model conceptualisation.

In Chapter 3, the major hard systems methodologies, selected especially for their particular applicability to the research in this thesis will be contextually analysed at a high level in terms of literature reviews. The analysis will cover the following hard systems methodologies:

- Systems engineering.
- Systems analysis.
- Operational research.

- Management cybernetics.
- Systems dynamics.

Chapter 3

A HIGH LEVEL ANALYSIS OF THE HARD SYSTEMS APPROACH

"It isn't that they can't see the solution".
"It is that they can't see the problem".
G.K. Chesterson

3.1 INTRODUCTION

The 'hard' systems approach as adapted from Checkland **[29]**, 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 cited by Jackson **[80]**, 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 Habermas, 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, the author acknowledges the fact that the hard systems methodology is an established concept with contributions over the years made by, amongst others: Hitch, Hall, Quade, Machol, Chestnut, Jenkins, Lee, De Neufville and Stafford, Miles, Chase, Daenmzer, and Wymore **[29]**. The problem solving methodologies specifically selected for their appropriateness to this research and included within the context of this chapter are, Systems Engineering and Systems Analysis as categorised by Checkland **[29]**, with Jackson **[80]** adding Operational Research, and Management Cybernetics to the list. In addition, Systems Dynamics pioneered by J.W Forrester concludes the list.

The analytical process followed thus far, is graphically depicted in Figure 3.1, which places the chapters in context with the overall thesis objectives, and furthermore indicates the relative positioning of this chapter.

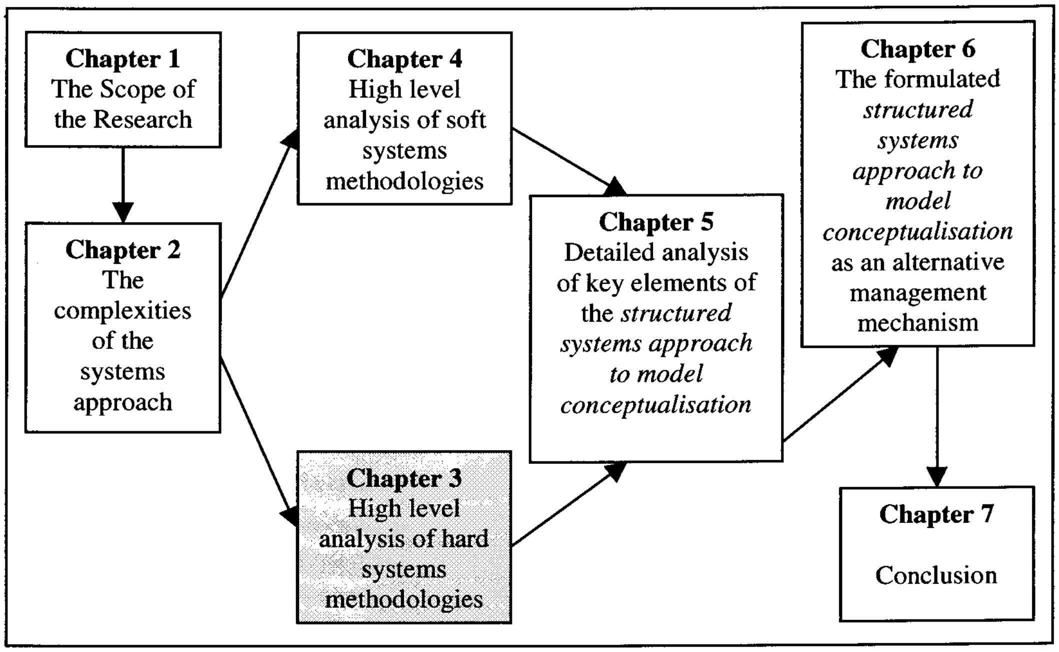

Figure 3.1: Chapters in context of the overall research

An analysis of Figure 3.1[1], shows Chapter 1 as the overall research approach to the thesis. Chapter 2, contains a number of key elements (complexities), which are explained in lieu of the high level analysis of hard systems contained in this chapter, and the high level analysis of soft systems, (contained in Chapter 4). Key elements from the high level analysis of hard systems and soft systems methodologies, will serve as preliminary input mechanisms to Chapter 5, where the elements will be further analysed in detail to ultimately culminate in a formulated *structured systems approach to model conceptualisation.* Chapter 6 will depict the *structured systems approach to model conceptualisation* as an

[1] Arrows in Figure 3.1 represent 'information flows' (inputs) from one chapter to the other.

alternative management mechanism in practice, while Chapter 7 will contain a summary of the thesis content.

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 this thesis, the classification of systems falling within the ambit of the systems approach depicted in Figure 2.2, is repeated here as Figure 3.2 for ease of reference.

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

- The hard systems approach.
- The soft systems approach.

3.2 SYSTEMS ENGINEERING

In his description of the nature of systems engineering, Checkland **[29]**, 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 **[80]**, cites Jenkins (1972) 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.
- Systems design.

- Systems implementation.
- Systems operation.

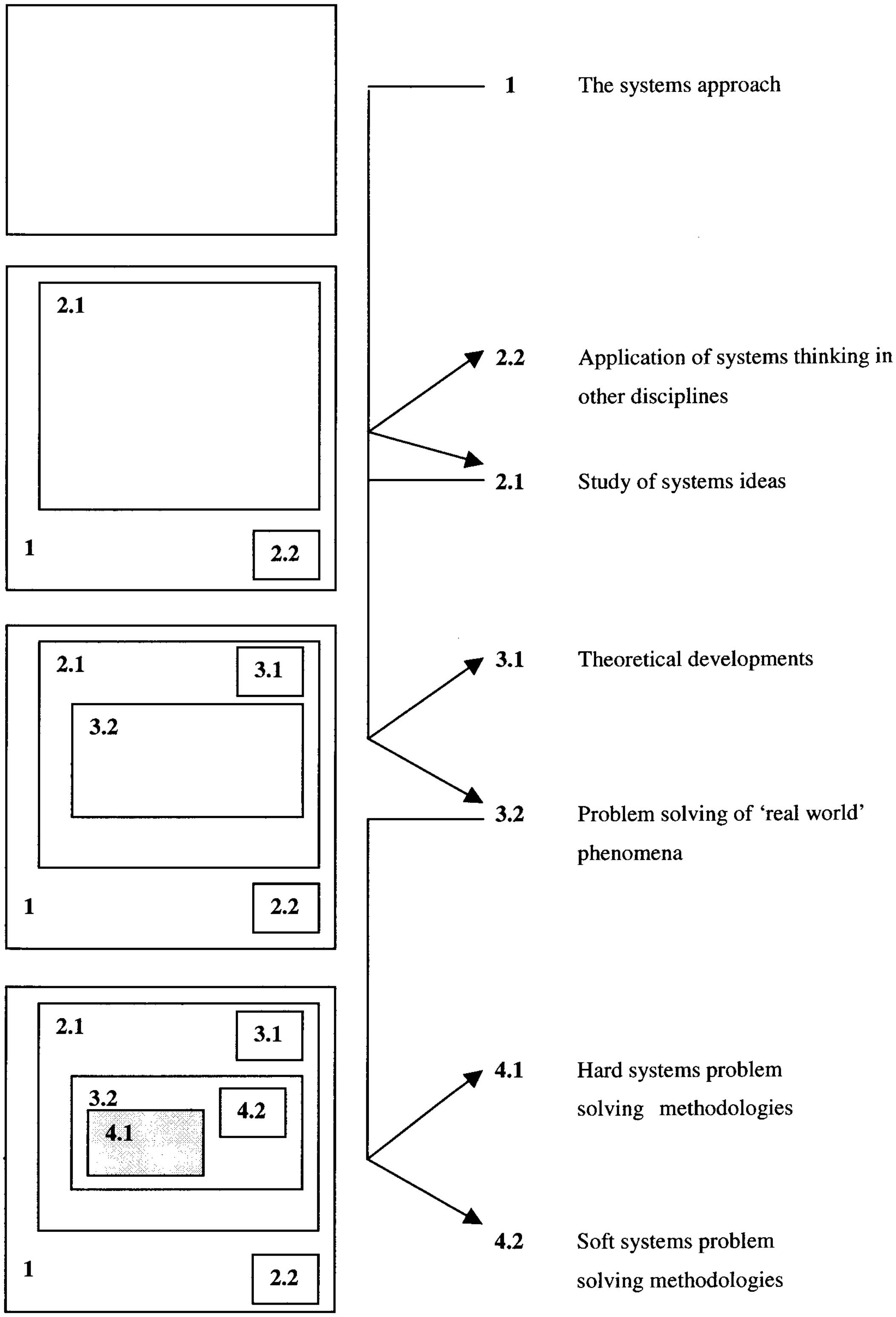

Figure 3.2: Classification of systems falling within the context of the systems approach

Systems analysis:- In this phase, the real world is taken to consist of systems and is 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. Hall (1962, 1969) cited by Checkland **[29]**, 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 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:

- Problem definition.
- Choice of objectives.
- System synthesis.
- System analysis.
- System selection.
- System development.
- Current engineering.

According to Checkland **[29]**, 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 is only concerned with a single '*Weltanschauung*'[2], a need is defined or an objective is stated, and an efficient means of meeting the need or reaching the objective is needed.

3.3 SYSTEMS ANALYSIS

Jackson **[80]** cites Quade (1963) 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 **[80]**, systems analysis developed out of wartime military operations planning, and during the 1940's and 1950's applications were mainly military, 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.

The Rand-style analysis is best described in the following, rather lengthy description thereof by Quade and Boucher (1968) cited by Checkland **[29]**:

> *"One strives to look at the entire problem, as a whole, in context, and to compare alternative choices in the light of their possible outcomes". "Three sorts of enquiry are required, any of which can modify the others as the work proceeds". "There is a need, first of all, for a systematic investigation of the decision-makers objectives and of the relevant criteria for deciding among the alternatives that promise*

[2] Refer to Chapter 2, Paragraph 2.8.

to achieve these objectives". "Next, the alternatives need to be identified, examined for feasibility, and then compared in terms of their effectiveness and cost, taking time and risk into account". "Finally, an attempt must be made to design better alternatives and select other goals if those previously examined are found wanting".

From the above description, Checkland **[29]** 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 **[179]**, "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 analogy is supported by Schoderbeck *et al* (1975) cited by Checkland **[29]**, 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 **[81]** clearly, 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. If we wanted to use analysis to define a University, we might first say that it consists of colleges, in turn, contain departments, and departments are made up of students, faculty, and areas of study. We would continue to reduce the University in this way until we arrive at its indivisible elements. Then we would try to build up our understanding of these elements into an understanding of the entire University.

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

Flow tracing is a dimension which Strümpher **[165]** adds to the concept 'analysis', and makes the following comparisons between 'analysis', 'flow tracing' and 'synthesis':

- **Analysis:-** Strümpher **[165]** is of the opinion that analysis cannot explain the dynamics of a system, but it can help identify and explain static relationships, i.e., structure. 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 confluence's and the transformations.

Synthesis:- Neither flow tracing nor analysis can form understanding, which 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 **[27]** summarises the functionality of the two entities by using the analogy that 'analysis' means taking something apart in order to understand it, and synthesis[3], means putting it into the context of a larger whole.

3.4 OPERATIONAL RESEARCH

The first textbook on 'operational research' appeared in 1957 and was written by Churchman *et al* entitled '*Introduction to Operations Research*' **[29]**. According to the authors **[29]**, 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 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 this 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 (1960) on the purpose of operational research is provided by Ackoff **[2]**, who was of the opinion that operational research is concerned with increasing the effectiveness of

[3] The original text used by Capra **[27]** refers to the concept 'systems thinking', as opposed to the word 'synthesis' as used within context of this thesis.

operations of organised man-machine systems, and according to Ackoff and Rivett **[5]**, based on three essential characteristics namely:

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

Jackson **[80]**, identifies seven phases of an operational research project, while Ackoff and Sasieni **[6]** identifies five stages, combined here for completeness 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 **[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 **[80]**, is the following:

> *"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 **[29]** 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 **[21]**, 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[4].
- 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, then we may feel reasonably confident that it reflects reality, however, these instances are extremely rare.
- No single performance criterion can possibly unite within itself the myriad considerations, which actually effect decisions in social systems.

From the above interpretation, Checkland **[29]** 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

[4] As described in Chapter 2, Paragraph 2.3.

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".

The criticism levelled at operational research by Checkland **[29]**, is echoed by Jackson **[80]** 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 **[2]**, as early as 1960 saw that systems engineering and operational research was converging into one entity, namely 'systems research'.

3.5 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 Chapter 4), do not form part of the core of the thought processes to address the research problem, the building blocks thereof however requires high level scrutiny. These building blocks of management cybernetics according to Jackson **[80]** 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 probabilism yields.

3.5.1 BLACK BOX TECHNIQUE

Exceedingly complex systems, which are so complicated that they cannot be described in any precise manner or detail, are commonly known in cybernetic terms as 'black boxes' **[38]**. The complexity of such systems according to Schoderbek *et al* (1985) cited by Jackson **[80]**, 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 **[161]**, consider certain computer models as being black boxes, due to the fact that these devices operate in completely mysterious ways.

The way 'not' to proceed in approaching an exceedingly complex system – a black box – according to Ashby **[17]**, is by analysis. Instead of analysis, the black box technique of input manipulation and output classification should preferably be employed. According to Jackson **[80]**, 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 **[17]** and Beer (1979) cited by Jackson **[80]**. According to Ashby **[17]**, 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 (1979), it is very important not to jump to conclusions about the behaviour of a system, without observing it for a sufficient length of time.

3.5.2 NEGATIVE FEEDBACK

According to Jackson **[80]**, 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' to all the decisions that will have to be made, managers should understand the nature of self-regulation they wish to induce in the organisation they manage. Furthermore, according to Beer **[22]**, managers are required to make their organisations 'ultra-stable' due to the fact that they will not be able to accurately determine what types of environmental disturbance their organisations will face.

The work of Wiener (1948) cited by Jackson **[80]**, 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 **[34]**, 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.

3.5.3 VARIETY ENGINEERING

Executive management are faced on an ongoing basis with complex phenomena, which are invariable unstructured and unexpected, resulting them to live with probabilistic systems. In this respect, Ashby **[17]**, provides some understanding of such difficulties and ways in which they should be dealt with from a cybernetic point of view using 'variety engineering'. According to Ashby **[17]**, 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 executive management, as Ashby's 'Law of Requisite Variety' has it, is that only variety can destroy variety, thus in order to control a system, we need as much variety available 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 **[22]**, 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, they will require all the skills availed to them by 'variety engineering' to balance varieties and (following the law of requisite variety) achieve control.

Beer **[22]**, 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 **[80]** 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 **[22]**, 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.

3.6 SYSTEMS DYNAMICS

The 'systems dynamics' approach of Forrester **[59a]**, 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.

While systems dynamics according to Richardson **[131]**, is not linked to the General Systems Theory, it is of importance to note that Senge **[152]**, identified systems thinking in the systems dynamics tradition as the fifth of five disciplines of the learning organisation **[132]**.

According to Sahin **[143a]**, 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 **[143a]**, 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 **[133]**, 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.

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 **[113]**, is being spearheaded by Wolstenholme (1983) and Wolstenholme and Coyle (1984). Furthermore, Checkland **[29]**, also supports the soft approach to systems dynamics.

3.6.1 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.

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, but the path to the implementation of insights is even more difficult **[132]**. It is in this arena that systems dynamics proves to be most appropriate from a modelling perspective as demonstrated in Table 3.1.

Public Sector Application	Authoritative reference
Forecasting.	Sterman and Richardson **[164]**.
Conservation policy.	Ford and Bull **[58]**.
Efficiency standards.	Ford **[57]**.
Energy policy planning.	Naill **[116]**.
Solid waste disposal.	Mashayekhi **[98]**.
Social organization underlying poverty and hunger.	Saeed **[142]**.
Rangeland destruction.	Mashayekhi **[97]**.
Social program management.	Richardson *et al* **[134]**.
Medical technologies.	Homer **[78]**.
Community care.	Wolstenholme **[184]**.
Cocaine prevalence.	Homer **[77]**.
Policy analysis.	Richardson and Lamitie **[135]**.
School finance reform.	Andersen **[12]**.

Table 3.1: Public sector applications of the systems dynamics model

3.6.2 PRINCIPLES OF SYSTEMS DYNAMICS

The philosophy of systems dynamics emphasises model structure, which supports an interest in prediction and control, and so these will be 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.

3.6.3 MODEL AND METHODOLOGY OF SYSTEMS DYNAMICS

Sahin **[143a]**, 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[5]. This is supported by Richardson **[133]**, who confirms that, "conceptually, the feedback concept is at the heart of the systems dynamics approach".

Morecroft **[112]**, 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".*

By their own admission, Flood and Jackson **[56]**, admits that there are many versions of how a quality model can be formulated, hence the approach to provide a model developed from their own work, which consist of the following elements:

- Identification of the organisational problem, which focuses the attention of the decision-makers, and leads to their purposeful activity.

[5] Refer to Chapter 2, Paragraph 2.9.

- Carry out 'task formulation' to assist in determining the appropriate way forward. A methodology, which typically can be used for task formulation is the 'Total Systems Intervention' described in Chapter 4, Paragraph 4.7.
- 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.

3.6.4 MODEL UTILISATION OF SYSTEMS DYNAMICS

According to Meadows cited by Flood and Jackson **[56]**, 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

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, and at the quantititative phase, are capable of being developed into computer-based micro-worlds and archtypes, by which insights can be disseminated in a 'hands-on' framework **[184]**.

3.6.5 TESTS FOR BUILDING CONFIDENCE IN SYSTEMS DYNAMICS MODELS

Confidence in systems dynamics models can be increased by a wide variety of tests **[60]**. The following serves as examples:

- Tests of model structure.
    - Structure verification test.
    - Parameter verification test.
    - Extreme conditions test.
    - Boundary adequacy test.
    - Dimensional consistency test.
- Tests for model behaviours.
    - Behaviour reproduction test.
    - Behaviour prediction test.
    - Behaviour anomaly test.
    - Family member test.
    - Surprise behaviour test.
    - Extreme policy test.
    - Boundary adequacy test.
    - Behaviour sensitivity test.

3.7 CRITICISM OF HARD SYSTEMS THINKING

We are now in a position to consider the criticisms that have been levelled at the hard systems approach. The catalogue of points that follow, has been compiled from a variety of sources namely:

- Checkland **[29]**.
- Hoos **[79]**.
- Watkins **[177]**.
- Jackson **[80]** citing:
    - Ackoff (1977, 1979a, 1979b).
    - Checkland (1978, 1983).
    - Churchman (1979b).
    - Hoos (1976).

- Lilienfeld (1978)
- Rosenhead (1981, 1989b)

First there are criticisms that suggest hard systems thinking has a very limited domain of applicability. Hard approaches demand that objectives be clearly defined at the very beginning of the methodology process. In the vast majority of managerial situations, however, the very definition of objectives will constitute a major part of the problem faced. Involved parties are likely to see the problem situation differently and to define objectives according to their own worldviews, values, and interests.

A second kind of criticism relates to the failure of hard system approaches to pay proper attention to the special characteristics of the human component in the socio-technical systems with which they sometimes aspire to deal. People are treated as components to be engineered just like other mechanical parts of the system. The fact that human beings possess understanding, and are only motivated to support change and perform well if they attach favourable meanings to the situation in which they find themselves, is ignored. This deterministic perspective in hard systems thinking, which puts the system before people and their perceptions, extends to the ability of humans to intervene in their own destiny.

The third group of criticisms concerns the demand for quantification and optimisation in hard systems methodologies. When highly complex systems are involved, the building of a quantitative model is inevitably a highly selective process and will reflect the limitations of vision and biases of its creator(s). Far from recognising this and demanding that the assumptions made in building the model be made explicit, hard systems thinking seems to acquiesce in the concealment of assumptions and to treat the model readily as synonymous with the reality. The model, which is of course far more easily manipulated than the real world, becomes the focus of attention and the generator of 'optimum' solutions. It is convenient and cosy to play with the model, but the result is solutions that are out of date answers to the wrong questions. Furthermore, another consequence of the demand for quantification and optimisation is the tendency to ignore those factors in the problem situation that are not amenable to quantification or, perhaps even more seriously, to distort them in the quest for quantification. Different aspirations or matters subject to differing value interpretations are forgotten or ground down on the wheel of optimisation.

Fourthly, the degree to which hard systems thinking offers succor to the status quo, and to the already powerful, is frequently noted. It goes without saying that the best way to ensure the continuance of a consultancy project, and the implementation of the proposals, is to privilege the objectives of the most powerful stakeholders. Having inevitably been forced into making such political choices, hard systems approaches seek to cover their tracks by encouraging 'depoliticisation' and 'scientisation'. The complicated mathematical modelling discourages ordinary people from believing that they might have anything useful to contribute to decision making. It also suggests that difference of opinion and interest, can be rationally dissolved by experts using the latest tools and techniques. Thus conflict is hidden. Furthermore, since conclusions emerge from a computer model programmed by white-collar scientists, they take on an air of objectivity that is, of course, entirely spurious.

Fifthly, the naïveté of the hard systems approach to complex socio-technical problems can be accounted for, at least in part, by its roots in the engineering tradition and the 'trained incapacity of engineers' to see systems as anything but things governed by predictable laws. The survival of such naïve orientation, is more difficult to explain. A feasible argument offered is that systems theory of this ilk should be regarded as 'ideology'. It flourishes because of the service it renders to the scientific and technocratic elite. Presenting as it does, a view of systems as entities to be manipulated from the outside on the basis of expertise, hard systems thinking justifies the position and privileges of the elite.

3.8 POSITIVE ASPECTS AND FEATURES OF HARD SYSTEMS

It is important to put the criticisms highlighted in the paragraph above in context by emphasising some of the positive achievements and features of hard systems. The following positive aspects of hard systems are identified by Jackson **[80]**.

- The problem solving characteristics of hard systems constitute an advance over *ad hoc* thinking about the executive management task.
- Mathematical models used to aid decision making in addition allowed for predictions to be made about the behaviour of real world systems without the attendant risks and costs of intervening in the actual system of concern.
- There is recognition in the interactive nature of systems parts and of the need to draw the boundaries of any investigation wide so as to include all-important influences on the system. This allowed the problem of sub-optimisation to be identified and avoided.
- The practice of hard systems has often been rather better than the precept. Indeed, this could hardly fail to be the case. For were operational research, for example, to be simply the set of techniques described in many of the textbooks, then it could hardly have survived in modern organisations, and yet there are examples in British industry of very successful operational research groups.

This section dealing with the positive aspects and features of hard systems was necessary in order to put the criticisms of the concept into context. The hard systems has registered some significant achievements, practitioners are more sophisticated than written accounts of hard methodologies suggest, and the hard tradition is not static- changes are taking place that show an awareness of some of the concerns evinced by the critics.

3.9 HARD AND SOFT SYSTEM METHODOLOGIES COMPARED

At this particular point in the research, where the reader has been exposed to hard systems thinking in this chapter, and is about to be introduced to soft systems thinking in the next chapter, it is most appropriate to compare the main differences between the two concepts, details of which is contained in Table 3.2.

HARD SYSTEMS METHODOLOGIES	SOFT SYSTEMS METHODOLOGIES
Concerned with the system dimension of the system of systems methodologies **[80]**.	Concerned with the dimension dealing with people and their perceptions, values and interests (the participants dimension) **[80]**.
Ignores issues of subjectivity **[80]**.	Admits there are multiple perceptions of reality **[80]**.
Hard systems are goal-directed, in the sense that a particular study begins with the definition of the desirable goal to be achieved **[29]**.	Soft systems work within real world manifestations of human activity systems in which something was perceived to be a problem **[29]**.
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 **[29]**.	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 **[29]**.
Hard systems methodology is concerned only with a single *'Weltanschauung'* **[29]** .	In soft systems methodology, we are forced to work at the level at which *'Weltanschauungen'* are questioned and debated **[29]**.
The hard approach can stand by asking: What system has to be engineered to evolve this problem, or what system will meet this need, and can take the problem **[29]** ?.	The soft approach has to allow completely unexpected answers to emerge at later stages **[29]**.
The hard methodology is seen to be 'special cases' **[29]**.	The soft methodology is seen to be the 'general cases' **[29]**.

Table 3.2: 'Hard' systems and 'Soft' systems compared.

The most important difference 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 **[29]**.

3.10 CONCLUSION

It is of interest to note, that the soft systems approach, the subject under discussion in Chapter 4, emerged as a result of the dissatisfaction with the development, content and limitations of the hard systems approach, in spite of the positive aspects thereof listed in Paragraph 3.7 above.

In this chapter, the major hard systems methodologies, selected especially for their particular applicability to the research in this thesis have been contextually analysed at a high level in terms of literature reviews. The analysis covered the following hard systems methodologies:

- Systems engineering.
- Systems analysis.
- Operational research.
- Management cybernetics.
- Systems Dynamics.

Included in this chapter and in lieu of Chapter 4, which will deal with the soft systems approach, hard and soft systems methodologies were compared to add to the conceptual understanding of the reader of the two concepts. Furthermore, to provide a balanced analysis, the hard systems approach was analysed to highlight its major criticisms, positive aspects and features.

In Chapter 4, the major soft systems methodologies, selected especially for their particular applicability to the research in this thesis will be contextually analysed at a high level in terms of literature reviews. The analysis will cover the following soft systems methodologies:

- 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.

As in the case of Chapter 3 to provide a balanced analysis, the soft systems approach will be analysed further to highlight its major features.

Chapter 4

A HIGH LEVEL ANALYSIS OF THE SOFT SYSTEMS APPROACH

"The aim of education is the knowledge,
not of fact, but of values"[1]

W R Inge. Dean of St Paul's

4.1 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, highly representative of this concept from a holistic point of view. 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 be limited to a select few and a brief overview of these methodologies will be provided at the end of this chapter for the purpose of completeness.

The following problem solving methodologies will be analysed at a high level in this chapter:

- 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.

[1] From: The Church is the World. October 1932.

- The analytical process followed thus far, is graphically depicted in Figure 4.1, which places the chapters in context with the overall thesis objectives, and furthermore indicates the relative positioning of this chapter.

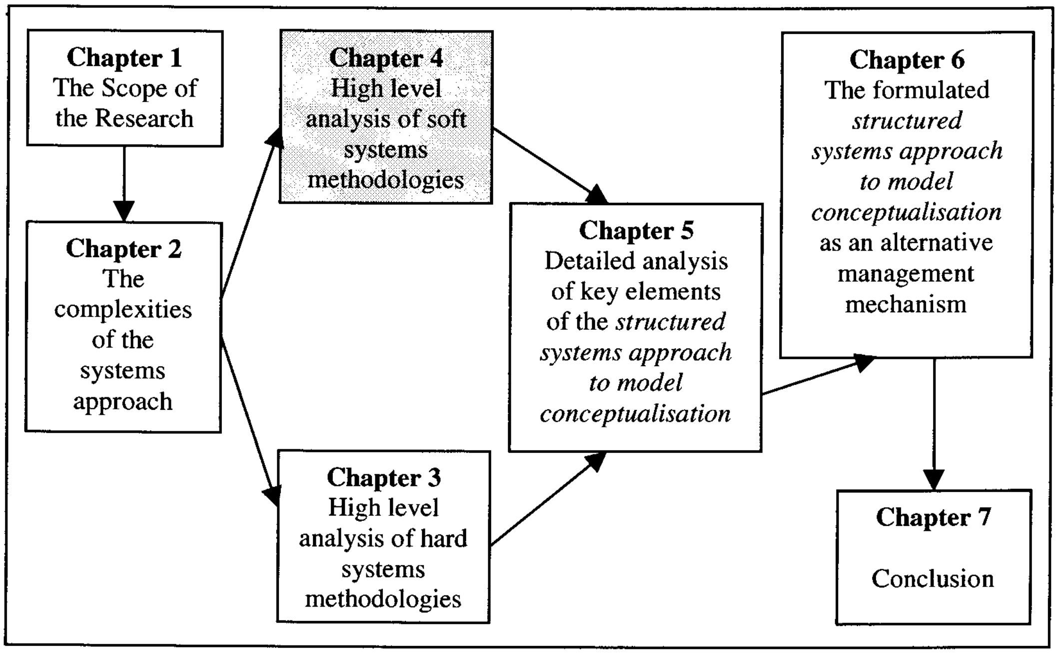

Figure 4.1: Chapters in context of the overall research

An analysis of Figure 4.1[2], shows Chapter 1 as the overall research approach to the thesis. Chapter 2, contains a number of key elements (complexities), which are explained in lieu of the high level analysis of hard systems contained in Chapter 3, and the high level analysis of soft systems, contained in this chapter. Key elements from the high level analysis of hard systems and soft systems methodologies, will serve as preliminary input mechanisms to Chapter 5, where the elements will be further analysed in detail to ultimately culminate in a formulated *structured systems approach to model conceptualisation.* Chapter 6 will depict the *structured systems approach to model conceptualisation* as an alternative management mechanism in practice, while Chapter 7 will contain a summary of the thesis content.

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

[2] Arrows in Figure 4.1 represents 'information flows' (inputs) from one chapter to the other.

this thesis, the classification of systems falling within the ambit of the systems approach depicted in Figure 2.1, is repeated here as Figure 4.2 for ease of reference.

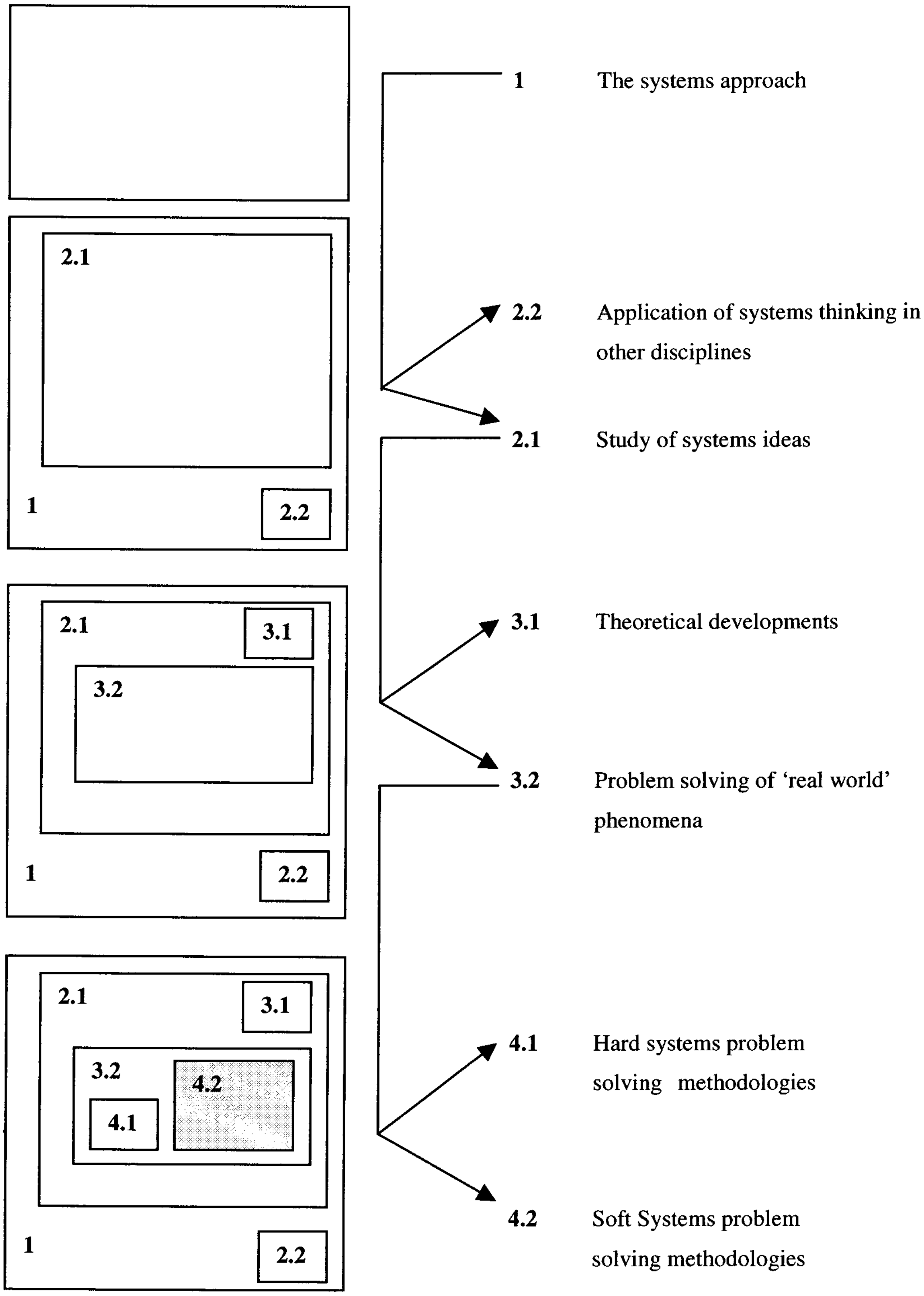

Figure 4.2: Classification of systems falling within the context of the systems approach

4.2 BEER'S VIABLE SYSTEMS MODEL

4.2.1 BACKGROUND

The traditional company organisational chart is, for Beer **[22]** 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 **[80]**, citing Beer (1979), the same model is derived from cybernetics and can therefore be applied to firms and organisations of all kinds[3]. Beer **[23]**, in a later work presents the model in the form of a 'managers guide', the intention being to aid application of the principles to complex phenomena pertaining to management *per se.*

According to Jackson **[80]**, a system is viable if it can respond to environmental changes, and to remain viable, 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 Chapter 3, Paragraph 3.5.3. Having previously created some understanding of 'organisational cybernetics' *per se*, (refer Chapter 2, Paragraph 2.5) the philosophy and principles of the Viable Systems model of Stafford Beer, which is intimately associated with this concept, require closer scrutiny.

4.2.2 PHILOSOPHY OF THE VIABLE SYSTEMS MODEL

The philosophy that drives Beer's (1979) view of cybernetics cited by Watkins **[177]**, concerns the kind of changes to be experienced in the Twenty First Century. Beer (1979) is of the opinion that 'new ways' are required to deal with difficulties associated with changes. The main points are summarised by Flood and Jackson **[56]** as follows:

[3] The reader is cautioned to view this statement against the background of the analysis of cybernetics (Refer Chapter 2, Paragraph 2.5), where a clear distinction is made between 'organisational cybernetics' and 'management cybernetics'.

- 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 our efforts to deal with modern complexities.
- 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.

4.2.3 PRINCIPLES OF THE VIABLE SYSTEMS MODEL

The principles that underpin the approach, are all cybernetic in nature and outlined by Flood and Jackson **[56]** 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 **[22]**, namely the concept of a 'recursion levels'. In its most elementary formulation according to Hobeke **[75]**, 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' (refer Chapter 3, Paragraph 3.5.3), that is, the variety of the controller must be equal to, or greater than that which is being controlled.

4.2.4 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 **[22]** in his work *'Brain of the Firm': 'The Managerial Cybernetics of Organization'*. Using the abbreviated analysis of Clemson **[39]**, as opposed to the comprehensive study of Beer **[22]**, the interactive components, which forms an operational unit are shown in Figure 4.3.

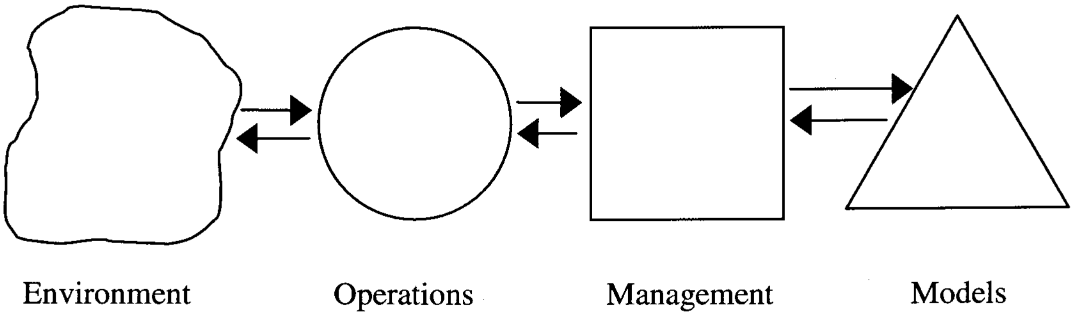

Figure 4.3: An operational unit dissected to show the major interactions **[39]**

Figure 4.3 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:-** (Of the operation) 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 4.4 depicts an operational unit showing the parts environment, operations, management, and models embedded within one another.

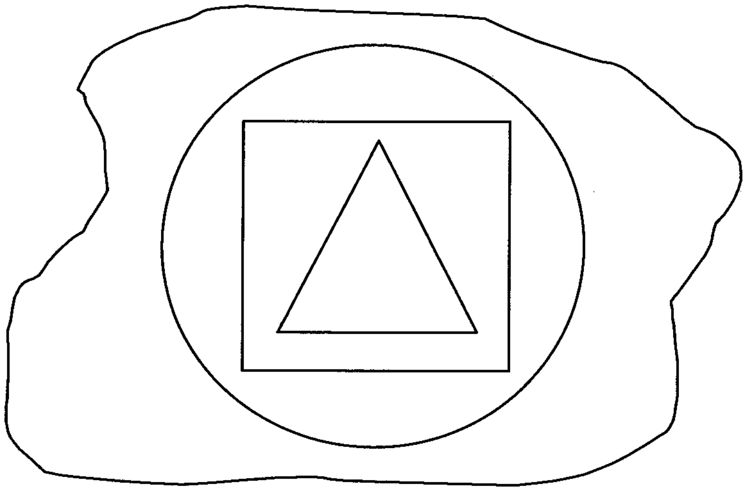

Figure 4.4: An operational unit showing the parts embedded [39]

To represent a whole organisation, Figure 4.3 can be expanded to reflect a set of related operational elements as depicted in Figure 4.5

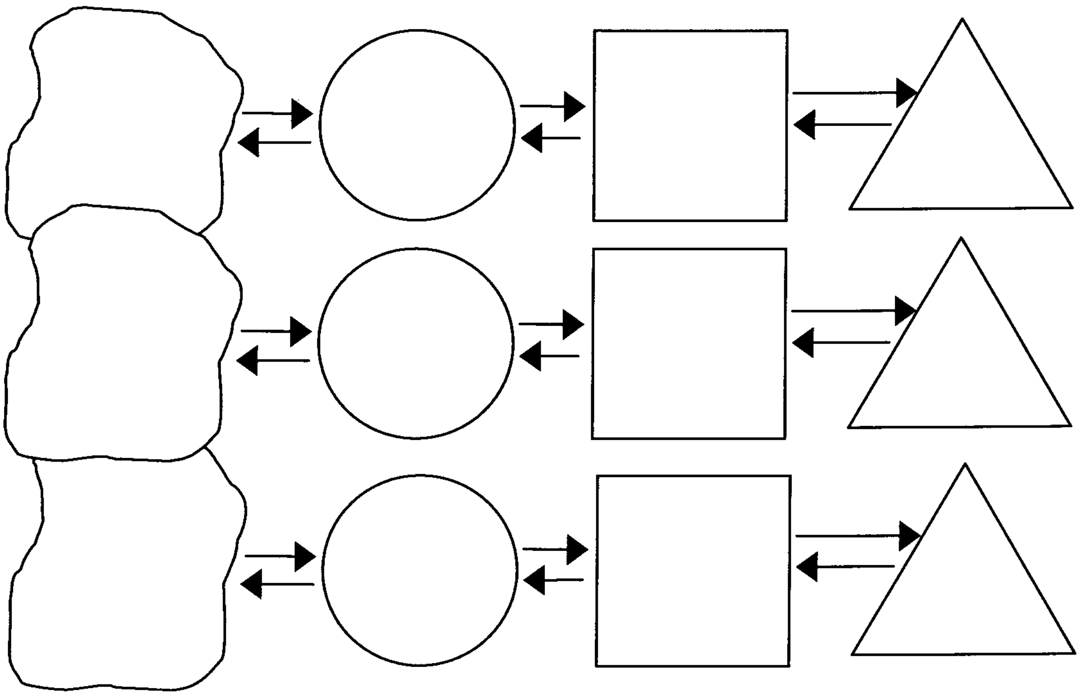

Figure 4.5: A set of related operational elements [39]

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 4.5 can be redrawn to collectively make up an organisational entity, termed 'System One' by Beer **[23]** and depicted in Figure 4.6.

In summary, the following key aspects concerning 'System One' are applicable **[56]**:

- 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.

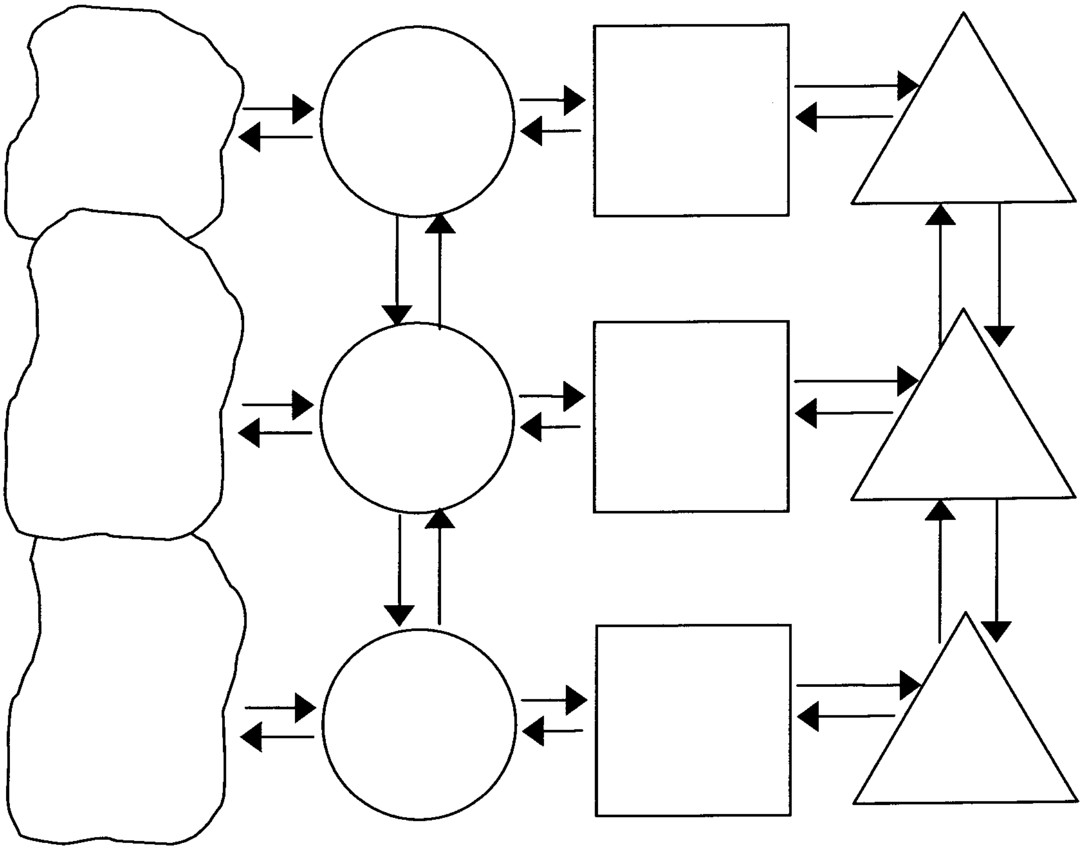

Figure 4.6: 'System One': A set of operational elements which collectively make up an organisational entity **[39]**

- **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, the following key aspects concerning System Two are applicable **[56]**:

- 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 may 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, the following key aspects concerning System Three are applicable **[56]**:

- 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' and, which may 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, the following key aspects concerning System Four are applicable **[56]**:

- 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, the following key aspects concerning System Five are applicable **[56]**:

  - 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 4.6 as follows, using the following set of conventions as suggested by Clemson **[39]**, and ultimately culminating in Figure 4.7.

- **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.

Analysing the Viable Systems model holistically, 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) **[56]** as depicted in Figure 4.7. 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.

Of importance is the presence of information and control loops (information links), depicted by ⟶ in Figure 4.7, interconnecting System One to System Five. The information flowing around the various system entities present within the model contains information about how the different parts of the organisation and the organisation as a whole are performing in relation to their respective functions.

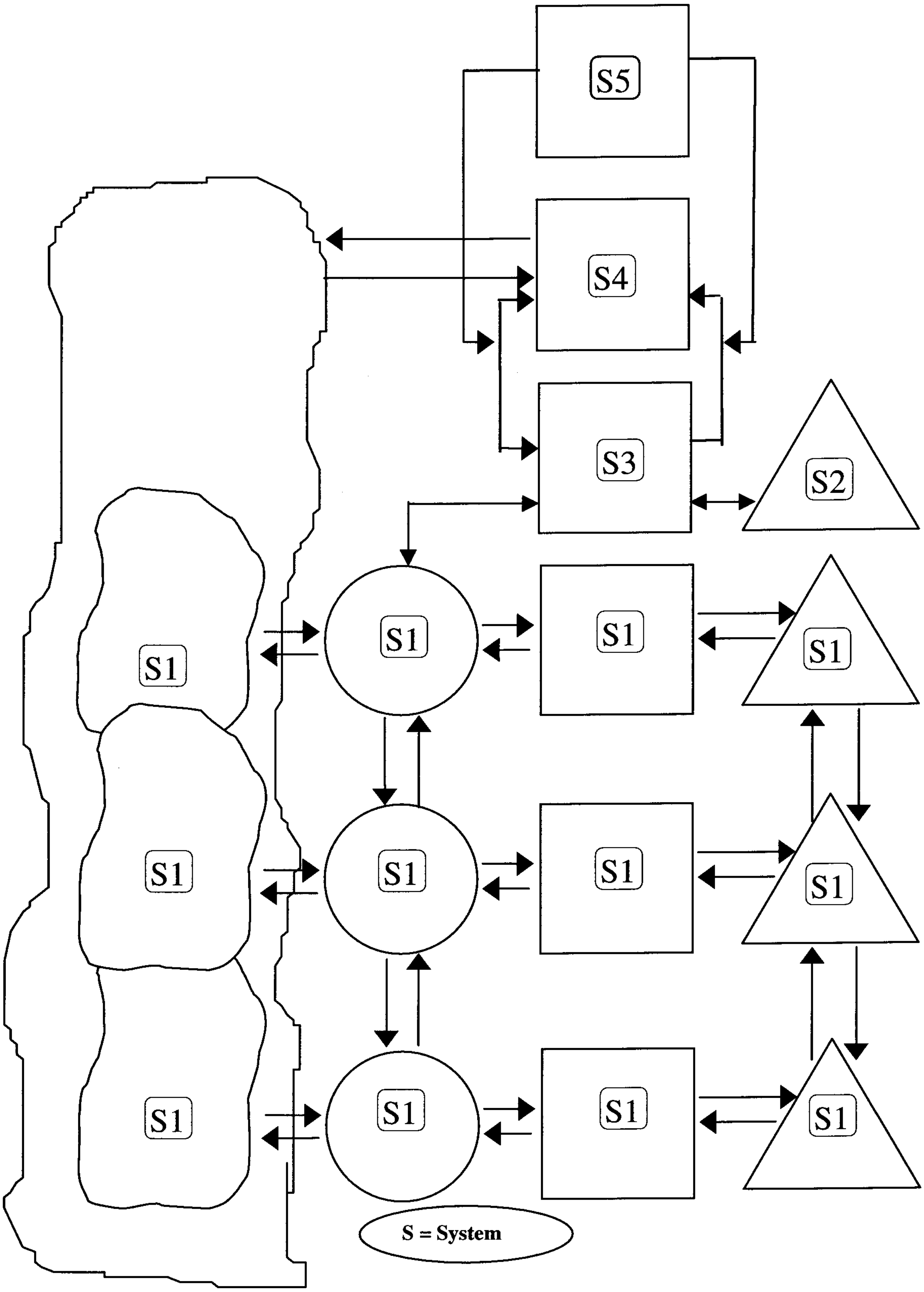

Figure 4.7: Outline of the structure of the Viable System model [39]

4.2.5 ADVANTAGES OF THE VIABLE SYSTEMS MODEL

The Viable Systems model offers the following notable advantages:

- There is a strong focus on organisational structure, communication and control processes.
- There is a distribution of control and authority (decision making and problem solving) to the correct levels.
- There is a distinct focus on relationships between the units within the organisation, their environments and the overall environment within which the organisation operates.

4.3 CHURCHMAN'S SOCIAL SYSTEMS DESIGN

4.3.1 INTRODUCTION

In an analysis of Churchman's Social Systems Design, it is interesting to note that Churchman **[34]** 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 **[29]**, Jackson **[80]** and Flood and Jackson **[56]** (by their own submissions). The work of Churchman relating to his Social Systems Design, is primarily contained within the ambit of the following academic publications:

- *'The Systems Approach'* **[34]**.
- *'The Design of Inquiring Systems'* **[35]**.
- *'The Systems Approach and its enemies'* **[32]**.

4.3.2 SOCIAL SYSTEMS DESIGN EXPLAINED

In his book *'The Design of Inquiring Systems'*, Churchman **[35]**, 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 **[80]**, Checkland **[29]**, and Flood and Jackson **[56]**, take the four aphorisms that Churchman use in his book *'The Systems Approach'* **[34]**, 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".*

4.3.2.1 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 Kant cited by Flood and Jackson **[56]** and Checkland **[29]**, we all tell a particular 'story of the world' (*'Weltanschauung'*), based on our 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 we recognise this, we are *en route* for the systems approach, because it becomes clear that 'subjectivity' must be embraced in systems thinking, different evaluations of what we want to attain 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 cited by Jackson **[80]**, 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 (1970) cited by Jackson **[80]**, is of the opinion that the only way we can get near to a view of the whole system, is to look at it from as many perspectives as possible.

4.3.2.2 THE SECOND APHORISM ANALYSED

The second aphorism, *"The systems approach goes on to discovering that every world-view is terribly restricted"*, according to Flood and Jackson **[56]**, and Jackson **[80]**, 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 **[123]**, and shown schematically in Figure 4.8, 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.

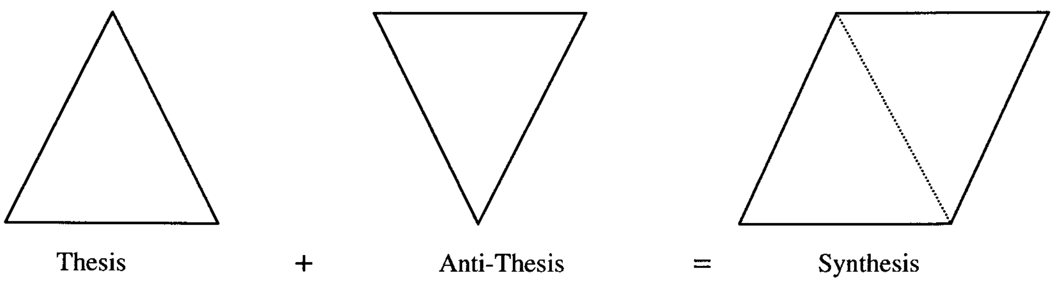

Figure 4.8: Hegel's Dialectic **[123]**

The analogy that can be drawn from this is 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, expressing elements of both positions while going beyond them as well (synthesis). The dialectical process advocated by Churchman can, according to Jackson **[80]**, 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.

4.3.2.3 THE THIRD APHORISM ANALYSED

The third aphorism, *"There are no experts in the systems approach"*, according to Jackson **[80]**, 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 **[32]**, reflect the very failure of the systems approach to be comprehensive.

4.3.2.4 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, E.A. Singer, (a former civil engineer **[108a]**) 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. Hence, Churchman **[35]** 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".*

Churchman **[35]**, 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.

4.4 CHECKLAND'S SOFT SYSTEMS METHODOLOGY

4.4.1 INTRODUCTION

Inspired by Churchman's Social Systems Design **[34]** discussed in Paragraph 4.3, Checkland **[29]**, developed his Soft Systems Methodology for use in ill-structured or messy problem contexts where there is no clear view 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 **[56]**.

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 **[56]**. The analogy can thus be made that Checkland's Soft Systems Methodology, has clear tangent planes with Beer's Viable System model discussed in Paragraph 4.2.

4.4.2 PHILOSOPY OF THE SOFT SYSTEMS METHODOLOGY

According to Flood and Jackson **[56]**, 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 **[29]**, 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.

4.4.3 PRINCIPLES OF THE SOFT SYSTEMS METHODOLOGY

The four main principles of the Soft Systems Methodology according to Checkland **[29]**, are summarised by Flood and Jackson **[56]** and concerns the elements of learning, culture, participation and two modes of thought.

- **Learning:-** Checkland **[29]**, 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.

4.4.4 SOFT SYSTEMS METHODOLOGY

According to Checkland **[29]**, 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 4.9, the Soft Systems Methodology, represents a chronological sequence of the stages of the methodology and is to be read from Stage 1 to Stage 7[4].

The seven stages making up the Soft Systems Methodology, can be analysed as follows **[29]**, **[56]**, **[80]**:

- **Stage 1:- The problem situation: Unstructured** (refer Figure 4.9, Stage 1).
- **Stage 2:- The problem situation: Expressed** (refer Figure 4.9, Stage 2).

These two phases are termed 'expression' by Checkland **[29]** 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.

[4] While Figure 4.9 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.

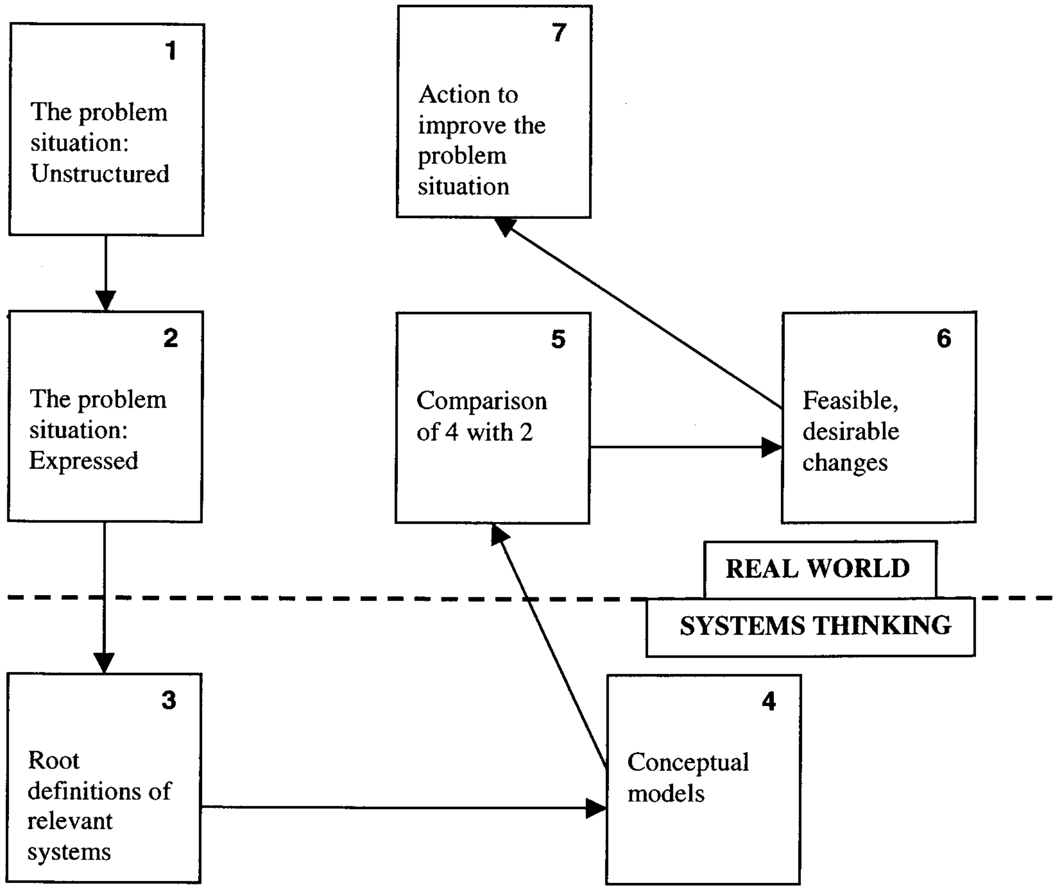

Figure 4.9: The Soft Systems Methodology in summary **[29]**

Flood and Jackson **[52]**, 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 4 of this chapter), 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 4.9, 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[5].
- **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 4.9, 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[6]. 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 **[29]**, 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.

[5] In this respect, refer to Chapter 2, Paragraph 2.8 and to Churchman's 'Social System Design' (refer Paragraph 4.3 of this chapter), for tangent planes to the concept *'weltanschauung'*.

[6] 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.

Furthermore, the final model should follow Churchman's **[35]** nine conditions that determine a system[7]. The components of the model according to Checkland are as follows: ***S*** is a formal system if, and only if:

- ***S*** has an on going purpose or mission.
- ***S*** has a measure of performance.
- ***S*** contains a decision-taking process.
- ***S*** has components, which are themselves systems having all the properties of ***S***.
- ***S*** has components, which interact, which show a degree of connectivity such that effects and actions can be transmitted through the system.
- ***S*** exists in wider systems and/or environments with which it interacts.
- ***S*** has a boundary, which separates it from the wider systems and/or environments with which it interacts.
- ***S*** has resources, which are at the disposal of the decision-taking process.
- ***S*** has some guarantee of continuity.

- **Stage 5:- Comparing conceptual models with reality models** (refer Figure 4.9, Stage 5). According to Checkland **[29]**, 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 of 'reality'. Flood and Jackson **[56]** 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. The authors **[56]** continue and expand on the following steps suggested by Checkland **[29]** 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.

[7] For an analysis of Churchman's **[35]** nine conditions of a system, refer to Chapter 2, Paragraph 2.2.

- 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 4.9, Stage 6). Changes of three kinds are possible, namely changes in structure, changes in procedures and changes in attitudes. According to Checkland **[29]**, 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 **[174]** terms an 'appreciative system'[8].
- **Stage 7:- Action to improve the problem situation** (refer Figure 4.9, Stage 7). This final stage according to Checkland **[29]**, 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.

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[8] For an analysis of 'appreciative systems', refer to Chapter 2, Paragraph 2.8.

- That the changes are culturally feasible given the characteristics of the situation, the people in it, their shared experiences and their prejudices[9].

4.5 ACKOFF'S INTERACTIVE PLANNING

Ackoff, as in the case of Churchman, has been much influenced by the pragmatist philosophy of E.A. Singer. Churchman's interpretation of this philosophy created a new understanding of 'objectivity' (refer Paragraph 4.3.2.2) in the systems approach which Ackoff endorsed, thus contributing to this new understanding of the concept.

4.5.1 PHILOSOPY OF INTERACTIVE PLANNING

For Ackoff (1974b), cited by Jackson **[80]**, 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 **[56]**, a number of significant Ackovian conclusions can be drawn namely:

- Planning and design requires wide participation and involvement.
- '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 thereof 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

[9] Of value is the work done by Watkins **[177]**, and Watkins *et al* **[178]**, on 'Change Management', which pertains to 'change' in organisations, subjected to forced interventions.

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 **[8]**, **[10]**, 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 according to Ackoff cited by Johnson **[81]**, 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 (1981b) cited by Jackson **[80]**, 'interactive planning', (which according to Ackoff **[7]**, includes the concept of 'contingency planning'), all of which has the aim to confront 'messes'[10]. Against the background of Ackoff's philosophy that planning should be participative and should be about enabling others to plan effectively for themselves, Ackoff **[10]** sets the scene by analysing the attitudes management have in respect of planning. The author **[10]**, classifies these attitudes 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.

[10] 'Messes' according to Flood and Jackson **[56]** can be defined as: "Sets of highly interdependent 'problems', where 'problem' formulation and structuring assume greater importance than 'problem solving' using conventional techniques". Ackoff cited by Mitroff and Linstone **[108a]**, defines a 'mess' as: "Every human problem associated and inextricable involved with every other human problem".

- **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 try 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, as he seeks 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, and 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.

4.5.2 PRINCIPLES OF INTERACTIVE PLANNING

According to Ackoff **[10]**, 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 **[56] [80]**, 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.

- **The participative principle:-** The principle that planning should be participative rests upon two connected ideas in Ackoff's thought. 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 and this 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.

4.5.3 INTERACTIVE PLANNING METHODOLOGY

According to Ackoff **[10]**, 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,[11] and none of the phases let alone the whole process should ever be regarded as completed. The five phases are:

- Formulating the 'mess'[12].
- Ends planning.
- Means planning.
- Resource planning.
- Design of implementation and control.

Each of these entities will be analysed, first in terms of Ackoff's **[10]** views, and then expanded upon in terms of Flood and Jackson's **[56]**, 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:

[11] Observe a similar situation in the use of the 'soft' systems methodology (refer Paragraph 4.4.4, Footnote 3).

[12] Refer to Footnote 10 of this chapter for a definition of the concept 'mess'

- 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.

  It is of interest to note that the resource types as identified by Ackoff **[10]**, very closely maps to the views of Forrester **[59a]**, who recognises that any economic or corporate activity consists of:
  - Flows of money.
  - Orders.
  - Materials.
  - Personnel.
  - Capital equipment.
- **Resource planning:-** This action determines the organisational requirements and design of organisational arrangements that makes 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 – their maintenance or improvement under changing conditions and with the acquisition of new information and knowledge that experience with the plan can bring.

4.6 MITROFF AND MASON'S STRATEGIC ASSUMPTION SURFACING AND TESTING

The inspiration for Mason and Mitroff's Strategic Assumption Surfacing and Testing methodology **[108]**, can be mapped back to Churchman's **[32]**, **[34]**, **[35]**, four aphorisms analysed in Paragraph 4.3.2 of this chapter, which serves as the underlying thinking of their approach to systems analysis.

4.6.1 PHILOSOPHY OF STRATEGIC ASSUMPTION SURFACING AND TESTING

The specific philosophy of Strategic Assumption Surfacing and Testing according to Mitroff and Mason **[108]**, 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 **[32]** **[34]** **[35]**, 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.

4.6.2 PRINCIPLES OF STRATEGIC ASSUMPTION SURFACING AND TESTING

From the philosophy of Strategic Assumption Surfacing and Testing **[108]**, 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 described in Paragraph 4.6.3.

4.6.3 METHODOLOGY OF STRATEGIC ASSUMPTION SURFACING AND TESTING

The methodology underpinning Strategic Assumption Surfacing and Testing **[108]**, has five phases:

- **Phase 1 - Group formation:-** The aim of this stage is to structure groups so that the productive operation of the later stages of the methodology is 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:-** 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. According to Mitroff and Mason **[108]**, there is a strong theoretical reason derived from the concept of telelogical[13] systems for surfacing assumptions by means of a stakeholder analysis. The authors **[108]** are of the opinion that 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:-** 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. They 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

[13] In this respect, refer to Chapter 2, Paragraph 2.2, Footnote 1.

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 debate:-** 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:-** The aim of synthesis stage, is to achieve a compromise on assumptions from which a new higher level of strategy/solution can be derived.

4.7 OTHER INFLUENTIAL SOFT SYSTEMS THINKERS

As indicated in the introductory section of this chapter, 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 **[56]** and Jackson **[80]**. 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 **[56]**. 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 **[56]**, and Jackson **[80]**, 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 **[56] [80]**, 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'* is contained in Chapter 5, Paragraph 5.3.

5 CONCLUSION

Soft systems methodologies the subject analysed at a high level in this chapter included:

- 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.

Furthermore, the analysis included popular problem solving methodologies of other influential 'soft' systems thinkers namely:

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

Chapter 3 and Chapter 4 also signify an end to the high level analysis of the soft systems and hard systems methodologies, which was underpinned by the details of the complexity of the systems approach from Chapter 2. Key criteria from the these high level analysis of hard systems and soft systems methodologies, will serve as preliminary input mechanisms to Chapter 5, where these criteria will be further analysed in detail to ultimately culminate in a formulated *structured systems approach to model conceptualisation*, the objective of this thesis.

Chapter 5

DETAILED ANALYSIS OF THE KEY ELEMENTS OF THE STRUCTURED SYSTEMS APPROACH TO MODEL CONCEPTUALISATION

"Education is what survives when what has been learnt, has been forgotten"[1]

Professor B F Skinner

5.1 INTRODUCTION

Chapter 5, in the opinion of the author, is one of the key chapters in this thesis, as the chapter contents are focused on a detailed analysis of all of the elements, which will ultimately culminate in the formulated *structured systems approach to model conceptualisation.* The analytical process followed thus far, is graphically depicted in Figure 5.1, which places the chapters in context with the overall thesis objectives, and furthermore indicates the relative positioning of this chapter.

An analysis of Figure 5.1[2], shows Chapter 1 as the overall research approach to the thesis. Chapter 2, contains a number of key elements (complexities), which are explained in lieu of the high level analysis of hard systems (contained in Chapter 3), and the high level analysis of soft systems, (contained in Chapter 4). Key elements from the high level analysis of hard systems and soft systems methodologies, will serve as preliminary input mechanisms to this chapter, where the elements will be further analysed in detail to ultimately culminate in a formulated *structured systems approach to model conceptualisation.* Chapter 6 depicts the *structured systems approach to model conceptualisation* as an alternative management mechanism in practice, while Chapter 7 contains a summary of the thesis content.

[1] New Scientist. 21 May 1964.
[2] Arrows in Figure 5.1 represents 'information flows' (inputs) from one chapter to the other.

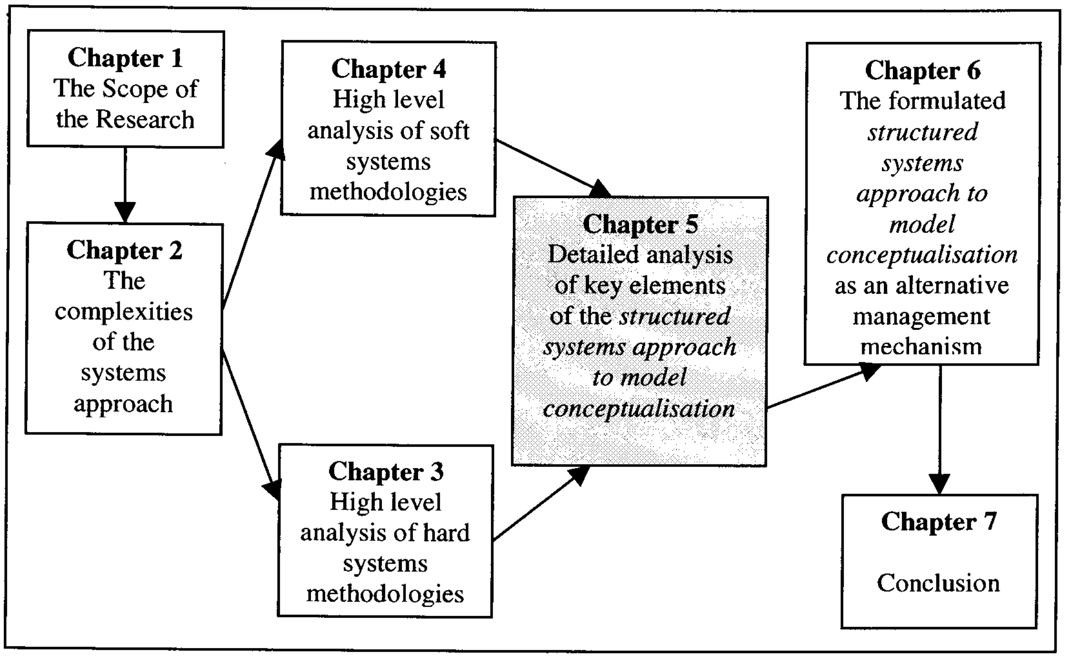

Figure 5.1: Chapters in context of the overall research

An important fact, which must be brought to the attention of the reader, is that in this chapter an 'approach'[3] will be formulated, namely the *structured systems approach to model conceptualisation*, which must be clearly distinguished from the process of building a 'model'[4]. This sequence of events, formulated here in its most basic format, is clearly depicted in Figure 5.2. This 'approach'[5] will primarily be concerned with the development of principles concerning the use of systems ideas in solving unstructured complex phenomena which confront executive management. The thesis deals with an 'approach' as opposed to a 'model', due to the fact that the research is focused on unstructured complex phenomena, which are invariably societal and organisational based and, which require systems-integrated solutions to solve. Randers **[126]**, adds credibility to this thesis content and objectives, when he makes the following, very important statement, in particular with respect to why the crux of this thesis pertains to an 'approach' as opposed to a 'model', when he states that:

[3] See Chapter 2 Paragraph 2.4, for a detailed analysis of the concept 'approach'.
[4] See Chapter 2 Paragraph 2.7, for a detailed analysis of the concept 'model'.
[5] The reader is cautioned that 'elements' of the concept 'model' are incorporated within the ambit of the approach, which is formulated in this thesis. In particular the attention of the reader is drawn to Phase 8 described in Paragraph 5.6.1 of this chapter, where the concept 'model' is used with reference to 'the pilot'.

"Because there is no educational text on model conceptualisation, the sequence of presentation in published papers describing models are commonly mistaken for the actual steps in the creation of those models".

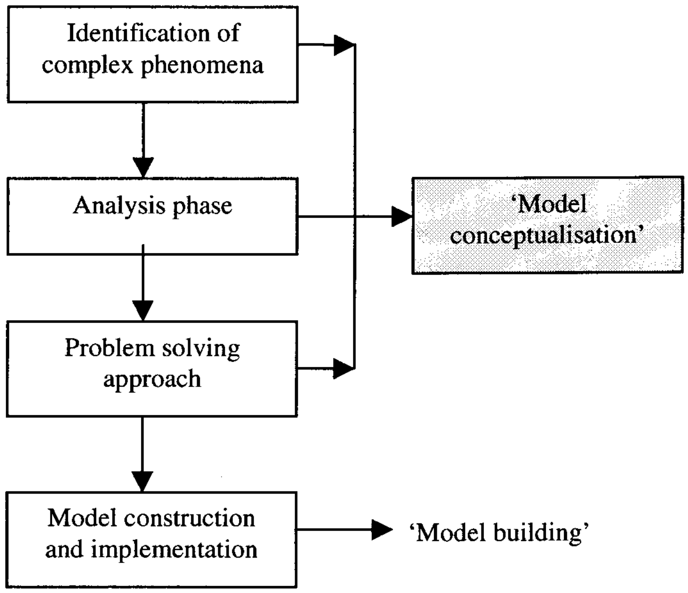

Figure 5.2: Conceptual sequence of events pertaining to 'model conceptualisation' and 'model building'

An 'approach' as suggested in this thesis, should, according to Randers **[126]**, deal with amongst others the following issues:

- How is the problem chosen?
- How does one achieve a useful perspective on the problem area?
- How does one succeed in capturing the essentials of a complex, real world phenomenon in a relatively simple model.

In view of this author, a *structured systems approach to model conceptualisation* to solve unstructured complex phenomena, will ensure that all of the variables pertaining to the unstructured complex phenomenon are selected, considered and structured to culminate in a feasible and viable systems model. In support of the authors 'thinking', the wisdom of the revered Dr. John D. Sterman **[161]**, who is of the opinion that one should, "beware the analyst who proposes to model entire social or economic systems, rather than the problem". Furthermore, it is of importance to note that the concept of a *structured systems approach to model conceptualisation*, is in line with:

- The approach of Clark and Augustine **[36]**, who are of the opinion that, "to pursue a modelling methodology, we must identify a complete and relevant set of information attributes, assign different dimensions to these attributes, and test the performance of the system on these several dimensions".
- The approach of Forrester **[59]**, who is of the opinion that, "the obvious purpose and test of a model of an industrial system is its ability to predict a specific future action". From this the obvious analogy can be drawn that the quality of input to a model, has a direct bearing on the model's ability to accurately predict the future action.
- The approach of Ackoff **[9]**, who is of the opinion that, "In dealing with a problematic situation, a decision maker must develop a concept – a representation or a model – of it". "He attempts to solve the problem as he conceives it". "Thus, if his conception is wrong, the solution to the problem as conceived may not solve the problem as it exists"

While a more general approach to problem solving will suffice for day to day organisational problems, unstructured complex phenomena would require a different approach, due to the fact that, according to Emery and Trist **[48]**, and Watkins **[177]**, **[178]**, the environmental contexts in which organisations exist are themselves changing at an increasing rate towards increasing complexity and very often as a result of a forced intervention. The 'characteristics' of organisational environments demand consideration if there is to be an advancement of the understanding in the behavioural sciences, specifically under the impact of technological change[6], which more often than not occurs as a result of a forced intervention **[177]**, **[178]**.

This chapter has been noted as one of the key chapters of this thesis, as it is within the ambit of this chapter that the *structured systems approach to model conceptualisation* will be formulated. Against this background, and to place the *structured systems approach to model conceptualisation* firmly in perspective to

[6] See Chapter 2 Paragraph 2.10, for a detailed analysis of the concept 'technological change'.

the research as a whole, the author deems it necessary to re-examine the initial objectives set in the early stages of the research, to force a refocus on the key issues pertaining to the research problem. This will be addressed in Paragraph 5.2 under the heading of: 'Refocus on Initial Objectives'. In addition, and perhaps controversial, the author will introduce his personal 'reasoning' and 'thinking' underlying the formulation criteria of the *structured systems approach to model conceptualisation*, which will be addressed in Paragraph 5.3 under the heading: 'Reasoning and Thinking: A Perspective'. Furthermore, before the construction elements of the *structured systems approach to model conceptualisation* can begin, assumptions pertaining to the process will be listed to ultimately facilitate a seamless transition to Chapter 6, where the *structured systems approach to model conceptualisation* will be introduced as an alternative management mechanism for executive management.

5.2 REFOCUS ON INITIAL OBJECTIVES

The following extracts from earlier chapters are repeated here *verbatim*, the purpose being to place the formulation process of the *structured systems approach to model conceptualisation* firmly in perspective to the research as a whole, and to refocus on the key issues pertaining to the research problem. This refocus on initial objectives, furthermore re-emphasises the complexity of the task of the executive management when dealing with unstructured complex phenomena, namely that they (executive management), can be compared to passengers on an aircraft, which they not only fly, but are busy redesigning in flight **[162]**.

Extract from the thesis Abstract:-

- The negative side of this trend, is that the engineer who primarily has had training in the engineering profession, a discipline grounded in analytical and reductionist thinking, now finds himself in the position of executive management, hardly equipped with the multi-faceted management skills typically demanded from an executive with respect to 'model conceptualisation', where the focus is typically concentrated on the handling of unstructured complex phenomena, which invariably are societal and organisational based, viewed as 'systems problems' within a particular world view or '*Weltanschauung*', and which require systems-integrated solutions to solve.

- While this thesis has at its core the objective to introduce the concept of a *structured systems approach to model conceptualisation* into the realm of executive management within a broader context, it is in view of the author the most suitable structured mechanism specifically aimed at the engineer in the emergent role of executive management dealing with unstructured complex phenomena.
- A further consequence of this thesis, is that the author succeeds to bridge the gap between 'hard' and 'soft' systems methodologies, by combining the two disciplines to form a 'midway approach' in solving unstructured complex phenomena. In addition, the research findings show that such an approach manifests as an essential mechanism for modern executives to facilitate the resolution of unstructured complex phenomena within their respective organisations in a structured way. Furthermore, the research findings show that management philosophies formulated by revered academics during the Twentieth Century, can be applied with success to Twenty First Century unstructured complex phenomena, thus becoming an accepted alternative management mechanism for this purpose.
- This thesis then, is about both a *structured 'systems approach' to model conceptualisation* and 'systems practice' and the relationship between the two entities, aimed at dealing with unstructured complex phenomena within the ambit of executive management. From this the conclusion can be drawn that the systems dynamics of the formulated *structured systems approach to model conceptualisation* specifically applied to the art of executive management, can be used to structure the outcomes of paradigm shifts introduced into organisations as a result of unstructured complex phenomena.

Extract from Chapter 1, Paragraph 1.1.1:-

- While this thesis has at its core the objective to introduce the concept of a *structured systems approach to model conceptualisation* into the realm of executive management within a broader context, it is in the view of the author the most suitable structured mechanism specifically aimed at the engineer in the emergent role as the executive decision maker dealing with unstructured complex phenomena in the Twenty First Century.

Extract from Chapter 1, Paragraph 1.2:-

- Field research by the author into unstructured complex phenomena associated with executive management, show that such entities are not commonly dealt with in terms of the systems approach **[59a]**, **[90]**, **[152]**, **[105]**, **[126]**. Furthermore, 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 the systems approach *per se*, specifically addressed 'model conceptualisation' to solve unstructured complex phenomena pertaining to executive management over a spectrum of disciplines in a structured way.

Extract from Chapter 1, Paragraph 1.4:-

- Can the systems approach, which is currently embedded in academic literature in various authoritative publications in various forms and permutations, be applied to model conceptualisation to solve unstructured complex phenomena from an executive management perspective?

Extract from Chapter 1, Paragraph 1.3:-

- The ultimate objective is to provide the engineer as emergent executive with a structured mechanism to address model conceptualisation in the quest to solve unstructured complex phenomena.

5.3 REASONING AND THINKING: A PERSPECTIVE

This author's attitude toward management philosophy is one of reverence for the great thinkers of the past, and confidence in his own personal and practical experience spanning some 32 years at various managerial levels. Furthermore, of pioneering originality regarding modern contemporary systems thinking to address unstructured complex phenomena, hence the author's reading far beyond normal academic requirements with readings in the likes of Charles Peirce's *'Theory of Scientific Method'* and Immanual Kant's *'Critique of Pure Reason'*. The 'reasoning and thinking' of the author has at its source the wisdom of Reilly **[129]**, referring to Pierce's pragmatism where:

> *"Knowledge must involve a reference to experience; and this reference is an expectation, an imaginary (in the case of theoretical knowledge) anticipation of experience".*

The rationale behind this being that knowledge, which has no possible bearing on any experience – brings no expectation whatever – would be information concerning a dream. And the fact that, in the words of Ackoff **[3]**, "theories taught in management schools are often useless when applied to practical business". The most complete statement of this position within a systematic theory is to be found in Immanual Kant's *'Critique of Pure Reason'*, which first appeared in 1781 and cited by Churchman and Ackoff **[30a]**, in three separate extracts as follows:

> *"There can be no doubt that all our knowledge begins with experience".*

> *"But though all our knowledge begins with experience, it does not follow that all arises out of experience".*

> *"By way of introduction or anticipation we need only say that there are two stems of human knowledge, namely, sensibility and understanding . . ." "Through the former, objects are given to us; through the latter they are thought".*

With this in mind, based on the personal and practical experience of this author[7], 'reasoning and thinking' as depicted in this thesis, are selectively based on the 'Ways of Knowing' as contained in Mitroff and Lintstone's **[108a]**, *"The Unbounded Mind"*, which has as its objective the breaking of the chains of traditional business thinking. Mitroff and Lintstone's 'Ways of Knowing' can be summarised as follows:

- **Agreement: The first way of knowing:-** Achieved through the use of an inquiry system[8] in the likes of Delphi[9] where the main characteristics pertaining to problem solving (where possible) are imbedded in the concepts of:

[7] See also Chapter 1, Paragraph 1.6.
[8] Defined by Churchman **[35]**, as 'a system of interrelated components for producing knowledge on a problem or issue of importance'.
[9] Rowe, G. Bolger, F. Wright, G. *'The Delphi Method: An Investigation of Richness of Feedback and Change in Majority/Minority Opinions'* Technology Forecasting & Social Change. Vol. 39, No. 3, May 1991.

- Group participation[10].
- Interaction of responses over various rounds.
- Anonymity of responses.

While agreement and consensus are important in reaching conclusion and in achieving the necessary support to address complex phenomena, a *caveat* must be observed, as with all things human, they cannot be followed exclusively, nor are they the ultimate consideration for deciding all important questions.

- **The world as a formula: The second way of knowing:-** Most of the academic literature cited in this thesis, contains mathematical models to help visualise complex phenomena. As a matter of fact, in the words of Toffler cited by Mitroff and Lintstone **[108a]**, "no matter how 'hard' the final output may appear, all models are ultimately and inescapably, based on 'soft' assumptions". "Moreover, decisions about how much importance to assign to any given variable or its weighting, are frequently 'soft', intuitive and arbitrary". This most appropriate conclusion against the background of the complex phenomena which is being dealt with in this thesis, which invariably are societal and organisational based, viewed as systems problems and, which require systems-integrated solutions to solve. The analogy can be drawn from the words of Mitroff and Lintstone **[108a]**, that, "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".
- **Multiple Realities: The third way of knowing:-** Ever since Emmanual Kant, educated people have realised that both the experience of reality as well as its description are heavily dependent on the structure of our minds, much more so then empiricists would have us believe. Contrary to the common-sense notion that reality is 'something out there' uninfluenced by human minds, we humans contribute a great deal of our nature to what we experience as reality and how

[10] This approach, in particular with respect to executive decision making, maps to the views of Beer **[22]**, who is of the opinion that executive decision making is an elaborate interactive assemblage of elements. Beer **[22]**, calls this a 'thinking shop' after the Greek *'phrontisterion'*.

we describe it. To this author, the following issues are of particular importance having direct bearing on the practising executive and the thesis *per se*:

- Due to the fact that long and arduous years are involved in mastering a particular discipline, the academic/professional mind easily becomes a prisoner of a particular way of viewing the world. For this reason, according to Mitroff and Lintstone **[108a]**, crossing academic disciplines or professional boundaries (as in the case of engineers drawn into other disciplines than engineering[11]), the experience is worse than crossing foreign cultures – it constitutes culture shock of the highest order, culminating in the requirement for 'change management' becoming a necessity in any organisation subjected to complex phenomena, especially should it take place against the background of a forced intervention **[177]**, **[178]**.
- The fact that complex phenomena can be defined in different ways, and furthermore, that such problems are problematic and of immense significance, which would require the executive manager to see a range of different representations of the phenomenon, in order to participate actively in the problem-solving process and not merely be a static recipient of the end results.
- The fact that complex phenomena invariably contains societal organisational based issues, viewed as 'systems' problems, which require systems-integrated solutions **[68]**, forces the executive manager not to be purely formalised and in addition, depend on the exercise of wisdom. Wisdom, according to Churchman **[31]**, "is the one factor that cannot be cast into mathematical formula or procedure".

- **Conflict: The forth way of knowing:-** The analytical reasoning, which is appropriate to address complex phenomena, the ability to zero in on the critical assumptions or key premises that underlie the phenomenon. This can only be achieved if analytical skills are honed in building models and determine solutions therefrom, however, more important is to challenge the assumptions on which the models rest. According to Mitroff and Lintstone **[108a]**, what is required is an intense, explicit debate between two polar

[11] See Chapter 1, Paragraph 1.1.1.

positions to enable the executive to be in a much stronger position to know the assumptions of the two adversaries and as a result, clarify his or her own assumptions.

- **Unbounded Systems Thinking: The fifth way of knowing:-** In terms of this thinking, 'everything interacts with everything', that all branches of inquiring depend fundamentally on one another, and that the widest possible array of disciplines, professions, and branches of knowledge – capturing distinctly different paradigms of thought – must be consciously brought to bear on the solving of complex phenomena.

It is the intention to formulate the *structured systems approach to model conceptualisation* in such a manner as to be an incumbent alternative approach to executive management for the purpose of ultimate model building based on:

- Personal and practical experience of the author combining the knowledge pools gleaned from years spent at lower, middle, senior and executive management levels, thus breaking the chains of traditional business thinking.
- Lessons learned from the author's own judgement errors in solving unstructured complex phenomena.
- Proven management philosophies of revered systems thinking academics gleaned from primarily 'soft' and 'hard' systems thinking methodologies.
- Contains the elements of practicality, validity, feasibility and reliability gleaned from 'world best practice' initiatives observed by the author in the US, EC including the UK and the Far East.
- Manifest as a recognised alternative approach for executive management in their quest to solve unstructured complex phenomena.

Although not exactly within context, support for this type of formulation approach comes from Takahashi and Takahara **[167]** who is of the opinion that:

> *"A reality itself is so complex that we cannot directly analyse it and obtain effective information from it to improve present situations including problems". "To attack the reality it is necessary not only to analyse precisely individual elements, but to 'recognize' the situations*

> *in question as a whole entity and 'abstract' essential factors to be examined".*

This view of Takahashi and Takahara **[167]**, also serves as impetus to the author's 'reasoning' and 'thinking' in respect to the approach in solving unstructured complex phenomena. Based on the above entities, the formulation approach, which has a holistic base, is graphically depicted in Figure 5.3, the key elements forming the assumptions discussed in Paragraph 5.4.

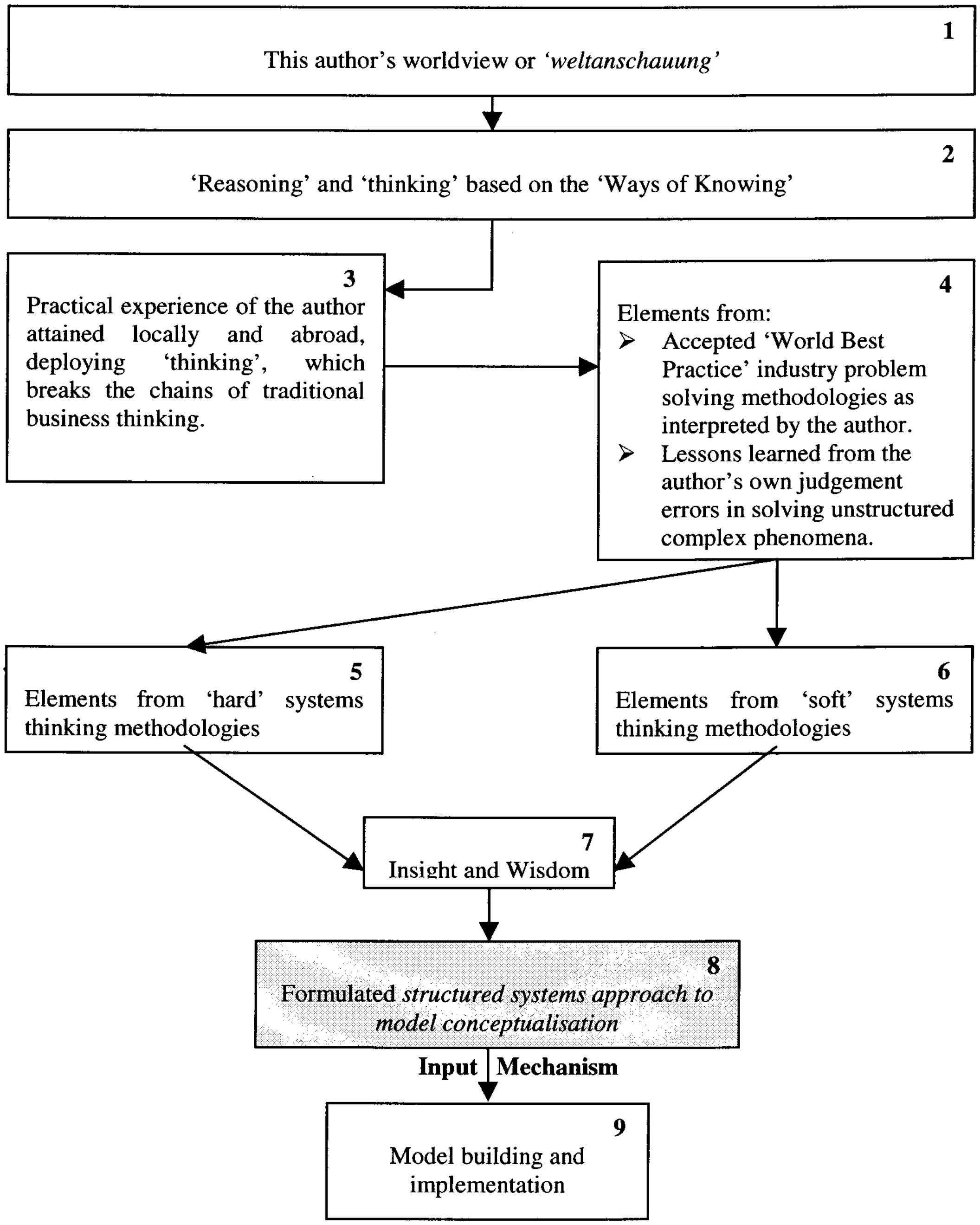

Figure 5.3: Formulation approach

5.4 ASSUMPTIONS

The following assumption applies to the formulation process of the *structured systems approach to model conceptualisation*:

- 'The Ways of Knowing' as described in Paragraph 5.3 of this chapter, will govern some of the key 'reasoning' and 'thinking' to be deployed in the formulation of the approach to model conceptualisation.
- The *structured systems approach to model conceptualisation* will represent an 'approach' to the formulation of a model.
- The *structured systems approach to model conceptualisation* in itself will not represent a model
- Soft systems thinking will be the ruling maxim to the formulation of the *structured systems approach to model conceptualisation*, but not limited thereto as a finely tuned equilibrium will be maintained between soft and hard approaches. This 'thinking' is in line with 'the world as a formula' of 'the second way of knowing', described in Paragraph 5.3 of this chapter.
- The *structured systems approach to model conceptualisation* will be designed as to become a 'logical' approach for executive management to address unstructured complex phenomena.
- Judgement errors in the past on the part of the author in solving unstructured complex phenomena (herein presented as part of the personal and practical experience) serving as impetus to the formulation of the *structured systems approach to model conceptualisation*. While not exactly within context, but highly appropriate, Abel-Hamid and Madnick **[1]** cite Boddie (1987) who argues that "we reject one of the most basic engineering practices: identifying and learning from our mistakes", the principles of which is also underwritten by Paich and Sterman **[121]**.
- Wisdom, the overriding element in the formulation of the *structured systems approach to model conceptualisation* is not based on the premise of *'doing the right things'* (my italics), but rather on *'doing things right'* (my italics). Wisdom according to Churchman **[35]**, "is the one factor that cannot be cast into a mathematical formula or procedure". The same maxim applies to unstructured complex phenomena when dealing with organisational and societal problems causing dynamic paradigm shifts within an organisation. In

stead of a mathematical formula or procedure, 'wisdom' is the only solution whereby a fine balance can be achieved between 'over control' and chaos[12].

- To formulate a *structured systems approach to model conceptualisation* from a holistic perspective where the whole entity pertaining to the complex phenomena under analysis is examined as part of the ultimate solution.
- The formulation of the *structured systems approach to model conceptualisation* will represent a finely tuned balance between 'over control' and 'chaos' which can be selectively compared with the *'Scylla'* and *'Charybdis'*[13] in Greek mythology and the *'Yin'* and *'Yang'* from Chinese ontology. This would imply that a finely tuned balance is observed between the 'hard' and 'soft' issues as depicted in Table 5.1. Furthermore, this 'thinking' is in line with 'the world as a formula' of 'the second way of knowing', described in Paragraph 5.3 of this chapter.
- The worldview or *'weltanschauung'* as personally perceived by the author, will apply in the formulation of the *structured systems approach to model conceptualisation.* In making this statement, it is acknowledged by the author that while the *'weltanschauung'*, which will be upheld in the formulation of the approach to model conceptualisation in this chapter and in the case study to be discussed in Chapter 6, are based on his 'own' *a priori* assumptions, there may be other equally legitimate views based upon alternative sets of assumptions. It is these 'other equally legitimate views based upon alternative sets of assumptions', which is of absolute vital importance in the formulation of the *structured systems approach to model conceptualisation.* These 'other equally legitimate views based upon alternative sets of assumptions', which bring to the fore the 'subjectivity' of the systems approach and, which will ensure that unstructured complex phenomena pertaining to the 'whole system' are grasped, and that as many as feasible possible different perspectives are swept in.

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[12] As illustrated in Table 5.1.

[13] With acknowledgement to Loutjie Bouwer. Johannesburg, April 2000.

The author wishes to draw the attention of the reader to the fact that some of the most powerful statements in this thesis are contained within the ambit of the above paragraph. This has been done intentionally, as these 'assumptions' forms the backbone to the *structured systems approach to model conceptualisation.*

Hard Executive Management Issues	Soft Executive Management Issues
Purpose	People
Environment	Management
Strategy	Vision
Structure	Commitment
Systems	Style
Fit	Split
Growth	Development
Control	Autonomy
Efficiency	Innovation
Cost control	Service
Executive decision making	Measured outcomes

Table 5.1: Observed balance between 'hard' and 'soft' issues.

The author acknowledges the work and time of prominent and lesser known academics cited in this thesis, however equally acknowledges the personal contributions of successful executives around the globe who contributed their 'thinking' in the creation of 'World Best Practice' industry standards in their quest in solving complex phenomena in their own respective organisations. All of this contributed to this author's own understanding of the concept over the years, actively practising a philosophical approach in solving unstructured complex phenomena. The works of these executives, most likely, will never be formally documented, but never-the-less, elements of their collective contributions will ultimately culminate in some form or other as an integral component of the *structured systems approach to model conceptualisation.*

5.5 ORGANISATION STRUCTURE: FACILITATING THE APPROACH TO MODEL CONCEPTUALISATION

This thesis is not about organisation structure *per se*, however, the *structured systems approach to model conceptualisation* would demand that a structured organisation structure be in place to facilitate such a process, and thus forming an integral part thereof. It is suggested that, by restructuring the organisation in a particular way, the approach to model conceptualisation, and for that matter, the process of solving unstructured complex phenomena by executive management can be enhanced, thus the key, according to Senge **[153]**, "is not getting the right strategy, but fostering strategic thinking". The attention of the reader is drawn to the fact that, based on the above reasons, the 'Structure Formulation and Approach' discussed in Paragraph 5.5.1 of this chapter, is represented by Phase 6 of the model conceptualisation process.

The information technology industry, in particular information technology functioning in large corporate conglomerates, to which the author has a close association, often prides itself in analysing any technology failure to the point of the 'root cause' thereof, and taking the appropriate remedial action, to not only remedy the failure at point of impact, but also in taking remedial action to remedy the failure at source and to avoid a similar occurrence of the failure in the future. The same situation however does not appear to prevail in some organisations where unstructured complex phenomena are equally experienced as a everyday occurrence. At these organisations, failures are invariably remedied at the point of impact (where it happens), and remedied at this very point, thus the results of the failure is rectified as opposed to the 'root cause' thereof, leaving open the possibility for a reoccurrence of the same problem.

While the information technology industry is cited here as an example of being diligent in their analysis of root cause failures, it would be extremely naïve to uphold this view for all information technology driven organisations, without the required *caveats*, that this industry too falls prey to such reoccurring complex phenomena. According to Abel-Hamid and Madnick **[1]**, "the record shows that the software industry has been marked by costly overruns, late deliveries, poor reliability and user-dissatisfaction".

While acknowledging the listed *caveats*, but primarily taking selective lessons from the information technology industry's approach to root cause failures, the task of the operating executive in dealing with unstructured complex phenomena, would be greatly facilitated should the structural 'foundations' of the organisation (it's individual system entities) be so positioned as to facilitate root cause analysis of unstructured complex phenomena at source in an attempt to stop re-occurrences of the same problems. A precipitation of 'root cause' failures could culminate in 'chaos', making the organisation un-manageable as all energy would be directed at the result and for that matter, re-occurring results of the failure as opposed to its 'root cause'. In such a situation of 'chaos', what is required is to call halt, cancel the current organisational structure, suspend all the routine regulative mechanisms and bring the situation 'back to normal', by restructuring in such a way as to strike a balance between over control and chaos. Support for this approach comes from Reagan-Cirincione *et al* **[127]**, citing Morris (1972), who is of the opinion that, "the things which go wrong may very well stem from the inadequacy of the structures we unconsciously impose on our available information".

It is most important to bring to the attention of the reader the underlying rationale of all of the above and on which the organisational approach described below, will be based upon namely, causal loop diagrams and reinforcing and balancing processes. These entities have been deliberated at length in Chapter 2, Paragraph 2.9, the importance of which cannot be overemphasised.

The reader is cautioned that this suggested organisational restructuring approach merely create 'structured foundations', where control and order can be regulated with the objective to facilitate the solving of unstructured complex phenomena. Using the analogy of the fable of the 'three little pigs', where a house (organisation) built from bricks and mortar have a better chance to survive the onslaught of unstructured complex phenomena. The realities of the boundaries of 'real world' phenomena however remain, as they are not rectilinear, but amorphous. Philosophically, Hegel's Axiom of Internal Relations[14], shows that the boundaries drawn to contain a system are purely conventional. A further objective of this 'midway approach' between over control and chaos, is that it automatically discounts the vast amount of proliferating information about world situations that is accessible to the executive and focuses on the issues of real importance namely the root cause of unstructured complex phenomena.

Should an organisation structure be formulated using this 'midway approach', it should be done in such a manner as to automatically correct small and large errors alike, and in the course of correcting them, report on them according to whatever criteria are laid down. Furthermore, the requirement is to restructure in such a way as to be totally organised and the inherent systemicity thereof has a teleological[15] context. The reader is cautioned that extremes in the formulation of organisation structures are a trap commonly experienced specifically if the 'perfect' system is sought. According to Selznick **[150]**, deviations from the formal system tend to become institutionalised, so that 'unwritten laws' and informal associations are established. This creation of 'informal structures' within various types of organisations, has received explicit recognition since 1941 **[138]**. In view of Beer's **[22]** approach to organisation levels[16], it is with irony to note his views on the complexity of the subject, which reads as follows:

> *"For someone to be able to grasp the complexity of the sum of all the levels of an organization, the volume of his or her head should grow exponentially with the number of levels he or she encompasses"*

It must be emphasised, that it is not suggested in this thesis that the traditional organisational chart, which in some cases could be extremely complex, be scrapped in favour of, for instance, the 'drastic' Viable Systems model[17] of Stafford Beer, in spite of the fact that it involves "a process of consciously creating a future" **[75]**. The proposed organisational structure, which is proposed

[14] Refer to Chapter 2, Paragraph 2.2.
[15] Refer to Chapter 2, Paragraph 2.2, Footnote 1.
[16] Refer to Chapter 4, Paragraph 4.2.
[17] Refer to Chapter 4, Paragraph 4.2.

to facilitate the solving of unstructured complex phenomena, should, in addition to the criteria listed above, contain the following:

- Have a dialectical approach to objectivity whereby equilibrium can be achieved when opposites are juxtaposed, very much in line with Hegel's Dialectical approach[18].
- Contain elements of functional restructuring in such a way as to facilitate both centralisation and de-centralisation, and that all parts irrespective of being centralised de-centralised, essentially have the same goals and values as the total organisation.
- All operational units operating as a integrated 'systems' within the organisation must map the organisational structure of the greater organisation. This implies levels of recursion of each autonomous entity within the greater organisation. Furthermore, the notion of 'recursion' is fundamental so that vertical interdependence can be dealt with. As defined before, 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, that organisation and its supra-system (that of which the system is a part or a division of).
- Maps to the definition of a 'system' as defined by Vickers (1984) and cited by Strümpher **[165]**, where a 'system is defined as, "a regulated set of relationships, and the key to its understanding is the way in which it is regulated". The attention of the reader is drawn specifically to this definition as the whole concept pertaining to the proposed organisation structure is formulated in terms of this definition. The importance of the definition cannot be overemphasised and for this reason, the interpretation of the definition is repeated yet again *verbatim,* as not to lose the true meaning of the author **[165]**:

  - *"The first aspect that Vickers' definition captures is that anything that we care to group together and label as an entity proves upon further investigation to be constituted from more relationships". "In fact why we care to label an entity as such is because the*

[18] Refer to Chapter 4, Paragraph 4.3.2.2.

constituent relationships show resilience or stability through time, i.e., 'it' persists". "It is precisely because the relationships hang together through time that we observe them (it) in the first place". "One perspective on relationships then is this stability, which I will call the structure". "By structure I therefore mean those relationships that remain relatively unchanged through the period of interest to the inquiry".

- *"A second aspect touched by Vickers' system definition is that there is a dynamic dimension to the relationships". "This perspective on systems relationships, which I will call the process dimension, refers to the altering or changing of relationships over the time frame of the enquiry". "Process refers to the matter/energy and/or information flow, and their transformations, which place within the entity, as well as between the entity and its environment, during the timeframe of interest in the inquiry". "Process describes the logical thinking of inputs to output(s)". "It should be borne in mind that definitions of input and output depend on how the systems boundary is drawn, which is by no means determined absolutely". "Whereas structure describe 'static' or (relatively) unchanged relationships, the process perspective describes the changes in relationships within the time frame of interest".*

- The proposed organisational structure ultimately be made up as "an integrated whole whose essential properties arise from the relationship between the parts" after Capra **[27]**.

5.5.1 STRUCTURE FORMULATION AND APPROACH

The attention of the reader is drawn to the fact that this paragraph is represented in Phase 6 of Figure 5.5 shown in Paragraph 5.6.1. Figure 5.4 is a graphical presentation of the proposed organisational structure, the details of which are discussed in detail below:

- **External Environment:-** The external environment is shown as Frame 1 and charged with the objectives of the greater organisation or operational unit which includes the mission of the entity, 'what' the organisation or organisational unit does and 'how' it is accomplished. This 'external environment', only implies the 'model' on which the organisation or operational unit is based.
- **Model:-** The model shown as Frame 2, represents the organisation or operational unit infrastructure environment and its interrelated communication, information, process flows and respective recursion levels. Furthermore, the model depicts the approach with respect to centralisation or de-centralisation of the organisation or operational unit. The model has tangent planes to each of the entities, which makes up the organisation or operational unit.
- **Internal Environment:-** The internal environment is shown as Frame 3, and is charged with the objectives of the internal mechanics of the organisation or operational unit, which could include the following:
  - 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 the organisation's operational units.
  - The internal environment has tangent planes to each of the entities, which makes up the organisation or operational unit.
- **Executive Management:-** Executive management shown as Frame 4 has as its prime responsibility the solving of unstructured complex phenomena pertaining to the organisation or operational unit. In addition, other charges may include:
  - Exercising a dialectical approach to objectivity.
  - Maintain equilibrium and stability when opposites are juxtaposed within the organisation or operational unit.
  - Handling all organisation or operational unit policy decisions.

- Handling all arbitration issues between external and internal environments.
- Functions as defined in Chapter 1, Paragraph 1.1, Footnote 4.

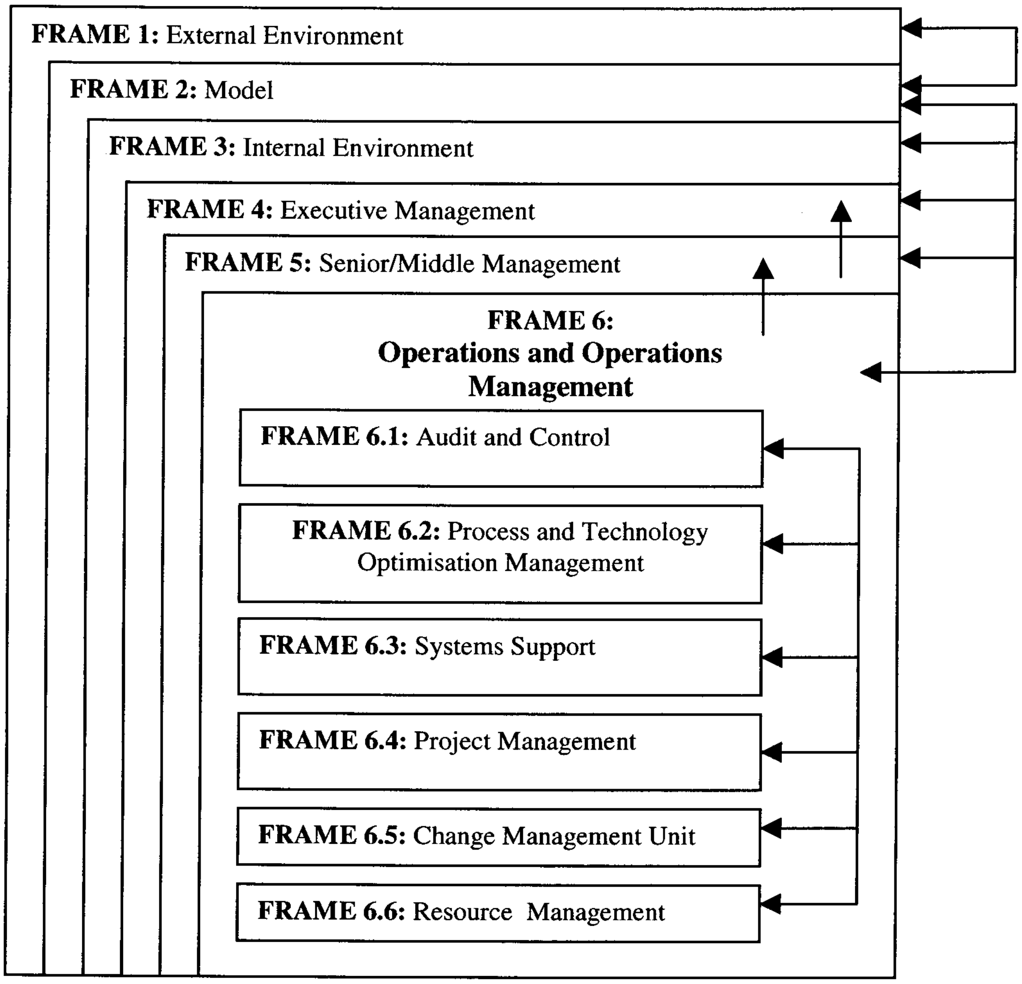

Figure 5.4: Proposed Organisational Structure for an Organisation or Operational Unit within an organisation (Representing Phase 6 shown in Figure 5.5).

- **Senior and Middle Management:-** Shown as Frame 5, senior and middle management has the 'traditional' responsibility of dealing with operational management issues. Within the context of this proposed structure, they have an additional function with respect to group participation in support of executive management in the solving of unstructured complex phenomena, literally operating as a 'think shop'. This approach maps to 'the first way of knowing' described in Paragraph 5.3 of this chapter and furthermore maps to the ideas of Morecroft **[111]**, and Simon **[195]**, the latter who is of the opinion that individuals who are faced with complex choices are unable to make objectively rational decisions because:
  - They cannot generate all the feasible alternative courses of action.

- They cannot collect and process all the information that would permit them to predict the consequences of choosing a given alternative.
- They cannot value anticipated consequences accurately and select among them.

- **Operations and Operations Management:-** Operations and operations management are shown as Frame 6, which consist of six separate interrelated entities namely:
  - **Audit and Control:-** Audit and control, shown as Frame 6.1, represent the 'traditional' audit and control functionality, which have the primary objective of 'watchdog', to ensure quality of outputs, risks are adequately monitored and that processes, procedures and controls are meticulously being adhered to. Furthermore, within the context of this proposed structure, the audit and control component will serve as input mechanism to executive management in the identification of elements attributing to unstructured complex phenomena. "Organisations do not look for problems until someone is dissatisfied", according to Glass (1977) cited by Abel-Hamid and Madnick **[1]**. It is for this very reason, that it is a requirement to structure an organisation in such a way as to identify in advance potential complex phenomena, as opposed being deluded into a false sense of security, which may breed complacency and possibly even enforce dysfunctional behaviour should it be assumed that the organisation is sound. This approach maps to the views of Senge **[153]**, who is of the opinion that, "in an increasingly dynamic, interdependent, and unpredictable world, it is simply no longer possible for anyone to figure it all out at the top". The author **[153]** continues his wisdom with the opinion that, "in the old model, 'the top thinks and the local acts', must now give way to integrated thinking and acting at all levels". This view is also supported by Morecroft **[113]**, when he views a business or social system as a set of decision making 'players' whose decisions and actions are coupled.
  - **Process and Technology Optimisation Management:-** This entity, shown as Frame 6.2, has at its core, sustained process improvement and technology optimisation. Process improvement does not only involve improvement to functional processes, but also the interactive flows within

the organisation or operational unit, which flows from one entity to the other. In addition, sustained process improvement serves as the co-ordinating channel between the various operational entities to ensure that a equilibrium is maintained within the organisation and the organisation and the external environment. Supporting sustained process improvement at each level of the organisation or operational unit, is sustained technology optimisation through computerisation, automation and new technology innovation.

- **Systems Support:**- This entity shown as Frame 6.3, forms the crux of the organisation or operational unit with respect to vital back office functionality. The traditional perception is that this entity is no more than a 'support' function, which is manned by lower level staff taking care of remedial and repetitive support type functions and not really part of the 'bigger picture'. This perception also lays the foundation for operational disaster forming the breeding ground for unstructured complex phenomena. No matter how sophisticated a front office environment is, being equipped with the latest technology and manned by competent staff all with tertiary qualifications, without a suitable and equipped systems support infrastructure, the organisation or operational unit is set for failure. The organisational structure proposed in this thesis, presupposed that systems support should form the 'heart beat' of any organisation or operational unit.
- **Project Management:**- This entity shown as Frame 6.4 suggest that 'all' organisational or organisational unit initiatives require a planned, ordered and structured project management approach, irrespective of the size of the initiative. The approach would include feasibility and viability studies, and business plans, which are supported by well-formulated project and execution plans.
- **Change Management Unit:**- This entity shown as Frame 6.5 is perhaps the most ignored and neglected function within organisations and operational units. Having made this statement, it is ironic that societal problems form the core of unstructured complex phenomena, which invariably manifest as a result of change management being neglected or totally being ignored in the face of change, irrespective of origin. Issues

such as communication, morale, well-being, career path, aspirations, worker satisfaction, union relations, salary negotiations, employee benefits, new processes, technology innovation, and resistance to change are all elements, which could potentially lead to societal problems within the organisation or operational unit thus creating the inevitable unstructured complex phenomenon. The presence of a change management unit and 'change agents' within an organisation or operational unit are considered an absolute requirement within the ambit of the suggested organisational structure. Furthermore, this approach is in line with 'multiple realities' of 'the third way of knowing' described in Paragraph 5.3 of this chapter.

- **Resource Management:-** This entity shown as Frame 6.6, should be clearly distinguished from the 'change agents' described under the change management unit. The 'traditional' roles of resource management responsible for counselling, job interviews, job descriptions, job evaluations, skills analysis, job seat profiling, disciplinary hearings, salary negotiations, promotions, bonus payments, leave administration and training, remains within the definition of resource management under the suggested structure. In addition however, the suggested structure adds productivity management, time and motion studies and job fit to the list.

The importance of structure in the ultimate practice of building and simulating models of social systems can be found within the context of the phrase "behaviour is the consequence of structure" **[133]**. Behaviour here denotes dynamic behaviour, phrased in terms of graphs over time, while structure refers to feedback structure: A circular causal complexity composed of stocks (levels), flows (rates), and information links. Furthermore, the phrase is, at the same time, a good conjecture, an article of faith, and a proposition repeatedly verified in the practice of building and simulating models of social systems **[133]**. The inclusion of organisation structure within the ambit of the process of model conceptualisation confirms the notion that, 'everything interacts with everything, that all branches of inquiring depend fundamentally on one another, and that the widest possible array of disciplines, professions, and branches of knowledge – capturing distinctly different paradigms of thought – must be consciously brought to bear on the solving of complex phenomena'. Furthermore, this 'thinking' is in line with 'unbounded systems thinking' of 'the fifth way of knowing', described in Paragraph 5.3 of this chapter.

5.6 FORMULATION OF THE STRUCTURED SYSTEMS APPROACH TO MODEL CONCEPTUALISATION

Soft systems thinking will be the ruling maxim to the formulation of the *structured systems approach to model conceptualisation*, but not limited thereto as a finely tuned equilibrium will be maintained between soft and hard approaches, and between over control and chaos. From a holistic perspective, elements of the hard systems approach will be deployed to take advantage as far as possible of the empirical analytical methods employed in the natural science. Adapted from Checkland **[29]**, this 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 executive management to find the best means of getting from $\mathbf{S_0}$ to $\mathbf{S_1}$.

5.6.1 THE DYNAMIC PROCESS OF MODEL CONCEPTUALISATION

The process of model conceptualisation is shown graphically in Figure 5.5. Each of the phases of the process are discussed in detail below:

- **Phase 1:-** The strength of the structured *systems approach to model conceptualisation*, lies within the premise that executive management formulate their solutions to unstructured complex phenomena by using inter-disciplinary teams. One of the main reasons for using inter-disciplinary teams, is to ensure that conclusions are reached based on secure scientific methods, and not falling into the trap of unsolved issues drawn out in time, or alternatively to prevent them from rushing into poorly thought-out solutions based on preconceived ideas about an assumed problem. Furthermore, the principles of group participation using inter-disciplinary teams, maps to the 'agreement' of 'the first way of knowing', described in Paragraph 5.3 of this chapter.

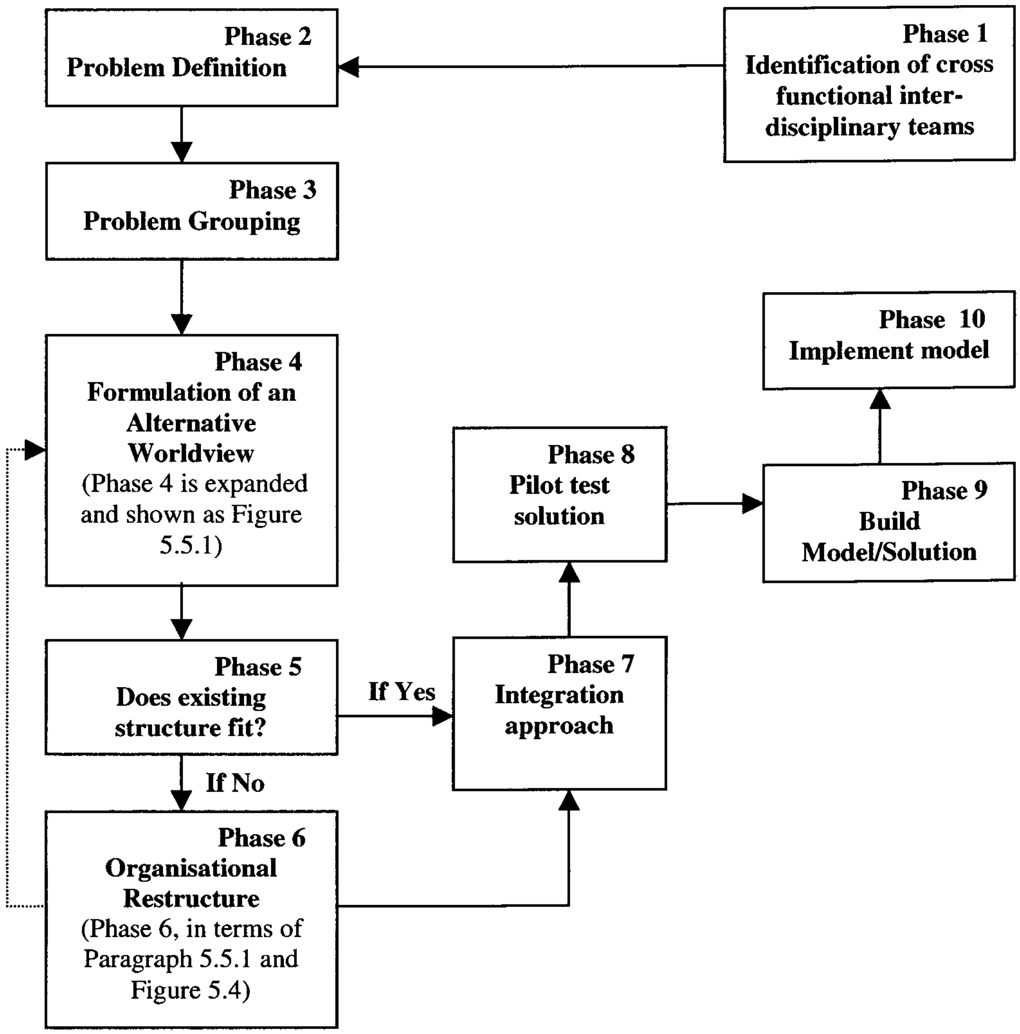

Figure 5.5: Model Conceptualisation Process (Includes Figure 5.4, which is represented by Phase 6, and Figure 5.5.1, which is presented by Phase 4)

- **Phase 2:-** This phase deals with the identification of the problem, commonly termed the 'problem definition'. Within the context of a 'research and development' style analysis, this phase forms the 'analysis' part where one would try to build up the understanding of the problem by 'taking it apart'. This, can typically be achieved by gathering information about structure and process by observation, and the collecting of secondary data through informal interviews. This phase also maps to the first phase of the decision making process from systems dynamics[19] namely, 'to appreciate in a broad sense the situation of concern and to develop a non-precise understanding of the dynamics'. Furthermore, this is also in line with 'conflict' of 'the forth way of knowing', described in Paragraph 5.3 of this chapter.

- **Phase 3:-** In this phase, the opposite of the process followed in the previous phase applies, whereby we would try to understand how the problem elements would fit into the larger system by grouping them together in terms of their tangent planes. This action equates to the assembling of the explanation of the parts into an explanation of the whole. More generalised, each item, in terms of its functions within the 'whole', will be grouped together in terms of their tangent planes. A different approach is to deploy the concept of 'variety reduction'[20], which will enhance the understanding of the difficulties and ways in which the problem elements should be dealt with. This phase also maps to the second stage of the decision making process from systems dynamics[21] which determines that, "this broad understanding needs to be translated into ideas about how to improve problematic aspects, which require deeper investigation into the structure that underlies behaviour". The aim is to draw out the essence of 'what it 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 facilitates or limits the proposed actions and activities'. A natural extension to Phase 3, is the aim to formulate the ultimate *desiderata*, the objective of Phase 4, where an 'alternative worldview' will be formulated. The reader's attention is drawn to the fact that the problem grouping phase shown in Phase 3, has tangent planes to the integration approach phase, shown in Phase 7. The tangent planes are vested in the principle of 'project management', as it is in this phase that the planning pertaining to the integration approach phase is initiated, in particular with reference to 'how to get to the pilot', the invention of new, or selection of ways of getting there. This requires specifying the courses of action, practices, programs and policies to be used. Furthermore, this phase is meant to generate maximum creativity amongst the members of

[19] Refer to Chapter 3, Paragraph 3.6.4.
[20] Refer to Chapter 3, Paragraph 3.5.3.
[21] Refer to Chapter 3, Paragraph 3.6.4.

the interdisciplinary teams in lieu of the creation of an alternative worldview shown in Phase 4.

- **Phase 4:-** This phase deals with the subjectivity of the *structured systems approach to model conceptualisation* and has been formulated from various conceptual ideas of the author from his own field experience, including those of the revered academics Hegel, Kant, Churchman, Checkland and Beer. These conceptual ideas, are primarily based on the following premises:
  - Recursion.
  - Causal loop diagrams and reinforcing and balancing processes.
  - Alternative sets of assumptions.

  These premises are juxtaposed to culminate in an 'alternative worldview' or '*Weltanschauung*', the latter, which has two perspectives, namely:
  - A microscopic view.
  - A telescopic view.

  This phase is best described if its individual parts are analysed, which is shown in Figure 5.5.1. In terms of Figure 5.5.1, the objective of the alternative worldview (shown in Frame 6) is to challenge (subjectively) a prevailing worldview (shown in Frame 4). Alternative sets of assumptions (shown in Frame 3) are considered the anti-thesis component of the process, and in line with 'multiple realities' of 'the third way of knowing', described in Paragraph 5.3 of this chapter. This 'alternative sets of assumptions', hold nothing more than when a problem situation arise and people have contrasting views on the 'same situation'. Increasing purposefulness and sustained improvement, are achieved through causal loop diagrams and reinforcing and balancing processes (shown in Frame 2) and recursion processes (shown in Frame 1), which is applied to not only the prevailing worldview (shown in Frame 4), but also the alternative worldview (shown in Frame 6 and represented by Frame 1.1 and Frame 2.1)). This ultimately results in the continuous development of dialectic worldviews – becoming a never ending process and culminating in the principle of 'continuity'. Should a worldview congeal into a *status quo*, it should have been subjected to forceful alternative perspectives, as upheld in this phase. The alternative worldview will represent the richest picture, 'not of the problem', but 'of the situation', in which there is perceived to be a problem. Synthesis of opposites (shown in Frame 5) requires closer scrutiny. Having challenged the prevailing worldview with the alternative sets of assumptions produced a set of conceptual entities, which would represent a synthesis of opposite ideas. It is of importance to note that in all of the problem solving handled by the author, it is most unlikely that all of the views emerged as being the 'same' idea in symbiotic unison. The concept 'synthesis of opposite ideas', are:

- Exact and concise formulated verbal descriptions of not only unstructured complex phenomena, which require solutions, but also the root causes of such phenomena.
- Pure views of purposeful potential activity, which represents a viable and feasible solution to the phenomena.
- That the views must be 'technologically' viable.

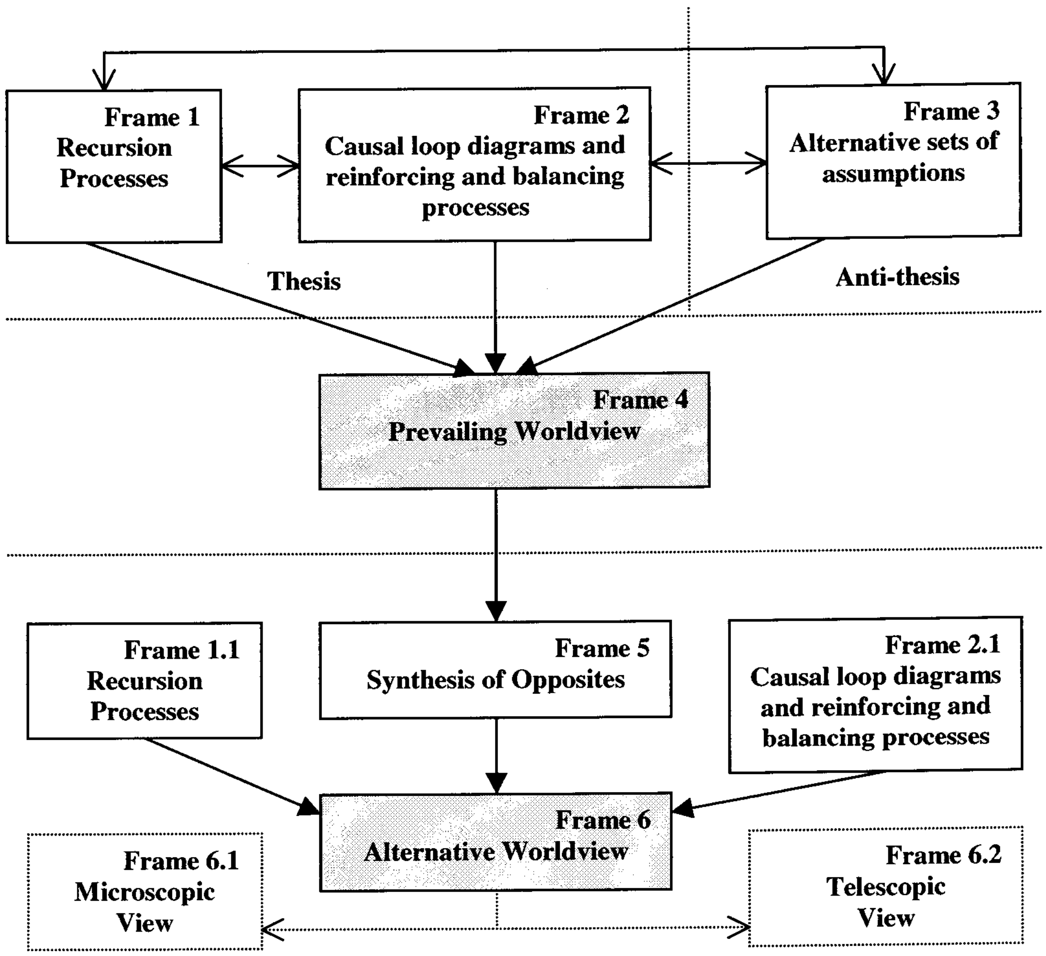

Figure 5.5.1: Alternative Worldview (Represented by Phase 4 in Figure 5.5)

- Before the synthesis of opposites (shown in Frame 5) can be transformed into the alternative worldview, the synthesis of opposites ideas must be subjected further to 'radical' thought, by selecting 'one' solution and furthermore, improving it further to ultimately culminate in a real world solution. This equates to a set of 'management principles', which have to be present if a set of activities is to comprise a system of purposeful activity being the telescopic view shown in Frame 6.2. It would be naïve to assume that only 'one' solution can manifest from the synthesis of opposite ideas. If this occurred in a simulated environment, it could indeed be possible, however, this thesis is about real world situations thus creating its own complexity and also its own simplistic remedial mechanisms. Sets of structured activities, can now be further compared whereby intuitive perceptions of the problem are brought together to provide an epistemologically, deeper and more general account of the realities beneath surface appearances, being the microscopic view shown in Frame 6.1. This gives effect to the basic systems hypothesis that systems concepts provide a means of 'teasing out' the complexity of 'reality'. This 'further comparison' gives effect to the concept of 'interaction of responses over various rounds' being part of 'agreement' of 'the first way of knowing' described in Paragraph 5.3 of this chapter. The concepts 'telescopic' and 'microscopic' views, has at its core the concept of 'interactivism' previously described in Chapter 4, Paragraph 4.5.1, which follow strictly the approach for true interactivists.
- **Phase 5:-**The ultimate *desiderata* formulated in Phase 4 as an 'alternative worldview', must now in this phase be mapped to the existing organisational infrastructure of the organisation. Should it be found that the alternative worldview maps to the existing organisational infrastructure, the next step in the process can be initiated whereby the integration approach phase, shown in Phase 7 can be formulated. Should it be found that the alternative worldview does not map to the existing organisational infrastructure, the organisation is required to restructure in the next phase. It is of the utmost importance to note that the alternative worldview formulated in Phase 4, may <u>include</u> an organisation restructuring.

- **Phase 6:-** In this phase, the restructuring process flowing from the previous phase must take place as described in Chapter 5, Paragraph 5.5.1 and associated Figure 5.4.
- **Phase 7:-** This phase, which can only be initiated 'after' the alternative worldview has been incorporated into either the existing infrastructure (refer to Phase 5) or into the restructured infrastructure (refer to Phase 6). Key elements listed below ideally form part of this phase in the form of 'formal structured project management' operating within the context of 'continuity' as described in Chapter 4, Paragraph 4.5.2.
    - Timeframes to pilot, model building and ultimate implementation.
    - Resource allocation.
    - Budgetary considerations.
    - Materials.
    - Equipment.
    - Physical location.
    - Project planning.
    - Planning decisions.
    - Communication, external and internal.
    - Change management.
    - Executive buy-in.
    - Staff acceptance.
- **Phase 8:-** Phase 8 represents the pilot, the future environment of the system, the latter which, will be represented as a quantitative model that simulates its performance under different operational conditions. The 'pilot' as described is a 'representation' of the 'ultimate model', which will be constructed in Phase 9. For this reason, it is of importance for the reader to orientate himself with the 'role of models' as described in Chapter 2, Paragraph 2.7. The pilot is based on the concept of 'negative feedback', whereby the pilot's output is compared with either a predetermined 'objective' or 'goal'. Should the system not achieve the objective or goal, then the margin of error (the negative feedback), becomes the basis for adjustments of the pilot design to bring it closer to realising the objective or goal. The comparisons referred to in this stage is of vital importance being essential to generate 'further' debate about possible changes that could be made to bring improvements to the problem

situation, which would be the impetus to rerun the pilot. This is also in line with 'conflict' of 'the forth way of knowing', described in Paragraph 5.3 of this chapter.

- **Phase 9 and Phase 10:-** Phase 9 (build model/solution), and phase 10 (implement model), strictly fall outside the ambit of the *structured systems approach to model conceptualisation.* They are however included to complete the process from a holistic perspective.

5.7 CHAPTER FIVE IN SUMMARY

Chapter 5 contains an analysis of the key elements of the *structured systems approach to model conceptualisation.* The importance of this chapter calls for a detailed summary of the model conceptualisation process to aid the reader to fully comprehend the complex, yet logical approach to the concept. This summary contains the following important elements:

5.7.1 HOLISTIC APPROACH

This author approached the proposed model conceptualisation process by providing a simplistic holistic conceptual sequence of events pertaining to 'model conceptualisation' and 'model building', which is shown in Figure 5.2 (refer to Paragraph 5.1). Figure 5.1 furthermore, has the objective to show that a clear distinction can be made between the two elements, and emphasises that what is proposed in this thesis is not a 'model', but an 'approach' to the formulation of a model.

In addition, 'model conceptualisation' is placed in perspective as an entity, which encompasses the variables of identification, analysis and approach to problem solving as opposed to the entities, 'model construction' and 'model implementation'. This author supports this perspective by citing authoritative academics in this field namely:

- Clark and Augustine **[36]**.
- Forrester **[59]**.
- Ackoff **[9]**.

5.7.2 REFOCUS ON INITIAL OBJECTIVES

Key extracts from earlier chapters are repeated *verbatim*, the purpose being to place the formulation process of the *structured systems approach to model conceptualisation* firmly in perspective to the research as a whole, and to refocus on the key issues pertaining to the research problem. This refocus on initial objectives, furthermore re-emphasised the complexity of the task of the executive management when dealing with unstructured complex phenomena, namely that they (executive management), can be compared to passengers on an aircraft, which they not only fly, but are busy redesigning in flight **[162]**.

5.7.3 REASONING AND THINKING: A PERSPECTIVE

This perspective, primarily philosophical in content, is combined with the 'reasoning and thinking' and personal field experience of this author, to culminate in a problem solving approach for the executive of the Twenty First Century.

Some of this author's 'reasoning and thinking', is based on the 'Ways of Knowing' of Mitroff and Lindstone **[108a]**, which primarily deals with the entities, which are appropriately annotated throughout the process of formulating the *structured systems approach to model conceptualisation* and listed below:

- Agreement.
- The world as a formula.
- Multiple realities.
- Conflict.
- Unbounded systems thinking.

5.7.4 ASSUMPTIONS

The assumptions which pertains to the formulation approach to model conceptualisation are graphically depicted in Figure 5.3. Key elements of this formulation approach starts with the author's worldview or *'weltanschauung'*, ultimately culminating in the formulated *structured systems approach to model conceptualisation*. Key elements forming the assumptions are based on:

- Reasoning and thinking.
- This author's practical field experience.
- Accepted world best practice, industry problem solving methodologies.
- This author's own judgement errors in solving unstructured complex phenomena.
- Hard systems thinking methodologies.
- Soft systems thinking methodologies.
- Wisdom. This overriding element is utilised to ensure that the formulated *structured systems approach to model conceptualisation* is not based on the premise of 'doing the right things', but on 'doing things right'.
- The balance between 'over control' and 'chaos' – a 'midway approach', which is demonstrated in Table 5.1 reflecting the balance between 'hard' and 'soft' issues.

5.7.5 THE CONSTRUCTION ELEMENTS OF THE STRUCTURED SYSTEMS APPROACH TO MODEL CONCEPTUALISATION

The model conceptualisation process, which is depicted in Figure 5.5, consists of nine phases namely:

- **Phase 1:-** Problem definition.
- **Phase 2:-** Identification of cross-functional interdisciplinary teams.
- **Phase 3:-** Problem grouping.
- **Phase 4:-** Formulation of an alternative worldview.
- **Phase 5:-** Structural fit decision.
- **Phase 6:-** Organisational restructuring.
- **Phase 7:-** Integration approach.
- **Phase 8:-** Pilot test solution.
- **Phase 9:-** Build model.
- **Phase 10:** Implement solution.

Phase 4, due to its complexity is further analysed and expanded upon, the pertaining process, which is depicted in Figure 5.5.1. Furthermore, Phase 6, due to the significant importance of the concept is further analysed and expanded upon, the pertaining process, which is depicted in Figure 5.4 as a proposed organisational structure for an organisation or organisational unit within an organisation. In both Phase 4 and Phase 6, the elements of recursion, causal loop diagrams and reinforcing and balancing processes are emphasised.

5.8 CONCLUSION

In this chapter, the key elements of the *structured systems approach to model conceptualisation* has been analysed in detail to culminate in a structured approach to be applied by executive management in their quest to solve unstructured complex phenomena.

This process can be viewed as a culmination of the previous chapters, in particular Chapter 2, where selected complexities of the systems approach were discussed. Chapter 3 and Chapter 4 contained the elements, which formed the crux of reasoning, namely hard and soft problem solving methodologies.

The process used to formulate the *structured systems approach to model conceptualisation* was highlighted through a series of graphical depictions of the process contained in:

- **Figure 5.3:** - The formulation approach.
- **Figure 5.4:** - Proposed organisational structure.
- **Figure 5.5:** - Model conceptualisation process.
- **Figure 5.5.1:** - Alternative worldview.

In Chapter 6, the formulated *structured systems approach to model conceptualisation* will be put to test as an alternative management mechanism by means of a case study. Furthermore, the case study will serve as validation for the *structured systems approach to model conceptualisation.*

Chapter 6

THE STRUCTURED SYSTEMS APPROACH TO MODEL CONCEPTUALISATION AS AN ALTERNATIVE MANAGEMENT MECHANISM

"The empires of the future are the empires of the mind"

Winston S. Churchill

6.1 INTRODUCTION

The analytical process followed thus far, is graphically depicted in Figure 6.1, which places the chapters in context with the overall thesis objectives, and furthermore indicates the relative positioning of this chapter.

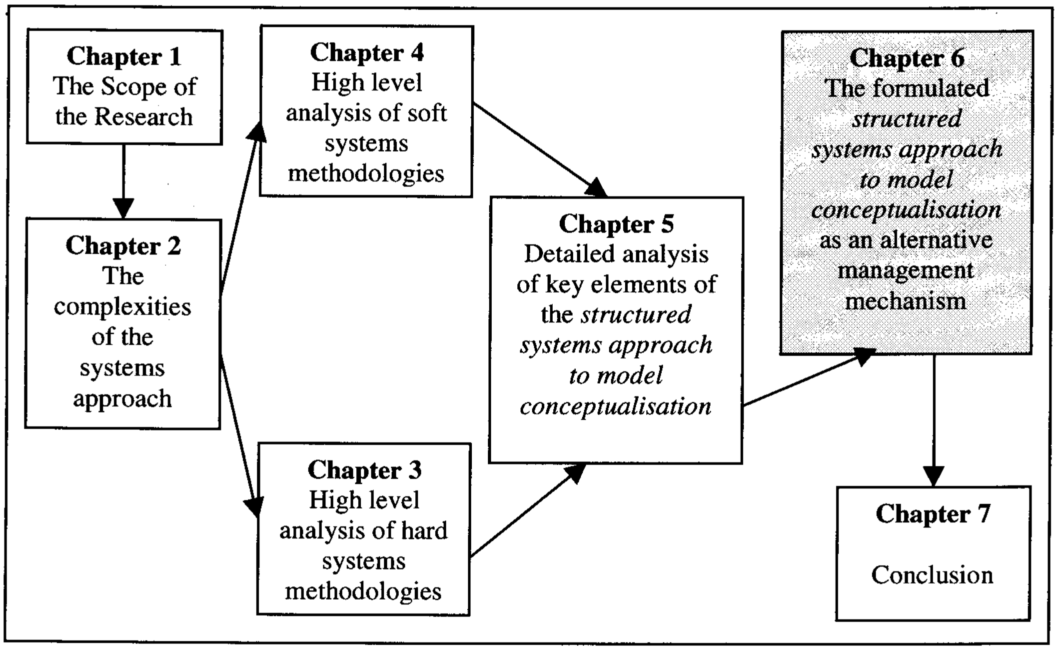

Figure 6.1: Chapters in context of the overall research

An analysis of Figure 6.1[1], shows Chapter 1 as the overall research approach to the thesis. Chapter 2, contains a number of key elements (complexities), which are explained in lieu of the high level analysis of hard systems (contained in Chapter 3), and the high level analysis of soft systems, (contained in Chapter 4). Key elements from the high level analysis of hard systems and soft systems

[1] Arrows in Figure 6.1 represents 'information flows' (inputs) from one chapter to the other.

methodologies, served as preliminary input mechanisms to Chapter 5, where the elements were analysed in detail to ultimately culminate in a formulated structured *systems approach to model conceptualisation*. This chapter depicts the structured *systems approach to model conceptualisation* as an alternative management mechanism in practice, while Chapter 7 contains a summary of the thesis content.

6.2 THE STRUCTURED SYSTEMS APPROACH TO MODEL CONCEPTUALISATION IN PRACTICE: A CASE STUDY

While the author was not availed of the opportunity to formally validate[2] the formulated *structured systems approach to model conceptualisation*, the impact of the concept will be demonstrated by means of an implementation in a real world situation, using a case study. Several such implementations have successfully been executed, however the case study depicted here was especially selected to take advantage of the spectrum of diverse unstructured complex phenomena it offered. The implementation spectrum included unstructured complex phenomena ranging from process reengineering, technology implementation and societal issues. In addition, the case study called for organisational restructuring, bringing into play the author's approach to 'structure' including the 'midway approach' between over control and chaos within the context of the *structured systems approach to model conceptualisation*.

The case study will furthermore serve as a test bed for the *structured systems approach to model conceptualisation* as an alternative management mechanism to address unstructured complex phenomena. The case study depicted below, is a true rendition of a real world situation, and will be subject to the following *caveats:*

- No confidentiality will be breached or compromised in terms of the organisation involved, its staff, processes, technical or functional data pertaining to the case study or the associated business case.

[2] See Appendix B, Paragraph B1.

- All of the issues of a sensitive nature observed in the limited survey depicted in Appendix B, would apply to the case study.

6.2.1 CURRENT REALITY: THE IMPETUS TO THE BUSINESS CASE

The 'current reality', which created a spectrum of unstructured complex phenomena and impetus to the business case can be explained in terms of the global infrastructure pertaining to the credit operations of a large commercial bank and shown in Figure 6.2.

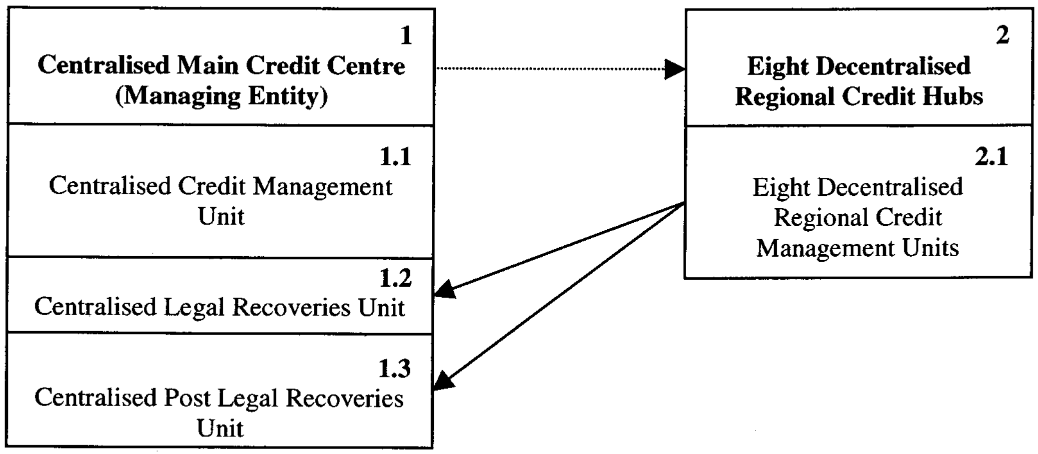

Figure 6.2: Global Credit Infrastructure: Current Reality

The centralised main credit centre, shown as Frame 1 in Figure 6.2, served as overriding 'managing entity' for the eight decentralised regional credit hubs shown as Frame 2, with the following functionality pertaining thereto:

- Overall credit policy.
- Vision and mission of credit countrywide.
- Full credit client credit management capabilities including providing legal recoveries and post legal recoveries as a centralised service to the eight decentralised regional credit hubs.

The eight decentralised regional credit hubs operated as autonomous entities from the centralised main credit centre in terms of their:

- Processes.
- Procedures.

- Organisational structures.
- Salary structures.
- Management structures.
- Client approaches.
- Credit targets.
- Standards.
- Technical infrastructures.
- Credit granting norms.

Unstructured complex phenomena manifested from this 'current reality' shown in Figure 6.2, are listed below in bullet format for ease of reference:

- Processes not uniform across the global infrastructure culminating in:
  - Clients not being handled in a similar manner by the different units, causing client dissatisfaction with service provided.
  - Process audit trails becoming 'fuzzy' making the audit of processes virtually impossible.
  - Skills diversification, a requirement within the centralised main credit centre to handle the diverse process implications emanating from the eight decentralised regional credit hubs with respect to legal recoveries. Furthermore, this aspect culminated in the requirement for costly differentiated training courses to meet the skill demands of the eight decentralised regional credit hubs.
  - Controls, which are compromised in the eight decentralised regional credit hubs, reflect negatively on the books of the centralised main credit centre, and furthermore, ultimately result in money lost to the company.
- Procedures not standardised across the global infrastructure culminating in:
  - Cross-functional skill levels being compromised, and as in the case above, the requirement for costly differentiated training courses.
  - Frequent 'misunderstandings' with clients and between the centralised main credit centre and the eight decentralised regional credit hubs.
- Differentiation in organisational structure between the eight decentralised regional credit hubs, and between the latter and the centralised main credit centre resulting in:
  - Differentiated job descriptions and job content.

- Differentiated remuneration structures being applied for the same job level and job content resulting in dissatisfied employees.
- Differentiated career paths been mapped for staff of equal status and potential.
- Inflexible inter-unit transfer program due to level of diversification, thus limiting employee growth.
- The centralised main credit centre becoming the 'elite' group as a result of the centralised main credit centre acting as the 'managing entity' of the global infrastructure.

- Differentiation between the eight decentralised regional credit hubs, and between the latter and the centralised main credit centre, resulted in a differentiation in the handling of the different client profiles (based on income), resulting in:
  - Client dissatisfaction of not being treated equal.
  - Staff confusion of not knowing how to handle the different client profiles.
- Differentiation in management structures between the eight decentralised regional credit hubs, and between the latter and the centralised main credit centre resulting in:
  - Operating executives having different career aspirations as a result of profile differentiation between the units.
  - Middle and lower management having different career aspirations as a result of profile differentiation between the units.
- Uniform credit targets across board creating dissatisfaction with management and staff alike. Should growth targets be set at say eight percent, the same target applies to each of the units irrespective of their individual size, growth potential, demographic placement or client distribution. The same maxim is applied to budget allocations/cuts and staff numbers resulting in certain units becoming 'unmanageable'.
- Losses (write-offs) within credit, are attributable to the fact that client credit management is done 'too late' or 'not at all' during the lifecycle of a defaulting client. This aspect, which escalated to not only unacceptable proportions in terms of company profitability, but also rated far above the lower quartile, set by international 'best practice' standards resulting in:
  - Losses of multiples of millions to the company.

- Company profitability being affected adversely.
- Shareholder income impacted.
- The technical infrastructures at the eight decentralised regional credit hubs, and at the centralised main credit centre can be described having no incumbent formal technology solutions in place for credit management. This situation was further exacerbated and impacted by:
  - Low computer literacy levels of staff.
  - Diverse, 'developed in need' personal computer applications to facilitate processes and workflow.
  - No computer generated management information.
  - No networked, integrated technical infrastructures.
- Credit granting rules, while in existence and clear in terms of the approach for different client segments, not implemented uniformly resulting in confusion of both staff and clients
- *Esprit de corps*, a unknown concept within the ambit of the eight decentralised regional credit hubs and the centralised main credit centre resulting in unhappy staff, no job satisfaction and uncertainty about future careers.
- Under utilisation of staff.

All of the above entities represents the 'current reality' and served as impetus to a business case for global remedial action.

6.2.2 KEY ELEMENTS OF THE BUSINESS CASE

An external company specialising in the analysis and formulation of professional business case compilation for the credit industry, was charged with the task to investigate the 'current reality' pertaining to the eight decentralised regional credit hubs and the centralised main credit centre. The brief had to include high level remedial recommendations to the board of directors contained within the ambit of an official business case.

Key elements of the business case recommendations (at a high level), are listed below, which is to apply universally across board, and can be explained in terms of the global infrastructure pertaining to the future credit operations and shown in Figure 6.3

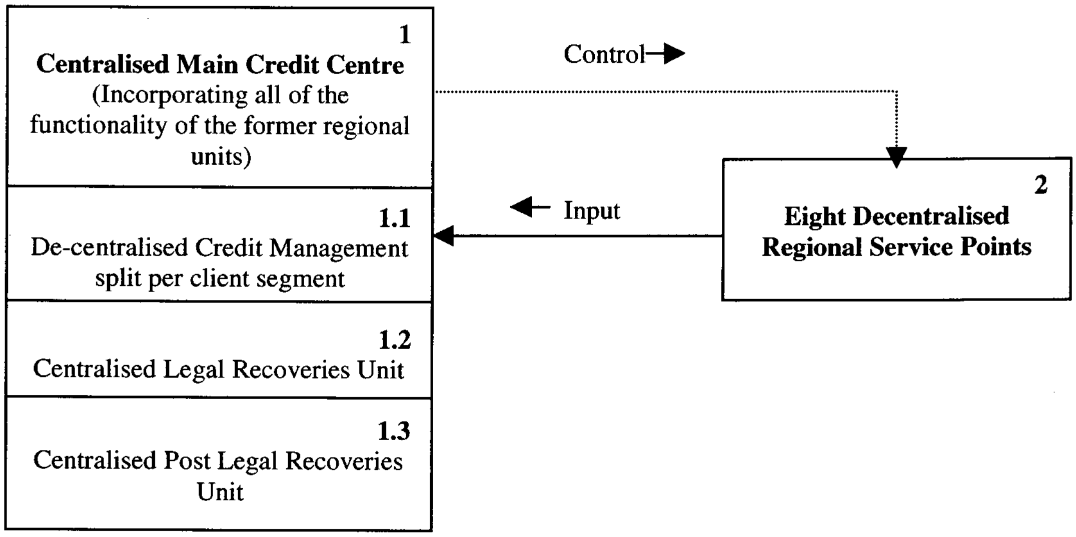

Figure 6.3: Global Credit Infrastructure: Future Credit Operations

- **Technology:-** The proposed technology solution forms the key component of the whole business case as all of the recommendations listed below have direct tangent planes thereto. In fact, the technology proposal, which was based on international best practice standards, was so dramatic in that it affected all of the known process and societal issues pertaining to the organisation.
- **Centralisation:-** Based on the proposed technology solution, the eight decentralised regional credit hubs are to be collapsed into the centralised main credit centre, the latter incorporating all of the credit management functionality of the former. Furthermore, the only element, which is to remain of the collapsed eight decentralised regional credit hubs, will be their service point capability to clients. The centralised legal recoveries unit and centralised post legal recoveries unit, will retain their status quo within the centralised main credit centre The centralised main credit centre will retain the control over the eight decentralised regional service points.
- **Decentralisation:-** Functionality of the eight decentralised regional credit management units, will be decentralised within the centralised main credit centre, not in terms of demographic placement, but in terms of client segment and technology demands.

- **Processes:-** All processes and controls are to be automated in terms of the technology recommendation, and thereafter reengineered in terms of world best practice standards.
- **Procedures:-** Procedures are to be standardised across board in terms of the technology recommendation, and thereafter centralised utilising the most up to date technological innovations.
- **Organisational structure:**- The high-level recommendations suggested an organisational restructure based on control and sustained improvement of processes, procedures and technological automation. Furthermore, staff savings would be based on the 'to be' environment proficiency measurements of time and motion studies.
- **Client profiles:**- The proposed technology would in future base client profiles on client segment, which in turn is determined by client behaviour (how a client conducts his account over time).
- **Staff structure:**- The client credit management split per client segment are to be used to formulate not only standardised managerial and staff structures, but also job descriptions, individual job content, salary structures and career paths. A productivity increase of twenty five percent, and a staff reduction of forty percent was prescribed.
- **Credit targets:-** The targets set will only pertain in future to the centralised main credit centre as an entity.
- **Losses:**- Will in future become a focus point of the organisational structure where control will be exercised.
- ***Esprit de corps:-*** The recommendation was that this element be formulated to become part of the organisational structure.

The business case, based on the above high level recommendations, reflected a payback of capital in excess of one hundred and fifty million rand over a five year period and returned a positive internal rate of return and net present value. Primarily, savings would culminate from technology, staff reductions, improved processes and procedures, improved productivity and improved service to client and reduced write-offs. The organisation's board of directors approved the business case, and the results were communicated to staff.

6.2.3 A NEW WAVE OF UNSTRUCTURED COMPLEX PHENOMENA.

Executive management was suddenly confronted with a new wave of unstructured complex phenomena when the board decision and results from the business case and organisation goal directives were communicated to staff. These new issues which were primarily organisational and societal based, and listed below in bullet format for ease of reference, appeared to be even more formidable[3] than the previously identified unstructured complex phenomena pertaining to the 'current reality'[4]

- The potential of retrenchments for all managerial levels and staff alike became an issue of very real concern and importance as the business case clearly alluded to this fact, calling for a forty percent reduction of staff. This aspect was even more daunting in the regional areas as the ability to procure new jobs in these areas was nearly impossible.
- The potential of being uprooted from a regional setting to a metropolitan environment should people be drawn from the regional hubs to the centralised main credit centre was extremely unsettling.
- The idea to transform from manual to automated processes was a potential threat, in particular to semi-skilled staff, who would not fit into the realm of a computerised world.
- The concept 'technology' a threat. This pertained not only to the computer literate, but also the computer illiterate, due to the notion that 'technology reduces headcount'.
- Staff opposed the business case recommendations and a formal complaint was lodged with the labour unions. This was based on the fact that they were not consulted on the possible impact of the recommendations prior to it being made public as they were under potential threat of facing significant job losses.
- Individual career paths were under threat, in particular as a result of the centralisation.

[3] Giving effect the 'wisdom' of Albert Einstein, who was of the opinion that: *"The world that we have made as a result of the level of thinking we have done thus far creates problems that we cannot solve at the same level as they were created"*.
[4] As listed in Paragraph 6.2.2.

- Personal aspirations, 'me issues', of staff being curtailed by the proposal.
- Normal human 'resistance to change', whereby staff refused to co-operate in their retraining, facing new process and systems challenges as a result of the technology impact.
- Limited communication of the real impact of the proposals created confusion for both staff and clients on the impact of the changes.
- Clients lodging complaints against proposed restructuring based on empathy for staff and limited information.
- Impact of the proposal exasperated by 'out of proportion' grape vine information and the natural fear of the unknown.
- Provided with only the high level recommendations to 'steer' by, executive management was confronted with not only the formidable task to implement the technology and associated solutions in terms of the business case recommendations, but also to find a solution for the existing and new unstructured complex phenomena. The initial issues they were confronted with were, 'what it 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 facilitates or limits the proposed actions and activities'.
- Managers (and in some instances senior staff), jostling for power, authority, control and position, using all the sources of power[5] available to them to achieve their individual goals prior to the proposed changes taking effect. Ironically, this gives effect to the words of Davidson **(undated reference)** cited by Skyrme **[157]**, who is of the opinion that, "management policy decisions may actually contribute to creating the dynamic problems they are intended to solve".

This situation left executive management little choice, but to opt for a structured approach to problem solving and it is at this particular point, that the *structured systems approach to model conceptualisation* was initiated to address the business case recommendations and unstructured complex phenomena in a structured way.

[5] Refer to Chapter 1, Paragraph 1.1.2, and Appendix A.

6.3 THE SYSTEMS APPROACH TO MODEL CONCEPTUALISATION APPLIED

To provide the reader with an incumbent analysis of the impact of the formulated *structured systems approach to model conceptualisation* as it was applied to the business case as described, would be inappropriate from a thesis perspective due to the voluminous nature of the ensuing data. Various approaches can be deployed to demonstrate the application of the formulated *systems approach to model conceptualisation* to the case study, which will also serve to validate the concept. As this thesis deals with unstructured complex phenomena, a logical approach would be to map the remedial actions in terms of approach to the unstructured complex phenomena as identified in the case study. Furthermore, this will not only demonstrate the approach to model conceptualisation as an alternative management mechanism, but also clearly prove its applicability in the solving of unstructured complex phenomena.

The following bullet points demonstrate how the structured *systems approach to model conceptualisation* was applied to complex phenomena identified in the case study[6]:

- In terms of Phase 1, nine interdisciplinary teams were identified to address the unstructured complex phenomena resulting from:
  - Technology.
  - Process.
  - Procedures.
  - Structure.
  - Change management (people issues).
  - Client dissatisfaction.
  - Controls.
  - Staff dissatisfaction.
  - Training.
- In terms of Phase 2, an intensive analysis was embarked upon, which confirmed the unstructured complex phenomena from the 'current reality' as

[6] Using the same phases as described in Chapter 5, Paragraph 5.6, and shown in Figure 5.5.

described in Paragraph 6.2.1. Furthermore, 'the new wave' of unstructured complex phenomena described in Paragraph 6.2.3, was mapped into the former to provide a holistic perspective of 'all' of the issues, which needed to be solved.

- Phase 3 resulted in an interesting development. The plethora of unstructured complex phenomena was grouped into the following logic categories using the tangent planes between the entities as guide:
  - Technology.
  - Process.
  - Structure.

  Correspondingly, this also results in the interdisciplinary teams being reduced to three to address the various categories. The attention of the reader is drawn to the fact that some of the interdisciplinary teams (i.e. change management) operated from within the newly formulated organisation structure discussed below.
- The formulation of the alternative worldview in Phase 4 resulted in a formidable, yet interesting exercise. Both of the concepts 'centralisation' and 'de-centralisation' were deployed to attain diverse yet optimised and effective results namely:
  - To provide enhanced personal and value driven service to clients, the eight de-centralised regional credit hubs are reconfigured to create client focus orientated service hubs in the various regions.
  - To contain cost, operations are centralised, which had a cascading effect with the following being impacted:
    - Staff numbers.
    - Training.
    - Process standardisation.
    - Procedure standardisation.
    - Levels of expertise.
    - Skills standardisation.
  - Processes were mapped to optimise the technology deployment impacting:
    - Audit trails.
    - Client service.
    - Resource utilisation

- Process and procedures
- Cost ratios.

- Organisational structure (now centralised), was reconfigured with respect to:
  - The operations unit dealing with:
    - Audit.
    - Controls.
    - Process.
    - Technology deployment.
    - Systems support.
    - Structured project management.
    - People issues impacted by the change.
    - Resource management.
- A competent senior management structure was formulated, where the overriding maxim of 'expertise' determined the ultimate positions in the hierarchy to ensure a stable internal environment and appropriate support to executive management. The executive management contingent was restructured with clear focus, in particular in dealing with the identified unstructured complex phenomena, utilising the structured *systems approach to model conceptualisation* as management mechanism.
- The technology solution formed the crux of the alternative worldview, as all of the technology and networked infrastructures could be addressed with the introduction of this mechanism. Furthermore, in addition, some of the unstructured complex phenomena which included some of the social phenomena was impacted by the technology solution, the ensuing list serves as examples:
  - Computer literacy.
  - Skills requirements.
  - Training.
  - Audit trails.
  - Client service
  - Process automation.
  - Job structure.
  - Remuneration.
  - Career paths.

- Client profiles.
- Control of financial losses.
- Management information.
- Increased productivity.

- The change management unit (now part of the organisational structure) was deployed to address specifically the following:
  - Retrenchment.
  - Relocation.
  - Technology intervention.
  - Resistance to change.
  - Career paths.
  - Personal aspirations.
  - Staff communication.
  - Client communication.
  - 'Power' struggles.
  - Trade union communication.

  The underpinning element was based on a structured and open communication strategy. The internal component of the communication strategy was addressed by specially appointed 'change agents', which were selected from the ranks of those staff feeling most threatened about the whole forced change intervention. Leading the initiatives and taking a leading role in this *structured systems approach to model conceptualisation*, the executives who provided the required impetus with respect to communication both external and internal, buy-in, acceptance, and drive. Furthermore, the executives specifically established a much needed and dynamic *esprit de corps* within the ranks of the organisation.

- It is of importance for the reader to note the fact that the alternative worldview formulated in the case study, included the element of organisational structure and was considered part of Phase 4. As a result of this, most of the unstructured complex phenomena were directed from the established interdisciplinary teams to the entities, which formed part of the organisational structure.

- Phase 7 included a structured and phased implementation approach, whereby a detailed plan was suitably formulated and tested within the ambit of the pilot test solution in Phase 8.
- The pilot test was compiled of a multiplicity of solutions formulated from within the context of the alternative worldview, of which the following serves as examples:
  - A marketing plan.
  - A resource management plan.
  - An organisational structure hierarchy.
  - Process mapping
  - Time and motion studies to measure the ensuing result.
  - Organisational change management forums.
  - Change management agents.
- The implemented 'midway approach' to regulate between over control and chaos, proved to create the required equilibrium within the organisation for successful people and organisation management.

6.3.1 THE FINAL OUTCOME

The *structured systems approach to model conceptualisation* returned the following documented outcomes in respect to its application to the case study over a nine-month period:

- An organisational infrastructure which not only remedied from within the identified inherent unstructured complex phenomena it was subjected to, but also sustained ongoing improvement after the final implementation of the ultimate model.
- A viable alternative worldview enhanced by technology to the extent that all of its unstructured complex phenomena, including the social aspects pertaining thereto, could be satisfactorily addressed and as thus sustained in the future.
- The *structured systems approach to model conceptualisation*, was accepted as a viable an alternative management mechanism to address unstructured complex phenomena.

6.4 RESULTS MAPPED TO THE FINDINGS IN APPENDIX B

Should the overall results from the application of the *structured systems approach to model conceptualisation* as applied to the case study be mapped to the expectations of the wider industry to model conceptualisation as depicted in Appendix B, a number of interesting analogies can be drawn therefrom namely:

- Technology implementation has a broader application than just 'automation'.
- Planning can be incumbent to extent long range and strategic perspectives as a result of the structured approach being deployed to model conceptualisation.
- 'Me issues', can effectively be addressed, not directly from the *structured systems approach to model conceptualisation*, but from its internal mechanistic functioning as a result of organisational restructuring and the mechanisms created therein. These issues include:
  - Resource management.
  - People problems.
  - Human resource planning.
- The *structured systems approach to model conceptualisation* results in technology and process forming a symbiotic relationship whereby both entities culminate in a formidable mechanism to the solving of unstructured complex phenomena commonly associated thereto.
- The *structured systems approach to model conceptualisation* facilitates communication. This communication extents beyond the normal demands of an organisation and 'forces' executives to involve themselves with not only external, but also critical internal communication.
- The *structured systems approach to model conceptualisation* establishes itself unequivocally as an alternative management mechanism to the solving of unstructured complex phenomena.

More specific to the research as a whole, the following tangent planes are present in the results from the case study and the industry requirements as depicted in Appendix B:

- The uniqueness of the *structured systems approach to model conceptualisation* was reinforced as an alternative management mechanism to current executive management approaches.

- It was unequivocally established that the *structured systems approach to model conceptualisation* had the potential to deal with the most challenging aspects pertaining to executive management namely:
  - Facilitating the identification of issues causing unstructured complex phenomena.
  - Structuring plans to deal with such unstructured complex phenomena.
- The *structured systems approach to model conceptualisation* manifested as the most suitable structured management mechanism, specifically aimed at the engineer in the emergent role of executive management dealing with unstructured complex phenomena.

6.5 CONCLUSION

This chapter availed the author of the opportunity to formally validate the formulated *structured systems approach to model conceptualisatio*n, the impact of the concept being demonstrated by means of an implementation in a real world situation, using a case study. The case study depicted here was especially selected to take advantage of the diverse spectrum of unstructured complex phenomena, which required solving. The unstructured complex phenomena ranged from process reengineering, technology implementation to societal issues. In addition, the case study called for organisational restructuring, bringing into play the author's approach to 'structure' including the 'midway approach' between over control and chaos within the context of the *structured systems approach to model conceptualisation.*

The case study furthermore served as a test bed for the *structured systems approach to model conceptualisation* as an alternative management mechanism to address unstructured complex phenomena, and in the process unequivocally established the fact when mapped backed to real world industry requirements. From this the conclusion can be drawn that the systems dynamics of the formulated *structured systems approach to model conceptualisation* specifically applied to the art of executive management, can be used to structure the outcomes of paradigm shifts introduced into organisations as a result of unstructured complex phenomena.

Chapter 7

CONCLUSION

> *"And thus we do not comprehend the practical unconditional necessity of the mortal imperative, we yet comprehend its incomprehensibility, and this is all that can fairly be demanded of a philosophy which strives to carry its principles up to the very limit of human reason".*
>
> **Immanuel Kant[1]**

7.1 INTRODUCTION

It was only when coming to write this concluding chapter that the author came to realise that the single factor, which unites all of the elements of the problem solving methodologies contained within the developed *structured systems approach to model conceptualisation*, is the fact that all were vehicles of the same thing namely:

> *"The development of principles concerning the use of system ideas in problem solving of real world situations". "All the studies had in common – the 'systems approach' to unstructured complex phenomena".*

These facts, culminate in the analogy that the outcome of this research is not as much *'an approach'*, as it is a *'set of principles to an approach'*, which in any particular situation have to be reduced to a method uniquely suitable to the particular situation, hence the applicability of the *structured systems approach to model conceptualisation* over a spectrum of disciplines.

7.2 CHAPTER AND CONTENT ANALYSIS

The chapter and content analysis, which is in line with the research design and methodology described in Chapter 1, Paragraph 1.5) provided the following details:

[1] From: "Foundations of the Metaphysics of Mortals".

- **Abstract:-** Provided the reader with a short synopsis of the extent of the research pertaining to the *structured systems approach to model conceptualisation* from an executive management perspective and associated complex phenomena in 'real world' situations.
- **Chapter 1 – The scope of the research:-** Set the scene for the research contained within the ambit of the thesis, starting with a brief introduction and background to the concept systems approach, the history thereof, which were expanded upon in Appendix C. This was followed by an insight into 'real world' phenomena and the mechanisms available to deal with such phenomena, primarily contained in the 'Sources of Power'. The latter concept, which was expanded upon in Appendix A. The remainder of the chapter focused on the Research Problem, the Research Question, the Research Process, the Research Design and Methodology and concluded with an item dealing with the Demand for a Qualitative Research Strategy.
- **Chapter 2 – The complexity of the systems approach:-** This chapter contained the key issues, which contribute to the complexities of the systems approach. Furthermore, these issues, which were considered to be pre-requisites to the understanding of the reader to ensure that the interrelationships which these entities have with the systems approach, were understood and viewed in context of the overall research. The concepts which were discussed in this chapter were:
  - The concept 'system'.
  - General Systems Theory.
  - The concept 'systems approach'.
  - The concept 'cybernetics'.
  - Closed and open systems.
  - The role of models.
  - The notions *'Weltanschauung'* and 'appreciative systems'.
  - 'Causal loop diagrams' and 'reinforcing and balancing processes'.
  - Science and Technology impact.
- **Chapter 3 – A high level analysis of the hard systems approach:-** In this chapter, the major 'hard' systems methodologies, selected especially for their particular applicability to the research in this thesis were contextually analysed

at a high level in terms of literature reviews. The analysis covered the following hard systems methodologies:

- Systems engineering.
- Systems analysis.
- Operational research.
- Management cybernetics.
- Systems Dynamics.

Included in this chapter and in lieu of Chapter 4, which dealt with the soft systems approach, hard and soft systems methodologies were compared to add to the conceptual understanding of the reader of the two concepts. Furthermore, to provide a balanced analysis, the hard systems approach was analysed to highlight its major criticisms, positive aspects and features.

- **Chapter 4 – A high level analysis of the soft systems approach:-** In this chapter, the major soft systems methodologies, selected especially for their particular applicability to the research in this thesis were contextually analysed at a high level in terms of literature reviews. The analysis covered the following 'soft' systems methodologies:
  - 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.

  As in the case of Chapter 3 to provide a balanced analysis, the soft systems approach were analysed to highlight its major criticisms, positive aspects and features.
- **Chapter 5 – In depth analysis of the construction elements for the structured systems approach to model conceptualisation:-** Chapter 5, in the opinion of the author, was the key chapter in this thesis, as the chapter contents were focused on a detailed analysis of all of the construction elements, which culminated in the formulated *structured systems approach to model conceptualisation*. This chapter also provided impetus to the author's objective with this thesis whereby, a 'set of principles to an approach', based on the philosophies formulated by revered academics during the Twentieth

Century, which includes the author's own contribution, can add value to the existing body of knowledge, in particular in the application of a *structured systems approach to model conceptualisation* by executive management of the Twenty First Century, when dealing with unstructured complex phenomena in a formalised and structured way.

- **Chapter 6 – Model conceptualisation as an alternative management mechanism:-** In this chapter the full potential of the *structured systems approach to model conceptualisation* were demonstrated using a case study. The benefits were compared to the requirements set in an analysis pertaining to an industry perception of the structured systems approach to model conceptualisation, which were contained in Appendix B.
- **Chapter 7 – Conclusion:-** In this concluding chapter, the research is summarised and evaluated in terms of 'real world' phenomena and the mechanisms available to deal with such phenomena, with particular reference to the formulated *structured systems approach to model conceptualisation.* Furthermore, the Research Problem and associated Research Questions are compared with the deliverables of the *structured systems approach to model conceptualisation* as an alternative management mechanism.

7.3 THE RESEARCH QUESTION

The research question, which was posed in this thesis, reads as follows:

- Can the systems approach, which is currently embedded in academic literature in various authoritative publications in various forms and permutations, be applied to 'model conceptualisation' to solve unstructured complex phenomena from an executive management perspective?

7.4 INVESTIGATIVE QUESTIONS

The investigative questions, which were posed in this thesis read as follows:

- Can the most pertinent elements and dominant traits of the systems approach as described by revered academics be extracted therefrom to culminate in a new formulated *structured systems approach to model conceptualisation*, from an executive management perspective?

- Can management philosophies formulated during the Twentieth Century, in any way apply to the technology driven, dynamic and constantly changing management environments of the Twenty First Century?
- Can the systems dynamics of the formulated *structured systems approach to model conceptualisation* specifically applied to the art of executive management, be used to structure the outcomes of paradigm shifts introduced into organisations as a result of unstructured complex phenomena?

7.5 THE SIGNIFICANCE OF THE STRUCTURED SYSTEMS APPROACH TO MODEL CONCEPTUALISATION

In this thesis, this author provided a balanced view of the entire problem solving methodologies afforded by the hard and soft systems approaches. All of the methodologies contained 'some' elements, which could be applied to unstructured complex phenomena with proven track records as proof of the success. It is ironic that not one of these methodologies researched afforded the operating organisation executive *per se* with a structured systems approach and all-incumbent solution to the solving of unstructured phenomena.

The significance of the *structured systems approach to model conceptualisation* as upheld in this thesis is contained within the ambit of the following three elements:

- The *structured systems approach to model conceptualisation* is directed to the solving of unstructured complex phenomena from an executive management perspective'.
- The *structured systems approach to model conceptualisation* can be applied as an alternative management mechanism for the operating executive
- The *structured systems approach to model conceptualisation* can be applied and fulfil the requirements as set in the research and associated investigative questions in this thesis.

This thesis is then about a formulated *structured systems approach to model conceptualisation*, the use of a particular derived set of systems norms to facilitate the art of executive management. Furthermore, the *structured systems approach to model conceptualisation*, made conscious use of a particular concept of wholeness captured in the word 'system' to order a set of executive management norms.

7.6 AVENUES FOR FURTHER RESEARCH

From a perspective of solving unstructured complex phenomena, within an organisation marred with societal issues, which may emanate from a diverse range of sources, some of which may be as a result of forced interventions, open a plethora of avenues for future research, which are listed below:

- Psychological impact of unstructured complex phenomena on the employee.
- Psychological impact of unstructured complex phenomena on the organisation.
- Impact of unstructured complex phenomena on organisational profitability.
- Impact of unstructured complex phenomena on morale.
- The 'hard' systems approach applied to societal issues.
- The 'soft' systems approach applied to societal issues.
- The 'hard' systems approach as a management mechanism.
- The 'soft' systems approach as a management mechanism.

7.7 KEY OBJECTIVES

The key objectives of the author with this thesis and by implication forming the basis of any research undertaken at doctoral level according to Easterby-Smith, Thorpe and Lowe **[47]** and Kennedy **[85]**, were:

- That the results of the proposed research make a significant contribution (add value) to the existing body of knowledge.
- That the results should be of such a nature that it can be applied immediately and effectively in any corporate or commercial business environment to enhance the art of executive management.

In view of this author, the *structured systems approach to model conceptualisation* as formulated in this thesis, amicably fulfils the above requirements as shown in Chapter 5 and Chapter 6.

7.8 FINAL CONCLUSION

In final conclusion then, this thesis, has been undertaken with the true belief that my years of 'thinking' and 'practising' a unique structured approach to management, can facilitate the task of every managing executive to the extent of solving unstructured complex phenomena. Furthermore, it is my conviction that this 'set of principles to an approach', which is based on the philosophies formulated by revered academics during the Twentieth Century, which includes the author's own contribution, can add value to the existing body of knowledge and the art of executive management. This with particular reference to the systems dynamics of the formulated *structured systems approach to model conceptualisation* when applied by executive management of the Twenty First Century to structure the outcomes of paradigm shifts introduced into organisations as a result of unstructured complex phenomena.

While this thesis has at its core the objective to introduce the concept of a *structured systems approach to model conceptualisation* into the realm of executive management within a broader context, it is in the view of the author the most suitable structured mechanism specifically aimed at the engineer in the emergent role of executive management dealing with unstructured complex phenomena.

Appendix A

ANALYSIS OF THE SOURCES OF POWER

Morgan **[114]** views power as the medium through which conflicts of interests are ultimately resolved. Furthermore, he is of the opinion that power influences who gets what, when and how. It is of interest to note the observation by Kauffmann **[84]**, who describes 'power' as a positive feedback loop[1], which has created problems for people since before the beginning of civilisation. Within the context of this thesis, complex phenomena pertaining to executive management, are in fact problems associated with the practice of executive management broadly defined, and sources of power the mechanisms to resolve these complex phenomena.

Without analysing each individual source of power to the fullest extent as in Morgan's **[114]** original text, each entity detailed hereunder is broadly defined or briefly described to provide the reader with an understanding of each of the concepts as it impacts executive management:

- **Formal authority:-** Formal authority is the most obvious source of power in an organisation, which can be described as a form of legitimised power that is respected and acknowledged by those with whom one interacts. Three kinds of formal authority can be found in modern organisations namely:
  - Charismatic authority.
  - Traditional authority.
  - Bureaucratic or rational-legal authority.
- **Control of scarce resources:-** Control of scarce resources includes control over scarce resources in the form of money, materials, technology, personnel, customer support, suppliers and the community at large.
- **Use of organisational structure, rules, and regulations:-** The use of organisational structure, rules and regulations are best understood as products

[1] See Chapter 2, Paragraph 2.9.

and reflections of a struggle for political control. These entities can also be viewed as notional instruments intended to aid task performance.

- **Control of decision processes:-** This well recognised source of power pertains to the ability to influence the outcomes of decision-making processes.
- **Control of knowledge and information:-** By controlling these key entities, a person can systematically influence the definition of organisational situations and subsequent create patterns of dependency.
- **Control of boundaries:-** The notion of boundary is used to refer to the interface between different elements of an organisation, and by monitoring changes occurring, one acquires knowledge of critical interdependencies over which one may be able to secure a degree of control.
- **Ability to cope with uncertainty:-** Organisation implies a certain degree of interdependence, so that discontinuous or unpredictable situations in one part of the organisation, have considerable implications for operations elsewhere. The ability to deal with and control such uncertainties, is a source of considerable power.
- **Control of technology:-** All organisations are dependent on some form of technology, even in its most basic form, to convert organisational inputs to outputs, and by implication, an instrument of power. The power associated with the control of technology becomes most visible in confrontations and negotiations surrounding organisational change.
- **Interpersonal alliances, networks, and control of the informal organisation:-** Although many forms of these concepts exist, friends in high places, sponsors, mentors, coalitions, networks, sounding out or merely shooting the breeze, all provide a powerful source of power. Furthermore, to extend the sources of power, a skilled executive would systematically build and cultivate such informal alliances and networks, incorporating whenever possible the help and influence of all those with an important stake in the domain in which he or she is operating.
- **Control of counter-organisations:-** This source of power can be explained the best using the example of trade unions. Whenever a group of people manages to build a concentration of power in relatively few hands, it is not uncommon for opposing forces to co-ordinate their actions to create a rival power bloc. This principle of countervailing power, is also often employed by

leaders of large conglomerates, who buy and sell organisations as corporate pawns.

- **Symbolism and the management of meaning:**- Pertains to the ability to persuade others to enact realities that further the interests one wishes to pursue. Two examples can be cited:
  - Authoritarian leaders attempt to 'sell', 'tell', or 'force' a reality on his or her subordinates
  - Democratic leaders allow definitions of a situation to evolve from the views of others.
- **Gender and the management of gender relations:**- Within the greater ambit of organisation management, it often makes a great deal of difference to which gender one belongs. Many organisations are dominated by gender-related values that bias organisational life in favour of one sex over another. Whether or not gender is perceived as a factor shaping power relations, the choice or inclination toward one gender as opposed to another, can have a major effect on one's success and general influence within an organisation.
- **Structural factors that define the stage of action:** - Within large organisations, power relations tend to become more or less balanced, which can be attributed to the fact that access to power is open, wide and varied. While some people may be able to amass considerable personal power, this is offset by the power of others, and even the powerful thus feel constrained.
- **The power one already has:** - Morgan **[114]**, is of the opinion that, "power is a route to power", and cites the following example to illustrate this fact: "A manager may use his or her power to support *X* in a struggle with *Y*, knowing that when *X* is successful, it will be possible to call upon similar support from *X*".

The importance of 'power' is highlighted by Churchman **[31]**, citing the pragmatist philosopher E.A. Singer (undated), who is of the opinion that:

> *"With only one wish to be had, choose rather the power to get whatever you may come to want than the pleasure of having any dearest thing in the world".*

In a broader context, Churchman **[30]** suggests that we develop a social structure in which people are given maximum opportunity to satisfy their basic needs as well as gain any other goals they wish to acquire. Churchman **[30]**, is of the opinion that the proper term might be power; that is, the social structure should supply sufficient power to every member of its society, so that each member can acquire what he wishes and certainly what he needs.

Appendix B

AN INDUSTRY PERCEPTION OF THE STRUCTURED SYSTEMS APPROACH TO MODEL CONCEPTUALISATION

B1 INTRODUCTION

The aim of this appendix and the limited industry survey contained therein, will be to provide the reader with insight into the specific applicability of a *structured systems approach to model conceptualisation* as perceived by executive management. In so doing, to reinforce both the uniqueness of this approach as well as the viability of the concept as an alternative approach to current executive management approaches to the solving of unstructured complex phenomena.

The industry perception of the *structured systems approach to model conceptualisation* to executive management was undertaken due to the fact that the concepts of practicality, validity and reliability defined by Emory and Cooper **[50]** quoting Thorndike and Hagen, were impacted adversely by various internal factors associated with organisations *per se*, making the validation of the formulated *structured systems approach to model conceptualisation* in a live environment virtually impractical. The most significant elements attributing to this situation were precipitated by the following:

- That the *structured systems approach to model conceptualisation* as formulated in this thesis is aimed at the top echelon of management namely executive management. To implement the formulated *structured systems approach to model conceptualisation* 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 invariably deviate from company and organisational policy.

- Should permission be granted to implement the *structured systems approach to model conceptualisation* in an organisation, it would be most likely that such an approach would be considered as confidential and part and parcel of the organisations Intellectual Property Rights. Making the results public, would constitute breach of these rights.
- Executives at the top echelon of an organisation normally follow a management approach, which stems from either tradition or from organisation culture, which is by implication a private and confidential matter to the exclusion of third parties. Furthermore, introducing a new approach on an experimental basis into established structures would require board approval and impact executive strategies and decision making. Such dynamic change, specifically should it involve organisational changes, would in addition require change management strategies to be implemented on a broad front to deal with the change dynamics associated thereto.
- An aspect, which Pascale **[123]** terms 'conservatism', has furthermore a significant impact on the validation potential of the *structured systems approach to model conceptualisation.* Due to the fact that management in the words of Pascale **[123]** 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, and adopting a new management approach would constitute not only personal but also organisational change.

Galliers and Land **[62]** recognises the *caveats* and disclaimers listed above as 'typical' of this kind of research. Furthermore, the use of statistical analysis to formulate a theory (or model) as proposed in this thesis is recognised by Yin **[185]**.

B2 DATA COLLECTION

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 questionnaire design, has been obtained primarily from the following authoritative sources: Emory and Cooper **[50]**, Slife and Williams **[158]**, Reaves **[128]**, Walizer and Wiener **[176]**, Oppenheim **[119]**, Easterby-Smith, Thorpe and Lowe **[47]**, Pryor and McGuire **[125]** and Kennedy **[85]**.

According to Emory and Cooper **[50]**, 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 questionnaire as a data collection instrument are varied, but the following elements are of importance:

- The ease with which the survey questionnaire 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.

B3 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 has identified the target population as senior executives, irrespective of industry, who has attained a level of management in their respective organisations which equates to executive management[1], and fits the profile of typical interactivists (refer Chapter 4, Paragraph 4.5.1).

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 disciplines, executives from South Africa, United Kingdom, Central Europe and the United States were selected for the survey.

B4 THE CHOICE OF SAMPLING METHOD

Emory and Cooper **[50]**, 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.
- The census approach, where an attempt is made to survey every element within the population.

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.

B5 MEASUREMENT SCALES

The survey questionnaires used in the research validation process of the *structured systems approach to model conceptualisation* are based on the well-known Lickert scale **[50]**, whereby respondents were asked to respond to each of the questions by choosing one of five agreement choices. The five agreement choices are shown in Table B1:

[1] As defined in Chapter 1, Paragraph 1.1, Footnote 4.

5	4	3	2	1
Strongly Agree	**Agree**	**Undecided**	**Disagree**	**Strongly Disagree**

Table B1: Agreement choices.

The advantages in using the popular Lickert scale according to Emory and Cooper **[50]**, are the following:

- 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 **[130]**, interval scales facilitate meaningful statistics when calculating means, standard deviation and Pearson correlation coefficients, most pertinent to the research at hand.

The most important reason however for choosing the Lickert scale in this research, which is supported by Emory and Cooper **[50]**, 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 solve the research problem in question.

B6 QUESTIONNAIRE 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 and questions within the survey have been designed with the following principles in mind:

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

B7 THE VALIDATION QUESTIONNAIRE

The author has developed ten survey questions designed to determine the opinions of survey respondents to various concepts as introduced throughout this thesis. Individual question content is contained within the ambit of Table B2.

Question 1	The systems approach to executive management can play an increasingly important role in the success of any organisation in the areas of competitiveness, quality and control. To what extent do you agree with this statement?
Question 2	As organisations evolve and grow, the role of executive management is increasing in complexity. To what extent do you agree with this statement?
Question 3	The systems approach to executive management can have a direct bearing on the strategic success of an organisation and the complex phenomena associated with this aspect, the most daunting aspect thereof, specifically in the absence of a structured systems approach customised to deal with such issues. To what extent do you agree with this statement?
Question 4	The *structured systems approach to model conceptualisation* applied to senior and middle management would facilitate sound objective decision-making and model building within operational areas. To what extent do you agree that the *structured systems approach to model conceptualisation* would facilitate the same result should the concept be applied to executive management?

Question 5	'Red Tape' is a known factor in organisations, which by implication, very often stalls critical corporate decision-making, to the detriment of the organisation as a whole. To what extent do you agree, that should this concept be replaced by structured decision processes in terms of the *structured systems approach to model conceptualisation*, 'red tape' can be eliminated?
Question 6	The holistic perspective of the *structured systems approach to model conceptualisation* to management in general, determines that unstructured complex phenomena (the properties of the parts thereof), can only be understood from the organisation of the whole. To what extent do you agree that this concept can be applied to the unstructured complex phenomena, which pertains to executive management?
Question 7	To what extent do you agree that the systems approach, which is currently embedded in academic literature in various authoritative publications in various forms and permutations, can be applied to model conceptualisation to solve unstructured complex phenomena from an executive management perspective?
Question 8	To what extent do you agree that the *structured systems approach to model conceptualisation*, has the potential to facilitate model building aimed to address unstructured complex phenomena?
Question 9	The *structured systems approach to model conceptualisation* is a feasible and viable alternative management approach, which can effectively be implemented. To what extent do you agree with this statement?
Question 10	To what extent do you agree that modern executive management, to cope with the demands of organisational leadership requires a customised structured approach to management, as offered by the *structured systems approach to model conceptualisation*, to meet the demands of the Twenty First Century?

Table B2: Validation Questionnaire

Prior to conducting the interviews with the respondents, the author provided each respondent with detailed information pertaining to the systems approach in general, irrespective if the respondents was *au fait* with the concept or not. In addition, an overview of the formulation mechanics and objectives of the *structured systems approach to model conceptualisation* was presented to each of the respondents. This exercise was undertaken to ensure that a common understanding of the issues raised in the questionnaire prevailed.

B8 ANALYSIS OF THE SURVEY RESULTS

A simple analysis of the survey results returned by the 15 respondents, all of whom had in excess of twenty years of management experience and at least five years of executive management experience, and selected from a cross section of organisations, to the limited scope survey depicted in Table B2. For the purpose of comparison, a five rating corresponds to a positive extreme scale response to the survey question, while a one rating corresponds to a negative extreme scale response to the survey question on the Lickert scale (see Table B1). Table B3 indicates the responses of the executive respondents to each of the questions posed in terms of the industry survey.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Ave.	SD
1	5	5	5	5	5	5	4	4	4	5	4.7	0.48
2	5	5	5	4	5	4	3	3	4	5	4.3	0.82
3	5	5	5	5	5	5	4	4	5	5	4.8	0.42
4	5	5	5	4	4	4	3	3	4	5	4.2	0.79
5	4	4	5	4	5	4	4	4	4	4	4.2	0.42
6	5	5	5	5	5	5	4	4	5	5	4.8	0.42
7	5	5	5	4	5	4	5	5	4	5	4.7	0.48
8	5	5	5	5	4	5	3	3	5	5	4.4	0.84
9	5	5	5	5	5	5	4	4	4	5	4.8	0.42
10	4	5	5	4	4	4	4	4	5	4	4.2	0.42
11	5	5	5	5	5	5	3	4	5	5	4.7	0.68
12	5	5	5	5	5	5	3	3	5	5	4.6	0.84
13	5	5	5	4	5	4	4	4	5	5	4.6	0.52
14	5	5	5	5	5	5	4	4	5	5	4.8	0.42
15	5	5	5	4	5	4	3	4	4	4	4.3	0.68
Ave	4.87	4.93	5	4.53	4.8	4.53	3.67	3.8	4.67	4.8		
SD	0.35	0.26	0	0.52	0.41	0.52	0.62	0.56	0.52	0.41		

Table B3: Survey Results

The responses are averaged across both the question number as well as the respondents. Similarly, the standard deviation of responses are indicated on a per question and per respondent basis.

Table B4 includes some basic biographical information pertaining to the respondents in terms of:

- Their total work experience at management and senior management level.
- Their total work experience at executive management level.
- Their education level.
- Their individual working disciplines.

As illustrated in Table B4, the average experience and education of the respondents is exceptionally high. The average number of years of working experience at management and senior management level across the fifteen respondents is 15.60 years, with a range from 9 years to 26 years. All of the respondents except one have more than 10 years experience at management and senior management level.

Respondent	Total number of years at management and senior management level	Total number of years at executive management level	Total number of years management experience	Education Level	Working disciplines
1	10	7	17	BSc	Banking
2	22	5	27	*Diplom Ing.*	Consulting
3	24	10	34	M.Sc.Ing.	Technology
4	14	9	23	M.Ing.	Processing
5	16	9	25	MBA	Banking
6	12	6	18	BS Ph.D.	Consulting
7	12	5	17	D.Litt.	Marketing
8	13	5	18	M.Sc.	Technology
9	26	6	32	*Diplom Ing.*	Technology
10	18	6	24	D.Com.	Finance
11	17	8	25	M.Ed.	Sales
12	13	9	22	M.Ing.	Technology
13	15	11	26	D.Ing.	Outsourcing
14	9	9	18	BS MBA	Integration
15	13	7	20	BScHons.	Reengineering
AVERAGE	15.60	8.13	23.07		

Table B4: Respondent biographical information

The average number of years of working experience at executive management level across the fifteen respondents is 8.13 years, with a range from 5 years to 11 years. All of the respondents except one have more than 5 years experience at executive management level. Taking a holistic approach, it is interesting to note that the average number of years experience the respondents have of management *per se* amounts to 23.07 years.

The education levels of the respondents are equally impressive. The tertiary education levels of the fifteen respondents are made up as follows:

- Four respondents with Ph.D's.
- Seven respondents with Masters degrees.
- One respondent with an Honours degree.
- Three respondents with Bachelors degrees.

It is interesting to note that the above findings confirm the prediction made in the McKinsey Report cited by Handy **[72]**, done in 1986 for the demand of University graduates in the Year 2000 to fill executive positions.

A notable fact and of significant importance to this thesis, is that out of the fifteen executive management respondents which took part in the survey, a total of eleven came from an engineering background. A further notable fact is that the respondents as part of their company resource employment strategies, primarily employ engineers from various disciplines, having recognised the unique potential of engineers within the organisational structures of so many organisations. Furthermore, the spectrum of working disciplines from which the respondents were drawn is representative of the application potential of the *structured systems approach to model conceptualisation*. The eleven companies headed up by executive management from engineering backgrounds were analysed to identify key performance areas making them unique in their respective fields and with the same time, establish the number of engineers employed and number of engineers forming part of their executive management contingent, details of which are shown in Table B5.

Work Discipline	No. of Engineers employed	No. of Engineers employed at executive management level	Key performance area
Banking	14	2	A UK based bank considered foremost in the Credit industry.
Consulting	8	1	EC distribution network serving Europe and the Far East.
Technology	22	4	A UK listed company with technology company acquisitions in the US, its prime objective.
Processing	15	3	Established hub processing as a unique venture for the banking industry.
Consulting	3	1	A UK based company specialising in credit technology.
Software Development	8	1	US based with business expansion into the EC, Far East, the Pacific Rim and Africa.
Technology	16	1	European listed company with world-wide software distribution.
Technology	4	4	South African based company with expansion into Central Africa and Brazil.
Outsourcing	1	2	This listed company forms part of a major South African conglomerate highly specialised in technical outsourcing projects for the South African financial industry.
Integration	3	1	Major international developers of dealing room technology and associated interface technologies.
Reengineering	5	2	A small, but highly profitable South African based company specialising in Business Process Engineering.

Table B5: Number of Engineers Employed / Key Performance areas

Table B5 indicates a significant reliance on the expertise of the engineering fraternity, in particular in the areas of technology and processing (the latter, which is primarily technology based). Furthermore, the small number of engineers employed, in particular at executive level indicate an emerging trend across industries, for the need for engineers at the top *echelon* of companies. Most important, is the fact that the key performance areas in Table B6, reflect in most instances companies, which are successful global market players, being headed up by engineers.

B8.1 RANKED AVERAGE RESPONSES PER INDIVIDUAL QUESTION

An analysis of the survey results in terms of ranked average responses per individual question leads to a number of interesting application observations. A ranking of the questions on an average response basis is illustrated in Table B6. Ranked responses were chosen as opposed to nominal averages as a result of the small size of the survey as well as the objective to avoid the statistical issues associated with average across extreme value scales.

Rank	Question	Average Response
1	3	5
2	2	4.93
3	1	4.87
4	5	4.8
4	10	4.8
5	9	4.67
6	6	4.53
6	4	4.53
7	7	3.8
8	8	3.67

Table B6: Survey Questions ranked by average response (Highest to Lowest)

The results of the survey measured by average response per question are extremely encouraging especially if viewed against the background of only two questions out of ten received an average response of under 4, namely Questions 7 and 8. This clearly indicates a high degree of acceptance of the concept of a *structured systems approach to model conceptualisation* by the respondents. Furthermore, in support of this analogy, the fact that the worst average response lies towards the top-end of neutrality in terms of the ranked scales used in the limited survey questionnaire.

It is of importance to note that the question, which featured prominently at the top of the ranked questions (Question 3), relate to the impact of a management approach and associated complex phenomena associated thereto. This question, which requires closer scrutiny, reads as follows: *"The systems approach to executive management can have a direct bearing on the strategic success of an organisation and the complex phenomena associated with this aspect, the most daunting aspect thereof, specifically in the absence of a structured systems approach customised to deal with such issues". "To what extent do you agree with this statement?"*

The fact that this question ranked the highest of the scored questions in the survey questionnaire, unequivocally confirms the following analogies:

- That the success of a company is largely attributed to the leadership of its executive management.
- There are identifiable tangent planes between the systems approach of executive management and the strategic success of an organisation.
- It is accepted that the complex phenomena associated with executive management, is the most daunting aspect thereof.
- That a structured systems approach customised to deal with complex phenomena within the context of executive management becomes a requirement, specifically in dealing with complex phenomena.

Furthermore, these analogies are carried forward in the questions which ranked second and third (Questions 2 and 1), in which the impact of executive management is emphasised as being complex, relating to competitiveness, quality and control. Questions around the 50th percentile (Questions 10 and 9) clearly confirms the sentiments typical to executive management, which relates to organisational leadership, structure and viability of anything new to be introduced, which are the subject of executive management scrutiny.

Questions occupying the lower half of the ranked list (Questions 7 and 8), relate to relatively unknown concepts pertaining to the systems approach, namely customisation of the concept to address model conceptualisation and the subsequent ability thereof to address unstructured complex phenomena in the arena of executive management. This result is not unexpected, and in view of the author relates simply to a natural response on the part of the survey respondents to concepts with which they are not familiar. Furthermore, it became apparent to the author during the interview process that respondents, although *au fait* with the term 'systems approach', were in general unaware of the potential of the concept being applied to model conceptualisation in dealing with complex phenomena. This fact is clearly demonstrated by the ranking of Question 7 at number 7, and Question 8 at number 8, on the ranked list.

From a holistic point of view, the results are extremely encouraging in the context of this thesis, due to the fact that the underlying principles of the *structured systems approach to model conceptualisation* as an alternative management approach to executive management are accepted. The respondents have illustrated exactly what the author anticipated to achieve with this research namely that:

- The *structured systems approach to model conceptualisation* is a feasible and viable alternative to conventional management approaches and most suited to be applied to executive management in dealing with complex phenomena.
- The *structured systems approach to model conceptualisation* as an executive management mechanism, has the potential to impact not only the management style of executive management, but also impact the quality of model building.
- The *structured systems approach to model conceptualisation* is recognised as having the potential of being applied by executive management over a spectrum of disciplines, which is clearly demonstrated in Table B4.

In addition to the survey responses, the survey process led to further subsequent discussions two months after the initial survey was conducted between the author and the respondents with regard to:

- The practical implementation of the *structured systems approach to model conceptualisation* being implemented in an organisation to validate the concept as a workable alternative management approach.
- To establish the root cause of the single most challenging aspect of the work of the modern executive.

Pertaining to the first aspect, the various internal factors associated with large organisations would make such a conceptual short-term validation process in a live environment virtually impractical. These internal factors which would directly impact a potential validation process for the *structured systems approach to model conceptualisation* and repeated here from Paragraph B1 for ease of reference, are listed below:

- That the *structured systems approach to model conceptualisation* as formulated in this thesis is aimed at the top echelon of management namely executive management. To implement the formulated *structured systems approach to model conceptualisation* 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 company and organisational policy.
- Should permission be granted to implement the *structured systems approach to model conceptualisation* in an organisation, it would be most likely that the new management approach 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.
- Executives at the top echelon of an organisation normally follow a management approach, which stems from either tradition or from organisation culture, which is by implication a private and confidential matter to the exclusion of third parties. Furthermore, introducing a new approach on an experimental basis into established structures would require board approval and impact executive strategies and decision making[2] and

[2] With this statement the author does not suggest that organisations are totally inflexible to their management approaches which they follow. As organizations 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.

furthermore would require the management of of such change on a broad front..

- An aspect, which Pascale **[123]** terms 'conservatism', has furthermore a significant impact on the validation potential of the *structured systems approach to model conceptualisation.* Due to the fact that management in the words of Pascale **[123]** 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, and adopting a new management approach would constitute not only personal but also organisational change.

It was therefore a requirement for the researcher to become aware of all these critical issues identified above, and prepare and equip himself to handle these issues with skill and sensitivity and guarantee the anonymity of all parties concerned in the quest to establish the validity of the *structured systems approach to model conceptualisation.* The second aspect (the single most difficult aspect facing the modern executive) produced some interesting results, which are contained in Table B7.

Respondent	**Root cause of the single most challenging aspect of the work of the modern executive.**
1	Company budgeting and technology requirement forecasting
2	Long range planning. How to begin to formulate a model?
3	Strategic planning, technology change and soft issues.
4	External and internal integration issues
5	Resource management and societal issues
6	People problems.
7	Technology and human resource planning.
8	Model building to address complex issues.
9	A combination of societal and organisational issues
10	Planning and process issues. Technology and people change
11	Resource planning and budgeting. Structuring solutions.
12	Complex integrated systemic problems
13	Identification of issues causing complex problems
14	Complex people and process issues
15	Company politics and societal issues

Table B7: Factor Analysis

From the analysis, the analogy can be drawn that 'planning for' and 'dealing with', unstructured complex phenomena, (the latter which includes most of the items listed) forms the root causes of the most challenging aspects of the work of the modern executive. This particular research finding is supported by the research findings of Brancheau and Wetherbe **[26]**, who identified 'strategic planning' as the most important issues for executives[3].

Most important for the author in terms of this research, the finding that all of the items listed can be effectively addressed within the ambit of the *structured systems approach to model conceptualisation.*

B9 CONCLUSION

In this appendix four major objectives have been accomplished in that:

- The author has illustrated the development of the limited survey questionnaire, reflecting on key components of the *structured systems approach to model conceptualisation.*
- The results of the industry survey were presented and discussed by the author.
- The reader was provided with insight into the specific applicability of the *structured systems approach to model conceptualisation* from an executive management perspective.
- The uniqueness of the *structured systems approach to model conceptualisation* was reinforced as an alternative approach to current executive management approaches.
- The internal factors associated with large organisations, which limited the validation process of the *structured systems approach to model conceptualisation* in a live environment was confirmed by the individual respondents during subsequent discussions which took place two months after the initial survey was conducted.
- It was unequivocally established that the *structured systems approach to model conceptualisation* had the potential to deal with the most challenging aspects pertaining to executive management namely:

[3] The research of Brancheau and Wetherbe **[26]**, focussed on 'Information Systems Management'.

  - Facilitating the identification of issues causing unstructured complex phenomena.
  - Structuring plans to deal with such unstructured complex phenomena.
- Complex phenomena associated with executive management are not commonly dealt with in terms of the systems approach in a structured way, which can be attributed to:
  - The limited penetration of the systems approach into mainstream practice **[59a]**, **[90]**, **[152]**, **[105]**.
  - The limited literature and expertise available on the subject of model conceptualisation **[126]**.

Appendix C

HISTORY AND EMERGENCE OF THE SYSTEMS APPROACH

C1 INTRODUCTION

It is customary for academic researchers to devote a portion of their research to the history and emergence of the subject matter they are researching. The research contained within the ambit of this thesis is no different, however the objective of this appendix is only to provide high-level background information to the history and emergence of the systems approach as opposed to an extensive historical analysis. Furthermore, the history and emergence of the concept spans a number of centuries and will thus be limited in its presentation thereof. A broad literature search by the author on the history and emergence of the systems approach, returned a number of authoritative sources of reference, however could not identify a single all incumbent authoritative version, which was in its entirety devoted to the history and emergence of the subject matter and, which could be used as a single point of reference. A high level of synergy however, prevailed in the various academic literature sources evaluated for this purpose, which maps to the view of Popper (1957) cited by Checkland **[29]** who points out (when referring to the history of the systems approach) that:

> *"the best we can do is to write history which is consistent with a particular point of view".*

In view of the author, the most comprehensive rendition of the history and emergence of the systems approach can be found in a 1996 publication of Fritjof Capra's book entitled '*The Web of life: A Synthesis of Mind and Matter*' **[27]**. The major portion of Capra's book deals with radical synthesis of such recent scientific breakthroughs as the Theory of Complexity, Gaia Theory, Chaos Theory and other explanations of the properties of organisms, social systems and ecosystems. Capra **[27]**, devotes a full chapter of his book to the history and emergence of the systems theory, of which certain portions will be reproduced *verbatim* or adapted for background information of the reader in this appendix[1], further enhanced by readings on the subject matter as identified in various other supporting literature searches.

C2 THE RISE OF SYSTEMS THINKING

To retain the thoughts of Capra **[27]**, and logically follow the history and emergence of the systems approach, the original sub-headings will be used as in the original text below. Furthermore, with Capra **[27]** as the prime source of the contextual data in this appendix, no further referencing in the ensuing text will be made to the said author. Other supporting sources cited will however carry the appropriate reference indicators.

C2.1 FROM THE PARTS TO THE WHOLE

In Twentieth Century science, the holistic perspective has become known as 'systemic' and the way of thinking it implies as 'systems thinking'. The main characteristics of 'systems thinking' emerged simultaneously in several disciplines during the first half of the century, especially during the 1920's.

The concept was first mooted by biologists, and Aristotle was the first in the Western tradition who created a formal system of logic and a set of unifying concepts, which he applied to the main disciplines of his time. The concept was further enriched by Gestalt psychology, and the new science of ecology with perhaps the most dramatic effect on quantum physics.

C2.2 SUBSTANCE AND FORM

It was Pythagoras at the dawn of the western philosophy and science, who distinguished between 'matter' and 'form'. Aristotle, in the Western tradition also

[1] With the written permission of the publisher: HarperCollins*Publishers*, 77-85 Fulham Palace Road, Hammersmith, London, W6 8JB. (19 November 1999)

distinguished between these two entities, but at the same time linked the two entities through a process of development.

Matter, according to Aristotle, contains the essential nature of all things, but only as potentiality. By means of form, this essence in the actual phenomena is called *'entelcchy'* (self-completion), by Aristotle. It is a process of development, a thrust towards full self-realisation. Matter and form are the two sides of this process, separable only through abstraction. Furthermore, Aristotle created a formal system of logic and a set of unifying concepts, which he applied to the main disciplines of his time.

C2.3 CARTESIAN MECHANISM

In the Sixteenth and Seventeenth Centuries, the medieval world view based on Aristotelian philosophy and Christian theology changed from the notion of an organic, living and spiritual universe to that of the world as a machine, and the world – machine became the dominant metaphor of the modern era. This change brought about new discoveries associated with the names of Copernicus, Galileo, Descartes, Bacon and Newton.

It was René Descartes who created the method of analytical thinking, which consists of breaking up complex phenomena into pieces to understand the behaviour of the whole from the properties of its parts. Decartes based his views of nature on the fundamental division between two independent and separate realms – "that of mind, and that of matter". The conceptual framework created by Descartes and Galileo – "the world as a perfect machine governed by exact mathematical laws",- was completed by Newton, whose grand synthesis, Newtonian mechanics, was the crowning achievement of Seventeenth Century science.

Cartesian mechanism was expressed in the dogma that the laws of biology could ultimately be reduced to those of physics and chemistry. At the same time, the rigidly mechanistic physiology found its most forceful and elaborate expression in a polemic treatise, *'Man a Machine'*, by Julien de La Mettrie, which remained famous well beyond the Eighteenth Century and generated many debates and controversies, some of which reached even into the Twentieth Century.

C2.4 THE ROMANTIC MOVEMENT

The first strong opposition to the mechanistic Cartesian paradigm, came from the Romantic movement in art, literature and philosophy in the late eighteenth and nineteenth centuries. It was Goethe who returned to the Aristotelian tradition by concentrating on the nature of organic form and was among the first to use the term 'morphology' for the study of biological form from a dynamic development point of view. Of importance to note is that Goethe admired nature's 'moving order' (*Bewegliche Ordnung*) and conceived of form as a pattern of relationships within an organised whole – a conception which is at the forefront of contemporary systems thinking. "Each creature", wrote Goethe, "is patterned gradation *(Schattierung)* of one harmonious whole".

The understanding of organic form also played an important role in the philosophy of Immanual Kant, who is often considered the greatest of the modern philosophers. In his *Critique of Judgement*, Kant discussed the nature of living organisms. He argued that organisms, in contrast to machines, are self-reproducing, self-organising wholes. In a machine, according to Kant, the parts only exist for each other, in the sense of supporting each within a functional whole. In an organism, the parts also exist by means of each other, in the sense of producing one another.

The Romantic view of nature as, "one great harmonious whole", as Goethe put it, led some scientists of that period to extend their search for wholeness to the entire planet and see the Earth an integrated whole, a living being.

C2.5 NINETEENTH CENTURY MECHANISM

The second half of the Nineteenth Century is best known for the establishment of evolutionary thought, and the swing back to mechanism. The following examples can be cited:

- Virchow who formulated cell theory in its modern form.
- Microbiology dominated by the discoveries of Pasteur and Bernard, the latter the founder of modern experimental medicine.

Within the context of the triumphs of the Nineteenth Century biology – cell theory, embryology, and microbiology – established the mechanistic conception of life as a firm dogma among biologists. However, carried within themselves the seeds of the next wave of opposition, the school known as organismic biology or 'organicism'.

C2.6 VITALISM

Before 'organicism' was born, many biologists went through a phase of vitalism, and for many years the debate between mechanism and holism was framed as one between mechanism and vitalism. Both vitalism and organicism maintain that, although the laws of physics and chemistry are applicable to organisms, they are insufficient to fully understand the phenomena of life. The behaviour of a living organism as an integrated whole cannot be understood from the study of its parts alone. This concept was re-phrased by theorists decades later to culminate in the concept that, "the whole is more than the sum of its parts".

C2.7 ORGANISMIC BIOLOGY

During the early Twentieth Century, organismic biologists, opposing both mechanism and vitalism, took up the problem of biological form, elaborating and refining many of the key insights of Aristotle, Goethe, Kant and Cuvier. Some of the main characteristics lay the foundations for modern 'systems thinking', which emerged from their extensive reflections. At this point it would be appropriate to acknowledge the contribution of the famed South African J.C. Smuts with his book *'Holism and Evolution'*, published in 1926 **[29]**. This tentative exposition and those of authors C.D. Broad and J.H. Woodger, would enhance the earlier reflections of organismic biology, and in fact illustrate (rather then themselves constitute) the emergence of a new mode of thought which we now call 'systems thinking'.

The above claim can be substantiated with the fact that the biochemist Lawrence Henderson was influenced through his early use of the term 'system' to denote both living organisms and social systems. From that time on, 'a system' has come to mean, 'an integrated whole whose essential properties arise from the relationships between the parts', and 'systems thinking' has come to mean 'the understanding of a phenomenon within the context of a larger whole'.

C2.8 SYSTEMS THINKING

It is of importance to note that the early systems thinkers recognised very clearly the existence of different levels of complexity with different kinds of laws operating at each level. At each level of complexity, the observed phenomena exhibit properties that do not exist at the lower level. This aspect is particular noticeable when the management style of executive management is compared to the management style of say middle and lower management. Even more important, an aspect which is supported by Checkland **[29]**, is that the concept of 'organised complexity' became the very subject of the 'systems approach'.

The emergence of systems thinking was a profound revolution in the history of Western scientific thought. The belief that, "in every complex system the behaviour of the whole can be understood entirely from the properties of its parts", was in effect Descartes' celebrated method of analytical thinking, which has been an essential characteristic of modern scientific thought.

The great shock of Twentieth Century science has been that systems cannot be understood by analysis. The properties of the parts are not intrinsic properties, but can be understood only within the context of the larger whole. In the systems approach, the properties of the parts can be understood only from the organisation of the whole.

Accordingly, systems thinking, does not concentrate on basic building blocks, but rather on basic principles of organisations. Systems thinking is contextual, which is the opposite of analytical thinking. Analysis means taking something apart in order to understand it; while systems thinking means, 'putting it into the context of a larger whole'.

C2.9 QUANTUM PHYSICS

The concept of 'wholeness' can also be mapped to quantum physics. This was precipitated by the realisation that systems are integrated wholes that cannot be understood by analysis. Whereas in classical mechanics the properties and behaviour of the parts determine those of the whole, the situation is reversed in quantum mechanics, "it is the whole that determines the behaviour of the parts".

C2.10 GESTALT PSYCHOLOGY

At the turn of the century, the philosopher Christian von Ehrenfels was the first to use *Gestalt* (as distinct from 'form', which denotes 'inanimate form'), in the sense of an irreducible perceptual pattern, which sparked the school of Gestalt psychology.

Gestalt psychologists led by Wertheimer and Köhler, saw the existence of irreducible wholes as a key aspect of perception. In terms of the holistic approach to psychology, the Gestalt therapy was formulated, which emphasises the integration of personal experience into mechanical wholes.

C3 CONCLUSION

From the above, the analogy can be drawn that organismic biology, Gestalt psychology and later on, the systems theory, all grew out of the holistic *zeitgeist*. Furthermore the systems approach due to the culmination of various forces over the years, has evolved where the parts can be understood only from the organisation of the whole.

This statement is supported by Mitroff and Lintstone **[108a]**, who cites Singer's analysis that, "there were no elementary or simple acts in science or profession to which supposedly more complex situations could be reduced". "Every act or action performed by humans was complex and therefore had within it a complex series of other actions". Furthermore, unlike the scientist and the philosophers of his day who believed that some sciences such as mathematics or physics were the most basic or fundamental, Singer believed that there were no fundamental sciences to which all others could be reduced. Since it was necessary at some point to involve every science in the actions of every other science, all the sciences and professions were equally fundamental. No single science stood at the top of the totem pole or hierarchy of science and in essence, every science depends on every other.

This fundamental notion of interconnectedness, or non-separability, forms the basis of what has come to be known as the systems approach. In essence the systems approach postulates that since every problem humans face is complicated, they must be perceived as such, that is, their complexity must be recognised, if they are to be managed properly. As a critical human activity, science, or the creation of a very special kind of knowledge, must be conceived of and managed as a whole system.

Appendix D

EXISTING GUIDELINES ON MODEL CONCEPTUALISATION

D1 INTRODUCTION

Randers **[126]**, is of the opinion that because there is no educational text on 'model conceptualisation', hence the sequence of presentation in published papers describing models, are commonly mistaken for the actual steps in the creation of those models.

D2 THE PROCESS OF MODELLING

The process of modelling, includes not only the process of model conceptualisation, but also three other stages namely, formulation, testing and implementation. Randers **[126]**, provides the following analysis of the modelling process, shown here in Table D1. It is of importance to note that the four stages, do not follow each other in tidy sequence, neither in practice nor ideally.

The conceptualisation stage establishes the focus of the study, the general perspective and time horizon. The critical decisions are made on what part of reality to study and how to describe it. Furthermore, the formulation stage casts the chosen perspective into a formal representation. The resulting model gives a precise, though not necessarily accurate, description of a slice of reality and is capable of generating images of alternative futures.

The process of modelling according to Randers **[126]**, contains elements of recursion. The goal of an effective procedure for model construction is not to remove all iterations, but to achieve a reasonable consistent degree of progress throughout the recursive process.

Stage in model construction	Analysis of stage content
Conceptualisation	Familiarisation with the general problem area. Definition of the question to be addressed –either: What caused a given development? or, What are the likely effects of a given policy? Description of the time development of interest (the reference mode) –defining the time horizon and the range of time constants in the model. Verbal descriptions of the feedback loops that are assumed to have caused the reference mode (the basic mechanisms) – defining the system boundary and the level of aggregation. Development of powerful organizing concepts. Description of the basic mechanisms in causal diagram form
Formulation	Postulation of detailed structure –selecting levels, selecting rates and describing their determinants. Selection of parameter values.
Testing	Testing the dynamic hypothesis –Do the basic mechanisms actually create the reference mode? Testing of model assumptions –Does the model include the important variable? Are the assumed relationships reasonable? Are parameters plausible?
Implementation	Testing of model behaviour and sensitivity of perturbations. Testing the response to different policies. Identification of potential users. Translation of study insights to an accessible form. Diffusion of study insights.

Table D1: The four stages of model construction **[126]**.

In the complex, unstructured conceptualisation stage, the aim is to strive toward a 'mental models'[1], that is, an understanding of the operation of the real world, and in the process making use of closed loops of cause and effect[2].

[1] As described in Chapter 2, Paragraph 2.7.
[2] As described in Chapter 2, Paragraph 2.9.

D3 THE SOCIAL PROCESS AS A BASIS FOR MODEL CONCEPTUALISATION

Randers **[126]**, suggests that in order to establish a useful model, it is more productive to grasp hold of a social process (a chain of events- that is, a time development of interest or 'reference mode'), and ask about its cause, than it is to select a slice of the real world and ask what behaviour it will generate. This reference mode, will serve as a tangible manifestation of the entity that is being portrayed by the model output, and the smallest set of realistic cause and effect relations that is capable of generating the reference mode, will be called 'the basic mechanism'.

D4 THE RECOMMENDED PROCEDURE

While Randers **[126]**, provides a detailed recommended procedure for model construction, however his deliberations will be limited here to 'model conceptualisation', to retain the focus on the thesis content.

The goal of the conceptualisation stage is to arrive at a high level conceptual model, capable of addressing the relevant problem. The process pertaining to the conceptualisation stage described by Randers **[126]**, is rather unstructured, and lengthy, and will, for the purpose of functionality and ease of reference, be repeated here in bullet point format. The conceptualisation stage requires the following steps:

- Select a process (observed or hypothetical, taking place through time) to represent the focus of the study.
- Describe the chosen process in terms of the time varying behaviour of certain key variables, recording only the most general features of the behaviour. The resulting reference mode serves as an approximate picture of the expected output of the initial model. Furthermore, the reference mode helps define the problem with greater clarity – it determines the time horizon of the study, and it indicates the necessary level of aggregation and the extent of the system boundary in the model.

- Identify the fundamental real world mechanisms assumed to produce the reference mode by describing the smallest set of feedback loops, considered sufficient to generate the reference mode, that is, select the basic mechanisms. The dynamic behaviour of interest – the reference mode – and the related causal structure – the basic mechanism – determine in a precise way the aspect of reality to be studied. The reference mode helps to focus on a specific phenomenon instead of ending in diffuse mapping of the system and furthermore, the reference mode acts as a catalyst in the transition from general speculation about a problem to an initial model that can later be left for routine improvement. Inclusion of the basic mechanisms forces the addressing of a meaningful whole at all stages of model improvement. Subsequent models simply describe in more detail the fundamental relationships already present in the initial model.

D5 ROLES IN MODEL BUILDING

Richardson and Anderson **[136]**, identify the following five essential roles as part of the teamwork concept for model building:

- **The Facilitator:-** This person pays constant attention to group process, the roles of individuals in the group, and the business of drawing out knowledge and insights of the group.
- **The Modeller/Reflector:**- This person focuses on the model that is being explicitly formulated by the facilitator on the group. The modeller/facilitator serves both the facilitator and the group. He thinks and sketches independently, reflects information back to the group, restructures formulations, exposes un-stated assumptions that need to be explicit, and in general, serves to crystallise important aspects of structure and behaviour.
- **The Process Coach:**- This person focuses on the dynamics of individuals and sub-groups within the group.
- **The Recorder:**- This person documents the important parts of the group proceedings.
- **The Gatekeeper:**- This person usually initiates the project, frames the problem, identifies the appropriate participants and structures sessions.

D6 OTHER PERSPECTIVES ON MODEL CONCEPTUALISATION

The guidelines to model conceptualisation as provided by Randers **[126]**, map to the approach thereto suggested by Saeed **[143]**. According to Saeed **[143]**, the first requirement of the method is to organise historical information into a reference mode. The reference mode leads to the formulation of a dynamic hypothesis expressed in terms of the important feedback loops existing among the decision elements in the system, that create the particular time-variant patterns contained in the reference mode. The dynamic hypothesis must incorporate casual relations based on information about the decision rules used by actors in the system, not on the correlation between variables observed in historical data.

Saeed **[143]**, is further of the opinion, that it is possible to partition a system to be modelled into smaller subsystems and to develop a policy design based on the many models representing these subsystems. However, such a policy design will be effective only if the model of each subsystem subsumes multiple modes of behaviour separated by time and geography.

Another approach to model conceptualisation, appropriately called, "a structured approach to knowledge elicitation in conceptual model building", is suggested by Vennix *et al* **[173]**. This approach involves a combination of different techniques to arrive at a conceptual model. The techniques are chosen to fit the various tasks in model conceptualisation and to account for differences between individual and group tasks. The procedures allow for a large number of participants, which is according to Vennix *et al* **[173]**, important because in large corporate and public policy organisations the needed information is often scattered among many different people.

The approach according to Vennix *et al* **[173]**, consists of three stages namely:

- The first stage entails the development of a preliminary conceptual model by a project group, based on relevant literature and on general insights.
- In the second and third stages, the actual consultation of experts takes place. A method frequently used when consulting a panel of experts is the Delphi method, which uses a series of mailed questionnaires, the first of which starts

the process while subsequent questionnaires provide feedback from the first ones, often to promote consensus within the panel. The authors **[173]**, suggest that as normal questionnaires do not allow the respondent to deal with complex interrelations between variables, the second stage is followed by a 'workbook' to deal with such matter. Furthermore, the Delphi method is not intended for the use in situations that require direct interaction and confrontation between experts, and to bridge this deficiency, a structured workshop is suggested in stage three. These three stages would produce a final conceptual model, which in turn, has to be formalised, tested, and validated.

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'Give Life Time'

Do not get embittered when fate seems unkind to you.
You cannot see the outcome from your present point of view.
Someday, if you can wait and trust the reason you will see.
Give life time to spin the unseen threads of destiny[1].

[1] From Patience Strong's book: 'By Quiet Waters'.