

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 loop¹, 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 subsequently 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 management¹, 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 <i>structured systems approach to model conceptualisation</i> 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 <i>structured systems approach to model conceptualisation</i> 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 <i>structured systems approach to model conceptualisation</i> , 'red tape' can be eliminated? |
| Question 6 | The holistic perspective of the <i>structured systems approach to model conceptualisation</i> 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 <i>structured systems approach to model conceptualisation</i> , has the potential to facilitate model building aimed to address unstructured complex phenomena? |
| Question 9 | The <i>structured systems approach to model conceptualisation</i> 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 <i>structured systems approach to model conceptualisation</i> , 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 | <i>Diplom Ing.</i> | 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 | <i>Diplom Ing.</i> | 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 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 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 making² 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 executives³.

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 appendix¹, 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: HarperCollinsPublishers, 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 '*entelechy*' (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. Descartes 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 Immanuel 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 than 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 particularly 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 Linstone [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 | <p>Familiarisation with the general problem area.</p> <p>Definition of the question to be addressed –either: What caused a given development? or, What are the likely effects of a given policy?</p> <p>Description of the time development of interest (the reference mode) –defining the time horizon and the range of time constants in the model.</p> <p>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.</p> <p>Development of powerful organizing concepts.</p> <p>Description of the basic mechanisms in causal diagram form</p> |
| Formulation | <p>Postulation of detailed structure –selecting levels, selecting rates and describing their determinants.</p> <p>Selection of parameter values.</p> |
| Testing | <p>Testing the dynamic hypothesis –Do the basic mechanisms actually create the reference mode?</p> <p>Testing of model assumptions –Does the model include the important variable? Are the assumed relationships reasonable? Are parameters plausible?</p> |
| Implementation | <p>Testing of model behaviour and sensitivity of perturbations.</p> <p>Testing the response to different policies.</p> <p>Identification of potential users.</p> <p>Translation of study insights to an accessible form.</p> <p>Diffusion of study insights.</p> |

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 effect².

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.

Bibliography

- [1] Abdel-Hamid, T.K. Madnick, S.E. *The Elusive Silver Lining: How We Fail to Learn from Software Development Failures*. Sloan Management Review. Fall 1990.
- [2] Ackoff, R.L. (1960) *Systems, Organizations, and Interdisciplinary Research*. Contained in: *Systems Thinking. Selected Readings (1969)* Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [3] Ackoff, R.L. (1994) *The Democratic Corporation*. Oxford University Press. New York. Oxford.
- [4] Ackoff, R.L. Emery, F.E. (1972) *On Purposeful Systems*. Tavistock Publications. 11 New Fetter Lane, London EC4.
- [5] Ackoff, R.L. Rivett, P. (1967) *A Manager's Guide to Operations Research*. John Wiley & Sons. New York. London. Sydney.
- [6] Ackoff, R.L. Sasieni, M.W. (1968) *Fundamentals of Operations Research*. John Wiley & Sons. New York. London. Sydney.
- [7] Ackoff, R.L. *Beyond Prediction and Preparation*. Journal of Management Studies. Vol. 20, No. 1, 1983.
- [8] Ackoff, R.L. (1974) *Redesigning the Future: A Systems Approach to Societal Problems*. John Wiley & Sons. New York. London. Sydney. Toronto.
- [9] Ackoff, R.L. (1978) *The Art of Problem Solving*. John Wiley & Sons. New York. Chichester. Brisbane. Toronto.
- [10] Ackoff, R.L. *The Systems Revolution*. Long Range Planning. Vol. 7, No. 6. December, 1974.
- [11] AMA Report. *Today's Business Realities: Confusion and Uncertainty*. American Management Association. December 1996.
- [12] Andersen, D.F. *Analyzing Who Gains and Who Loses: The Case of School Finance Reform in New York State*. System Dynamics Review. Vol. 6, No. 1, Winter 1990.

- [13] Angyal, A. (1941) *A Logic of Systems*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [14] Aoki, M (1976) *Optimal Control and System Theory in Dynamic Economic Analysis*. North-Holland Publishing Company. New York. Oxford. Amsterdam.
- [15] Argyris, C. (1970) *Intervention Theory and Method: A Behavioural Science View*. Addison–Wesley Publishing Company. Reading, Massachusetts. Menlo Park, California. London. Don Mills, Ontario.
- [16] Ashby, W.R. (1960) *Adaptation in the Multistable System*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [17] Ashby, W.R. (1956) *Self-regulation and Requisite Variety*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [18] Athey, T.H. (1982) *Systematic Systems Approach. An Integrated Method for Solving Systems Problems*. Prentice-Hall, Inc. Englewood Cliffs, New Jersey 07632.
- [19] Ballé, M. (1994) *Managing with Systems Thinking*. McGraw-Hill Book Company. London. New York. St. Louis. San Francisco. Auckland. Bogotá. Caracas. Lisbon. Madrid. Mexico. Milan. Montreal. New Delhi. Panama. Paris. San Juan. São Paulo. Singapore. Sydney. Tokyo. Toronto.
- [20] Beck, L.L. (1973) *An Ode to Problem Solving Using the Systems Approach*. Contained in: *The Educational Technology Review Series. Number three. Introduction to the Systems Approach.*(1973) Educational Technology Publications, Inc. 140 Sylvan Avenue, Englewood Cliffs, New Jersey 07632.
- [21] Beer, S. (1970) *Decision and Control. The meaning of Operational Research and Management Cybernetics*. John Wiley & Sons. London. New York. Sydney. Toronto.
- [22] Beer, S. (1981) *Brain of the Firm: The Managerial Cybernetics of Organization*. Second Edition. John Wiley & Sons. Chichester. New York. Brisbane. Toronto.

- [23] Beer, S. (1995) *Diagnosing The System for Organizations*. John Wiley & Sons. Chichester. New York. Brisbane. Toronto. Singapore.
- [23a] Blake, R.R. Mouton, J.S. *Change by Design, Not by Default*. Essay contained in: *Tomorrow's Organizations: Challenges and Strategies*. Editors: Jun, J.S. Storm, W.B. (1973) Scott, Foresman and Company. Glenview, Illinois. Brighton, England.
- [24] Blanchard, B.S. (1992) *Logistics Engineering and Management*. Fourth Edition. Prentice Hall. Englewood Cliffs, NJ 07632.
- [25] Bond, P.L. *Technics and Systemicity: Keys to Technology Management Beyond Year 2000*. Paper presented at PICMET 1997. Innovation in Technology Management: Proceedings of the Portland International Conference on Management of Engineering and Technology. Portland, Oregon, USA. July 27 – 31, 1997.
- [26] Brancheau, J.C. Wetherbe, J.C. *Key Issues in Information Systems Management*. MIS Quarterly. March 1987.
- [27] Capra, F. (1996) *The Web of Life: A New Synthesis of Mind and Matter*. HarperCollinsPublishers. 77 – 78 Fulham Palace Road, Hammersmith, London W6 8JB.
- [28] Cavalieri, M.T. (1986) *The Systemic Perspective and Psychotherapy: A Literature Survey*. Human Sciences Research Council. Pretoria.
- [29] Checkland, P. (1989) *Systems Thinking, Systems Practice*. John Wiley & Sons. Chichester. New York. Brisbane. Toronto.
- [30] Churchman, C.W. (1968) *Challenge to reason*. McGraw-Hill book Company. New York. San Francisco. St. Louis. Toronto. London. Sydney.
- [30a] Churchman, C.W. and Ackoff, R.L. (1950) *Methods of Inquiry: An Introduction in Philosophy and Scientific Method*. Educational Publishers, Inc. Saint Louis.
- [31] Churchman, C.W. (1982) *Thought and Wisdom*. Intersystems Publications of the Systems Inquiry Series. Seaside, Calif. 93955.
- [32] Churchman, C.W. (1979) *The Systems Approach and Its Enemies*. Basic Books, Inc., Publishers. New York.

- [33] Churchman, C.W. Ackoff, R.L. Arnoff, E.L. (1966) *Introduction to Operations Research*. John Wiley & Sons, Inc. New York. London. Sydney.
- [34] Churchman, C.W. (1983) *The Systems Approach*. Dell Publishing Co., Inc. New York, NY 10017.
- [35] Churchman, C.W. (1971) *The Design of Inquiring Systems: Basic Concepts of Systems and Organization*. Basic Books, Inc., Publishers. New York. London.
- [36] Clark, Jr, T.D. Augustine, Jr, F.K. *Using System Dynamics to Measure the Value of Information in a Business Firm*. System Dynamics Review. Vol. 8, No. 2, Summer 1992.
- [37] Clark, Jr, T.D. Trempe, R.E. Trichlin, H.E. *Complex Multiechelon Inventory System Management using a Dynamic Simulation Model*. Decision Sciences. Vol. 14, 1983.
- [38] Cleland, D.I. King, W.R. (1972) *Management: A Systems Approach*. McGraw-Hill Book Company. New York. St. Louis. San Francisco. Düsseldorf. Johannesburg. Kuala Lumpur. London. Mexico. Montreal. New Delhi. Panama. Rio de Janeiro. Singapore. Sydney. Toronto.
- [39] Clemson, B. (1984) *Cybernetics: A New Management Tool*. Abacus Press, Abacus House, Turnbridge Wells, Kent. TN4 0HU.
- [40] Cook, T.M. Russell, R.A. (1981) *Introduction to Management Science*. Prentice-Hall, Inc. Englewood Cliffs, New Jersey 07632.
- [41] Cooper, K.G. *Naval Ship Production: A Claim Settled and a Framework Built*. Interfaces. Vol. 10, No. 6, December 1980
- [42] Davenport, T.H. Stoddard, D.B. *Reengineering Business Change of Mythic Proportions?* MIS Quarterly. June 1994.
- [43] Davis, G.B. (1974) *Management Information Systems: Conceptual foundations, Structure, and Development*. McGraw-Hill International Book Company. Auckland. Bogotá. Guatemala. Hamburg. Johannesburg. Lisbon. Madrid. Mexico. New Delhi. Panama. Paris. San Juan. São Paulo. Singapore. Sydney. Tokyo.
- [44] Dearden, J. *MIS is a Mirage*. Harvard Business Review. January – February 1972.

- [45] Dickerson, S.L. Robertshaw, J.E. (1975) *Planning and design: A Systems Approach*. Lexington Books. D.C. Heath and Company. Lexington. Massachusetts. Toronto. London.
- [46] Duhl, B.S. (1983) *From the inside out, and other metaphors. Creative and Integrative Approaches to Training in Systems Thinking*. Brunner/Mazel, Inc. 19 Union Square West, New York, N.Y. 10003.\
- [47] Easterby-Smith, M. Thorpe, R. Lowe, A. (1992) *Management Research: An Introduction*. Sage Publications. London. Newbury Park. New Delhi.
- [48] Emery, F.E. Trist, E.L. (1965) *The Causal Texture of Organizational Environments*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [49] Emery, F.E. Trist, E.L. (1960) *Socio-technical Systems*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [50] Emory, C.W. Cooper, D.R. (1995) *Business Research Methods*. Fifth Edition. Irwin. Homewood, IL 60430. Boston, MA 02116.
- [51] English, F. (1973) *What Philosophy Systems Approach?* Contained in: *The Educational Technology Review Series. Number three. Introduction to the Systems Approach*. (1973) Educational Technology Publications, Inc. 140 Sylvan Avenue, Englewood Cliffs, New Jersey 07632.
- [52] Feeny, D.F. Willcocks, L.P. *Core IS capabilities for exploiting information technology*. Sloan Management Review. Spring 1998.
- [53] Feibleman, J. Friend, J.W. (1945) *The Structure and Function of Organization*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [54] Feintuck, A. Saeks, R. (1982) *Systems Theory: A Hilbert Space Approach*. Academic Press. San Diego, San Francisco. São Paulo. Sydney. Tokyo. Toronto.
- [55] Flood, R.L. (1990) *Liberating Systems Theory*. Plenum Press. New York. London.

- [56] Flood, R.L. Jackson, M.C. (1991) *Creative Problem Solving: Total Systems Intervention*. John Wiley & Sons. Chichester. New York. Brisbane. Toronto. Singapore.
- [57] Ford, A. *Estimating the Impact of Efficiency Standards on the Uncertainty of the Northwest Electric System*. Operations Research. Vol. 38, No. 4, July-August 1990.
- [58] Ford, A. Bull, M. *Using System Dynamics for Conservation Policy Analysis in the Pacific Northwest*. System Dynamics Review. Vol. 3. No. 1, Winter 1989.
- [59] Forrester, J.W. 14 "Obvious Truths". System Dynamics Review. Vol. 3, No. 2. Summer 1987.
- [59a] Forrester, J.W. (1972) *Industrial Dynamics*. The M.I.T. Press. Massachusetts Institute of Technology. Cambridge. Massachusetts.
- [60] Forrester, J.W. Senge, P.M. (1980) *Tests for Building Confidence in Systems Dynamics Models* in Augusto A. Legasto, Jay W. Forrester and James M. Lyneis (eds.) *System Dynamics*. New York: North Holland.
- [61] Frey, M.A. Sieloff, C.L. (1995) *Advancing King's Systems Framework and Theory for Nursing*. Sage Publications. International Educational and Professional Publisher, Thousand Oaks. London New Delhi.
- [62] Galliers, R.D. Land, F.F. *Choosing Appropriate Information Systems Methodologies*. Communication of the ACM. Volume 30, Number 11. November 1987.
- [63] Garrido, M.S. Mendes, R.V. (1992) *Complexity in Physics and Technology*. World Scientific. Singapore. New Jersey. London Hong Kong.
- [64] Gharajedaghi, J. (1985) *Towards a Systems Theory of Organization*. The Systems Inquiry Series. Published by Intersystems Publications, Seaside, California 93955, U.S.A.
- [65] Goodman, M. Karash, R. Lannon, C. O'Reilly, K.W. Seville, D. (1997) *Designing a Systems Thinking Intervention*. Innovation in Management Series. Pegasus Communications, Inc. One Moody Street, Waltham, MA 02453-5339.

- [66] Goodman, M. (1994) *Systems Thinking as a Language*. Contained in: *A Beginner's Guide to Systems Thinking*. (1994) Edited by Lannon-Kim, C. Pegasus Communications, Inc. PO Box 120 Kendall Square Cambridge, MA 02142-0001.
- [67] Gray, C.M. *Systems Thinking in Information Service Delivery*. *Journal of Library Administration*. (The Haworth Press, Inc.) Vol. 20, Nos. 3/4, 1995.
- [68] Haines, S.G. (1998) *Systems Thinking & Learning*. HRD Press, 22 Amherst Road Amherst, MA 01002.
- [69] Halal, W.E. Geranmayeh, A. Pourdehnad, J. (1993) *Internal Markets: Bringing the Power Of Free Enterprise Inside Your Organization*. John Wiley & Sons, Inc. Chichester. New York. Brisbane. Toronto. Singapore.
- [70] Hall, R.I. *A System Pathology of an Organization: The Rise and Fall of the Old Saturday Evening Post*. *Administrative Science Quarterly*. Vol. 21, June 1976.
- [71] Handy, C. (1995) *Beyond Certainty: The Changing Worlds of Organisations*. Hutchinson. Random House, 20 Vauxhall Bridge Road, London SW1V 2SA.
- [72] Handy, C. (1992) *The Age Of Unreason*. Arrow Books Limited, Random House, 20 Vauxhall Bridge Road, London SW1V 2SA.
- [73] Hesselbein, F. *The Circular Organization*. Essay contained in: *The Organization of the Future*. Editors: Hesselbein, F. Goldsmith, M. Beckhard, R. The Drucker Foundation. (1997) Jossey-Bass Publishers. San Francisco.
- [74] Hirschman, A.O. Lindblom, C.E. (1962) *Economic Development, Research and Development, Policy Making: Some Converging Views*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [75] Hoebeke, L. (1993) *Making Work Systems better*. John Wiley & Sons. Chichester. New York. Brisbane. Toronto. Singapore.
- [76] Homer, J.B. *Worker Burnout: A Dynamic Model with Implications for Prevention and Control*. *System Dynamics Review*. Vol. 1, No. 1, Summer 1985.

- [77] Homer, J.B. *A System Dynamics Model of National Cocaine Prevalence*. System Dynamics Review. Vol. 9, No. 1, Winter 1993.
- [78] Homer, J.B. *A Diffusion Model with Application to Evolving Medical Technologies*. Technological Forecasting and Social Change. Vol. 31, 1987.
- [79] Hoos, I.R. (1974) *Systems Analysis in Public Policy: A Critique*. University of California Press. Berkely. Los Angeles. London.
- [80] Jackson, M.C. (1991) *Systems Methodology for the Management Sciences*. Plenum Press. New York. London.
- [81] Johnson, L. (1997) *From Mechanistic to Social Systemic Thinking. A Digest of a Talk by Russell L. Ackoff*. Pegasus Communications, Inc. PO Box 120 Kendall Square Cambridge, MA 02142-0001.
- [82] Kast, F.E. Rosenzweig, J.E. (1974) *Organization and Management. A Systems Approach*. McGraw-Hill Book Company. New York. St. Louis. San Francisco. Düsseldorf. Johannesburg. Kuala Lumpur. London. Mexico. Montreal. New Delhi. Panama. Rio de Janeiro. Singapore. Sydney. Toronto.
- [83] Katz, D. Kahn, R.L. (1966) *Common Characteristics of Open Systems*. Contained in: *Systems Thinking. Selected Readings (1969)* Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [84] Kauffmann Jr, D.L. (1980) *Systems One: An Introduction to Systems Thinking*. Future Systems, Inc. Minneapolis.
- [85] Kennedy, I.G. (1994) *How to do Research*. Published privately by the author. Glenstantia 0010. South Africa.
- [86] Kerzner, H. (1992) *Project Management. A Systems Approach to Planning and Scheduling and Controlling*. Forth Edition. Van Nostrand Reinhold. 115 Fifth Avenue, New York, NY 10003.
- [87] Kim, D.H. (1999) *Introduction to Systems Thinking*. Innovation in Management Series. Pegasus Communications, Inc. One Moody Street, Waltham, MA 02453-5339.
- [88] Kim, D.H. (1994) *A Palette of Systems Thinking Tools*. Contained in: *A Beginner's Guide to Systems Thinking. (1994)* Edited by Lannon-Kim, C. Pegasus Communications, Inc. PO Box 120 Kendall Square Cambridge, MA 02142-0001.

- [89] Kim, D.H. (1992) *Systems Archetypes: Diagnosing Systemic Issues and Designing High-Leverage Interventions*. Toolbox Reprint Series: *Systems Archetypes*. Cambridge: Pegasus Communications.
- [90] Kim, D.H. Senge, P.M. *Putting Systems Thinking into Practice*. System Dynamics Review. Vol 10, Nos. 2-3, Summer-Fall 1994.
- [91] Kircher, P. Mason, R.O. (1975) *Introduction to Enterprise: A Systems Approach*. Melville Publishing Company. Los Angeles, California.
- [92] Koehler, W. (1938) *Closed and Open Systems*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [93] Kramer, N.J.T.A. de Smit, J. (1977) *Systems Thinking: Concepts and Notions*. Martinus Nijhoff Social Sciences Division. Leiden.
- [94] Kremyanskiy, V.I. (1960) *Certain Peculiarities of Organisms as a "System" from the Point of View of Physics, Cybernetics, and Biology*. [This paper first appeared in Russian in *Voprosy Filosofii*, August 1959] Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [95] Lannon-Kim, C. (1994) *The Vocabulary of Systems Thinking: A Pocket Guide*. (1994) Contained in: *A Beginner's Guide to Systems Thinking*. (1994) Edited by Lannon-Kim, C. Pegasus Communications, Inc. PO Box 120 Kendall Square Cambridge, MA 02142-0001
- [96] Lerner, A. Ya. (1975) *Fundamentals of Cybernetics*. Plenum Publishing Corporation. 227 West 17th Street, New York, N.Y. 10011.
- [97] Mashayekhi, A.N. *Rangelands Destruction Under Population Growth: The Case of Iran*. System Dynamics Review. Vol. 6, No. 2. Summer 1990.
- [98] Mashayekhi, A.N. *Transition in the New York State Solid Waste System: A Dynamic Analysis*. System Dynamics Review. Vol. 9, No. 2. Winter 1993.
- [99] Maso, I. (1996) *The excellent researcher*. In W. Harmann & J. Clark (Eds), *Metaphysical foundations of modern science*. New York: Institute of Noetic Sciences.

- [100] Mass, N.J. *Diagnosing Surprise Model Behavior: A Tool for Evolving Behavioral and Policy Insights*. System Dynamics Review. Vol. 7, No. 1, Winter 1991.
- [101] Mattessich, R. (1978) *Instrumental Reasoning and Systems Methodology: An Epistemology of the Applied and Social Sciences*. D. Reidel Publishing Company. Dordrecht : Holland. Boston : U.S.A. London : England.
- [102] Matthies, L.H. *The System Is a Social, Not a Technical Device*. Journal of Systems Management. December 1993.
- [103] McLeod, Jr. R. (1983) *Management Information Systems*. Science Research Associates. Inc. Chicago. Palo Alto. Henley-on-Thames. Sydney.
- [104] Meadows, D.H. *Whole Earth Models and Systems*. Coevolution Quarterly, Summer 1982.
- [105] Meadows, D.H. *System Dynamics Meets the Press*. System Dynamics Review. Vol. 5, No. 1, Winter 1989.
- [106] Merten, P.P. Löffler, R. Wiedmann, K. *Portfolio Simulation: A Tool to Support Strategic Management*. System Dynamics Review. Vol. 3, No. 2, Summer 1987.
- [107] Meulenber-Buskens, I. *Turtles all the way down? – On a quest for quality in qualitative research*. South African Journal of Psychology. Vol. 27, No. 2, June 1997.
- [108] Mitroff, I.I. and Mason, R.O. (1981) *Challenging Strategic Planning Assumptions: Theory, Cases, and Techniques*. John Wiley & Sons. New York. Chichester. Brisbane. Toronto.
- [108a] Mitroff, I.I. Linstone, H.A. (1993) *The Unbounded Mind: Breaking the Chains of Traditional Business Thinking*. Oxford University Press. New York. Oxford.
- [109] Morecroft, J.D.W. Lane, D.C. Viita, P.S. *Modeling Growth Strategy in a Biotechnology Startup Firm*. System Dynamics Review. Vol. 7, No. 2, Summer 1991.
- [110] Morecroft, J.D.W. *Concepts, Theory, and Techniques: A Systems Perspective on Material Requirements Planning*. Decision Sciences. Vol. 14, 1983.

- [111] Morecroft, J.D.W. *Rationality in the Analysis of the Behavioral Simulation Models*. Management Science. Vol. 31, No. 7, July 1985.
- [112] Morecroft, J.D.W. *Strategy Support Models*. Strategic Management Journal. Vol. 5, 1984.
- [113] Morecroft, J.D.W. *System Dynamics and Microworlds for Policymakers*. European Journal of Operational Research. Vol.35, 1988. North-Holland.
- [114] Morgan, G. (1986) *Images of Organization*. Sage Publications. Newbury Park. London. New Delhi.
- [115] Motil, J.M. (1972) *Digital Systems Fundamentals*. McGraw-Hill Book Company. New York. St Louis. San Francisco. Düsseldorf. Johannesburg. Kuala Lumpur. London. Mexico. Montreal. New Delhi. Panama. Rio de Janeiro. Singapore. Sydney. Toronto.
- [116] Naill, R.F. *A Systems Dynamics Model for National Energy Policy Planning*. System Dynamics Review. Vol. 8, No. 1, Winter 1992.
- [117] Nagel, E. (1956) *A Formalization of Functionalism*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [118] Odum, H.T. (1994) *Ecological and General Systems*. University Press of Colorado.
- [119] Oppenheim, A.N. (1966) *Questionnaire Design and Attitude Measurement*. Heinemann.
- [120] Oskowitz, B. Meulenberg-Buskens, I. *Preparing researchers for qualitative investigation of a particularly sensitive nature: Reflections from the field*. South African Journal of Psychology. Vol. 27, No. 2, June 1997.
- [121] Paich, M. Sterman, J.D. *Boom, Bust, and Failures to Learn in Experimental Markets*. Management Science. Vol. 39, No. 12, December 1993.
- [122] Palazzoli, M.S. Anolli, L. Di Blasio, P. Giossi, L. Pisano, I. Ricci, C. Sacchi, M. Ugazio, V. (1986) *The Hidden Games of Organizations*. Pantheon Books. New York.
- [123] Pascale, R.T. (1991) *Managing on the Edge*. Penguin Books Ltd, 27 Wrights lane, London W8 5TZ, England.

- [124] Piquito, N.P. *Financial Product Development: A Strategically Competitive System Engineering Approach to Innovative Risk Based Financial Engineering*. A thesis submitted in partial fulfilment of the requirements for the degree of *Doctor Ingenieriae* in Engineering Management in the Faculty of Engineering at the Rand Afrikaans University. October 1999.
- [125] Pryor, A.N. McGuire, E.G. *Organizational tailoring of the CMM Questionnaire for Internal Process Improvement*. Paper presented at PICMET 1997, and published in: *Innovation in Technology Management: Proceedings of the Portland International Conference on Management of Engineering and Technology*. Portland, Oregon, USA. July 27 – 31, 1997.
- [126] Randers, J. (1980) *Guidelines for Model Conceptualization* in Jørgen Randers (ed.), *Elements of the System Dynamics Method*. Cambridge, MA: Productivity Press.
- [127] Reagan-Cirincione, P. Schuman, S. Richardson, G.P. Dorf, S.A. *Decision Modeling: Tools for Strategic Thinking*. *Interfaces*. Vol. 21, No. 6, November-December 1991.
- [128] Reaves, C.C. (1992) *Quantitative Research for the Behavioural Sciences*. John Wiley & Sons. Chichester. New York. Brisbane. Toronto. Singapore.
- [129] Reilly, F.E. (1970) *Charles Peirce's Theory of Scientific Method*. Fordham University Press. New York.
- [130] Remenyi, D. Money, A. Twite, A. (1995) *Effective Measurement & Management of IT Costs & Benefits*. Butterworth-Heinemann Ltd. Linacre House, Jordan Hill, Oxford. OX2 8DP.
- [131] Richardson, G.P. (Ed.) (1996) *Modelling for Management Volume I: Simulation in Support of Systems Thinking*. The International Library of Management. Dartmouth Publishing Company Limited. Aldershot. Brookfield USA. Singapore. Sydney.
- [132] Richardson, G.P. (Ed.) (1996) *Modelling for Management Volume II: Simulation in Support of Systems Thinking*. The International Library of Management. Dartmouth Publishing Company Limited. Aldershot. Brookfield USA. Singapore. Sydney.

- [133] Richardson, G.P. (1991) *System Dynamics: Simulation for Policy Analysis from a Feedback Perspective* in P.A. Fishwick and P.A. Luker (eds), *Qualitative Simulation Modeling and Analysis*, New York: Springer-Verlag.
- [134] Richardson, G.P. Andersen, D.F. Lurie, I. Ratanawijitrasin, S. (1990) *Simulating the Dynamics of Social Program Mngement: The Case of JOBS Implementation*. Albany, NY: Rockefeller College, University of Albany.
- [135] Richardson, G.P. Lamitie, R.E. *Improving Connecticut School Aid: A Case Study with Model-Based Policy Analysis*. Journal of Education Finance. Vol. 15, Fall 1989.
- [136] Richardson, G.P. Andersen, D.F. *Teamwork in Group Model Building*. System Dynamics Review. Vol 11, No. 2, Summer 1995.
- [137] Richmond, B. *Systems thinking: critical thinking skills for the 1990s and beyond*. System Dynamics Review. Vol. 9, No. 2, Summer 1993.
- [138] Roethlisberger, F.J. Dickson, W.J. (1941) *Management and the Worker*. Harvard University Press.
- [139] Roman, D.D. (1980) *Science, Technology and Innovation. A Systems Approach*. Grid Publishing, Inc. 4666 Indianola Avenue, Columbus, Ohio 43214.
- [140] Rosen, R. (1985) *Anticipatory Systems. A Philosophical, Mathematical & Methodological Foundations*. Pergamon Press. Oxford. New York. Toronto. Sydney. Paris. Frankfurt.
- [141] Rosenblatt, S.B. Bonnington, R.L. Needles, Jr. B.E. (1977) *Modern Business a Systems Approach*. Houghton Mifflin Company. Boston. Atlanta. Dallas. Geneva, Illinois. Hopewell, New Jersey. Palo Alto. London.
- [142] Saeed, K. *A Re-Evaluation of the Efford to Alleviate Poverty and Hunger*. Socio-Economic Planning Science. Vol. 21, No. 5, 1987.
- [143] Saeed, K. *Slicing a Complex Problem for System Dynamics Modeling*. System Dynamics Review. Vol 8, No. 3, Fall 1992.
- [143a] Sahin, K.E. *System Dynamics Modeling*. Omega. The International Journal of Management Science. Vol. 8 No. 2. September 1979.

- [144] Sanderson, M. (1979) *Successful Problem Management*. A Wiley-Interscience Publication. John Wiley & Sons. New York. Chichester. Brisbane. Toronto.
- [145] Schilpp, P.A. (Ed.) (1949) *Albert Einstein: Philosopher-Scientist*. La Salle, III: Open Court.
- [146] Schultheis, R. Sumner, M. (1989) *Management Information Systems. The Manager's View*. IRWIN. Homewood, IL 60430/Boston, Ma 02116.
- [147] Schützenberger, M.P. (1954) *A Tentative Classification of Goal-seeking Behaviours*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [148] Schwartz, P. (1996) *The Art of the Long View*. Doubleday. 1540 Broadway, New York, NY 10036.
- [149] Scott, W.E. Cummings, L.L. (1973) *Readings in Organizational Behavior and Human Performance*. Richard D. Irwin, Inc, Homewood, Illinois 60430. Irwin-Dorsey International, London England WC2H 9NJ. Irwin-Dorsey Limited, Georgetown, Ontario LTG 4B3.
- [150] Selznick, P. (1948) *Foundations of the Theory of Organizations*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [151] Senge, P.M. Kleiner, A. Roberts, C. Ross, R.B. Smith, B.J. (1996) *The Fifth Discipline Fieldbook: Strategies and Tools for Building a Learning Organization*. Nicholas Brealey Publishing. London.
- [152] Senge, P. (1990) *The Fifth Discipline: The Art and Practice of the Learning Organization*. Doubleday Currency. New York. London. Toronto. Sydney. Auckland.
- [153] Senge, P. *The Leader's New Work: Building Learning Organizations*. Sloan Management Review No 7. Fall 1990.
- [154] Silvern, L.C. (1973) "Systems Approach" – *What is it?* Contained in: *The Educational Technology Review Series. Number three. Introduction to the Systems Approach.*(1973) Educational Technology Publications, Inc. 140 Sylvan Avenue, Englewood Cliffs, New Jersey 07632.

- [155] Simon, H.A. (1956) *Rational Choice and the Structure of the Environment*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [156] Sisk, H.L. (1969) *Principles of Management. A Systems Approach to the Management Process*. G40 South-Western Publishing Company. Cincinnati. Chicago. Dallas. Burlingame, Calif. New Rochelle, N.Y. Brighton, England.
- [157] Skyrme, D.J. Book Review: *Modelling for Management: Simulation in support of Systems Thinking*. Long Range Planning. Vol. 31, February 1998.
- [158] Slife, B.D. Williams, R.N. *What's Behind The Research?* Sage Publications. 1995.
- [159] Sommerhoff, G. (1969) *The Abstract Characteristics of Living Systems*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [160] Stata, R. *Organizational Learning- The Key to Management Innovation*. Sloan Management Review. Spring 1989.
- [161] Sterman, J.D. (1988) *A Sceptic's Guide to Computer Models*, in Gerald O. Barney, W. Brian Kreutzer and Martha J. Garrett (eds), *Managing a Nation: The Microcomputer Software Catalog*. Boulder: Westview Press.
- [162] Sterman, J.D. *Learning in and about Complex Systems*. System Dynamics Review. Vol. 10, Nos. 2-3. Summer – Fall 1994.
- [163] Sterman, J.D. *Modeling Managerial Behaviour: Misconceptions of Feedback in a Dynamic Decision Making Experiment*. Management Science. Vol. 35, No. 3, March 1989.
- [164] Sterman, J.D. Richardson, G.P. *An Experiment to Evaluate Methods for Estimating Fossil Fuel Resources*. Journal of Forecasting. Vol. 4, 1985.
- [165] Strümpfer, J.P. (1992) *Modes of Inquiry: Acquiring Knowledge about Complex Phenomena*. Unpublished research material quoted in terms of the kind approval of Dr. Strümpfer (1999). Institute for Futures Research, University of Stellenbosch, South Africa.
- [166] Sztompka, P. (1974) *System and Function: Toward a Theory of Society*. Academic Press. New York. San Francisco. London.

- [167] Takahashi, S. Takahara, Y. (1995) *Logical approach to Systems Theory*. Springer-Verlag London Limited. London. Berlin. Heidelberg. New York. Paris. Tokyo. Hong kong. Barcelona. Budapest.
- [168] The Oxford English Dictionary. (1989) Second Edition. Prepared by J.A. Simpson and E.S.C. Weiner. *Volume: I*. Clarendon Press. Oxford.
- [169] The Oxford English Dictionary. (1989) Second Edition. Prepared by J.A. Simpson and E.S.C. Weiner. *Volume: XVII*. Clarendon Press. Oxford.
- [170] Thierauf, R.J. (1975) *Systems Analysis and Design of Real-Time Management Information Systems*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.
- [171] Unbehauen, R. (1971) *Systemtheorie. Eine Einführung für Ingenieure*. R. Oldenbourg Verlag. München – Wien.
- [172] Urban, G.L. Hauser, J.R. Roberts, J.H. *Prelaunch Forecasting of New Automobiles*. Management Science. Vol. 36, No.4, April 1990.
- [173] Vennix, J.A.M. Gubbels, J.W. Post, D. Poppen, H.J. *A Structured Approach to Knowledge Elicitation in Conceptual Model Building*. System Dynamics Review. Vol 6, No. 2, Summer 1990.
- [174] Vickers, Sir G. (1968) *The Art of Judgment*. Chapman & Hall. 11 New Fetter Lane, London EC4.
- [175] von Bertalanffy, L. (1950) *The Theory of Open Systems in Physics and Biology*. Contained in: *Systems Thinking. Selected Readings* (1969) Edited by Emery, F.E. Penguin Books Ltd, Harmondsworth, Middlesex, England.
- [176] Walizer, M.H. Wiener, P.L. (1978) *Research Methods and Analysis: Searching for Relationships*. Harper & Row.
- [177] Watkins, J.A. *An Alternative Approach to the Attainment of Sustained Process Improvement in Information Technology Driven Infrastructures Subjected to Forced Interventions*. A thesis submitted in partial fulfilment of the requirements for the degree of *Doctor Philosophiae* in Engineering Management in the Faculty of Engineering at the Rand Afrikaans University. May 1999.

'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 destiny¹.*

¹ From Patience Strong's book: 'By Quiet Waters'.