CHAPTER 3: SYSTEMS AND MODELS

1. INTRODUCTION TO SYSTEMS

It is important to note the difference between the following concepts in the context of this thesis (Bellinger, 2001:1):

A system exists and operates in time and space. It is an entity that maintains its existence through the mutual interaction of its parts. The key emphasis here is one of "mutual interaction," in that something is occurring between the parts, over time, which maintains the system. A system is different from a heap or a collection. This definition of a system implies something beyond cause and effect. Rather than simply A affecting B, there is an implication that B also affects A. Examples of systems are particle, atom, molecule, cell, organ, person, community, state, nation, world, solar system, galaxy, and universe, in increasing levels of complexity. Bellinger believes that there is actually only one system, "the Universe". All other systems are really sub-systems of this larger system. He is of the opinion that all systems can be defined by the drawing of boundaries.

A model is a simplified representation of a system at some particular point in time or space. It is intended to promote understanding of the real system.

A simulation is the manipulation of a model in such a way that it operates in time or space to compress it. This enables one to perceive the interactions that would not otherwise be apparent because of their separation in time or space.

Systems approaches to the theoretical ordering of information are widely used in a variety of fields requiring scientific analysis, systematic study and simulation. Carter, Martin, Mayblin & Munday (1988:12) identified the following types of systems:

- Natural systems, such as the ecosystems of forests.
- Abstract systems, such as a set of linked mathematical equations or a computer program.
- Designed systems, such as telephone hardware.
- Systems of human activities, such as a person making coffee or people organising to meet a certain goal.

The study of human activities, however, is difficult due to the many and diverse variables that influence it. Scientists have developed several methods for studying human behaviour in organisations. The systems approach have proved most useful (Van der Merwe, 1989: 26-29). Systems have also been described as:

An organised structured whole composed of parts, derived from the Greek word "Systéma" (Mautner, 1997:554).

"...... a group of parts united by some form of regular interaction or interdependence, in such a way that they form a united whole" (Athos and Coffey ,1968:30).

"...... an organized whole, consisting of interrelating and interdependent parts.........Interdependency is a key concept in systems theory. The elements of a system interact with one another and are interdependent" (Beach,1980:137).

"........ something that is made out of parts that, in turn, are related in an orderly fashion" (Connellan,1978:18).

" .... An organisation of pieces which interface or operate together to accomplish the purpose for which they were designed" (Warren, 1979:19).

"....an integrated set of elements that interact with each other" (Briggs, Gustafson & Tillman,1991:5).

"....... a number of interdependent components that form a whole and work together with a view to attaining a common goal" (Gerber, Nel & van Dyk ,1998:35).

Systems are related to cybernetics which is the study of the control and internal governance of systems, where the various operations interact reciprocally and systematically (Scruton, 1992:124).

2. SYSTEMS THINKING

Systems thinking is a mindset for understanding how things work. The application of systems thinking is founded on the Gestalt concept. According to this concept the whole is more than a mere summation of its constituent parts (Davies, 1973:13). It is a perspective for going beyond events, to look for patterns of behaviour, to seek underlying systemic interrelationships which are responsible for the patterns of behavior and the events. It embodies a world-view which implies that the foundation for understanding lies in interpreting interrelationships within systems. The interrelationships are responsible for the manner in which systems operate and result in the patterns of behavior and events that are being perceived (Bellinger, 2001:1).

Lynch (1971:12) proposed that the following general aspects of systems be investigated in the context of systems analysis:

- The objectives of the system.
- The environment of the system.
- The resources of the system.
- The components of the system.
- The activities, goals and measures of performance of system components.
- The management of the system.

Romiszowski (1981:11) proposed that a systems approach to solving a problem will generally follow five general stages:

- Problem definition in systems terms.
- Analysis of problem with a view to generating alternatives.
- Selection and synthesis of an optimal solution.
- Controlled implementation.
- Evaluation and possible revision.

Ballé (1994:35-42) provided more insight on the analysis of the actual behaviour within a system. He is of the opinion that systems thinking allows an analyst or researcher to gain a more accurate impression of the actions and components of a system. He described the following conceptual characteristics of systems:

i. Systems thinking takes into account that the various forms of events or components of a system influence each other through different forms of feedback. A feedback loop may exist when A influences B in a cause and effect relationship, or in the form of a loop when A influences B and B again causes a change in A. The feedback may also exist in the relationships between more than two variables.

ii. A feedback diagram, or systems model, will be helpful in determining and reflecting the linear causes of actions within the system. It may be viewed as a story that follows a course of events to a conclusion.

iii. Certain behaviour and components in a system can cause various forms of delays that will influence the behaviour within a system. The delays should be objectively evaluated in the context of the behaviour and components of a whole system, rather than individual events.

iv. There are positive and negative influences on events and actions that take place within the system. These influences may change the behaviour and outcomes of the system. The outcomes that follow these influences may vary due to different circumstances that prevail within the system and its environment.

v. The population of a system refers to the number of roleplayers that are involved in the attainment of the required outcomes of the system. The behaviour of the system may change when the characteristics and behaviour of the population changes significantly.

vi. There is a causal relationship between the structure of the system and the dynamic behaviour that occurs within a system. Different structures may therefore cause different forms of behaviour and outcomes within a system.

vii. An influence diagram such as a systems model enables the explanation of concepts that will often be impossible or difficult to explain in writing or verbally.

viii. Systems models may be viewed as a form of language used to describe and predict the dynamic behaviour and outcomes of complex systems. This language allows researchers to understand the dynamics and complexities better.

ix. A systems approach provides a vocabulary to describe organisations in operational terms, as opposed to normal correlationary thinking mostly limited to relationships and not the eventual influences, causes and outcomes of relationships.

x. Operational thinking will normally focus on analysis resources, actions, motivations, conditions and delays, whereas in systems thinking the the dynamic influences, conditions and flow rates occurring in the model may also be added.

xi. Systems thinking is based on the principle that nothing comes from nothing and that all that is produced will stem from a primary resource. Resources refer to the stockpile of elements that can be used to produce an outcome. Only some resources are seen as renewable.

xii. The actions in a system can be viewed as that which is being done in the system. It will influence the flow of resources in the system.

xiii. Motivations are the reasons why roleplayers in a system do certain things. Motivations may be rooted in internal motives, the environment, structure or behaviour of other people.

xiv. Conditions are what people monitor to see whether they have achieved their objectives or goals. They serve as points of reference and have a primary impact on the actions within a system.

3. CLASSIFICATION OF SYSTEMS

3.1 Introduction

Systems may be simply characterised as open or closed, although no system will ever be totally open or closed. The distinction can be explained as follows (Carter et al, 1988:7 ; Bellinger, 2001:2):

A totally closed system would be self-contained, with no environment at all. It could not be influenced by any external events and it would not serve any purpose in an external environment. A closed system is one that does not need to interact with its environment to maintain its existence. Examples are atoms and molecules. Mechanical systems are closed systems.

A totally open system is an organic system that must interact with its environment in order to maintain its existence and the environment will at least be influenced by the actions within and output of the system. An open system may interact with its environment in a growth or balancing fashion.

3.2. Boulding's Classification

Five general classes of systems which encompass all other systems were defined by Boulding (in Bellinger, 2001:2-3). These classes provide a means of understanding some general characteristics of systems. These systems are arranged in what Boulding considered to be an evolutionary hierarchy.

3.2.1 Parasitic System

This is a system in which a positive influence from one element to another provides a negative influence in return to the first element, eg: " I get positive things from you and provide you a negative return in response. Essentially I subsist on you."

3.2.2 Prey/Predator System

In this type of system the elements are essentially dependent on each other from the perspective that the quantity of one element determines the quantity of the other element. Foxes and rabbits are an example of such a system. Even though the fox may eat an individual rabbit, the fox is instrumental in maintaining the health of the overall rabbit population. "I will feed upon you even though my existence is dependent upon your existence."

3.2.3 Threat System

A threat system is one in which one element doesn't do something if the other element doesn't do something else. The U.S./Soviet Arms Race was a specific example. This particular example lead to escalation since each side said to the other, "if you start a war I will destroy you." Yet to continue to validate the threat each side had to continue building arms. This is a fine example of two countries racing headlong to where neither of them wanted to be. Other examples are "if you don't do something I don't want you to do then I won't do something you don't want me to do" or "if you do something I want you to do, then I won't do something you don't want me to."

3.2.4 Exchange System

The capitalist economy is a very good example of an exchange system. Elements of the system provide goods and services to other elements in exchange for money or other goods and services, eg "if you do something I want you to do, then I will do something you want me to do". This may also be stated as "if I do something you want me to do then I expect you will do something I want you to do."

3.2.5 Integrative System

Examples of an integrative system are charitable organisations or business endeavors where individuals will co-operate to accomplish some common desired objective or goal. This means that they do something together because of what they want to accomplish.

3.3 Bellinger's Classification

Bellinger (2001:3) recognises the classification of Boulding, but proposed the following supplementary classification method based on the actual behaviour that occurs in a system.

A Protection System is reactive and will only act when certain events occur.

A Regulating System continuously measures or samples control variables and compares actual results with pre-set desired values and responds by adjusting accordingly to regulate control variables.

An Optimising System is systemic by nature and regulates selected variables in accordance with desired values. It also ascertains what the desired values should be to satisfy pre-determined goals.

An Adaptive System is evolutionary in that the system changes its internal structure in order to optimise its behaviour in spite of continuous changes in the environment.

3.4 The nature of employment systems

The relationships between employers and employees are systems that are often transformed from an exchange system to a threat system. The employee is hired under an exchange premise. "I will pay you (what you want) if you do this work (what I want)".

Once the employee is hired the situation changes and becomes, "if you do what I want, I won't fire you." The greatest leverage is found in integrative systems, where all individuals are motivated by what they are endeavoring to create (Bellinger, 2001:3).

4. CHARACTERISTICS OF OPEN SYSTEMS

The following discussion is a summary of related literature in Gerber et al (1998:34-38), Connellan (1978:15-19), Katz&Kahn,1978:17-34, Baron (1986: 427-430), Cascio (1982:40), Arnold & Feldman,(1988:3-12) and Carter, Martin, Mayblin & Munday (1988:8-23).

4.1 Input process:

Any open system depends on the intake of energy or input to activate the functioning process. Input in organisations may include labour, capital, resources and information.

4.2 Transformation process:

All open systems transform inputs by means of a specifically ordered transformation process, in order to produce the desired outcome that the system aims to provide. Transformation processes will therefore differ between systems.

4.3 Output process:

Each open system has an output process that will be the result of the transformation of input in transformation process. The way in which the specific transformation of input takes place, will depend on the nature and specifications of the output. It is therefore important to know which output is desired from a system before deciding on the input and throughput processes. A system can evaluate its outcomes, and feeds back the evaluation information into the system components and processes. It will therefore be possible to modify a system as necessary, to correct or improve its performance, or to adapt the goals or targets. Goals and targets represent the required outcomes of the system.

4.4 A process or cycle of events takes place:

The output of the system is generated through a cycle of events that takes place between and in the system components. This new output energy will often be re-introduced to the system as new input.

4.5 Mutual dependence:

The components of a system are interdependent on one another. Should a change take place in one part of the system, all the other components of the system will be directly or indirectly influenced.

4.6 Control of output

The output of a system will depend on the system environment, system structure and the processes that occur within the system. Control over the aforementioned can take place in the form of a self-maintaining causal network that will maintain itself in the same general state indefinitely (eg, rainforests).

It is also possible to exercise deliberate or purposeful control of structures and processes in a system to achieve a preset goal or desired outcome (eg. Making ice cream). This control form involves:

- Specialised arrangements for decision making and control.
- Free choice among a number of competing alternatives.

Outcomes are determined by choices made in accordance with a plan and not just by the working of natural forces. Purposeful models will require a controller who may perform the role of a change facilitator or a direct interventionist. Effective purposeful control requires that controllers have in-depth knowledge and understanding of a system's functioning, and the effects those different interventions will have on systems outcomes.

4.7 A system has boundaries

The boundaries of a system will indicate the outer perimeters of the environment that will interact with the components of the system. Boundaries will depend on whether the system is open or closed. A closed system is self-sustaining and independent from all external input or influences, whereas an open system will take inputs from its environment, process the inputs in a specific throughput pattern and return the inputs to the environment in a different form as an output. A system will therefore be open if there is interaction and mutual dependence between the system and the environment.

5. LABOUR RELATIONS AS AN OPEN SYSTEM

It is apparent that a systems approach toward the analysis of labour relations in South Africa would necessitate the analysis of a whole, which comprises components and interactions within a specific environment. Carter <u>et al</u> (1988:40) propose that the following questions be asked to ascertain whether a phenomenon has systemic content:

i. Is it reasonably clear what success would consist of?
ii. Is the effort spent on analysis justifiable, or is the phenomena simple to understand?
iii. Will an investigation lead to the answering of questions such as "how does it work" or what causes behaviour?
iv. Will information on the particular nature of the phenomenon be an important contributor to the effective answering of a question, solving of a problem or the completion of a task?

Specific statements that represent the characteristics of open systems may prove useful to establish criteria statements. These criteria statements can be applied to determine whether a specific phenomenon possesses an open systems nature.

Table 3-1 reflects such statements and tabulates the relationship between labour relationship characteristics and the characteristics of open systems. The statements were identified from the discussion of system characteristics, and were used as criteria to determine whether labour relations as a field of study can be represented as an open system. A perusal of the content of Table 3-1 provides adequate proof that labour relations can be viewed as an open system.

TABLE 3-1: LABOUR RELATIONS AS AN OPEN SYSTEM

CHARACTERISTICS OF OPEN SYSTEMS	LR COMPLIANCE
1. A system will process, or transform, input to a form of output.	COMPLIES
2. A system functions in an environment, and will be influenced by the environment, and may also influence its environment.	COMPLIES
3. A system is composed of components that are all part of the input, transformation and output processes in a system.	COMPLIES
4. System components may contain related sub-components, which are also linked to and dependent on the processes taking place in the model, and other components and sub-components.	COMPLIES
5. Components are linked and mutually dependent. The connecting links between components represent the interaction and causal connections between components.	COMPLIES
6. Connecting links between components represent processes, that makes the system components interact according to a cycle of events to achieve its output.	COMPLIES
7. The input and transformation components and processes of a system may be controlled to achieve a specified output. To enable control a specific outcome needs to be defined.	COMPLIES
8. There are boundaries to the system and its components.	COMPLIES

6. INTRODUCTION TO MODELS

A model may be defined as different forms of abstractions of reality at a given time through a simplified representation of a particular real-world phenomenon (Robbins, 2001:19). Models exist most commonly as mental pictures or stories that represent people's assumptions about how their world works. These mental models tend to be stable, consistent and often over-simplified and are the product of education, experience, purpose and context. They are used in specific ways. Mental models are required to think, and have the potential to limit or expand human thought and subsequently the aim should be to analyse and manage mental models (Ballé, 1994:33).

Hanneman & McEwan (1975:23) define a model as "..... a structure of symbols and rules for relating those symbols, isomorphic with a set of points (data or theoretic) in an existing structure or process." It is accepted that all models are speculative by nature and will take on the form of theories and statements concerning laws and principles. Models provide a researcher with an organised structure which can be applied to test assumptions in practice (Hanneman et al, 1975: 421). A model may also be viewed as a conceptual framework, or structure that has been successfully developed in one field and is then applied, primarily as a guide for research and thinking, in some other, usually less well-developed field (Marx & Goodson,1976:244).

A model can be especially useful if it has been found to posses an acceptable level of predictive validity, since it may then be used to make predictions that will enable researchers to make inferences without having to laboriously observe and test phenomena that may lie in future. The predictive function will further enable researchers using a model, to predict alternative outcomes of behavioural events with a higher probability than what would have been the case without a model (Hanneman et al,1975: 424 & 428).

According to Marx and Goodson (1976:245) the use of a model relieves the researcher, or at least may be intended to relieve a researcher, of the responsibility for checking the adequacy of any substantive theoretical propositions. The researcher is, however, still expected to accept more responsibility in establishing relationships in the construction of a model. The symbols that are used to construct a model may be viewed as representations of related principles or theories. Literature indicates that it is possible to construct either symbolic or physical models. Hanneman et al (1975:428) are of the opinion that symbolic models, which include mathematical and verbal models, are easily co-ordinated to the subject matter, because only the logical characteristics of a system are symbolised.

7. RESEARCH APPLICATIONS OF MODELS

Marx and Hillix (1963:52) proposed that a model and theory supplement each other. They explain the difference between theory and models in the following words: "Today we hear less about theories and more about models. What is the difference? The theory claims to be true, even though we all know that assurance about the validity of these claims varies greatly from theory to theory and from time to time for the same theory. The theory is an 'as', whereas the model is an 'as-if'. The theory is indicative, the model, subjunctive."

The use of a sound theoretical foundation to describe and organise the components and principles in the construction of a theoretical model, enhances the possibility of high descriptive and content validity of the components in, and processes of a system or whole under consideration. The proposing and proving of hypothesis for purposes of model construction and validation, will therefore contribute to the theoretical worth of a model, since a researcher will be in a position to prove propositions and deductions that were applied in the process of constructing the theoretical model.

Hypothesis in this regard, may include statements aimed at establishing content validity, representation, discrimination ability, reliability, consistency, overlap, applicability, theoretical soundness, predictive validity, flexibility or any other relevant criteria which are required for the purposes of the research.

8. MODEL CONSTRUCTION

The following table provides a broad overview of the most important steps that need to be considered in the construction of a scientifically valid model. The table was adapted from Erasmus, 1991:32 and Carter et al, 1988:1-17.

TABLE 3-2: STEPS IN THE CONSTRUCTION OF A THEORETICAL MODEL

1.	Consider the **FUNCTION** that the abstraction should fulfil and decide if a model is the most appropriate form.
2.	Consider the **ADVANTAGES AND DISADVANTAGES** of a model in the specific circumstances.
3.	Consider the **SCIENTIFIC REQUIREMENTS** that need to be met in the specific circumstances.
4.	Consider the **TYPE** of model that will be constructed.
5.	Consider the different **VARIABLES** which may influence the nature and specifications of the model that is to be constructed.
6.	Define the actual **STEPS** that will be followed in constructing the model.
7.	Determine the **EVALUATION** method that will be used to evaluate the model.

The following is a discussion of the various steps that should be followed in the construction of a theoretical model:

8.1 Functions of models

8.1.1 Organise

A model allows a researcher to organise and structure theoretical concepts in a manner that allows the analysis and explanation of a phenomenon as a whole, instead of isolated individual components.

8.1.2 Explore

Models allow researchers to explore and analyse the dynamic relationships and interaction within a system for purposes of the development of new theories and solutions to problems.

8.1.3 Predict

Marx & Hillix (1963:54) were of the opinion that theories can no longer be founded on superficial statements without real predictive value. A well researched and valid model allows researchers to predict alternative outcomes of behavioural events with a higher probability than what would have been possible without a model (Hanneman et al, 1975: 432).

8.1.4 Measure

Measurement can only be done if the desired objective has been defined, and preferably clearly quantified. The outcomes that are defined in a model can be used for purposes of measurement, if the outcome of the model can be compared to the actual outcomes of a real-world system or phenomena. It will also be possible to determine the relationship between specific levels of outcome and behaviour of different influencing variables if the outcomes and behaviour in a system are accurately measured.

8.1.5 Explain

A valid model has the benefit that it can explain the relationships that occur in a system in the context of the whole system. The various behavioural outcomes of a system can also be traced and explained in terms of the influence of various systems components and actions that are causal to the outcome. A model also has the benefit that it can explain primary, secondary and even tertiary influences on variables and activities.

8.1.6 Illustrate

Models provide an illustration of the flow of activities in a system at a given point in time by means of drawings, diagrams, flowcharts or writing. This is especially beneficial when researchers and learners are required to understand the relationships between abstract or behavioural concepts.

8.2 Advantages and disadvantages of models

The obvious disadvantage of a model is that it is only a representation of a real world phenomenon, and that the actual behaviour in the phenomena may differ from the behaviour being represented and explained by the model. A model may also be invalid if it was developed without recognising the principles, environment or specific peculiarities of the phenomena being represented. Models may also lead to generalisation or oversimplification of complex phenomena, which in turn may lead to ineffective decisions or actions that are directly related to the phenomena. In spite of these disadvantages, a model still holds considerable benefits for research in behavioural sciences which is often abstract and complex.

Models lead to greater precision in thinking due their logical and explicit nature. The objective of research is to solve problems or to explain phenomena and models have proved to be most useful tools in this respect. A model will also allow a researcher to investigate practical phenomena and convert it to theory. This means that a researcher may convert an abstract or physical phenomenon into a structured theoretical model that has the ability to represent and explain the components and actions in a system. This leads to a closer relationship between theory and practice. Models are also suitable for the representation of systemic phenomena. The various input, transformation and output components of a system are easily converted to a structured model. The relationships and interactions in the system can also be represented in the model. Physical models provide an opportunity to analyse and evaluate physical realities of an object before constructing the object. The accurate representation of reality through a model may also hold economic benefits in the sense that accurate models will lead to improved decisionmaking (Erasmus, 1991:18-22).

8.3 Scientific requirements

8.3.1 Definitions of applicable research concepts

The following are brief definitions of some of the most important scientific requirements that should be met before a theoretical model can be viewed as valid (Robbins, 2001: 26-42; Chadwick et al, 1984:433-443; Kreitner & Kinicki, 1998:16 -18):

i. Validity refers to the degree to which a model is actually representing or explaining what it claims to.

ii. Reliability refers to the consistency of the same method of measurement which are made by different persons, or at different time periods. Different persons should therefore be able to agree on the validity and generalisability of a model.

iii. Generalisability refers to the degree in which results of a research study is applicable to groups of individuals other than those who participate in the original study. A model should therefore be representative of the components and behaviour of the system that it wishes to represent and explain.

iv. Analysis is the process of studying the nature of events, cultures, practices or other social entities by identifying component parts and how they relate to each other and to the larger entities in which they occur.

v. A variable is any general characteristic that can be measured and that changes in either amplitude, intensity or both. Variables may exist, among others, on individual levels, group levels, organisational system levels, process levels, interaction levels, physical levels or environmental levels. A dependent variable is a response that is affected by an independent variable. An independent variable is the presumed cause of some change in the dependent variable. A moderating variable abates the effect of the interdependent variable on the dependent variable. It is also known as a contingency variable. It is important to identify and categorise the different variables that are represented within a model.

vi. Causality refers to the implication that the independent variable causes the dependent variable. Proof of causality between behaviour and/or components will be required to determine the predictive validity of a model.

8.3.2 Research methodology

Several authors are of the opinion that most research projects are executed in accordance with basic steps (Kreitner & Kinicki, 1998:645, Chadwick et al, 1984:35). Figure 3-3 reflects such steps.

FIGURE 3-3: GENERIC STEPS IN A RESEARCH PROJECT

1. Select the area of investigation, and formulate the research problem. Clear propositions or empirically testable hypotheses should be identifiable

2. Review relevant literature on the area of investigation and research methods, as well as previous research

3. Formulate hypotheses, if the research problem has not been solved

4. Determine the research universe or sample, and design a research procedure to test hypotheses

5. Apply the research procedure by collecting data and processing the data into a practical format

6. Analyse results that were obtained through the application of acceptable interpretation methods

7.1. If the results do not support hypotheses, revert back to step 1, to develop alternative hypotheses

7.2. If the results support the hypotheses at required scientific levels, results should be reported

8.4 Types of models

8.4.1 Symbolic models

Symbolic models use numbers, words and symbols to represent specific characteristics and behaviour within phenomena. They are normally easily co-ordinated with the actual subject matter, since it only symbolizes the logical characteristics of a system or phenomena (Hanneman et al, 1975:428).

i. Mathematical models

A mathematical model is constructed in such a way that a quantifiable evaluation of outcomes and interactions can be achieved. These normally have predictive ability in specific statistical, mathematical and economic applications. These types of models were not considered for the purpose of this thesis, due to the need for a model that can explain behaviour and behavioural outcomes that are mostly difficult to quantify.

ii. Verbal models

A verbal model will use words and diagrams to represent the components of and explain the activities that occur within a phenomena. These are commonly applied in behavioural science since they provide an effective method for representing and explaining abstract and logical behavioural phenomena. Verbal models are typically applied in the early phases of the development of a science and for the most part constitute the type of model still prevalent in behavioural and communication research (Hanneman et al, 1975:426).

8.4.2 Physical models

Physical models will normally be encountered in the form of replica scale models of an object or a drawing of a structure. Physical models were not considered for purposes of this thesis.

8.4.3 Open models

Models can be classified as either open or closed. An open model considers that outside factors exist which can have an impact on the design process (Nadler,1982:6). An open model interacts with the environment and has a number of characteristics:

- it tends to be verbal as opposed to a closed model which is mathematical,
- it is descriptive in nature, as it tends to describe a likely outcome if the model is applied,
- it provides no guarantees on the outcomes of the design process and feedback is not automatic in open models ,
- it has to be catered for specifically if required.

8.4.4 Closed models

A closed model will be based on the assumption that all inputs can be identified (Nadler, 1982:6). All possible variables are normally included when a model is constructed. A closed model has the following characteristics:

- it is predictive in the sense that the outcome is predictable,
- it tends to be mathematical; it is distinguished by the use of algorithms or yes-no choices,
- movement through the model tends to be linear.

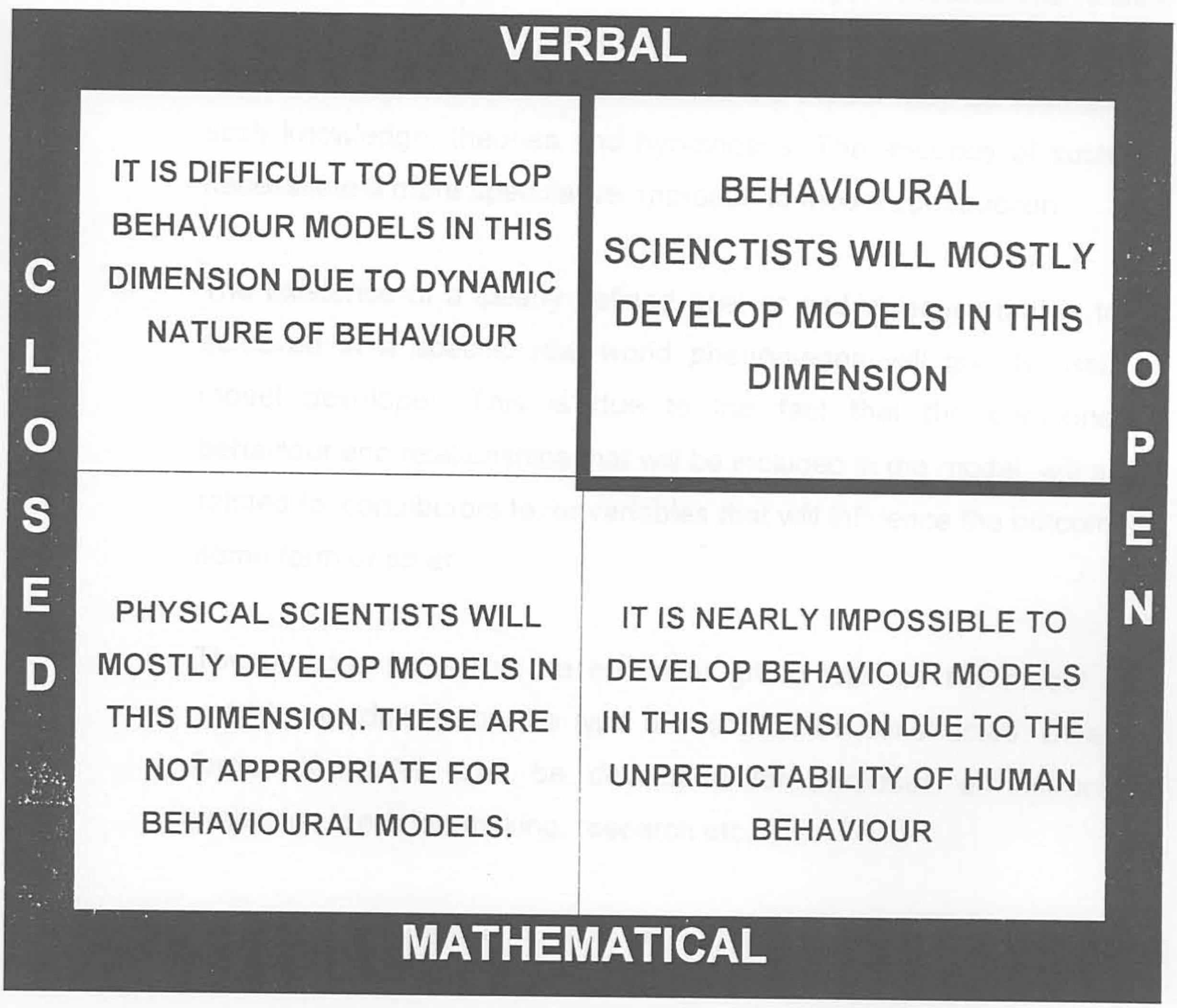
8.4.5 Dimensions of models

Models exist in certain dimensions. These dimensions can be defined as:

- Open or closed
- Verbal (symbolic) or mathematical.

Figure 3-4 illustrates the dimensions of models and the most appropriate dimensions for the development of behavioural models.

FIGURE 3-4: DIMENSIONS OF MODELS



8.5 Variables influencing the choice of model

Erasmus (1991:23) and Carter et al (1988:10) propose that the following variables be considered when deciding on the type and nature of a model that is to be constructed:

i. The actual nature of the whole or system under consideration. Certain themes can be easily analysed without the use of a model, whereas others that are more complex and dynamic must be represented in the form of a model.

ii. The quantity and quality of available knowledge, validated and reliable theories and existing proven hypotheses will largely assist a researcher in the development of a model, since the model may be founded on such knowledge, theories and hypotheses. The absence of such will necessitate a more speculative approach to model construction.

iii. The existence of a clearly defined goal or end objective that is to be achieved in a specific real world phenomenon will greatly assist a model developer. This is due to the fact that the components, behaviour and relationships that will be included in the model, will all be related to, contributors to, or variables that will influence the outcome in some form or other.

iv. The purpose for which the end user group will use the model also provides guidelines on the type of model to be constructed. Different forms of models can be developed for purposes of instruction, prediction, decision-making, research etc.

v. The scope of a model could be defined as broad or narrow. A broader scope of application could necessitate the development of a more comprehensive and complex model, whereas a narrow scope could only require a simple model.

vi. The description level of a model could be viewed as the resolution or level of measurement, that the researcher will be applying in the investigation process. A coarse resolution investigation normally refers to a less detailed investigation and requires a simple model. A fine resolution investigation might require a more detailed and complex model that has the ability to represent multiple variables under consideration.

vii. The nature of components, processes and resources will influence the choice of models. A motorcar may easily be represented as a physical scale model, but abstract constructs would require verbal descriptions and symbolic representations.

viii. The timescale during which events occur within a phenomenon will influence the nature of the model, due to the fact that behaviour and the nature of components and output needs may change over time.

ix. The availability and willingness of experts to contribute to the development of a model will influence the choice of model. A complex and detailed model would require the input of experts, opposed to a simple model that can be easily constructed through observation and analysis by a single investigator.

8.6 Steps in the development of a systems model

A detailed description of the steps that were followed in researching and developing the model for purposes of this thesis was included in Chapter two.

8.7 Evaluation of a model

A model should be evaluated in the context of the purpose for which the model is designed (Hanneman et al, 1975:432). The evaluation of a model is situation bound, and therefore the worth of a model is arbitrary. A model cannot be viewed as true or false, since its value will be judged against the actual contribution to the understanding of a phenomena or problem at hand. Marx & Hillix (1963:245) were of the opinion that researchers involved in the development of a model are often not directly concerned with the validity of their assumptions, but only with their practical value in leading them to useful research and interpretation. They will therefore often rely on assumptions that are assumed to be true. Although this approach seems to be practical and focused on problem solving, it may lead to the development of models that are invalid and unreliable.

A validated model will be more reliable, useful and applicable if it has been evaluated against recognised criteria for determining validity, reliability and generalisability. There are several evaluation methods that can be applied for this purpose. The evaluation methods that were applied for purposes of this thesis were comprehensively discussed in Chapter two.

9. SUMMARY

The first part of this Chapter provided definitions and an overview of systems and systems thinking. It was concluded that labour relations phenomena could indeed be analysed and represented as a system. The latter part of the Chapter introduced the concept of constructing valid models as a research method and provided an overview of the different variables that should be considered in the process of constructing a theoretical model. This Chapter established that the development of a theoretical model of the South African labour relations system is possible, and that specific guidelines in this regard have been defined in literature.